Mankiw N G

Macroeconomics

(5th)

Introduction

CHAPTER ONE

The Science of Macroeconomics

> *The whole of science is nothing more than the refinement of everyday thinking.*
>
> — Albert Einstein

1-1 What Macroeconomists Study

Why have some countries experienced rapid growth in incomes over the past century while others stay mired in poverty? Why do some countries have high rates of inflation while others maintain stable prices? Why do all countries experience recessions and depressions—recurrent periods of falling incomes and rising unemployment—and how can government policy reduce the frequency and severity of these episodes? Macroeconomics, the study of the economy as a whole, attempts to answer these and many related questions.

To appreciate the importance of macroeconomics, you need only read the newspaper or listen to the news. Every day you can see headlines such as INCOME GROWTH SLOWS, FED MOVES TO COMBAT INFLATION, or STOCKS FALL AMID RECESSION FEARS. Although these macroeconomic events may seem abstract, they touch all of our lives. Business executives forecasting the demand for their products must guess how fast consumers' incomes will grow. Senior citizens living on fixed incomes wonder how fast prices will rise. Recent college graduates looking for jobs hope that the economy will boom and that firms will be hiring.

Because the state of the economy affects everyone, macroeconomic issues play a central role in political debate. Voters are aware of how the economy is doing, and they know that government policy can affect the economy in powerful ways. As a result, the popularity of the incumbent president rises when the economy is doing well and falls when it is doing poorly.

Macroeconomic issues are also at the center of world politics. In recent years, Europe has moved toward a common currency, many Asian countries have experienced financial turmoil and capital flight, and the United States has financed large trade deficits by borrowing from abroad. When world leaders meet, these topics are often high on their agendas.

Although the job of making economic policy falls to world leaders, the job of explaining how the economy as a whole works falls to macroeconomists. Toward this end, macroeconomists collect data on incomes, prices, unemployment, and many other variables from different time periods and different countries. They then attempt to formulate general theories that help to explain these data. Like astronomers studying the evolution of stars or biologists studying the evolution of species, macroeconomists cannot conduct controlled experiments. Instead, they must make use of the data that history gives them. Macroeconomists observe that economies differ from one another and that they change over time. These observations provide both the motivation for developing macroeconomic theories and the data for testing them.

To be sure, macroeconomics is a young and imperfect science. The macroeconomist's ability to predict the future course of economic events is no better than the meteorologist's ability to predict next month's weather. But, as you will see, macroeconomists do know quite a lot about how the economy works. This knowledge is useful both for explaining economic events and for formulating economic policy.

Every era has its own economic problems. In the 1970s, Presidents Richard Nixon, Gerald Ford, and Jimmy Carter all wrestled in vain with a rising rate of inflation. In the 1980s, inflation subsided, but Presidents Ronald Reagan and George Bush presided over large federal budget deficits. In the 1990s, with President Bill Clinton in the Oval Office, the budget deficit shrank and even turned into a budget surplus, but federal taxes as a share of national income reached a historic high. So it was no surprise that when President George W. Bush moved into the White House in 2001, he put a tax cut high on his agenda. The basic principles of macroeconomics do not change from decade to decade, but the macroeconomist must apply these principles with flexibility and creativity to meet changing circumstances.

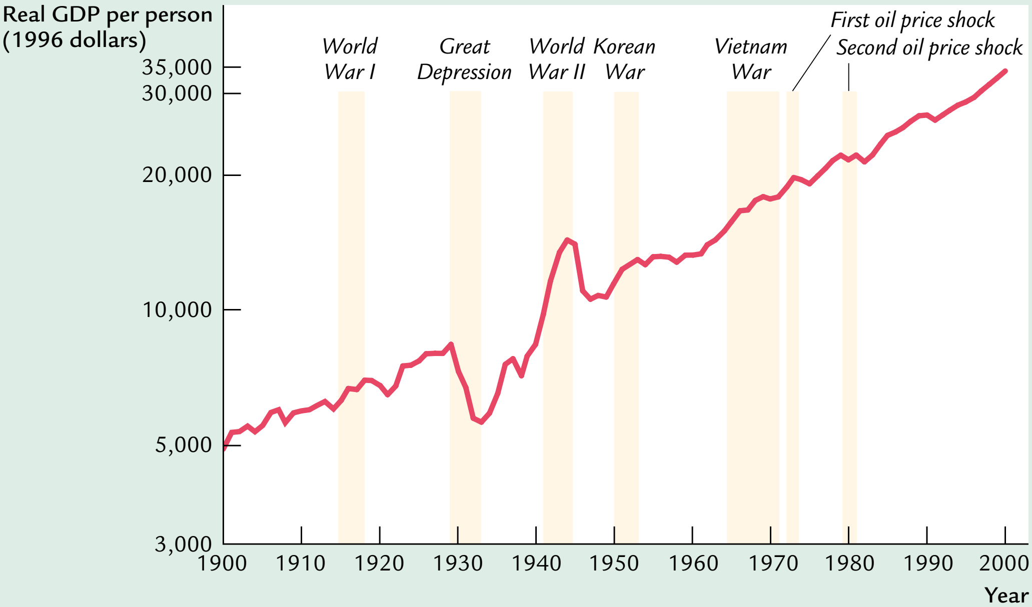
CASE STUDY

The Historical Performance of the U.S. Economy

Economists use many types of data to measure the performance of an economy. Three macroeconomic variables are especially important: real gross domestic product (GDP), the inflation rate, and the unemployment rate. **Real GDP** measures the total income of everyone in the economy (adjusted for the level of prices). The **inflation rate** measures how fast prices are rising. The **unemployment rate** measures the fraction of the labor force that is out of work. Macroeconomists study how these variables are determined, why they change over time, and how they interact with one another.

Figure 1-1 shows real GDP per person in the United States. Two aspects of this figure are noteworthy. First, real GDP grows over time. Real GDP per person is today about five times its level in 1900. This growth in average

figure 1-1



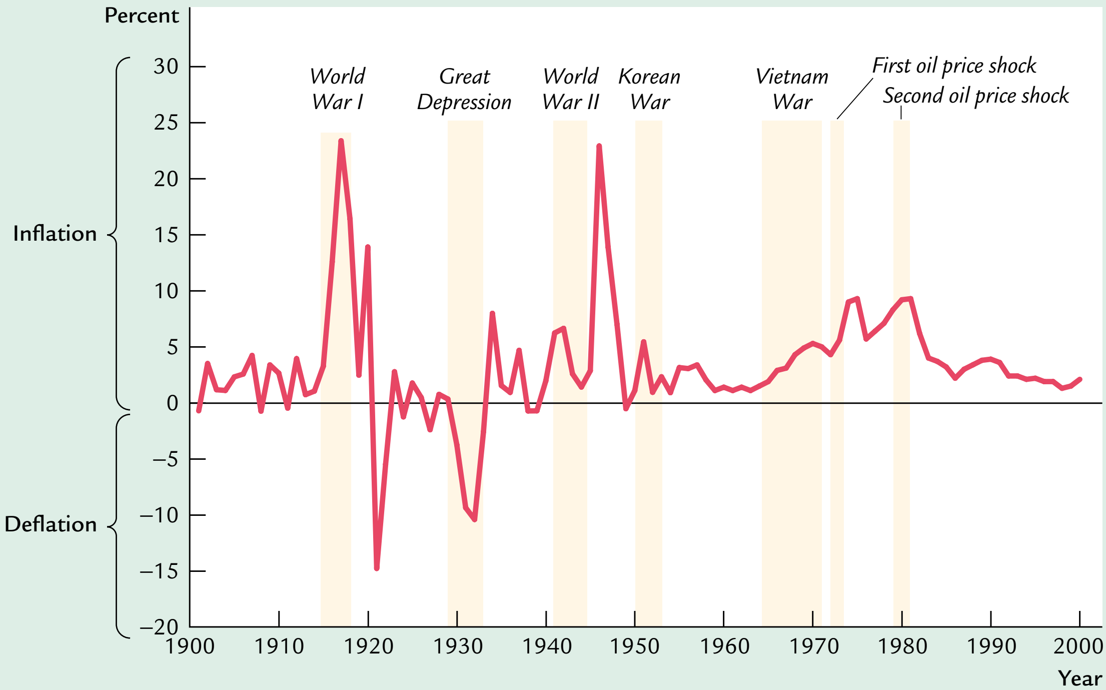
Real GDP per Person in the U.S. Economy
Real GDP measures the total income of everyone in the economy, and real GDP per person measures the income of the average person in the economy. This figure shows that real GDP per person tends to grow over time and that this normal growth is sometimes interrupted by periods of declining income, called recessions or depressions.

Note: Real GDP is plotted here on a logarithmic scale. On such a scale, equal distances on the vertical axis represent equal *percentage* changes. Thus, the distance between $5,000 and $10,000 (a 100 percent change) is the same as the distance between $10,000 and $20,000 (a 100 percent change).
Source: U.S. Bureau of the Census (*Historical Statistics of the United States: Colonial Times to 1970*) and U.S. Department of Commerce.

income allows us to enjoy a higher standard of living than our great-grandparents did. Second, although real GDP rises in most years, this growth is not steady. There are repeated periods during which real GDP falls, the most dramatic instance being the early 1930s. Such periods are called **recessions** if they are mild and **depressions** if they are more severe. Not surprisingly, periods of declining income are associated with substantial economic hardship.

Figure 1-2 shows the U.S. inflation rate. You can see that inflation varies substantially. In the first half of the twentieth century, the inflation rate averaged only slightly above zero. Periods of falling prices, called **deflation**, were almost as common as periods of rising prices. In the past half century, inflation has been the norm. The inflation problem became most severe during the late 1970s, when prices rose at a rate of almost 10 percent per year. In recent years,

figure 1-2



The Inflation Rate in the U.S. Economy
The inflation rate measures the percentage change in the average level of prices from the year before. When the inflation rate is above zero, prices are rising. When it is below zero, prices are falling. If the inflation rate declines but remains positive, prices are rising but at a slower rate.

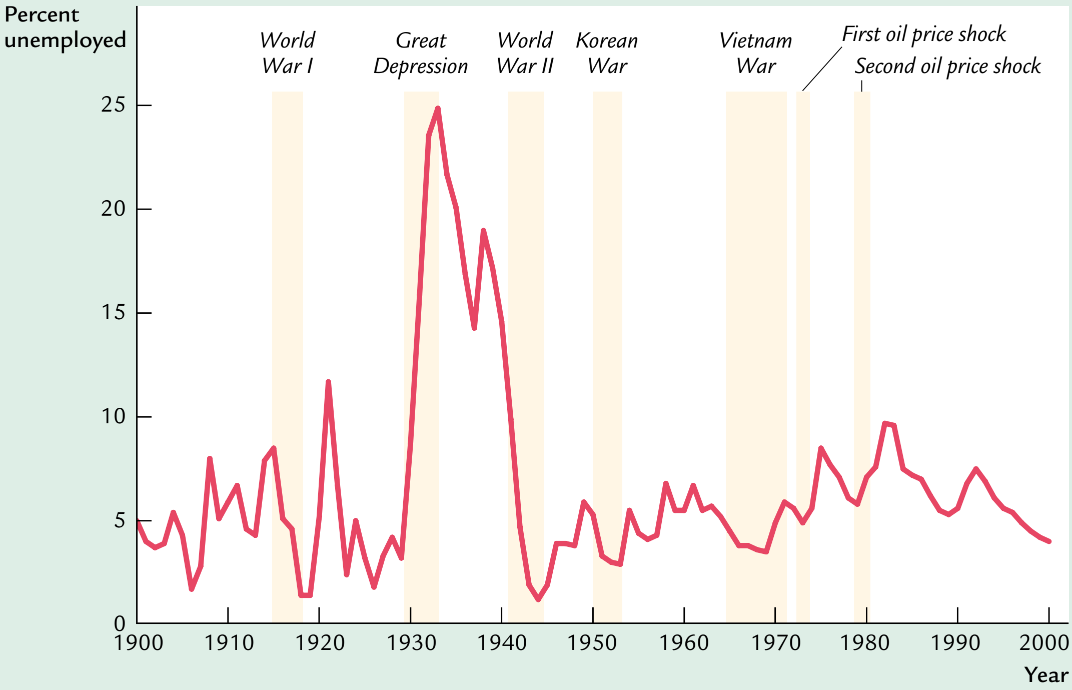
Note: The inflation rate is measured here using the GDP deflator.
Source: U.S. Bureau of the Census (*Historical Statistics of the United States: Colonial Times to 1970*) and U.S. Department of Commerce.

the inflation rate has been about 2 or 3 percent per year, indicating that prices have been fairly stable.

Figure 1-3 shows the U.S. unemployment rate. Notice that there is always some unemployment in our economy. In addition, although there is no long-term trend, the amount of unemployment varies from year to year. Recessions and depressions are associated with unusually high unemployment. The highest rates of unemployment were reached during the Great Depression of the 1930s.

These three figures offer a glimpse at the history of the U.S. economy. In the chapters that follow, we first discuss how these variables are measured and then develop theories to explain how they behave.

figure 1-3



The Unemployment Rate in the U.S. Economy
The unemployment rate measures the percentage of people in the labor force who do not have jobs. This figure shows that the economy always has some unemployment and that the amount fluctuates from year to year.

Source: U.S. Bureau of the Census (*Historical Statistics of the United States: Colonial Times to 1970*) and U.S. Department of Commerce.

1-2 How Economists Think

Although economists often study politically charged issues, they try to address these issues with a scientist's objectivity. Like any science, economics has its own set of tools—terminology, data, and a way of thinking—that can seem foreign and arcane to the layman. The best way to become familiar with these tools is to practice using them, and this book will afford you ample opportunity to do so. To make these tools less forbidding, however, let's discuss a few of them here.

Theory as Model Building

Young children learn much about the world around them by playing with toy versions of real objects. For instance, they often put together models of cars, trains, or planes. These models are far from realistic, but the model-builder learns a lot from them nonetheless. The model illustrates the essence of the real object it is designed to resemble.

Economists also use **models** to understand the world, but an economist's model is more likely to be made of symbols and equations than plastic and glue. Economists build their "toy economies" to help explain economic variables, such as GDP, inflation, and unemployment. Economic models illustrate, often in mathematical terms, the relationships among the variables. They are useful because they help us to dispense with irrelevant details and to focus on important connections.

Models have two kinds of variables: endogenous variables and exogenous variables. **Endogenous variables** are those variables that a model tries to explain. **Exogenous variables** are those variables that a model takes as given. The purpose of a model is to show how the exogenous variables affect the endogenous variables. In other words, as Figure 1-4 illustrates, exogenous variables come from outside the model and serve as the model's input, whereas endogenous variables are determined inside the model and are the model's output.

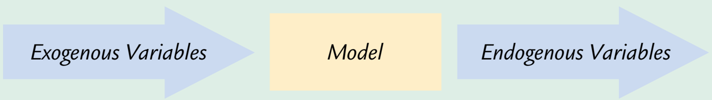
To make these ideas more concrete, let's review the most celebrated of all economic models—the model of supply and demand. Imagine that an economist were interested in figuring out what factors influence the price of pizza and the quantity of pizza sold. He or she would develop a model that described the behavior of pizza buyers, the behavior of pizza sellers, and their interaction in the market for pizza. For example, the economist supposes that the quantity of pizza demanded by consumers Q^d depends on the price of pizza P and on aggregate income Y. This relationship is expressed in the equation

$$Q^d = D(P, Y),$$

where $D(\ )$ represents the demand function. Similarly, the economist supposes that the quantity of pizza supplied by pizzerias Q^s depends on the price of pizza P and on the price of materials P_m, such as cheese, tomatoes, flour, and anchovies. This relationship is expressed as

$$Q^s = S(P, P_m),$$

figure 1-4



How Models Work
Models are simplified theories that show the key relationships among economic variables. The exogenous variables are those that come from outside the model. The endogenous variables are those that the model explains. The model shows how changes in the exogenous variables affect the endogenous variables.

where $S(\,)$ represents the supply function. Finally, the economist assumes that the price of pizza adjusts to bring the quantity supplied and quantity demanded into balance:

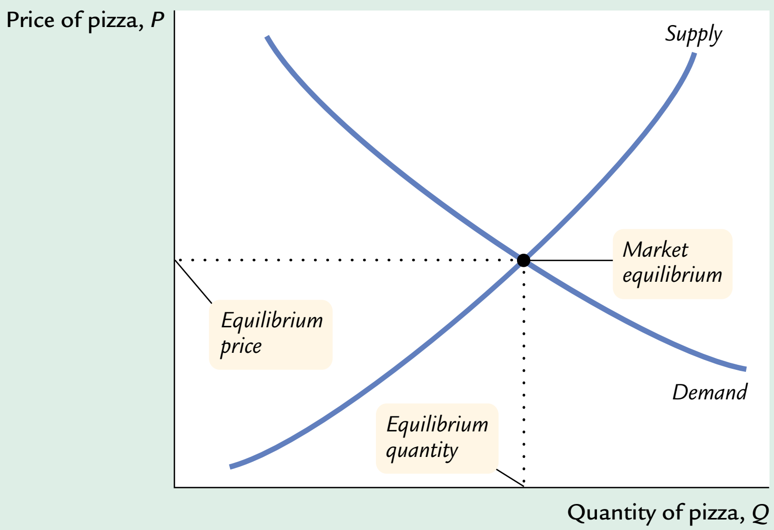
$$Q^s = Q^d.$$

These three equations compose a model of the market for pizza.

The economist illustrates the model with a supply-and-demand diagram, as in Figure 1-5. The demand curve shows the relationship between the quantity of pizza demanded and the price of pizza, while holding aggregate income constant. The demand curve slopes downward because a higher price of pizza encourages consumers to switch to other foods and buy less pizza. The supply curve shows the relationship between the quantity of pizza supplied and the price of pizza, while holding the price of materials constant. The supply curve slopes upward because a higher price of pizza makes selling pizza more profitable, which encourages pizzerias to produce more of it. The equilibrium for the market is the price and quantity at which the supply and demand curves intersect. At the equilibrium price, consumers choose to buy the amount of pizza that pizzerias choose to produce.

This model of the pizza market has two exogenous variables and two endogenous variables. The exogenous variables are aggregate income and the price of materials. The model does not attempt to explain them but takes them as given (perhaps to be explained by another model). The endogenous variables are the

figure 1-5

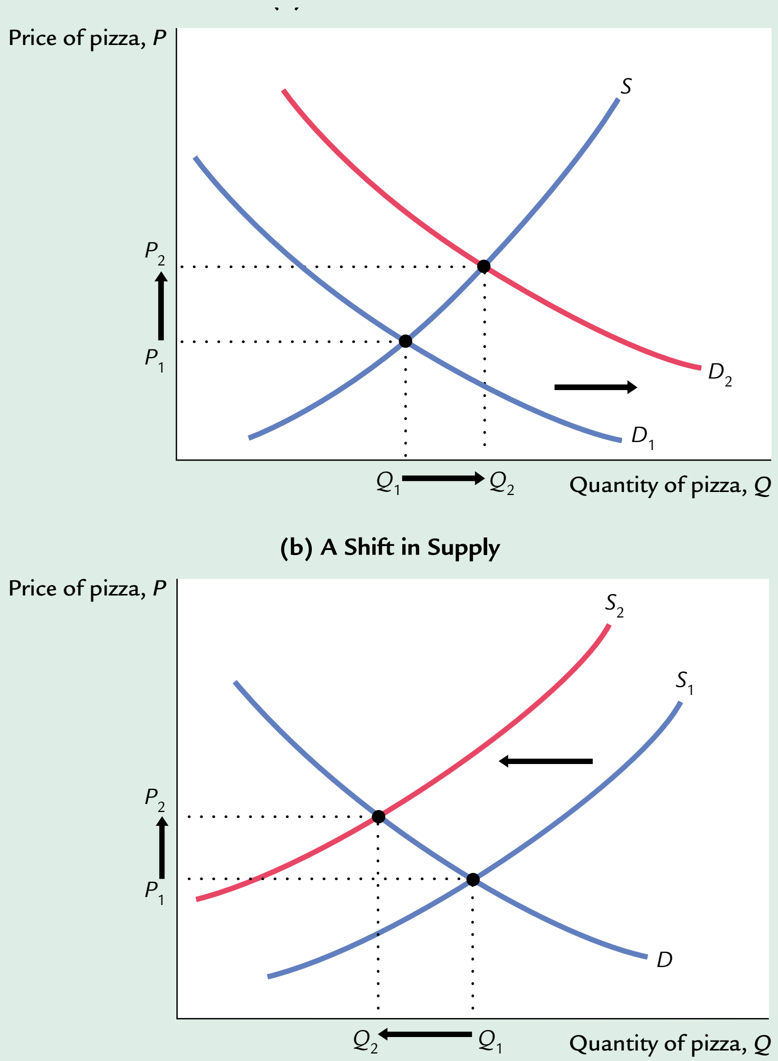


The Model of Supply and Demand
The most famous economic model is that of supply and demand for a good or service—in this case, pizza. The demand curve is a downward-sloping curve relating the price of pizza to the quantity of pizza that consumers demand. The supply curve is an upward-sloping curve relating the price of pizza to the quantity of pizza that pizzerias supply. The price of pizza adjusts until the quantity supplied equals the quantity demanded. The point where the two curves cross is the market equilibrium, which shows the equilibrium price of pizza and the equilibrium quantity of pizza.

price of pizza and the quantity of pizza exchanged. These are the variables that the model attempts to explain.

The model can be used to show how a change in one of the exogenous variables affects both endogenous variables. For example, if aggregate income increases, then the demand for pizza increases, as in panel (a) of Figure 1-6. The model shows that both the equilibrium price and the equilibrium quantity of pizza rise. Similarly, if the price of materials increases, then the supply of pizza decreases, as in panel (b) of Figure 1-6. The model shows that in this case the equilibrium price of pizza rises and the equilibrium quantity of pizza falls. Thus, the model shows how changes in aggregate income or in the price of materials affect price and quantity in the market for pizza.

figure 1-6



Changes in Equilibrium In panel (a), a rise in aggregate income causes the demand for pizza to increase: at any given price, consumers now want to buy more pizza. This is represented by a rightward shift in the demand curve from D_1 to D_2. The market moves to the new intersection of supply and demand. The equilibrium price rises from P_1 to P_2, and the equilibrium quantity of pizza rises from Q_1 to Q_2. In panel (b), a rise in the price of materials decreases the supply of pizza: at any given price, pizzerias find that the sale of pizza is less profitable and therefore choose to produce less pizza. This is represented by a leftward shift in the supply curve from S_1 to S_2. The market moves to the new intersection of supply and demand. The equilibrium price rises from P_1 to P_2, and the equilibrium quantity falls from Q_1 to Q_2.

Like all models, this model of the pizza market makes simplifying assumptions. The model does not take into account, for example, that every pizzeria is in a different location. For each customer, one pizzeria is more convenient than the others, and thus pizzerias have some ability to set their own prices. Although the model assumes that there is a single price for pizza, in fact there could be a different price at every pizzeria.

How should we react to the model's lack of realism? Should we discard the simple model of pizza supply and pizza demand? Should we attempt to build a more complex model that allows for diverse pizza prices? The answers to these questions depend on our purpose. If our goal is to explain how the price of cheese affects the average price of pizza and the amount of pizza sold, then the diversity of pizza prices is probably not important. The simple model of the pizza market does a good job of addressing that issue. Yet if our goal is to explain why towns with three pizzerias have lower pizza prices than towns with one pizzeria, the simple model is less useful.

FYI

Using Functions to Express Relationships Among Variables

All economic models express relationships among economic variables. Often, these relationships are expressed as functions. A *function* is a mathematical concept that shows how one variable depends on a set of other variables. For example, in the model of the pizza market, we said that the quantity of pizza demanded depends on the price of pizza and on aggregate income. To express this, we use functional notation to write

$$Q^d = D(P, Y).$$

This equation says that the quantity of pizza demanded Q^d is a function of the price of pizza P and aggregate income Y. In functional notation, the variable preceding the parentheses denotes the function. In this case, $D(\ )$ is the function expressing how the variables in parentheses determine the quantity of pizza demanded.

If we knew more about the pizza market, we could give a numerical formula for the quantity of pizza demanded. We might be able to write

$$Q^d = 60 - 10P + 2Y.$$

In this case, the demand function is

$$D(P, Y) = 60 - 10P + 2Y.$$

For any price of pizza and aggregate income, this function gives the corresponding quantity of pizza demanded. For example, if aggregate income is \$10 and the price of pizza is \$2, then the quantity of pizza demanded is 60 pies; if the price of pizza rises to \$3, the quantity of pizza demanded falls to 50 pies.

Functional notation allows us to express a relationship among variables even when the precise numerical relationship is unknown. For example, we might know that the quantity of pizza demanded falls when the price rises from \$2 to \$3, but we might not know by how much it falls. In this case, functional notation is useful: as long as we know that a relationship among the variables exists, we can remind ourselves of that relationship using functional notation.

The art in economics is in judging when an assumption is clarifying and when it is misleading. Any model constructed to be completely realistic would be too complicated for anyone to understand. Simplification is a necessary part of building a useful model. Yet models lead to incorrect conclusions if they assume away features of the economy that are crucial to the issue at hand. Economic modeling therefore requires care and common sense.

A Multitude of Models

Macroeconomists study many facets of the economy. For example, they examine the role of saving in economic growth, the impact of labor unions on unemployment, the effect of inflation on interest rates, and the influence of trade policy on the trade balance and exchange rates. Macroeconomics is as diverse as the economy.

Although economists use models to address all these issues, no single model can answer all questions. Just as carpenters use different tools for different tasks, economists uses different models to explain different economic phenomena. Students of macroeconomics, therefore, must keep in mind that there is no single "correct" model useful for all purposes. Instead, there are many models, each of which is useful for shedding light on a different facet of the economy. The field of macroeconomics is like a Swiss army knife—a set of complementary but distinct tools that can be applied in different ways in different circumstances.

This book therefore presents many different models that address different questions and that make different assumptions. Remember that a model is only as good as its assumptions and that an assumption that is useful for some purposes may be misleading for others. When using a model to address a question, the economist must keep in mind the underlying assumptions and judge whether these are reasonable for the matter at hand.

Prices: Flexible Versus Sticky

Throughout this book, one group of assumptions will prove especially important—those concerning the speed with which wages and prices adjust. Economists normally presume that the price of a good or a service moves quickly to bring quantity supplied and quantity demanded into balance. In other words, they assume that a market goes to the equilibrium of supply and demand. This assumption is called **market clearing** and is central to the model of the pizza market discussed earlier. For answering most questions, economists use market-clearing models.

Yet the assumption of *continuous* market clearing is not entirely realistic. For markets to clear continuously, prices must adjust instantly to changes in supply and demand. In fact, however, many wages and prices adjust slowly. Labor contracts often set wages for up to three years. Many firms leave their product prices the same for long periods of time—for example, magazine publishers typically change their newsstand prices only every three or four years. Although market-clearing models assume that all wages and prices are **flexible**, in the real world some wages and prices are **sticky**.

The apparent stickiness of prices does not make market-clearing models useless. After all, prices are not stuck forever; eventually, they do adjust to changes in supply and demand. Market-clearing models might not describe the economy at every instant, but they do describe the equilibrium toward which the economy gravitates. Therefore, most macroeconomists believe that price flexibility is a good assumption for studying long-run issues, such as the growth in real GDP that we observe from decade to decade.

For studying short-run issues, such as year-to-year fluctuations in real GDP and unemployment, the assumption of price flexibility is less plausible. Over short periods, many prices are fixed at predetermined levels. Therefore, most macroeconomists believe that price stickiness is a better assumption for studying the behavior of the economy in the short run.

Microeconomic Thinking and Macroeconomic Models

Microeconomics is the study of how households and firms make decisions and how these decisionmakers interact in the marketplace. A central principle of microeconomics is that households and firms *optimize*—they do the best they can for themselves given their objectives and the constraints they face. In microeconomic models, households choose their purchases to maximize their level of satisfaction, which economists call *utility*, and firms make production decisions to maximize their profits.

Because economy-wide events arise from the interaction of many households and many firms, macroeconomics and microeconomics are inextricably linked. When we study the economy as a whole, we must consider the decisions of individual economic actors. For example, to understand what determines total consumer spending, we must think about a family deciding how much to spend today and how much to save for the future. To understand what determines total investment spending, we must think about a firm deciding whether to build a new factory. Because aggregate variables are the sum of the variables describing many individual decisions, macroeconomic theory rests on a microeconomic foundation.

Although microeconomic decisions always underlie economic models, in many models the optimizing behavior of households and firms is implicit rather than explicit. The model of the pizza market we discussed earlier is an example. Households' decisions about how much pizza to buy underlie the demand for pizza, and pizzerias' decisions about how much pizza to produce underlie the supply of pizza. Presumably, households make their decisions to maximize utility, and pizzerias make their decisions to maximize profit. Yet the model did not focus on these microeconomic decisions; it left them in the background. Similarly, in much of macroeconomics, the optimizing behavior of households and firms is left implicit.

1-3 How This Book Proceeds

This book has six parts. This chapter and the next make up Part One, the Introduction. Chapter 2 discusses how economists measure economic variables, such as aggregate income, the inflation rate, and the unemployment rate.

Part Two, "Classical Theory: The Economy in the Long Run," presents the classical model of how the economy works. The key assumption of the classical model is that prices are flexible. That is, with rare exceptions, the classical model assumes market clearing. Because the assumption of price flexibility describes the economy only in the long run, classical theory is best suited for analyzing a time horizon of at least several years.

Part Three, "Growth Theory: The Economy in the Very Long Run," builds on the classical model. It maintains the assumption of market clearing but adds a new emphasis on growth in the capital stock, the labor force, and technological knowledge. Growth theory is designed to explain how the economy evolves over a period of several decades.

Part Four, "Business Cycle Theory: The Economy in the Short Run," examines the behavior of the economy when prices are sticky. The non-market-clearing model developed here is designed to analyze short-run issues, such as the reasons for economic fluctuations and the influence of government policy on those fluctuations. It is best suited to analyzing the changes in the economy we observe from month to month or from year to year.

Part Five, "Macroeconomic Policy Debates," builds on the previous analysis to consider what role the government should take in the economy. It considers how, if at all, the government should respond to short-run fluctuations in real GDP and unemployment. It also examines the various views on the effects of government debt.

Part Six, "More on the Microeconomics Behind Macroeconomics," presents some of the microeconomic models that are useful for analyzing macroeconomic issues. For example, it examines the household's decisions regarding how much to consume and how much money to hold and the firm's decision regarding how much to invest. These individual decisions together form the larger macroeconomic picture. The goal of studying these microeconomic decisions in detail is to refine our understanding of the aggregate economy.

Summary

1. Macroeconomics is the study of the economy as a whole—including growth in incomes, changes in prices, and the rate of unemployment. Macroeconomists attempt both to explain economic events and to devise policies to improve economic performance.

2. To understand the economy, economists use models—theories that simplify reality in order to reveal how exogenous variables influence endogenous variables. The art in the science of economics is in judging whether a model

captures the important economic relationships for the matter at hand. Because no single model can answer all questions, macroeconomists use different models to look at different issues.

3. A key feature of a macroeconomic model is whether it assumes that prices are flexible or sticky. According to most macroeconomists, models with flexible prices describe the economy in the long run, whereas models with sticky prices offer a better description of the economy in the short run.

4. Microeconomics is the study of how firms and individuals make decisions and how these decisionmakers interact. Because macroeconomic events arise from many microeconomic interactions, macroeconomists use many of the tools of microeconomics.

KEY CONCEPTS

Macroeconomics
Real GDP
Inflation rate
Unemployment rate
Recession
Depression
Deflation
Models
Endogenous variables
Exogenous variables
Market clearing
Flexible and sticky prices
Microeconomics

QUESTIONS FOR REVIEW

1. Explain the difference between macroeconomics and microeconomics. How are these two fields related?
2. Why do economists build models?
3. What is a market-clearing model? When is the assumption of market clearing appropriate?

PROBLEMS AND APPLICATIONS

1. What macroeconomic issues have been in the news lately?
2. What do you think are the defining characteristics of a science? Does the study of the economy have these characteristics? Do you think macroeconomics should be called a science? Why or why not?
3. Use the model of supply and demand to explain how a fall in the price of frozen yogurt would affect the price of ice cream and the quantity of ice cream sold. In your explanation, identify the exogenous and endogenous variables.
4. How often does the price you pay for a haircut change? What does your answer imply about the usefulness of market-clearing models for analyzing the market for haircuts?

CHAPTER 2 TWO

The Data of Macroeconomics

It is a capital mistake to theorize before one has data. Insensibly one begins to twist facts to suit theories, instead of theories to fit facts.

— *Sherlock Holmes*

Scientists, economists, and detectives have much in common: they all want to figure out what's going on in the world around them. To do this, they rely on both theory and observation. They build theories in an attempt to make sense of what they see happening. They then turn to more systematic observation to evaluate the theories' validity. Only when theory and evidence come into line do they feel they understand the situation. This chapter discusses the types of observation that economists use to develop and test their theories.

Casual observation is one source of information about what's happening in the economy. When you go shopping, you see how fast prices are rising. When you look for a job, you learn whether firms are hiring. Because we are all participants in the economy, we get some sense of economic conditions as we go about our lives.

A century ago, economists monitoring the economy had little more to go on than these casual observations. Such fragmentary information made economic policymaking all the more difficult. One person's anecdote would suggest the economy was moving in one direction, while a different person's anecdote would suggest it was moving in another. Economists needed some way to combine many individual experiences into a coherent whole. There was an obvious solution: as the old quip goes, the plural of "anecdote" is "data."

Today, economic data offer a systematic and objective source of information, and almost every day the newspaper has a story about some newly released statistic. Most of these statistics are produced by the government. Various government agencies survey households and firms to learn about their economic activity—how much they are earning, what they are buying, what prices they are charging, whether they have a job or are looking for work, and so on. From these surveys, various statistics are computed that summarize the state of the economy. Economists use these statistics to study the economy; policymakers use them to monitor developments and formulate policies.

This chapter focuses on the three statistics that economists and policymakers use most often. **Gross domestic product**, or **GDP**, tells us the nation's total income and the total expenditure on its output of goods and services. The **consumer price index**, or **CPI,** measures the level of prices. The **unemployment rate** tells us the fraction of workers who are unemployed. In the following pages, we see how these statistics are computed and what they tell us about the economy.

2-1 Measuring the Value of Economic Activity: Gross Domestic Product

Gross domestic product is often considered the best measure of how well the economy is performing. This statistic is computed every three months by the Bureau of Economic Analysis (a part of the U.S. Department of Commerce) from a large number of primary data sources. The goal of GDP is to summarize in a single number the dollar value of economic activity in a given period of time.

There are two ways to view this statistic. One way to view GDP is as *the total income of everyone in the economy*. Another way to view GDP is as *the total expenditure on the economy's output of goods and services*. From either viewpoint, it is clear why GDP is a gauge of economic performance. GDP measures something people care about—their incomes. Similarly, an economy with a large output of goods and services can better satisfy the demands of households, firms, and the government.

How can GDP measure both the economy's income and the expenditure on its output? The reason is that these two quantities are really the same: for the economy as a whole, income must equal expenditure. That fact, in turn, follows from an even more fundamental one: because every transaction has both a buyer and a seller, every dollar of expenditure by a buyer must become a dollar of income to a seller. When Joe paints Jane's house for $1,000, that $1,000 is income to Joe and expenditure by Jane. The transaction contributes $1,000 to GDP, regardless of whether we are adding up all income or adding up all expenditure.

To understand the meaning of GDP more fully, we turn to **national income accounting**, the accounting system used to measure GDP and many related statistics.

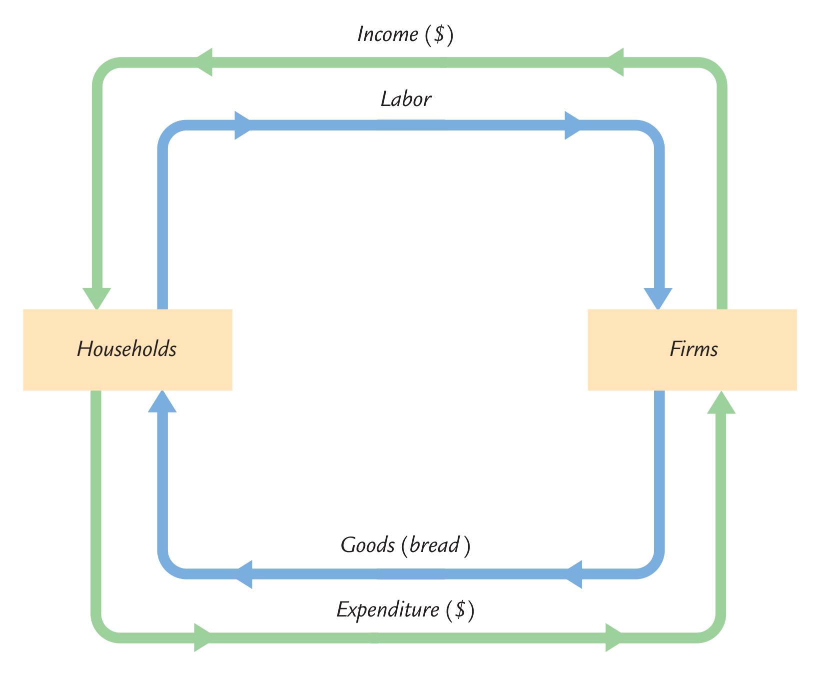
Income, Expenditure, and the Circular Flow

Imagine an economy that produces a single good, bread, from a single input, labor. Figure 2-1 illustrates all the economic transactions that occur between households and firms in this economy.

The inner loop in Figure 2-1 represents the flows of bread and labor. The households sell their labor to the firms. The firms use the labor of their workers to produce bread, which the firms in turn sell to the households. Hence, labor flows from households to firms, and bread flows from firms to households.

The outer loop in Figure 2-1 represents the corresponding flow of dollars. The households buy bread from the firms. The firms use some of the revenue

figure 2-1



The Circular Flow This figure illustrates the flows between firms and households in an economy that produces one good, bread, from one input, labor. The inner loop represents the flows of labor and bread: households sell their labor to firms, and the firms sell the bread they produce to households. The outer loop represents the corresponding flows of dollars: households pay the firms for the bread, and the firms pay wages and profit to the households. In this economy, GDP is both the total expenditure on bread and the total income from the production of bread.

from these sales to pay the wages of their workers, and the remainder is the profit belonging to the owners of the firms (who themselves are part of the household sector). Hence, expenditure on bread flows from households to firms, and income in the form of wages and profit flows from firms to households.

GDP measures the flow of dollars in this economy. We can compute it in two ways. GDP is the total income from the production of bread, which equals the sum of wages and profit—the top half of the circular flow of dollars. GDP is also the total expenditure on purchases of bread—the bottom half of the circular flow of dollars. To compute GDP, we can look at either the flow of dollars from firms to households or the flow of dollars from households to firms.

These two ways of computing GDP must be equal because the expenditure of buyers on products is, by the rules of accounting, income to the sellers of those products. Every transaction that affects expenditure must affect income, and every transaction that affects income must affect expenditure. For example, suppose that a firm produces and sells one more loaf of bread to a household. Clearly this transaction raises total expenditure on bread, but it also has an equal effect on total income. If the firm produces the extra loaf without hiring any more labor (such as by making the production process more efficient), then profit increases. If the firm produces the extra loaf by hiring more labor, then wages increase. In both cases, expenditure and income increase equally.

FYI Stocks and Flows

Many economic variables measure a quantity of something—a quantity of money, a quantity of goods, and so on. Economists distinguish between two types of quantity variables: stocks and flows. A **stock** is a quantity measured at a given point in time, whereas a **flow** is a quantity measured per unit of time.

The bathtub, shown in Figure 2-2, is the classic example used to illustrate stocks and flows. The amount of water in the tub is a stock: it is the quantity of water in the tub at a given point in time. The amount of water coming out of the faucet is a flow: it is the quantity of water being added to the tub per unit of time. Note that we measure stocks and flows in different units. We say that the bathtub contains 50 *gallons* of water, but that water is coming out of the faucet at 5 *gallons per minute*.

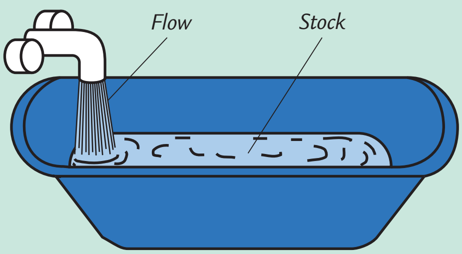
GDP is probably the most important flow variable in economics: it tells us how many dollars are flowing around the economy's circular flow per unit of time. When you hear someone say that the U.S. GDP is $10 trillion, you should understand that this means that it is $10 trillion *per year*. (Equivalently, we could say that U.S. GDP is $317,000 per second.)

Stocks and flows are often related. In the bathtub example, these relationships are clear. The stock of water in the tub represents the accumulation of the flow out of the faucet, and the flow of water represents the change in the stock. When building theories to explain economic variables, it is often useful to determine whether the variables are stocks or flows and whether any relationships link them.

Here are some examples of related stocks and flows that we study in future chapters:

- A person's wealth is a stock; income and expenditure are flows.
- The number of unemployed people is a stock; the number of people losing their jobs is a flow.
- The amount of capital in the economy is a stock; the amount of investment is a flow.
- The government debt is a stock; the government budget deficit is a flow.

figure 2-2



Stocks and Flows The amount of water in a bathtub is a stock: it is a quantity measured at a given moment in time. The amount of water coming out of the faucet is a flow: it is a quantity measured per unit of time.

Rules for Computing GDP

In an economy that produces only bread, we can compute GDP by adding up the total expenditure on bread. Real economies, however, include the production and sale of a vast number of goods and services. To compute GDP for such a complex economy, it will be helpful to have a more precise definition: *gross* *domestic product (GDP) is the market value of all final goods and services produced within an economy in a given period of time.* To see how this definition is applied, let's discuss some of the rules that economists follow in constructing this statistic.

Adding Apples and Oranges The U.S. economy produces many different goods and services—hamburgers, haircuts, cars, computers, and so on. GDP combines the value of these goods and services into a single measure. The diversity of products in the economy complicates the calculation of GDP because different products have different values.

Suppose, for example, that the economy produces four apples and three oranges. How do we compute GDP? We could simply add apples and oranges and conclude that GDP equals seven pieces of fruit. But this makes sense only if we thought apples and oranges had equal value, which is generally not true. (This would be even clearer if the economy had produced four watermelons and three grapes.)

To compute the total value of different goods and services, the national income accounts use market prices because these prices reflect how much people are willing to pay for a good or service. Thus, if apples cost \$0.50 each and oranges cost \$1.00 each, GDP would be

$$\begin{aligned} \text{GDP} &= (\text{Price of Apples} \times \text{Quantity of Apples}) \\ &\quad + (\text{Price of Oranges} \times \text{Quantity of Oranges}) \\ &= (\$0.50 \times 4) + (\$1.00 \times 3) \\ &= \$5.00. \end{aligned}$$

GDP equals \$5.00—the value of all the apples, \$2.00, plus the value of all the oranges, \$3.00.

Used Goods When the Topps Company makes a package of baseball cards and sells it for 50 cents, that 50 cents is added to the nation's GDP. But what about when a collector sells a rare Mickey Mantle card to another collector for \$500? That \$500 is not part of GDP. GDP measures the value of currently produced goods and services. The sale of the Mickey Mantle card reflects the transfer of an asset, not an addition to the economy's income. Thus, the sale of used goods is not included as part of GDP.

The Treatment of Inventories Imagine that a bakery hires workers to produce more bread, pays their wages, and then fails to sell the additional bread. How does this transaction affect GDP?

The answer depends on what happens to the unsold bread. Let's first suppose that the bread spoils. In this case, the firm has paid more in wages but has not received any additional revenue, so the firm's profit is reduced by the amount that wages are increased. Total expenditure in the economy hasn't changed because no one buys the bread. Total income hasn't changed either—although more is distributed as wages and less as profit. Because the transaction affects neither expenditure nor income, it does not alter GDP.

Now suppose, instead, that the bread is put into inventory to be sold later. In this case, the transaction is treated differently. The owners of the firm are assumed to have "purchased" the bread for the firm's inventory, and the firm's profit is not reduced by the additional wages it has paid. Because the higher wages raise total income, and greater spending on inventory raises total expenditure, the economy's GDP rises.

What happens later when the firm sells the bread out of inventory? This case is much like the sale of a used good. There is spending by bread consumers, but there is inventory disinvestment by the firm. This negative spending by the firm offsets the positive spending by consumers, so the sale out of inventory does not affect GDP.

The general rule is that when a firm increases its inventory of goods, this investment in inventory is counted as expenditure by the firm owners. Thus, production for inventory increases GDP just as much as production for final sale. A sale out of inventory, however, is a combination of positive spending (the purchase) and negative spending (inventory disinvestment), so it does not influence GDP. This treatment of inventories ensures that GDP reflects the economy's current production of goods and services.

Intermediate Goods and Value Added Many goods are produced in stages: raw materials are processed into intermediate goods by one firm and then sold to another firm for final processing. How should we treat such products when computing GDP? For example, suppose a cattle rancher sells one-quarter pound of meat to McDonald's for \$0.50, and then McDonald's sells you a hamburger for \$1.50. Should GDP include both the meat and the hamburger (a total of \$2.00), or just the hamburger (\$1.50)?

The answer is that GDP includes only the value of final goods. Thus, the hamburger is included in GDP but the meat is not: GDP increases by \$1.50, not by \$2.00. The reason is that the value of intermediate goods is already included as part of the market price of the final goods in which they are used. To add the intermediate goods to the final goods would be double counting—that is, the meat would be counted twice. Hence, GDP is the total value of final goods and services produced.

One way to compute the value of all final goods and services is to sum the value added at each stage of production. The **value added** of a firm equals the value of the firm's output less the value of the intermediate goods that the firm purchases. In the case of the hamburger, the value added of the rancher is \$0.50 (assuming that the rancher bought no intermediate goods), and the value added of McDonald's is \$1.50 − \$0.50, or \$1.00. Total value added is \$0.50 + \$1.00, which equals \$1.50. For the economy as a whole, the sum of all value added must equal the value of all final goods and services. Hence, GDP is also the total value added of all firms in the economy.

Housing Services and Other Imputations Although most goods and services are valued at their market prices when computing GDP, some are not sold in the marketplace and therefore do not have market prices. If GDP is to include the value of these goods and services, we must use an estimate of their value. Such an estimate is called an **imputed value**.

Imputations are especially important for determining the value of housing. A person who rents a house is buying housing services and providing income for the landlord; the rent is part of GDP, both as expenditure by the renter and as income for the landlord. Many people, however, live in their own homes. Although they do not pay rent to a landlord, they are enjoying housing services similar to those that renters purchase. To take account of the housing services enjoyed by homeowners, GDP includes the "rent" that these homeowners "pay" to themselves. Of course, homeowners do not in fact pay themselves this rent. The Department of Commerce estimates what the market rent for a house would be if it were rented and includes that imputed rent as part of GDP. This imputed rent is included both in the homeowner's expenditure and in the homeowner's income.

Imputations also arise in valuing government services. For example, police officers, firefighters, and senators provide services to the public. Giving a value to these services is difficult because they are not sold in a marketplace and therefore do not have a market price. The national income accounts include these services in GDP by valuing them at their cost. That is, the wages of these public servants are used as a measure of the value of their output.

In many cases, an imputation is called for in principle but, to keep things simple, is not made in practice. Because GDP includes the imputed rent on owner-occupied houses, one might expect it also to include the imputed rent on cars, lawn mowers, jewelry, and other durable goods owned by households. Yet the value of these rental services is left out of GDP. In addition, some of the output of the economy is produced and consumed at home and never enters the marketplace. For example, meals cooked at home are similar to meals cooked at a restaurant, yet the value added in meals at home is left out of GDP.

Finally, no imputation is made for the value of goods and services sold in the *underground economy*. The underground economy is the part of the economy that people hide from the government either because they wish to evade taxation or because the activity is illegal. Domestic workers paid "off the books" is one example. The illegal drug trade is another.

Because the imputations necessary for computing GDP are only approximate, and because the value of many goods and services is left out altogether, GDP is an imperfect measure of economic activity. These imperfections are most problematic when comparing standards of living across countries. The size of the underground economy, for instance, varies from country to country. Yet as long as the magnitude of these imperfections remains fairly constant over time, GDP is useful for comparing economic activity from year to year.

Real GDP Versus Nominal GDP

Economists use the rules just described to compute GDP, which values the economy's total output of goods and services. But is GDP a good measure of economic well-being? Consider once again the economy that produces only apples and oranges. In this economy GDP is the sum of the value of all the apples produced and the value of all the oranges produced. That is,

$$\begin{aligned}\text{GDP} = {} & (\text{Price of Apples} \times \text{Quantity of Apples}) \\ & + (\text{Price of Oranges} \times \text{Quantity of Oranges}).\end{aligned}$$

Notice that GDP can increase either because prices rise or because quantities rise.

It is easy to see that GDP computed this way is not a good gauge of economic well-being. That is, this measure does not accurately reflect how well the economy can satisfy the demands of households, firms, and the government. If all prices doubled without any change in quantities, GDP would double. Yet it would be misleading to say that the economy's ability to satisfy demands has doubled, because the quantity of every good produced remains the same. Economists call the value of goods and services measured at current prices **nominal GDP**.

A better measure of economic well-being would tally the economy's output of goods and services and would not be influenced by changes in prices. For this purpose, economists use **real GDP**, which is the value of goods and services measured using a constant set of prices. That is, real GDP shows what would have happened to expenditure on output if quantities had changed but prices had not.

To see how real GDP is computed, imagine we wanted to compare output in 2002 and output in 2003 in our apple-and-orange economy. We could begin by choosing a set of prices, called *base-year prices*, such as the prices that prevailed in 2002. Goods and services are then added up using these base-year prices to value the different goods in both years. Real GDP for 2002 would be

$$\begin{aligned}\text{Real GDP} = {} & (\text{2002 Price of Apples} \times \text{2002 Quantity of Apples})\\ & + (\text{2002 Price of Oranges} \times \text{2002 Quantity of Oranges}).\end{aligned}$$

Similarly, real GDP in 2003 would be

$$\begin{aligned}\text{Real GDP} = {} & (\text{2002 Price of Apples} \times \text{2003 Quantity of Apples})\\ & + (\text{2002 Price of Oranges} \times \text{2003 Quantity of Oranges}).\end{aligned}$$

And real GDP in 2004 would be

$$\begin{aligned}\text{Real GDP} = {} & (\text{2002 Price of Apples} \times \text{2004 Quantity of Apples})\\ & + (\text{2002 Price of Oranges} \times \text{2004 Quantity of Oranges}).\end{aligned}$$

Notice that 2002 prices are used to compute real GDP for all three years. Because the prices are held constant, real GDP varies from year to year only if the quantities produced vary. Because a society's ability to provide economic satisfaction for its members ultimately depends on the quantities of goods and services produced, real GDP provides a better measure of economic well-being than nominal GDP.

The GDP Deflator

From nominal GDP and real GDP we can compute a third statistic: the GDP deflator. The **GDP deflator**, also called the implicit price deflator for GDP, is defined as the ratio of nominal GDP to real GDP:

$$\text{GDP Deflator} = \frac{\text{Nominal GDP}}{\text{Real GDP}}.$$

The GDP deflator reflects what's happening to the overall level of prices in the economy.

To better understand this, consider again an economy with only one good, bread. If P is the price of bread and Q is the quantity sold, then nominal GDP is the total number of dollars spent on bread in that year, $P \times Q$. Real GDP is the number of loaves of bread produced in that year times the price of bread in some base year, $P_{\text{base}} \times Q$. The GDP deflator is the price of bread in that year relative to the price of bread in the base year, P/P_{base}.

The definition of the GDP deflator allows us to separate nominal GDP into two parts: one part measures quantities (real GDP) and the other measures prices (the GDP deflator). That is,

$$\text{Nominal GDP} = \text{Real GDP} \times \text{GDP Deflator}.$$

Nominal GDP measures the current dollar value of the output of the economy. Real GDP measures output valued at constant prices. The GDP deflator measures the price of output relative to its price in the base year. We can also write this equation as

$$\text{Real GDP} = \frac{\text{Nominal GDP}}{\text{GDP Deflator}}.$$

In this form, you can see how the deflator earns its name: it is used to deflate (that is, take inflation out of) nominal GDP to yield real GDP.

Chain-Weighted Measures of Real GDP

We have been discussing real GDP as if the prices used to compute this measure never change from their base-year values. If this were truly the case, over time the prices would become more and more dated. For instance, the price of computers has fallen substantially in recent years, while the price of a year at college has risen. When valuing the production of computers and education, it would be misleading to use the prices that prevailed ten or twenty years ago.

To solve this problem, the Bureau of Economic Analysis used to update periodically the prices used to compute real GDP. About every five years, a new base year was chosen. The prices were then held fixed and used to measure year-to-year changes in the production of goods and services until the base year was updated once again.

In 1995, the bureau announced a new policy for dealing with changes in the base year. In particular, it now emphasizes *chain-weighted* measures of real GDP. With these new measures, the base year changes continuously over time. In essence, average prices in 2001 and 2002 are used to measure real growth from 2001 to 2002; average prices in 2002 and 2003 are used to measure real growth from 2002 to 2003; and so on. These various year-to-year growth rates are then put together to form a "chain" that can be used to compare the output of goods and services between any two dates.

This new chain-weighted measure of real GDP is better than the more traditional measure because it ensures that the prices used to compute real GDP are never far out of date. For most purposes, however, the differences are not important. It turns out that the two measures of real GDP are highly correlated with each other. The reason for this close association is that most relative prices change slowly over time. Thus, both measures of real GDP reflect the same thing: economy-wide changes in the production of goods and services.

FYI

Two Arithmetic Tricks for Working With Percentage Changes

For manipulating many relationships in economics, there is an arithmetic trick that is useful to know: *the percentage change of a product of two variables is approximately the sum of the percentage changes in each of the variables*.

To see how this trick works, consider an example. Let P denote the GDP deflator and Y denote real GDP. Nominal GDP is $P \times Y$. The trick states that

$$\begin{aligned}&\text{Percentage Change in } (P \times Y)\\ &\approx (\text{Percentage Change in } P)\\ &+ (\text{Percentage Change in } Y).\end{aligned}$$

For instance, suppose that in one year, real GDP is 100 and the GDP deflator is 2; the next year, real GDP is 103 and the GDP deflator is 2.1. We can calculate that real GDP rose by 3 percent and that the GDP deflator rose by 5 percent. Nominal GDP rose from 200 the first year to 216.3 the second year, an increase of 8.15 percent. Notice that the growth in nominal GDP (8.15 percent) is approximately the sum of the growth in the GDP deflator (5 percent) and the growth in real GDP (3 percent).[1]

A second arithmetic trick follows as a corollary to the first: *the percentage change of a ratio is approximately the percentage change in the numerator minus the percentage change in the denominator*. Again, consider an example. Let Y denote GDP and L denote the population, so that Y/L is GDP per person. The second trick states

$$\begin{aligned}&\text{Percentage Change in } (Y/L)\\ &\approx (\text{Percentage Change in } Y)\\ &- (\text{Percentage Change in } L).\end{aligned}$$

For instance, suppose that in the first year, Y is 100,000 and L is 100, so Y/L is 1,000; in the second year, Y is 110,000 and L is 103, so Y/L is 1,068. Notice that the growth in GDP per person (6.8 percent) is approximately the growth in income (10 percent) minus the growth in population (3 percent).

The Components of Expenditure

Economists and policymakers care not only about the economy's total output of goods and services but also about the allocation of this output among alternative uses. The national income accounts divide GDP into four broad categories of spending:

- Consumption (C)
- Investment (I)
- Government purchases (G)
- Net exports (NX).

Thus, letting Y stand for GDP,

$$Y = C + I + G + NX.$$

[1] *Mathematical note:* The proof that this trick works begins with the chain rule from calculus:

$$d(PY) = Y\,dP + P\,dY.$$

Now divide both sides of this equation by PY to obtain

$$d(PY)/(PY) = dP/P + dY/Y.$$

Notice that all three terms in this equation are percentage changes.

FYI What Is Investment?

Newcomers to macroeconomics are sometimes confused by how macroeconomists use familiar words in new and specific ways. One example is the term "investment." The confusion arises because what looks like investment for an individual may not be investment for the economy as a whole. The general rule is that the economy's investment does not include purchases that merely reallocate existing assets among different individuals. Investment, as macroeconomists use the term, creates new capital.

Let's consider some examples. Suppose we observe these two events:

- Smith buys for himself a 100-year-old Victorian house.
- Jones builds for herself a brand-new contemporary house.

What is total investment here? Two houses, one house, or zero?

A macroeconomist seeing these two transactions counts only the Jones house as investment. Smith's transaction has not created new housing for the economy; it has merely reallocated existing housing. Smith's purchase is investment for Smith, but it is disinvestment for the person selling the house. By contrast, Jones has added new housing to the economy; her new house is counted as investment.

Similarly, consider these two events:

- Gates buys \$5 million in IBM stock from Buffett on the New York Stock Exchange.
- General Motors sells \$10 million in stock to the public and uses the proceeds to build a new car factory.

Here, investment is \$10 million. In the first transaction, Gates is investing in IBM stock, and Buffett is disinvesting; there is no investment for the economy. By contrast, General Motors is using some of the economy's output of goods and services to add to its stock of capital; hence, its new factory is counted as investment.

GDP is the sum of consumption, investment, government purchases, and net exports. Each dollar of GDP falls into one of these categories. This equation is an *identity*—an equation that must hold because of the way the variables are defined. It is called the **national income accounts identity**.

Consumption consists of the goods and services bought by households. It is divided into three subcategories: nondurable goods, durable goods, and services. Nondurable goods are goods that last only a short time, such as food and clothing. Durable goods are goods that last a long time, such as cars and TVs. Services include the work done for consumers by individuals and firms, such as haircuts and doctor visits.

Investment consists of goods bought for future use. Investment is also divided into three subcategories: business fixed investment, residential fixed investment, and inventory investment. Business fixed investment is the purchase of new plant and equipment by firms. Residential investment is the purchase of new housing by households and landlords. Inventory investment is the increase in firms' inventories of goods (if inventories are falling, inventory investment is negative).

Government purchases are the goods and services bought by federal, state, and local governments. This category includes such items as military equipment, highways, and the services that government workers provide. It does not include transfer payments to individuals, such as Social Security and welfare. Because transfer payments reallocate existing income and are not made in exchange for goods and services, they are not part of GDP.

The last category, **net exports**, takes into account trade with other countries. Net exports are the value of goods and services exported to other countries minus the value of goods and services that foreigners provide us. Net exports represent the net expenditure from abroad on our goods and services, which provides income for domestic producers.

CASE STUDY

GDP and Its Components

In 2000 the GDP of the United States totaled about $10 trillion. This number is so large that it is almost impossible to comprehend. We can make it easier to understand by dividing it by the 2000 U.S. population of 275 million. In this way, we obtain GDP per person—the amount of expenditure for the average American—which equaled $36,174 in 2000.

table 2-1

GDP and the Components of Expenditure: 2000

	Total (billions of dollars)	Per Person (dollars)
Gross Domestic Product	**9,963.1**	**36,174**
Consumption	**6,757.3**	**24,534**
Nondurable goods	2,010.0	7,298
Durable goods	820.3	2,978
Services	3,927.0	14,258
Investment	**1,832.7**	**6,654**
Nonresidential fixed investment	1,362.2	4,946
Residential fixed investment	416.0	1,510
Inventory investment	54.5	198
Government Purchases	**1,743.7**	**6,331**
Federal	595.2	2,161
Defense	377.0	1,369
Nondefense	218.2	792
State and local	1,148.6	4,170
Net Exports	**–370.7**	**–1,346**
Exports	1,097.3	3,984
Imports	1,468.0	5,330

Source: U.S. Department of Commerce.

How did this GDP get used? Table 2-1 shows that about two-thirds of it, or \$24,534 per person, was spent on consumption. Investment was \$6,654 per person. Government purchases were \$6,331 per person, \$1,369 of which was spent by the federal government on national defense.

The average American bought \$5,330 of goods imported from abroad and produced \$3,984 of goods that were exported to other countries. Because the average American imported more than he exported, net exports were negative. Furthermore, because the average American earned less from selling to foreigners than he spent on foreign goods, the difference must have been financed by taking out loans from foreigners (or, equivalently, by selling them some assets). Thus, the average American borrowed \$1,346 from abroad in 2000.

Other Measures of Income

The national income accounts include other measures of income that differ slightly in definition from GDP. It is important to be aware of the various measures, because economists and the press often refer to them.

To see how the alternative measures of income relate to one another, we start with GDP and add or subtract various quantities. To obtain *gross national product (GNP)*, we add receipts of factor income (wages, profit, and rent) from the rest of the world and subtract payments of factor income to the rest of the world:

$$\text{GNP} = \text{GDP} + \text{Factor Payments From Abroad} - \text{Factor Payments to Abroad}.$$

Whereas GDP measures the total income produced *domestically*, GNP measures the total income earned by *nationals* (residents of a nation). For instance, if a Japanese resident owns an apartment building in New York, the rental income he earns is part of U.S. GDP because it is earned in the United States. But because this rental income is a factor payment to abroad, it is not part of U.S. GNP. In the United States, factor payments from abroad and factor payments to abroad are similar in size—each representing about 3 percent of GDP—so GDP and GNP are quite close.

To obtain *net national product (NNP)*, we subtract the depreciation of capital—the amount of the economy's stock of plants, equipment, and residential structures that wears out during the year:

$$\text{NNP} = \text{GNP} - \text{Depreciation}.$$

In the national income accounts, depreciation is called the *consumption of fixed capital*. It equals about 10 percent of GNP. Because the depreciation of capital is a cost of producing the output of the economy, subtracting depreciation shows the net result of economic activity.

The next adjustment in the national income accounts is for indirect business taxes, such as sales taxes. These taxes, which make up about 10 percent of NNP, place a wedge between the price that consumers pay for a good and the price that firms receive. Because firms never receive this tax wedge, it is not part of their income. Once we subtract indirect business taxes from NNP, we obtain a measure called *national income*:

$$\text{National Income} = \text{NNP} - \text{Indirect Business Taxes.}$$

National income measures how much everyone in the economy has earned.

The national income accounts divide national income into five components, depending on the way the income is earned. The five categories, and the percentage of national income paid in each category, are

- *Compensation of employees* (70%). The wages and fringe benefits earned by workers.
- *Proprietors' income* (9%). The income of noncorporate businesses, such as small farms, mom-and-pop stores, and law partnerships.
- *Rental income* (2%). The income that landlords receive, including the imputed rent that homeowners "pay" to themselves, less expenses, such as depreciation.
- *Corporate profits* (12%). The income of corporations after payments to their workers and creditors.
- *Net interest* (7%). The interest domestic businesses pay minus the interest they receive, plus interest earned from foreigners.

A series of adjustments takes us from national income to *personal income*, the amount of income that households and noncorporate businesses receive. Three of these adjustments are most important. First, we reduce national income by the amount that corporations earn but do not pay out, either because the corporations are retaining earnings or because they are paying taxes to the government. This adjustment is made by subtracting corporate profits (which equals the sum of corporate taxes, dividends, and retained earnings) and adding back dividends. Second, we increase national income by the net amount the government pays out in transfer payments. This adjustment equals government transfers to individuals minus social insurance contributions paid to the government. Third, we adjust national income to include the interest that households earn rather than the interest that businesses pay. This adjustment is made by adding personal interest income and subtracting net interest. (The difference between personal interest and net interest arises in part from the interest on the government debt.) Thus, personal income is

$$\begin{aligned} \text{Personal Income} = {} & \text{National Income} \\ & - \text{Corporate Profits} \\ & - \text{Social Insurance Contributions} \\ & - \text{Net Interest} \\ & + \text{Dividends} \\ & + \text{Government Transfers to Individuals} \\ & + \text{Personal Interest Income.} \end{aligned}$$

Next, if we subtract personal tax payments and certain nontax payments to the government (such as parking tickets), we obtain *disposable personal income*:

$$\text{Disposable Personal Income} = \text{Personal Income} - \text{Personal Tax and Nontax Payments.}$$

We are interested in disposable personal income because it is the amount households and noncorporate businesses have available to spend after satisfying their tax obligations to the government.

CASE STUDY

The Seasonal Cycle and Seasonal Adjustment

Because real GDP and the other measures of income reflect how well the economy is performing, economists are interested in studying the quarter-to-quarter fluctuations in these variables. Yet when we start to do so, one fact leaps out: all these measures of income exhibit a regular seasonal pattern. The output of the economy rises during the year, reaching a peak in the fourth quarter (October, November, and December), and then falling in the first quarter (January, February, and March) of the next year. These regular seasonal changes are substantial. From the fourth quarter to the first quarter, real GDP falls on average about 8 percent.[2]

It is not surprising that real GDP follows a seasonal cycle. Some of these changes are attributable to changes in our ability to produce: for example, building homes is more difficult during the cold weather of winter than during other seasons. In addition, people have seasonal tastes: they have preferred times for such activities as vacations and holiday shopping.

When economists study fluctuations in real GDP and other economic variables, they often want to eliminate the portion of fluctuations caused by predictable seasonal changes. You will find that most of the economic statistics reported in the newspaper are *seasonally adjusted*. This means that the data have been adjusted to remove the regular seasonal fluctuations. (The precise statistical procedures used are too elaborate to bother with here, but in essence they involve subtracting those changes in income that are predictable simply from the change in season.) Therefore, when you observe a rise or fall in real GDP or any other data series, you must look beyond the seasonal cycle for the explanation.

[2] Robert B. Barsky and Jeffrey A. Miron, "The Seasonal Cycle and the Business Cycle," *Journal of Political Economy* 97 (June 1989): 503–534.

2-2 Measuring the Cost of Living: The Consumer Price Index

A dollar today doesn't buy as much as it did 20 years ago. The cost of almost everything has gone up. This increase in the overall level of prices is called *inflation*, and it is one of the primary concerns of economists and policymakers. In later chapters we examine in detail the causes and effects of inflation. Here we discuss how economists measure changes in the cost of living.

The Price of a Basket of Goods

The most commonly used measure of the level of prices is the consumer price index (CPI). The Bureau of Labor Statistics, which is part of the U.S. Department of Labor, has the job of computing the CPI. It begins by collecting the prices of thousands of goods and services. Just as GDP turns the quantities of many goods and services into a single number measuring the value of production, the CPI turns the prices of many goods and services into a single index measuring the overall level of prices.

How should economists aggregate the many prices in the economy into a single index that reliably measures the price level? They could simply compute an average of all prices. Yet this approach would treat all goods and services equally. Because people buy more chicken than caviar, the price of chicken should have a greater weight in the CPI than the price of caviar. The Bureau of Labor Statistics weights different items by computing the price of a basket of goods and services purchased by a typical consumer. The CPI is the price of this basket of goods and services relative to the price of the same basket in some base year.

For example, suppose that the typical consumer buys 5 apples and 2 oranges every month. Then the basket of goods consists of 5 apples and 2 oranges, and the CPI is

$$\text{CPI} = \frac{(5 \times \text{Current Price of Apples}) + (2 \times \text{Current Price of Oranges})}{(5 \times 2002 \text{ Price of Apples}) + (2 \times 2002 \text{ Price of Oranges})}.$$

In this CPI, 2002 is the base year. The index tells us how much it costs now to buy 5 apples and 2 oranges relative to how much it cost to buy the same basket of fruit in 2002.

The consumer price index is the most closely watched index of prices, but it is not the only such index. Another is the producer price index, which measures the price of a typical basket of goods bought by firms rather than consumers. In addition to these overall price indices, the Bureau of Labor Statistics computes price indices for specific types of goods, such as food, housing, and energy.

The CPI Versus the GDP Deflator

Earlier in this chapter we saw another measure of prices—the implicit price deflator for GDP, which is the ratio of nominal GDP to real GDP. The GDP deflator and the CPI give somewhat different information about what's happening to the overall level of prices in the economy. There are three key differences between the two measures.

The first difference is that the GDP deflator measures the prices of all goods and services produced, whereas the CPI measures the prices of only the goods and services bought by consumers. Thus, an increase in the price of goods bought by firms or the government will show up in the GDP deflator but not in the CPI.

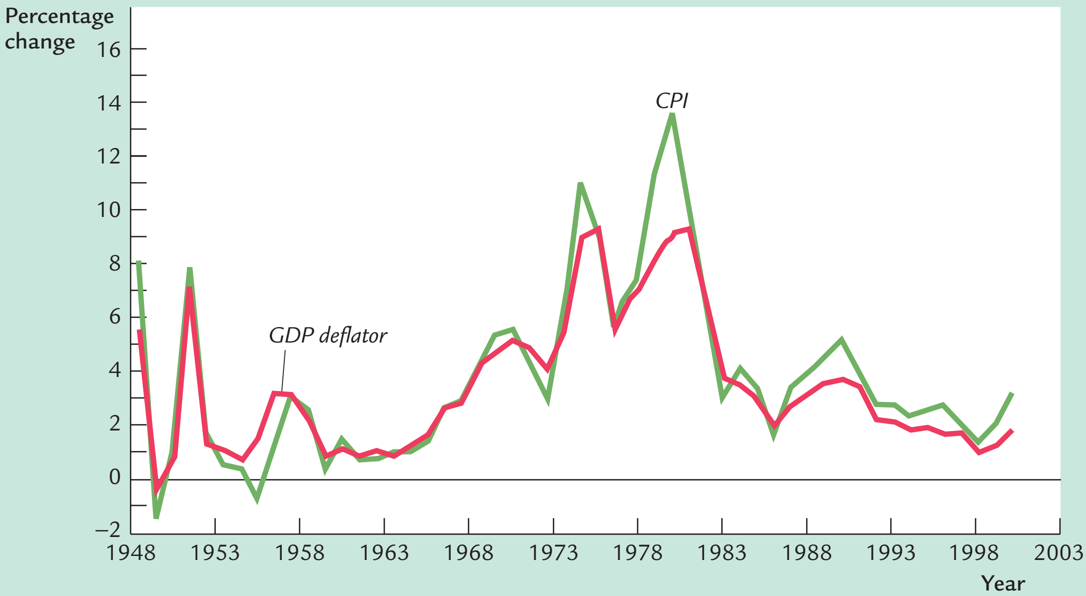
The second difference is that the GDP deflator includes only those goods produced domestically. Imported goods are not part of GDP and do not show up in the GDP deflator. Hence, an increase in the price of a Toyota made in Japan and sold in this country affects the CPI, because the Toyota is bought by consumers, but it does not affect the GDP deflator.

The third and most subtle difference results from the way the two measures aggregate the many prices in the economy. The CPI assigns fixed weights to the prices of different goods, whereas the GDP deflator assigns changing weights. In other words, the CPI is computed using a fixed basket of goods, whereas the GDP deflator allows the basket of goods to change over time as the composition of GDP changes. The following example shows how these approaches differ. Suppose that major frosts destroy the nation's orange crop. The quantity of oranges produced falls to zero, and the price of the few oranges that remain on grocers' shelves is driven sky-high. Because oranges are no longer part of GDP, the increase in the price of oranges does not show up in the GDP deflator. But because the CPI is computed with a fixed basket of goods that includes oranges, the increase in the price of oranges causes a substantial rise in the CPI.

Economists call a price index with a fixed basket of goods a *Laspeyres index* and a price index with a changing basket a *Paasche index*. Economic theorists have studied the properties of these different types of price indices to determine which is a better measure of the cost of living. The answer, it turns out, is that neither is clearly superior. When prices of different goods are changing by different amounts, a Laspeyres (fixed basket) index tends to overstate the increase in the cost of living because it does not take into account that consumers have the opportunity to substitute less expensive goods for more expensive ones. By contrast, a Paasche (changing basket) index tends to understate the increase in the cost of living. Although it accounts for the substitution of alternative goods, it does not reflect the reduction in consumers' welfare that may result from such substitutions.

The example of the destroyed orange crop shows the problems with Laspeyres and Paasche price indices. Because the CPI is a Laspeyres index, it overstates the impact of the increase in orange prices on consumers: by using a fixed basket of goods, it ignores consumers' ability to substitute apples for oranges. By contrast,

figure 2-3



The GDP Deflator and the CPI This figure shows the percentage change in the GDP deflator and in the CPI for every year since 1948. Although these two measures of prices diverge at times, they usually tell the same story about how quickly prices are rising. Both the CPI and the GDP deflator show that prices rose slowly in most of the 1950s and 1960s, that they rose much more quickly in the 1970s, and that they rose slowly again in the 1980s and 1990s.

Source: U.S. Department of Commerce, U.S. Department of Labor.

because the GDP deflator is a Paasche index, it understates the impact on consumers: the GDP deflator shows no rise in prices, yet surely the higher price of oranges makes consumers worse off.

Luckily, the difference between the GDP deflator and the CPI is usually not large in practice. Figure 2-3 shows the percentage change in the GDP deflator and the percentage change in the CPI for each year since 1948. Both measures usually tell the same story about how quickly prices are rising.

CASE STUDY

Does the CPI Overstate Inflation?

The consumer price index is a closely watched measure of inflation. Policymakers in the Federal Reserve monitor the CPI when choosing monetary policy. In addition, many laws and private contracts have cost-of-living allowances, called *COLAs*, which use the CPI to adjust for changes in the price level. For instance, Social Security benefits are adjusted automatically every year so that inflation will not erode the living standard of the elderly.

Because so much depends on the CPI, it is important to ensure that this measure of the price level is accurate. Many economists believe that, for a number of reasons, the CPI tends to overstate inflation.

One problem is the substitution bias we have already discussed. Because the CPI measures the price of a fixed basket of goods, it does not reflect the ability of consumers to substitute toward goods whose relative prices have fallen. Thus, when relative prices change, the true cost of living rises less rapidly than the CPI.

A second problem is the introduction of new goods. When a new good is introduced into the marketplace, consumers are better off, because they have more products from which to choose. In effect, the introduction of new goods increases the real value of the dollar. Yet this increase in the purchasing power of the dollar is not reflected in a lower CPI.

A third problem is unmeasured changes in quality. When a firm changes the quality of a good it sells, not all of the good's price change reflects a change in the cost of living. The Bureau of Economic Analysis does its best to account for changes in the quality of goods over time. For example, if Ford increases the horsepower of a particular car model from one year to the next, the CPI will reflect the change: the quality-adjusted price of the car will not rise as fast as the unadjusted price. Yet many changes in quality, such as comfort or safety, are hard to measure. If unmeasured quality improvement (rather than unmeasured quality deterioration) is typical, then the measured CPI rises faster than it should.

Because of these measurement problems, some economists have suggested revising laws to reduce the degree of indexation. For example, Social Security benefits could be indexed to CPI inflation minus 1 percent. Such a change would provide a rough way of offsetting these measurement problems. At the same time, it would automatically slow the growth in government spending.

In 1995, the Senate Finance Committee appointed a panel of five noted economists—Michael Boskin, Ellen Dulberger, Robert Gordon, Zvi Griliches, and Dale Jorgenson—to study the magnitude of the measurement error in the CPI. The panel concluded that the CPI was biased upward by 0.8 to 1.6 percentage points per year, with their "best estimate" being 1.1 percentage points. This report led to some changes in the way the CPI is calculated, so the bias is now thought to be slightly under 1 percentage point. The CPI still overstates inflation, but not by as much as it once did.[3]

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[3] For further discussion of these issues, see Matthew Shapiro and David Wilcox, "Mismeasurement in the Consumer Price Index: An Evaluation," *NBER Macroeconomics Annual*, 1996, and the symposium on "Measuring the CPI" in the Winter 1998 issue of *The Journal of Economic Perspectives*.

2-3 Measuring Joblessness: The Unemployment Rate

One aspect of economic performance is how well an economy uses its resources. Because an economy's workers are its chief resource, keeping workers employed is a paramount concern of economic policymakers. The unemployment rate is the statistic that measures the percentage of those people wanting to work who do not have jobs.

Drawing M. Stevens; © 1980 The New Yorker Magazine, Inc.

"Well, so long Eddie, the recession's over."

Every month the U.S. Bureau of Labor Statistics computes the unemployment rate and many other statistics that economists and policymakers use to monitor developments in the labor market. These statistics come from a survey of about 60,000 households. Based on the responses to survey questions, each adult (16 years and older) in each household is placed into one of three categories: employed, unemployed, or not in the labor force. A person is employed if he or she spent some of the previous week working at a paid job. A person is unemployed if he or she is not employed and has been looking for a job or is on temporary layoff. A person who fits into neither of the first two categories, such as a full-time student or retiree, is not in the labor force. A person who wants a job but has given up looking—a *discouraged worker*—is counted as not being in the labor force.

The **labor force** is defined as the sum of the employed and unemployed, and the unemployment rate is defined as the percentage of the labor force that is unemployed. That is,

$$\text{Labor Force} = \text{Number of Employed} + \text{Number of Unemployed},$$

and

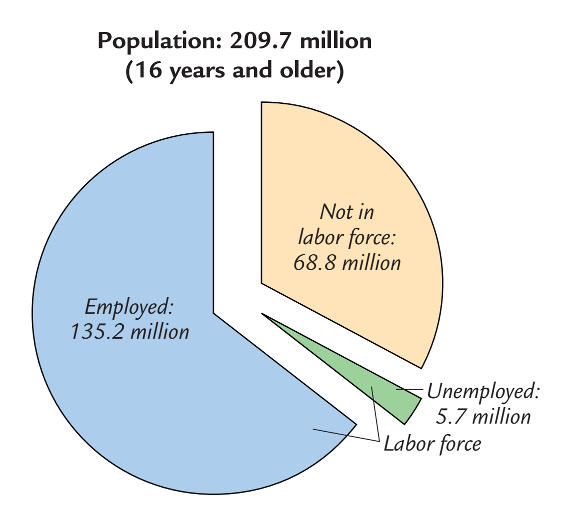
$$\text{Unemployment Rate} = \frac{\text{Number of Unemployed}}{\text{Labor Force}} \times 100.$$

A related statistic is the **labor-force participation rate**, the percentage of the adult population that is in the labor force:

$$\text{Labor-Force Participation Rate} = \frac{\text{Labor Force}}{\text{Adult Population}} \times 100.$$

The Bureau of Labor Statistics computes these statistics for the overall population and for groups within the population: men and women, whites and blacks, teenagers and prime-age workers.

figure 2-4



The Three Groups of the Population When the Bureau of Labor Statistics surveys the population, it places all adults into one of three categories: employed, unemployed, or not in the labor force. This figure shows the number of people in each category in 2000.

Source: U.S. Department of Labor.

Figure 2-4 shows the breakdown of the population into the three categories for 2000. The statistics broke down as follows:

$$\text{Labor Force} = 135.2 + 5.7 = 140.9 \text{ million.}$$
$$\text{Unemployment Rate} = (5.7/140.9) \times 100 = 4.0\%.$$
$$\text{Labor-Force Participation Rate} = (140.9/209.7) \times 100 = 67.2\%.$$

Hence, about two-thirds of the adult population was in the labor force, and about 4 percent of those in the labor force did not have a job.

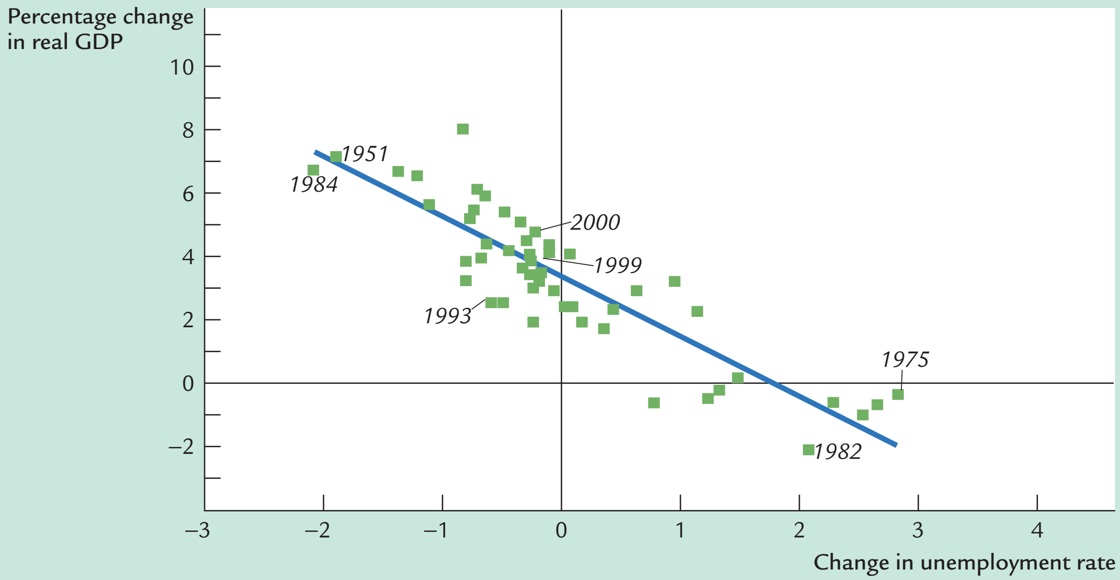
CASE STUDY

Unemployment, GDP, and Okun's Law

What relationship should we expect to find between unemployment and real GDP? Because employed workers help to produce goods and services and unemployed workers do not, increases in the unemployment rate should be associated with decreases in real GDP. This negative relationship between unemployment and GDP is called **Okun's law**, after Arthur Okun, the economist who first studied it.[4]

[4] Arthur M. Okun, "Potential GNP: Its Measurement and Significance," in *Proceedings of the Business and Economics Statistics Section, American Statistical Association* (Washington, DC: American Statistical Association, 1962), 98–103; reprinted in Arthur M. Okun, *Economics for Policymaking* (Cambridge, MA: MIT Press, 1983), 145–158.

figure 2-5



Okun's Law This figure is a scatterplot of the change in the unemployment rate on the horizontal axis and the percentage change in real GDP on the vertical axis, using data on the U.S economy. Each point represents one year. The negative correlation between these variables shows that increases in unemployment tend to be associated with lower-than-normal growth in real GDP.

Source: U.S. Department of Commerce, U.S. Department of Labor.

Figure 2-5 uses annual data for the United States to illustrate Okun's law. This figure is a scatterplot—a scatter of points where each point represents one observation (in this case, the data for a particular year). The horizontal axis represents the change in the unemployment rate from the previous year, and the vertical axis represents the percentage change in GDP. This figure shows clearly that year-to-year changes in the unemployment rate are closely associated with year-to-year changes in real GDP.

We can be more precise about the magnitude of the Okun's law relationship. The line drawn through the scatter of points (estimated with a statistical procedure called ordinary least squares) tells us that

$$\text{Percentage Change in Real GDP} = 3\% - 2 \times \text{Change in the Unemployment Rate.}$$

If the unemployment rate remains the same, real GDP grows by about 3 percent; this normal growth in the production of goods and services is a result of growth in the labor force, capital accumulation, and technological progress. In addition, for every percentage point the unemployment rate rises, real GDP growth typically falls by 2 percent. Hence, if the unemployment rate rises from 6 to 8 percent, then real GDP growth would be

$$\begin{aligned}\text{Percentage Change in Real GDP} &= 3\% - 2 \times (8\% - 6\%)\\ &= -1\%.\end{aligned}$$

In this case, Okun's law says that GDP would fall by 1 percent, indicating that the economy is in a recession.

2-4 Conclusion: From Economic Statistics to Economic Models

The three statistics discussed in this chapter—gross domestic product, the consumer price index, and the unemployment rate—quantify the performance of the economy. Public and private decisionmakers use these statistics to monitor changes in the economy and to formulate appropriate policies. Economists use these statistics to develop and test theories about how the economy works.

In the chapters that follow, we examine some of these theories. That is, we build models that explain how these variables are determined and how economic policy affects them. Having learned how to measure economic performance, we are now ready to learn how to explain it.

Summary

1. Gross domestic product (GDP) measures both the income of everyone in the economy and the total expenditure on the economy's output of goods and services.
2. Nominal GDP values goods and services at current prices. Real GDP values goods and services at constant prices. Real GDP rises only when the amount of goods and services has increased, whereas nominal GDP can rise either because output has increased or because prices have increased.
3. GDP is the sum of four categories of expenditure: consumption, investment, government purchases, and net exports.
4. The consumer price index (CPI) measures the price of a fixed basket of goods and services purchased by a typical consumer. Like the GDP deflator, which is the ratio of nominal GDP to real GDP, the CPI measures the overall level of prices.
5. The unemployment rate shows what fraction of those who would like to work do not have a job. When the unemployment rate rises, real GDP typically grows slower than its normal rate and may even fall.

KEY CONCEPTS

Gross domestic product (GDP)
Consumer price index (CPI)
Unemployment rate
National income accounting
Stocks and flows
Value added
Imputed value
Nominal versus real GDP
GDP deflator
National income accounts identity
Consumption
Investment
Government purchases
Net exports
Labor force
Labor-force participation rate
Okun's law

QUESTIONS FOR REVIEW

1. List the two things that GDP measures. How can GDP measure two things at once?
2. What does the consumer price index measure?
3. List the three categories used by the Bureau of Labor Statistics to classify everyone in the economy. How does the bureau compute the unemployment rate?
4. Explain Okun's law.

PROBLEMS AND APPLICATIONS

1. Look at the newspapers for the past few days. What new economic statistics have been released? How do you interpret these statistics?
2. A farmer grows a bushel of wheat and sells it to a miller for \$1.00. The miller turns the wheat into flour and then sells the flour to a baker for \$3.00. The baker uses the flour to make bread and sells the bread to an engineer for \$6.00. The engineer eats the bread. What is the value added by each person? What is GDP?
3. Suppose a woman marries her butler. After they are married, her husband continues to wait on her as before, and she continues to support him as before (but as a husband rather than as an employee). How does the marriage affect GDP? How should it affect GDP?
4. Place each of the following transactions in one of the four components of expenditure: consumption, investment, government purchases, and net exports.
   a. Boeing sells an airplane to the Air Force.
   b. Boeing sells an airplane to American Airlines.
   c. Boeing sells an airplane to Air France.
   d. Boeing sells an airplane to Amelia Earhart.
   e. Boeing builds an airplane to be sold next year.
5. Find data on GDP and its components, and compute the percentage of GDP for the following components for 1950, 1975, and 2000.
   a. Personal consumption expenditures
   b. Gross private domestic investment
   c. Government purchases
   d. Net exports
   e. National defense purchases
   f. State and local purchases
   g. Imports

   Do you see any stable relationships in the data? Do you see any trends? (*Hint:* A good place to look for data is the statistical appendices of the *Economic Report of the President*, which is written each year by the Council of Economic Advisers. Alternatively, you can go to www.bea.doc.gov, which is the Web site of the Bureau of Economic Analysis.)
6. Consider an economy that produces and consumes bread and automobiles. In the following table are data for two different years.

	Year 2000	Year 2010
Price of an automobile	\$50,000	\$60,000
Price of a loaf of bread	\$10	\$20
Number of automobiles produced	100	120
Number of loaves of bread produced	500,000	400,000

a. Using the year 2000 as the base year, compute the following statistics for each year: nominal GDP, real GDP, the implicit price deflator for GDP, and a fixed-weight price index such as the CPI.

b. How much have prices risen between year 2000 and year 2010? Compare the answers given by the Laspeyres and Paasche price indices. Explain the difference.

c. Suppose you are a senator writing a bill to index Social Security and federal pensions. That is, your bill will adjust these benefits to offset changes in the cost of living. Will you use the GDP deflator or the CPI? Why?

7. Abby consumes only apples. In year 1, red apples cost \$1 each, green apples cost \$2 each, and Abby buys 10 red apples. In year 2, red apples cost \$2, green apples cost \$1, and Abby buys 10 green apples.

a. Compute a consumer price index for apples for each year. Assume that year 1 is the base year in which the consumer basket is fixed. How does your index change from year 1 to year 2?

b. Compute Abby's nominal spending on apples in each year. How does it change from year 1 to year 2?

c. Using year 1 as the base year, compute Abby's real spending on apples in each year. How does it change from year 1 to year 2?

d. Defining the implicit price deflator as nominal spending divided by real spending, compute the deflator for each year. How does the deflator change from year 1 to year 2?

e. Suppose that Abby is equally happy eating red or green apples. How much has the true cost of living increased for Abby? Compare this answer to your answers to parts (a) and (d). What does this example tell you about Laspeyres and Paasche price indexes?

8. Consider how each of the following events is likely to affect real GDP. Do you think the change in real GDP reflects a similar change in economic well-being?

a. A hurricane in Florida forces Disney World to shut down for a month.

b. The discovery of a new, easy-to-grow strain of wheat increases farm harvests.

c. Increased hostility between unions and management sparks a rash of strikes.

d. Firms throughout the economy experience falling demand, causing them to lay off workers.

e. Congress passes new environmental laws that prohibit firms from using production methods that emit large quantities of pollution.

f. More high-school students drop out of school to take jobs mowing lawns.

g. Fathers around the country reduce their workweeks to spend more time with their children.

9. In a speech that Senator Robert Kennedy gave when he was running for president in 1968, he said the following about GDP:

> [It] does not allow for the health of our children, the quality of their education, or the joy of their play. It does not include the beauty of our poetry or the strength of our marriages, the intelligence of our public debate or the integrity of our public officials. It measures neither our courage, nor our wisdom, nor our devotion to our country. It measures everything, in short, except that which makes life worthwhile, and it can tell us everything about America except why we are proud that we are Americans.

Was Robert Kennedy right? If so, why do we care about GDP?

part II

Classical Theory: The Economy in the Long Run

CHAPTER THREE

National Income: Where It Comes From and Where It Goes

> *A large income is the best recipe for happiness I ever heard of.*
>
> *— Jane Austen*

The most important macroeconomic variable is gross domestic product (GDP). As we have seen, GDP measures both a nation's total output of goods and services and its total income. To appreciate the significance of GDP, one need only take a quick look at international data: compared with their poorer counterparts, nations with a high level of GDP per person have everything from better childhood nutrition to more televisions per household. A large GDP does not ensure that all of a nation's citizens are happy, but it may be the best recipe for happiness that macroeconomists have to offer.

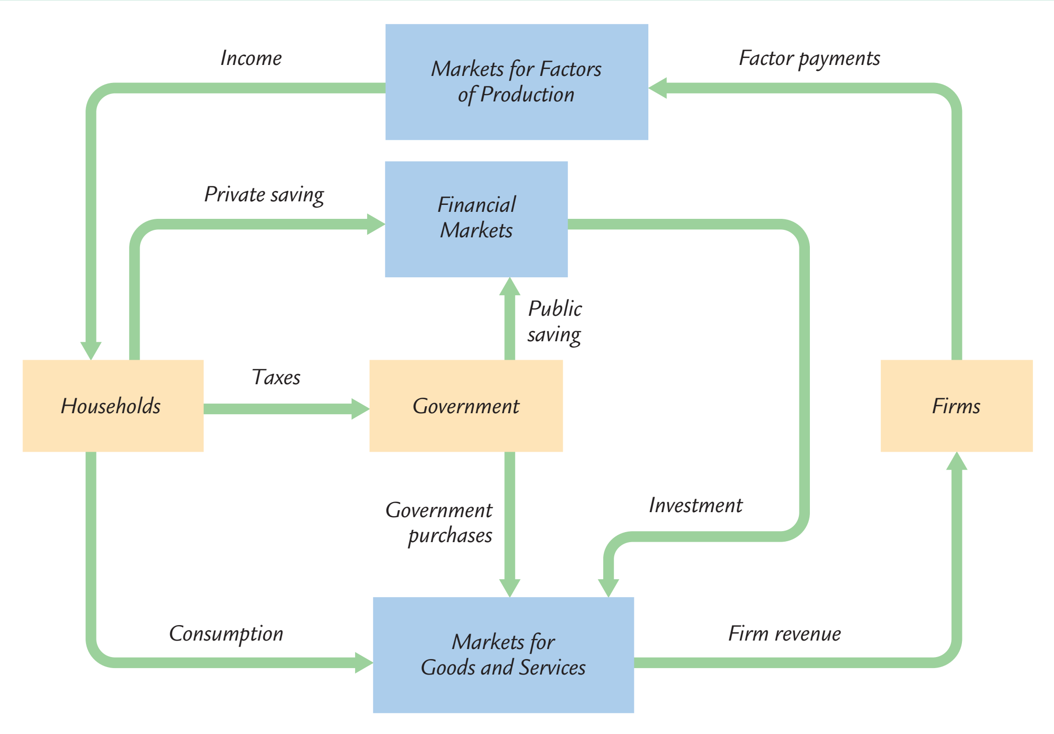
This chapter addresses four groups of questions about the sources and uses of a nation's GDP:

- How much do the firms in the economy produce? What determines a nation's total income?
- Who gets the income from production? How much goes to compensate workers, and how much goes to compensate owners of capital?
- Who buys the output of the economy? How much do households purchase for consumption, how much do households and firms purchase for investment, and how much does the government buy for public purposes?
- What equilibrates the demand for and supply of goods and services? What ensures that desired spending on consumption, investment, and government purchases equals the level of production?

To answer these questions, we must examine how the various parts of the economy interact.

A good place to start is the circular flow diagram. In Chapter 2 we traced the circular flow of dollars in a hypothetical economy that produced one product, bread, from labor services. Figure 3-1 more accurately reflects how real economies function. It shows the linkages among the economic actors—households, firms,

figure 3-1



The Circular Flow of Dollars Through the Economy This figure is a more realistic version of the circular flow diagram found in Chapter 2. Each yellow box represents an economic actor—households, firms, and the government. Each blue box represents a type of market—the markets for goods and services, the markets for the factors of production, and financial markets. The green arrows show the flow of dollars among the economic actors through the three types of markets.

and the government—and how dollars flow among them through the various markets in the economy.

Let's look at the flow of dollars from the viewpoints of these economic actors. Households receive income and use it to pay taxes to the government, to consume goods and services, and to save through the financial markets. Firms receive revenue from the sale of goods and services and use it to pay for the factors of production. Both households and firms borrow in financial markets to buy investment goods, such as houses and factories. The government receives revenue from taxes and uses it to pay for government purchases. Any excess of tax revenue over government spending is called public saving, which can be either positive (a budget surplus) or negative (a budget deficit).

In this chapter we develop a basic classical model to explain the economic interactions depicted in Figure 3-1. We begin with firms and look at what determines their level of production (and, thus, the level of national income). Then we examine how the markets for the factors of production distribute this income to households. Next, we consider how much of this income households consume and how much they save. In addition to discussing the demand for goods and services arising from the consumption of households, we discuss the demand arising from investment and government purchases. Finally, we come full circle and examine how the demand for goods and services (the sum of consumption, investment, and government purchases) and the supply of goods and services (the level of production) are brought into balance.

3-1 What Determines the Total Production of Goods and Services?

An economy's output of goods and services—its GDP—depends on (1) its quantity of inputs, called the factors of production, and (2) its ability to turn inputs into output, as represented by the production function. We discuss each of these in turn.

The Factors of Production

Factors of production are the inputs used to produce goods and services. The two most important factors of production are capital and labor. Capital is the set of tools that workers use: the construction worker's crane, the accountant's calculator, and this author's personal computer. Labor is the time people spend working. We use the symbol K to denote the amount of capital and the symbol L to denote the amount of labor.

In this chapter we take the economy's factors of production as given. In other words, we assume that the economy has a fixed amount of capital and a fixed amount of labor. We write

$$K = \bar{K}.$$
$$L = \bar{L}.$$

The overbar means that each variable is fixed at some level. In Chapter 7 we examine what happens when the factors of production change over time, as they do in the real world. For now, to keep our analysis simple, we assume fixed amounts of capital and labor.

We also assume here that the factors of production are fully utilized—that is, that no resources are wasted. Again, in the real world, part of the labor force is unemployed, and some capital lies idle. In Chapter 6 we examine the reasons for unemployment, but for now we assume that capital and labor are fully employed.

The Production Function

The available production technology determines how much output is produced from given amounts of capital and labor. Economists express the available technology using a **production function**. Letting Y denote the amount of output, we write the production function as

$$Y = F(K, L).$$

This equation states that output is a function of the amount of capital and the amount of labor.

The production function reflects the available technology for turning capital and labor into output. If someone invents a better way to produce a good, the result is more output from the same amounts of capital and labor. Thus, technological change alters the production function.

Many production functions have a property called **constant returns to scale**. A production function has constant returns to scale if an increase of an equal percentage in all factors of production causes an increase in output of the same percentage. If the production function has constant returns to scale, then we get 10 percent more output when we increase both capital and labor by 10 percent. Mathematically, a production function has constant returns to scale if

$$zY = F(zK, zL)$$

for any positive number z. This equation says that if we multiply both the amount of capital and the amount of labor by some number z, output is also multiplied by z. In the next section we see that the assumption of constant returns to scale has an important implication for how the income from production is distributed.

As an example of a production function, consider production at a bakery. The kitchen and its equipment are the bakery's capital, the workers hired to make the bread are its labor, and the loaves of bread are its output. The bakery's production function shows that the number of loaves produced depends on the amount of equipment and the number of workers. If the production function has constant returns to scale, then doubling the amount of equipment and the number of workers doubles the amount of bread produced.

The Supply of Goods and Services

We can now see that the factors of production and the production function together determine the quantity of goods and services supplied, which in turn equals the economy's output. To express this mathematically, we write

$$\begin{aligned} Y &= F(\bar{K}, \bar{L}) \\ &= \bar{Y}. \end{aligned}$$

In this chapter, because we assume that the supplies of capital and labor and the technology are fixed, output is also fixed (at a level denoted here as $\bar{Y}$). When we discuss economic growth in Chapters 7 and 8, we will examine how increases in capital and labor and improvements in the production technology lead to growth in the economy's output.

3-2 How Is National Income Distributed to the Factors of Production?

As we discussed in Chapter 2, the total output of an economy equals its total income. Because the factors of production and the production function together determine the total output of goods and services, they also determine national income. The circular flow diagram in Figure 3-1 shows that this national income flows from firms to households through the markets for the factors of production.

In this section we continue developing our model of the economy by discussing how these factor markets work. Economists have long studied factor markets to understand the distribution of income. (For example, Karl Marx, the noted nineteenth-century economist, spent much time trying to explain the incomes of capital and labor. The political philosophy of communism was in part based on Marx's now-discredited theory.) Here we examine the modern theory of how national income is divided among the factors of production. This theory, called the *neoclassical theory of distribution*, is accepted by most economists today.

Factor Prices

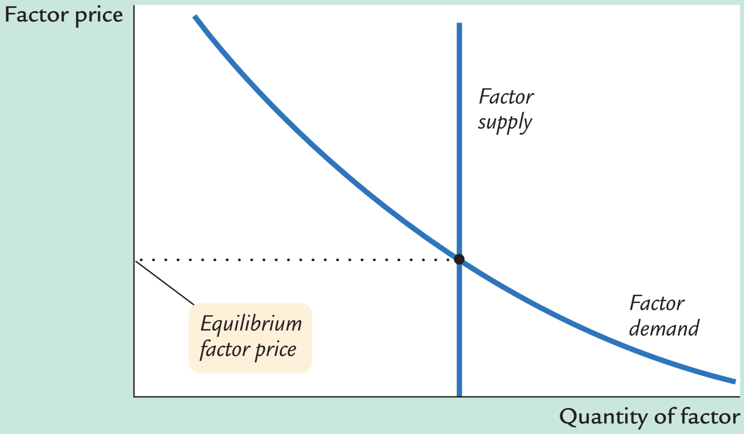
The distribution of national income is determined by factor prices. **Factor prices** are the amounts paid to the factors of production—the wage workers earn and the rent the owners of capital collect. As Figure 3-2 illustrates, the price each factor of production receives for its services is in turn determined by the supply and demand for that factor. Because we have assumed that the economy's factors of production are fixed, the factor supply curve in Figure 3-2 is vertical. The intersection of the downward-sloping factor demand curve and the vertical supply curve determines the equilibrium factor price.

To understand factor prices and the distribution of income, we must examine the demand for the factors of production. Because factor demand arises from the thousands of firms that use capital and labor, we now look at the decisions faced by a typical firm about how much of these factors to employ.

The Decisions Facing the Competitive Firm

The simplest assumption to make about a typical firm is that it is **competitive**. A competitive firm is small relative to the markets in which it trades, so it has little influence on market prices. For example, our firm produces a good and sells it at the market price. Because many firms produce this good, our firm can sell as

figure 3-2



How a Factor of Production Is Compensated The price paid to any factor of production depends on the supply and demand for that factor's services. Because we have assumed that supply is fixed, the supply curve is vertical. The demand curve is downward sloping. The intersection of supply and demand determines the equilibrium factor price.

much as it wants without causing the price of the good to fall, or it can stop selling altogether without causing the price of the good to rise. Similarly, our firm cannot influence the wages of the workers it employs because many other local firms also employ workers. The firm has no reason to pay more than the market wage, and if it tried to pay less, its workers would take jobs elsewhere. Therefore, the competitive firm takes the prices of its output and its inputs as given.

To make its product, the firm needs two factors of production, capital and labor. As we did for the aggregate economy, we represent the firm's production technology by the production function

$$Y = F(K, L),$$

where Y is the number of units produced (the firm's output), K the number of machines used (the amount of capital), and L the number of hours worked by the firm's employees (the amount of labor). The firm produces more output if it has more machines or if its employees work more hours.

The firm sells its output at a price P, hires workers at a wage W, and rents capital at a rate R. Notice that when we speak of firms renting capital, we are assuming that households own the economy's stock of capital. In this analysis, households rent out their capital, just as they sell their labor. The firm obtains both factors of production from the households that own them.[1]

The goal of the firm is to maximize profit. *Profit* is revenue minus costs—it is what the owners of the firm keep after paying for the costs of production. Revenue equals $P \times Y$, the selling price of the good P multiplied by the amount of

[1] This is a simplification. In the real world, the ownership of capital is indirect because firms own capital and households own the firms. That is, real firms have two functions: owning capital and producing output. To help us understand how the factors of production are compensated, however, we assume that firms only produce output and that households own capital directly.

the good the firm produces Y. Costs include both labor costs and capital costs. Labor costs equal $W \times L$, the wage W times the amount of labor L. Capital costs equal $R \times K$, the rental price of capital R times the amount of capital K. We can write

$$\begin{aligned} \text{Profit} &= \text{Revenue} - \text{Labor Costs} - \text{Capital Costs} \\ &= \quad PY \quad - \quad WL \quad - \quad RK. \end{aligned}$$

To see how profit depends on the factors of production, we use the production function $Y = F(K, L)$ to substitute for Y to obtain

$$\text{Profit} = PF(K, L) - WL - RK.$$

This equation shows that profit depends on the product price P, the factor prices W and R, and the factor quantities L and K. The competitive firm takes the product price and the factor prices as given and chooses the amounts of labor and capital that maximize profit.

The Firm's Demand for Factors

We now know that our firm will hire labor and rent capital in the quantities that maximize profit. But what are those profit-maximizing quantities? To answer this question, we first consider the quantity of labor and then the quantity of capital.

The Marginal Product of Labor The more labor the firm employs, the more output it produces. The **marginal product of labor (*MPL*)** is the extra amount of output the firm gets from one extra unit of labor, holding the amount of capital fixed. We can express this using the production function:

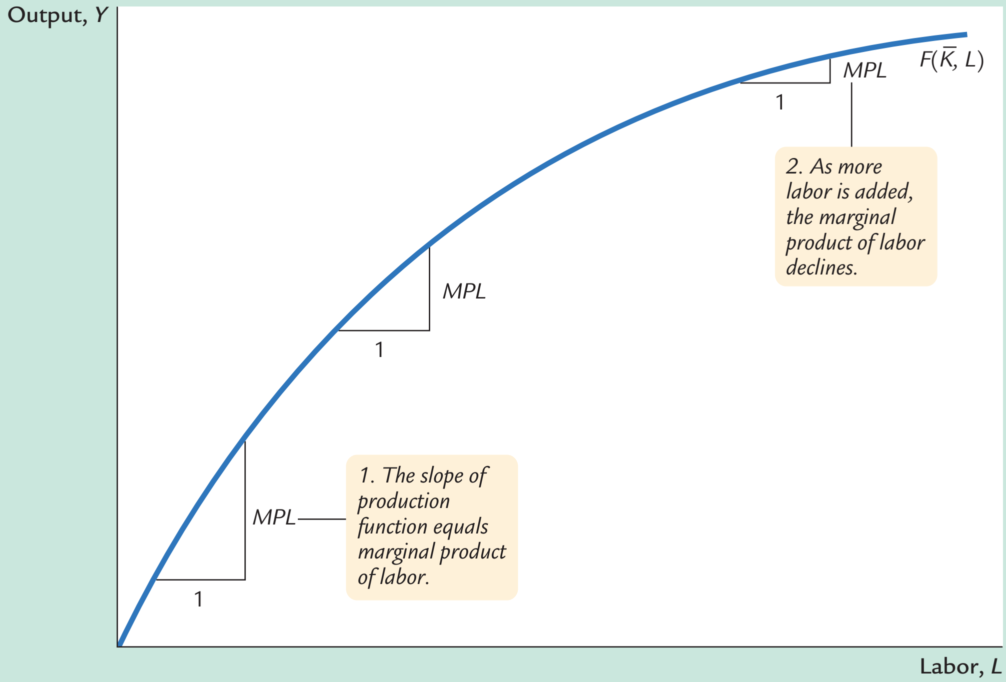
$$MPL = F(K, L + 1) - F(K, L).$$

The first term on the right-hand side is the amount of output produced with K units of capital and $L + 1$ units of labor; the second term is the amount of output produced with K units of capital and L units of labor. This equation states that the marginal product of labor is the difference between the amount of output produced with $L + 1$ units of labor and the amount produced with only L units of labor.

Most production functions have the property of **diminishing marginal product**: holding the amount of capital fixed, the marginal product of labor decreases as the amount of labor increases. Consider again the production of bread at a bakery. As a bakery hires more labor, it produces more bread. The *MPL* is the amount of extra bread produced when an extra unit of labor is hired. As more labor is added to a fixed amount of capital, however, the *MPL* falls. Fewer additional loaves are produced because workers are less productive when the kitchen is more crowded. In other words, holding the size of the kitchen fixed, each additional worker adds fewer loaves of bread to the bakery's output.

Figure 3-3 graphs the production function. It illustrates what happens to the amount of output when we hold the amount of capital constant and vary the

figure 3-3



The Production Function This curve shows how output depends on labor input, holding the amount of capital constant. The marginal product of labor *MPL* is the change in output when the labor input is increased by 1 unit. As the amount of labor increases, the production function becomes flatter, indicating diminishing marginal product.

amount of labor. This figure shows that the marginal product of labor is the slope of the production function. As the amount of labor increases, the production function becomes flatter, indicating diminishing marginal product.

From the Marginal Product of Labor to Labor Demand When the competitive, profit-maximizing firm is deciding whether to hire an additional unit of labor, it considers how that decision would affect profits. It therefore compares the extra revenue from the increased production that results from the added labor to the extra cost of higher spending on wages. The increase in revenue from an additional unit of labor depends on two variables: the marginal product of labor and the price of the output. Because an extra unit of labor produces MPL units of output and each unit of output sells for P dollars, the extra revenue is $P \times MPL$. The extra cost of hiring one more unit of labor is the wage W. Thus, the change in profit from hiring an additional unit of labor is

$$\begin{aligned}\Delta \text{ Profit} &= \Delta\text{Revenue} - \Delta\text{Cost} \\ &= (P \times MPL) - W.\end{aligned}$$

The symbol Δ (called *delta*) denotes the change in a variable.

We can now answer the question we asked at the beginning of this section: How much labor does the firm hire? The firm's manager knows that if the extra revenue $P \times MPL$ exceeds the wage W, an extra unit of labor increases profit. Therefore, the manager continues to hire labor until the next unit would no longer be profitable—that is, until the MPL falls to the point where the extra revenue equals the wage. The firm's demand for labor is determined by

$$P \times MPL = W.$$

We can also write this as

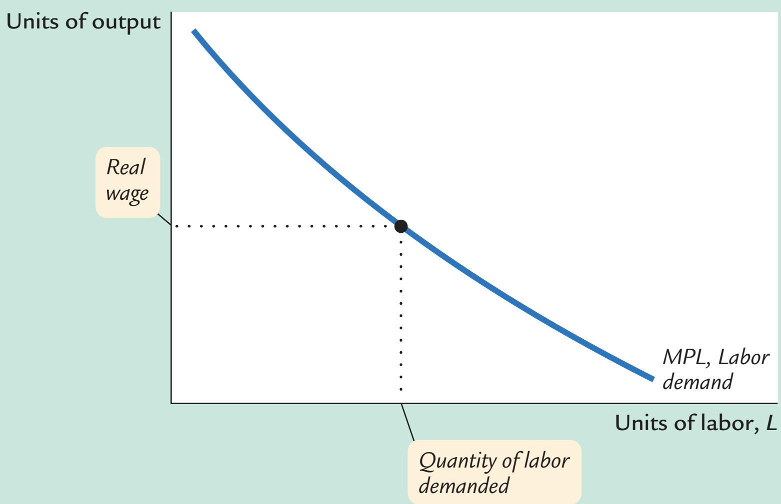
$$MPL = W/P.$$

W/P is the **real wage**—the payment to labor measured in units of output rather than in dollars. To maximize profit, the firm hires up to the point at which the marginal product of labor equals the real wage.

For example, again consider a bakery. Suppose the price of bread P is \$2 per loaf, and a worker earns a wage W of \$20 per hour. The real wage W/P is 10 loaves per hour. In this example, the firm keeps hiring workers as long as each additional worker would produce at least 10 loaves per hour. When the MPL falls to 10 loaves per hour or less, hiring additional workers is no longer profitable.

Figure 3-4 shows how the marginal product of labor depends on the amount of labor employed (holding the firm's capital stock constant). That is, this figure graphs the MPL schedule. Because the MPL diminishes as the amount of labor increases, this curve slopes downward. For any given real wage, the firm hires up to the point at which the MPL equals the real wage. Hence, the MPL schedule is also the firm's labor demand curve.

figure 3-4



The Marginal Product of Labor Schedule The marginal product of labor MPL depends on the amount of labor. The MPL curve slopes downward because the MPL declines as L increases. The firm hires labor up to the point where the real wage W/P equals the MPL. Hence, this schedule is also the firm's labor demand curve.

The Marginal Product of Capital and Capital Demand The firm decides how much capital to rent in the same way it decides how much labor to hire. The **marginal product of capital (*MPK*)** is the amount of extra output the firm gets from an extra unit of capital, holding the amount of labor constant:

$$MPK = F(K + 1, L) - F(K, L).$$

Thus, the marginal product of capital is the difference between the amount of output produced with $K + 1$ units of capital and that produced with only K units of capital. Like labor, capital is subject to diminishing marginal product.

The increase in profit from renting an additional machine is the extra revenue from selling the output of that machine minus the machine's rental price:

$$\begin{aligned}\Delta\text{Profit} &= \Delta\text{Revenue} - \Delta\text{Cost}\\ &= (P \times MPK) - R.\end{aligned}$$

To maximize profit, the firm continues to rent more capital until the MPK falls to equal the real rental price:

$$MPK = R/P.$$

The **real rental price of capital** is the rental price measured in units of goods rather than in dollars.

To sum up, the competitive, profit-maximizing firm follows a simple rule about how much labor to hire and how much capital to rent. *The firm demands each factor of production until that factor's marginal product falls to equal its real factor price.*

The Division of National Income

Having analyzed how a firm decides how much of each factor to employ, we can now explain how the markets for the factors of production distribute the economy's total income. If all firms in the economy are competitive and profit maximizing, then each factor of production is paid its marginal contribution to the production process. The real wage paid to each worker equals the MPL, and the real rental price paid to each owner of capital equals the MPK. The total real wages paid to labor are therefore $MPL \times L$, and the total real return paid to capital owners is $MPK \times K$.

The income that remains after the firms have paid the factors of production is the **economic profit** of the owners of the firms. Real economic profit is

$$\text{Economic Profit} = Y - (MPL \times L) - (MPK \times K).$$

Because we want to examine the distribution of national income, we rearrange the terms as follows:

$$Y = (MPL \times L) + (MPK \times K) + \text{Economic Profit}.$$

Total income is divided among the return to labor, the return to capital, and economic profit.

How large is economic profit? The answer is surprising: if the production function has the property of constant returns to scale, as is often thought to be the case, then economic profit must be zero. That is, nothing is left after the factors of production are paid. This conclusion follows from a famous mathematical result called *Euler's theorem*,[2] which states that if the production function has constant returns to scale, then

$$F(K, L) = (MPK \times K) + (MPL \times L).$$

If each factor of production is paid its marginal product, then the sum of these factor payments equals total output. In other words, constant returns to scale, profit maximization, and competition together imply that economic profit is zero.

If economic profit is zero, how can we explain the existence of "profit" in the economy? The answer is that the term "profit" as normally used is different from economic profit. We have been assuming that there are three types of agents: workers, owners of capital, and owners of firms. Total income is divided among wages, return to capital, and economic profit. In the real world, however, most firms own rather than rent the capital they use. Because firm owners and capital owners are the same people, economic profit and the return to capital are often lumped together. If we call this alternative definition **accounting profit**, we can say that

$$\text{Accounting Profit} = \text{Economic Profit} + (MPK \times K).$$

Under our assumptions—constant returns to scale, profit maximization, and competition—economic profit is zero. If these assumptions approximately describe the world, then the "profit" in the national income accounts must be mostly the return to capital.

We can now answer the question posed at the beginning of this chapter about how the income of the economy is distributed from firms to households. Each factor of production is paid its marginal product, and these factor payments exhaust total output. *Total output is divided between the payments to capital and the payments to labor, depending on their marginal productivities.*

CASE STUDY

The Black Death and Factor Prices

As we have just learned, in the neoclassical theory of distribution, factor prices equal the marginal products of the factors of production. Because the marginal products depend on the quantities of the factors, a change in the quantity of any one factor alters the marginal products of all the factors. Therefore, a change in the supply of a factor alters equilibrium factor prices.

Fourteenth-century Europe provides a vivid example of how factor quantities affect factor prices. The outbreak of the bubonic plague—the Black Death—in

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[2] *Mathematical note:* To prove Euler's theorem, begin with the definition of constant returns to scale: $zY = F(zK, zL)$. Now differentiate with respect to z and then evaluate at $z = 1$.

1348 reduced the population of Europe by about one-third within a few years. Because the marginal product of labor increases as the amount of labor falls, this massive reduction in the labor force raised the marginal product of labor. (The economy moved to the left along the curves in Figures 3-3 and 3-4.) Real wages did increase substantially during the plague years—doubling, by some estimates. The peasants who were fortunate enough to survive the plague enjoyed economic prosperity.

The reduction in the labor force caused by the plague also affected the return to land, the other major factor of production in medieval Europe. With fewer workers available to farm the land, an additional unit of land produced less additional output. This fall in the marginal product of land led to a decline in real rents of 50 percent or more. Thus, while the peasant classes prospered, the landed classes suffered reduced incomes.[3]

3-3 What Determines the Demand for Goods and Services?

We have seen what determines the level of production and how the income from production is distributed to workers and owners of capital. We now continue our tour of the circular flow diagram, Figure 3-1, and examine how the output from production is used.

In Chapter 2 we identified the four components of GDP:

- Consumption (C)
- Investment (I)
- Government purchases (G)
- Net exports (NX).

The circular flow diagram contains only the first three components. For now, to simplify the analysis, we assume a *closed economy*—a country that does not trade with other countries. Thus, net exports are always zero. (We examine the macroeconomics of *open economies* in Chapter 5.)

A closed economy has three uses for the goods and services it produces. These three components of GDP are expressed in the national income accounts identity:

$$Y = C + I + G.$$

Households consume some of the economy's output; firms and households use some of the output for investment; and the government buys some of the output for public purposes. We want to see how GDP is allocated among these three uses.

[3] Carlo M. Cipolla, *Before the Industrial Revolution: European Society and Economy, 1000–1700*, 2d ed. (New York: Norton, 1980), 200–202.

Consumption

When we eat food, wear clothing, or go to a movie, we are consuming some of the output of the economy. All forms of consumption together make up two-thirds of GDP. Because consumption is so large, macroeconomists have devoted much energy to studying how households decide how much to consume. Chapter 16 examines this work in detail. Here we consider the simplest story of consumer behavior.

Households receive income from their labor and their ownership of capital, pay taxes to the government, and then decide how much of their after-tax income to consume and how much to save. As we discussed in Section 3-2, the income that households receive equals the output of the economy Y. The government then taxes households an amount T. (Although the government imposes many kinds of taxes, such as personal and corporate income taxes and sales taxes, for our purposes we can lump all these taxes together.) We define income after the payment of all taxes, $Y - T$, as **disposable income**. Households divide their disposable income between consumption and saving.

We assume that the level of consumption depends directly on the level of disposable income. The higher the disposable income, the greater the consumption. Thus,

$$C = C(Y - T).$$

This equation states that consumption is a function of disposable income. The relationship between consumption and disposable income is called the **consumption function**.

The **marginal propensity to consume (*MPC*)** is the amount by which consumption changes when disposable income increases by one dollar. The *MPC* is between zero and one: an extra dollar of income increases consumption, but by less than one dollar. Thus, if households obtain an extra dollar of income, they save a portion of it. For example, if the *MPC* is 0.7, then households spend 70 cents of each additional dollar of disposable income on consumer goods and services and save 30 cents.

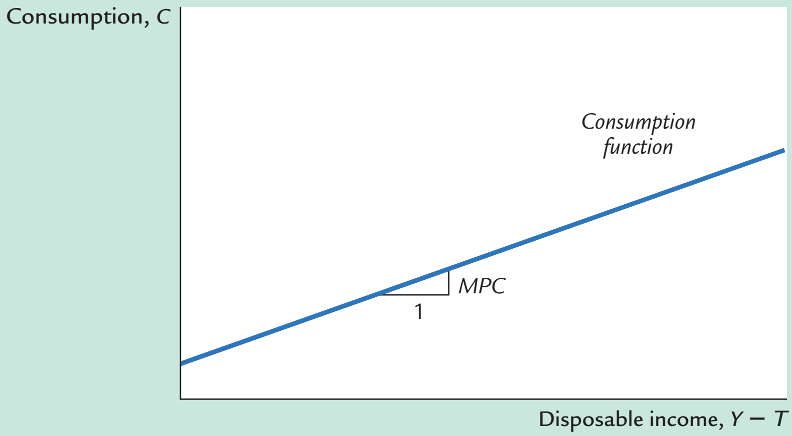
Figure 3-5 illustrates the consumption function. The slope of the consumption function tells us how much consumption increases when disposable income increases by one dollar. That is, the slope of the consumption function is the *MPC*.

Investment

Both firms and households purchase investment goods. Firms buy investment goods to add to their stock of capital and to replace existing capital as it wears out. Households buy new houses, which are also part of investment. Total investment in the United States averages about 15 percent of GDP.

The quantity of investment goods demanded depends on the interest rate, which measures the cost of the funds used to finance investment. For an investment project to be profitable, its return (the revenue from increased future

figure 3-5



The Consumption Function The consumption function relates consumption C to disposable income $Y - T$. The marginal propensity to consume MPC is the amount by which consumption increases when disposable income increases by one dollar.

production of goods and services) must exceed its cost (the payments for borrowed funds). If the interest rate rises, fewer investment projects are profitable, and the quantity of investment goods demanded falls.

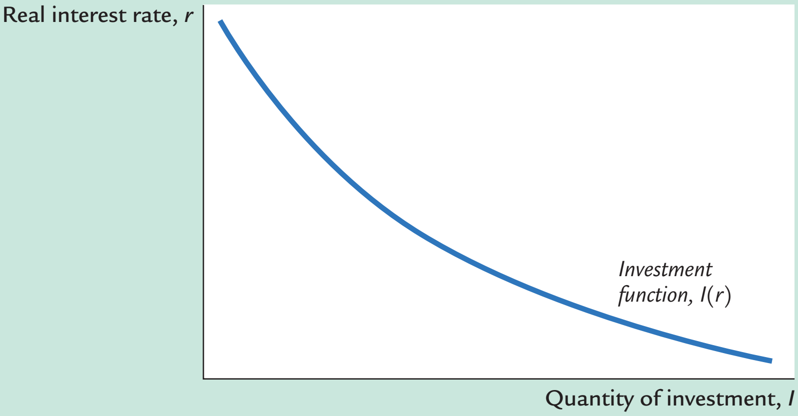
For example, suppose a firm is considering whether it should build a $1 million factory that would yield a return of $100,000 per year, or 10 percent. The firm compares this return to the cost of borrowing the $1 million. If the interest rate is below 10 percent, the firm borrows the money in financial markets and makes the investment. If the interest rate is above 10 percent, the firm forgoes the investment opportunity and does not build the factory.

The firm makes the same investment decision even if it does not have to borrow the $1 million but rather uses its own funds. The firm can always deposit this money in a bank or a money market fund and earn interest on it. Building the factory is more profitable than the deposit if and only if the interest rate is less than the 10 percent return on the factory.

A person wanting to buy a new house faces a similar decision. The higher the interest rate, the greater the cost of carrying a mortgage. A $100,000 mortgage costs $8,000 per year if the interest rate is 8 percent and $10,000 per year if the interest rate is 10 percent. As the interest rate rises, the cost of owning a home rises, and the demand for new homes falls.

When studying the role of interest rates in the economy, economists distinguish between the nominal interest rate and the real interest rate. This distinction is relevant when the overall level of prices is changing. The **nominal interest rate** is the interest rate as usually reported: it is the rate of interest that investors pay to borrow money. The **real interest rate** is the nominal interest rate corrected for the effects of inflation. If the nominal interest rate is 8 percent and the inflation rate is 3 percent, then the real interest rate is 5 percent. In Chapter 4 we discuss the relation between nominal and real interest rates in detail. Here it is sufficient to note that the real interest rate measures the true cost of borrowing and, thus, determines the quantity of investment.

figure 3-6



The Investment Function The investment function relates the quantity of investment I to the real interest rate r. Investment depends on the real interest rate because the interest rate is the cost of borrowing. The investment function slopes downward: when the interest rate rises, fewer investment projects are profitable.

We can summarize this discussion with an equation relating investment I to the real interest rate r:

$$I = I(r).$$

Figure 3-6 shows this investment function. It slopes downward, because as the interest rate rises, the quantity of investment demanded falls.

Government Purchases

Government purchases are the third component of the demand for goods and services. The federal government buys guns, missiles, and the services of government employees. Local governments buy library books, build schools, and hire teachers. Governments at all levels build roads and other public works. All these transactions make up government purchases of goods and services, which account for about 20 percent of GDP in the United States.

These purchases are only one type of government spending. The other type is transfer payments to households, such as welfare for the poor and Social Security payments for the elderly. Unlike government purchases, transfer payments are not made in exchange for some of the economy's output of goods and services. Therefore, they are not included in the variable G.

Transfer payments do affect the demand for goods and services indirectly. Transfer payments are the opposite of taxes: they increase households' disposable income, just as taxes reduce disposable income. Thus, an increase in transfer payments financed by an increase in taxes leaves disposable income unchanged. We can now revise our definition of T to equal taxes minus transfer payments. Disposable income, $Y - T$, includes both the negative impact of taxes and the positive impact of transfer payments.

If government purchases equal taxes minus transfers, then $G = T$, and the government has a *balanced budget*. If G exceeds T, the government runs a *budget*

FYI The Many Different Interest Rates

If you look in the business section of a newspaper, you will find many different interest rates reported. By contrast, throughout this book, we will talk about "the" interest rate, as if there were only one interest rate in the economy. The only distinction we will make is between the nominal interest rate (which is not corrected for inflation) and the real interest rate (which is corrected for inflation). Almost all of the interest rates reported in the newspaper are nominal.

Why does the newspaper report so many interest rates? The various interest rates differ in three ways:

- *Term*. Some loans in the economy are for short periods of time, even as short as overnight. Other loans are for 30 years or even longer. The interest rate on a loan depends on its term. Long-term interest rates are usually, but not always, higher than short-term interest rates.
- *Credit risk*. In deciding whether to make a loan, a lender must take into account the probability that the borrower will repay. The law allows borrowers to default on their loans by declaring bankruptcy. The higher the perceived probability of default, the higher the interest rate. The safest credit risk is the government, and so government bonds tend to pay a low interest rate. At the other extreme, financially shaky corporations can raise funds only by issuing *junk bonds*, which pay a high interest rate to compensate for the high risk of default.
- *Tax treatment*. The interest on different types of bonds is taxed differently. Most important, when state and local governments issue bonds, called *municipal bonds*, the holders of the bonds do not pay federal income tax on the interest income. Because of this tax advantage, municipal bonds pay a lower interest rate.

When you see two different interest rates in the newspaper, you can almost always explain the difference by considering the term, the credit risk, and the tax treatment of the loan.

Although there are many different interest rates in the economy, macroeconomists can usually ignore these distinctions. The various interest rates tend to move up and down together. The assumption that there is only one interest rate is, for our purposes, a useful simplification.

deficit, which it funds by issuing government debt—that is, by borrowing in the financial markets. If G is less than T, the government runs a *budget surplus*, which it can use to repay some of its outstanding debt.

Here we do not try to explain the political process that leads to a particular fiscal policy—that is, to the level of government purchases and taxes. Instead, we take government purchases and taxes as exogenous variables. To denote that these variables are fixed outside of our model of national income, we write

$$G = \bar{G}.$$
$$T = \bar{T}.$$

We do, however, want to examine the impact of fiscal policy on the variables determined within the model, the endogenous variables. The endogenous variables here are consumption, investment, and the interest rate.

To see how the exogenous variables affect the endogenous variables, we must complete the model. This is the subject of the next section.

3-4 What Brings the Supply and Demand for Goods and Services Into Equilibrium?

We have now come full circle in the circular flow diagram, Figure 3-1. We began by examining the supply of goods and services, and we have just discussed the demand for them. How can we be certain that all these flows balance? In other words, what ensures that the sum of consumption, investment, and government purchases equals the amount of output produced? We will see that in this classical model, the interest rate has the crucial role of equilibrating supply and demand.

There are two ways to think about the role of the interest rate in the economy. We can consider how the interest rate affects the supply and demand for goods or services. Or we can consider how the interest rate affects the supply and demand for loanable funds. As we will see, these two approaches are two sides of the same coin.

Equilibrium in the Market for Goods and Services: The Supply and Demand for the Economy's Output

The following equations summarize the discussion of the demand for goods and services in Section 3-3:

$$
\begin{aligned}
Y &= C + I + G.\\
C &= C(Y - T).\\
I &= I(r).\\
G &= \bar{G}.\\
T &= \bar{T}.
\end{aligned}
$$

The demand for the economy's output comes from consumption, investment, and government purchases. Consumption depends on disposable income; investment depends on the real interest rate; and government purchases and taxes are the exogenous variables set by fiscal policymakers.

To this analysis, let's add what we learned about the supply of goods and services in Section 3-1. There we saw that the factors of production and the production function determine the quantity of output supplied to the economy:

$$
\begin{aligned}
Y &= F(\bar{K}, \bar{L})\\
&= \bar{Y}.
\end{aligned}
$$

Now let's combine these equations describing the supply and demand for output. If we substitute the consumption function and the investment function into the national income accounts identity, we obtain

$$Y = C(Y - T) + I(r) + G.$$

Because the variables G and T are fixed by policy, and the level of output Y is fixed by the factors of production and the production function, we can write

$$\bar{Y} = C(\bar{Y} - \bar{T}) + I(r) + \bar{G}.$$

This equation states that the supply of output equals its demand, which is the sum of consumption, investment, and government purchases.

Notice that the interest rate r is the only variable not already determined in the last equation. This is because the interest rate still has a key role to play: it must adjust to ensure that the demand for goods equals the supply. The greater the interest rate, the lower the level of investment, and thus the lower the demand for goods and services, $C + I + G$. If the interest rate is too high, investment is too low, and the demand for output falls short of the supply. If the interest rate is too low, investment is too high, and the demand exceeds the supply. *At the equilibrium interest rate, the demand for goods and services equals the supply*.

This conclusion may seem somewhat mysterious. One might wonder how the interest rate gets to the level that balances the supply and demand for goods and services. The best way to answer this question is to consider how financial markets fit into the story.

Equilibrium in the Financial Markets: The Supply and Demand for Loanable Funds

Because the interest rate is the cost of borrowing and the return to lending in financial markets, we can better understand the role of the interest rate in the economy by thinking about the financial markets. To do this, rewrite the national income accounts identity as

$$Y - C - G = I.$$

The term $Y - C - G$ is the output that remains after the demands of consumers and the government have been satisfied; it is called **national saving** or simply **saving** (S). In this form, the national income accounts identity shows that saving equals investment.

To understand this identity more fully, we can split national saving into two parts—one part representing the saving of the private sector and the other representing the saving of the government:

$$(Y - T - C) + (T - G) = I.$$

The term $(Y - T - C)$ is disposable income minus consumption, which is **private saving**. The term $(T - G)$ is government revenue minus government spending, which is **public saving**. (If government spending exceeds government revenue, the government runs a budget deficit, and public saving is negative.) National saving is the sum of private and public saving. The circular flow diagram in Figure 3-1 reveals an interpretation of this equation: this equation states that the flows into the financial markets (private and public saving) must balance the flows out of the financial markets (investment).

To see how the interest rate brings financial markets into equilibrium, substitute the consumption function and the investment function into the national income accounts identity:

$$Y - C(Y - T) - G = I(r).$$

Next, note that G and T are fixed by policy and Y is fixed by the factors of production and the production function:

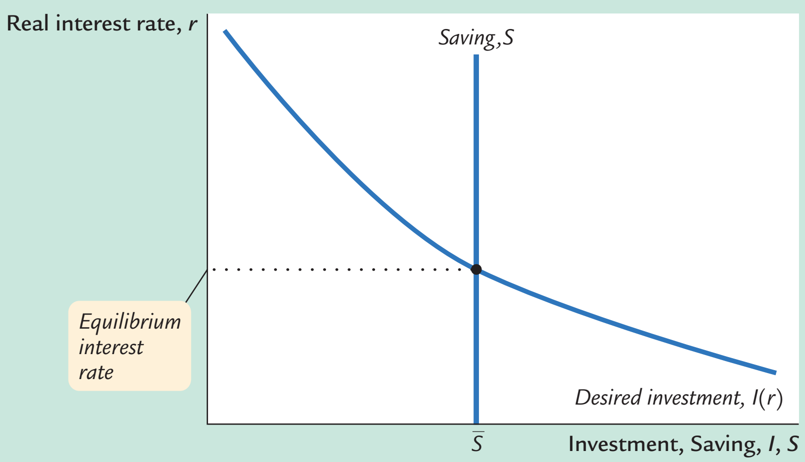
$$\bar{Y} - C(\bar{Y} - \bar{T}) - \bar{G} = I(r)$$
$$\bar{S} = I(r).$$

The left-hand side of this equation shows that national saving depends on income Y and the fiscal-policy variables G and T. For fixed values of Y, G, and T, national saving S is also fixed. The right-hand side of the equation shows that investment depends on the interest rate.

Figure 3-7 graphs saving and investment as a function of the interest rate. The saving function is a vertical line because in this model saving does not depend on the interest rate (although we relax this assumption later). The investment function slopes downward: the higher the interest rate, the fewer profitable investment projects.

From a quick glance at Figure 3-7, one might think it was a supply-and-demand diagram for a particular good. In fact, saving and investment can be interpreted in terms of supply and demand. In this case, the "good" is **loanable funds**, and its "price" is the interest rate. Saving is the supply of loanable funds—

figure 3-7



Saving, Investment, and the Interest Rate The interest rate adjusts to bring saving and investment into balance. The vertical line represents saving—the supply of loanable funds. The downward-sloping line represents investment—the demand for loanable funds. The intersection of these two curves determines the equilibrium interest rate.

households lend their saving to investors or deposit their saving in a bank that then loans the funds out. Investment is the demand for loanable funds—investors borrow from the public directly by selling bonds or indirectly by borrowing from banks. Because investment depends on the interest rate, the quantity of loanable funds demanded also depends on the interest rate.

The interest rate adjusts until the amount that firms want to invest equals the amount that households want to save. If the interest rate is too low, investors want more of the economy's output than households want to save. Equivalently, the quantity of loanable funds demanded exceeds the quantity supplied. When this happens, the interest rate rises. Conversely, if the interest rate is too high, households want to save more than firms want to invest; because the quantity of loanable funds supplied is greater than the quantity demanded, the interest rate falls. The equilibrium interest rate is found where the two curves cross. *At the equilibrium interest rate, households' desire to save balances firms' desire to invest, and the quantity of loanable funds supplied equals the quantity demanded.*

Changes in Saving: The Effects of Fiscal Policy

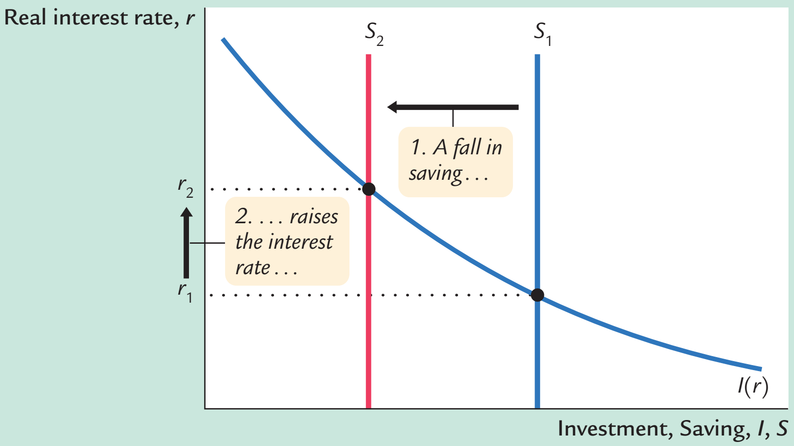
We can use our model to show how fiscal policy affects the economy. When the government changes its spending or the level of taxes, it affects the demand for the economy's output of goods and services and alters national saving, investment, and the equilibrium interest rate.

An Increase in Government Purchases Consider first the effects of an increase in government purchases of an amount ΔG. The immediate impact is to increase the demand for goods and services by ΔG. But since total output is fixed by the factors of production, the increase in government purchases must be met by a decrease in some other category of demand. Because disposable income $Y - T$ is unchanged, consumption C is unchanged. The increase in government purchases must be met by an equal decrease in investment.

To induce investment to fall, the interest rate must rise. Hence, the increase in government purchases causes the interest rate to increase and investment to decrease. Government purchases are said to **crowd out** investment.

To grasp the effects of an increase in government purchases, consider the impact on the market for loanable funds. Because the increase in government purchases is not accompanied by an increase in taxes, the government finances the additional spending by borrowing—that is, by reducing public saving. With private saving unchanged, this government borrowing reduces national saving. As Figure 3-8 shows, a reduction in national saving is represented by a leftward shift in the supply of loanable funds available for investment. At the initial interest rate, the demand for loanable funds exceeds the supply. The equilibrium interest rate rises to the point where the investment schedule crosses the new saving schedule. Thus, an increase in government purchases causes the interest rate to rise from r_1 to r_2.

figure 3-8



A Reduction in Saving A reduction in saving, possibly the result of a change in fiscal policy, shifts the saving schedule to the left. The new equilibrium is the point at which the new saving schedule crosses the investment schedule. A reduction in saving lowers the amount of investment and raises the interest rate. Fiscal-policy actions that reduce saving are said to crowd out investment.

CASE STUDY

Wars and Interest Rates in the United Kingdom, 1730–1920

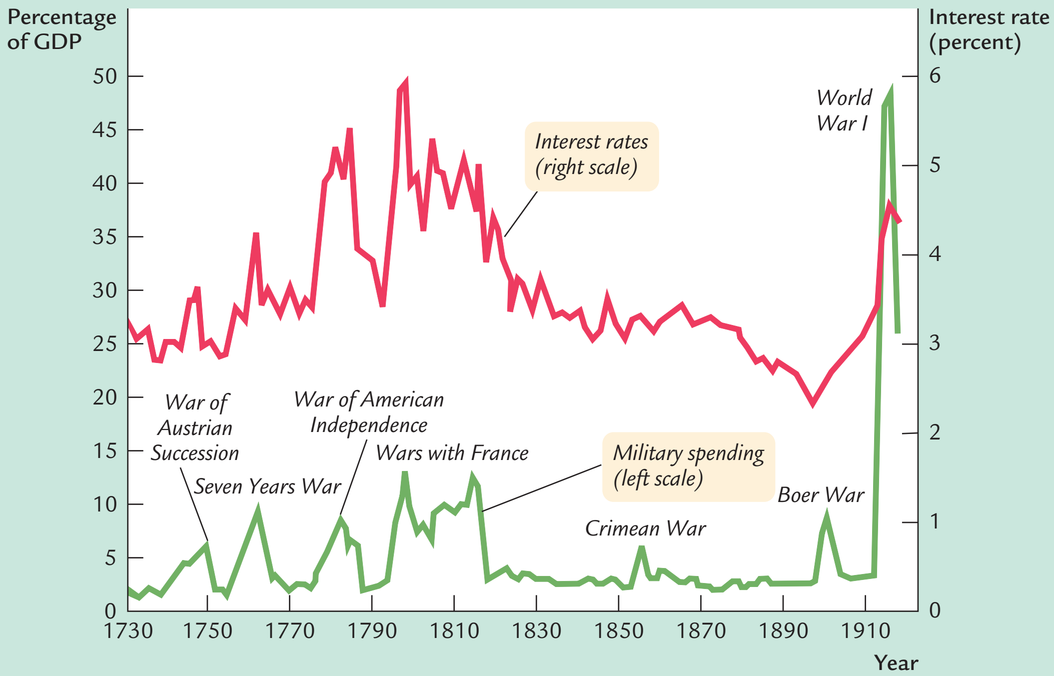
Wars are traumatic—both for those who fight them and for a nation's economy. Because the economic changes accompanying them are often large, wars provide a natural experiment with which economists can test their theories. We can learn about the economy by seeing how in wartime the endogenous variables respond to the major changes in the exogenous variables.

One exogenous variable that changes substantially in wartime is the level of government purchases. Figure 3-9 shows military spending as a percentage of GDP for the United Kingdom from 1730 to 1919. This graph shows, as one would expect, that government purchases rose suddenly and dramatically during the eight wars of this period.

Our model predicts that this wartime increase in government purchases—and the increase in government borrowing to finance the wars—should have raised the demand for goods and services, reduced the supply of loanable funds, and raised the interest rate. To test this prediction, Figure 3-9 also shows the interest rate on long-term government bonds, called *consols* in the United Kingdom. A positive association between military purchases and interest rates is apparent in this figure. These data support the model's prediction: interest rates do tend to rise when government purchases increase.[4]

[4] Daniel K. Benjamin and Levis A. Kochin, "War, Prices, and Interest Rates: A Martial Solution to Gibson's Paradox," in M. D. Bordo and A. J. Schwartz, eds., *A Retrospective on the Classical Gold Standard, 1821–1931* (Chicago: University of Chicago Press, 1984), 587–612; Robert J. Barro, "Government Spending, Interest Rates, Prices, and Budget Deficits in the United Kingdom, 1701–1918," *Journal of Monetary Economics* 20 (September 1987): 221–248.

figure 3-9



Military Spending and the Interest Rate in the United Kingdom This figure shows military spending as a percentage of GDP in the United Kingdom from 1730 to 1919. Not surprisingly, military spending rose substantially during each of the eight wars of this period. This figure also shows that the interest rate tended to rise when military spending rose.

Source: Series constructed from various sources described in Robert J. Barro, "Government Spending, Interest Rates, Prices, and Budget Deficits in the United Kingdom, 1701–1918," *Journal of Monetary Economics* 20 (September 1987): 221–248.

One problem with using wars to test theories is that many economic changes may be occurring at the same time. For example, in World War II, while government purchases increased dramatically, rationing also restricted consumption of many goods. In addition, the risk of defeat in the war and default by the government on its debt presumably increases the interest rate the government must pay. Economic models predict what happens when one exogenous variable changes and all the other exogenous variables remain constant. In the real world, however, many exogenous variables may change at once. Unlike controlled laboratory experiments, the natural experiments on which economists must rely are not always easy to interpret.

A Decrease in Taxes Now consider a reduction in taxes of ΔT. The immediate impact of the tax cut is to raise disposable income and thus to raise consumption. Disposable income rises by ΔT, and consumption rises by an amount equal to

ΔT times the marginal propensity to consume MPC. The higher the MPC, the greater the impact of the tax cut on consumption.

Because the economy's output is fixed by the factors of production and the level of government purchases is fixed by the government, the increase in consumption must be met by a decrease in investment. For investment to fall, the interest rate must rise. Hence, a reduction in taxes, like an increase in government purchases, crowds out investment and raises the interest rate.

We can also analyze the effect of a tax cut by looking at saving and investment. Because the tax cut raises disposable income by ΔT, consumption goes up by $MPC \times \Delta T$. National saving S, which equals $Y - C - G$, falls by the same amount as consumption rises. As in Figure 3-8, the reduction in saving shifts the supply of loanable funds to the left, which increases the equilibrium interest rate and crowds out investment.

Changes in Investment Demand

So far, we have discussed how fiscal policy can change national saving. We can also use our model to examine the other side of the market—the demand for investment. In this section we look at the causes and effects of changes in investment demand.

One reason investment demand might increase is technological innovation. Suppose, for example, that someone invents a new technology, such as the railroad or the computer. Before a firm or household can take advantage of the innovation, it must buy investment goods. The invention of the railroad had no value until railroad cars were produced and tracks were laid. The idea of the computer was not productive until computers were manufactured. Thus, technological innovation leads to an increase in investment demand.

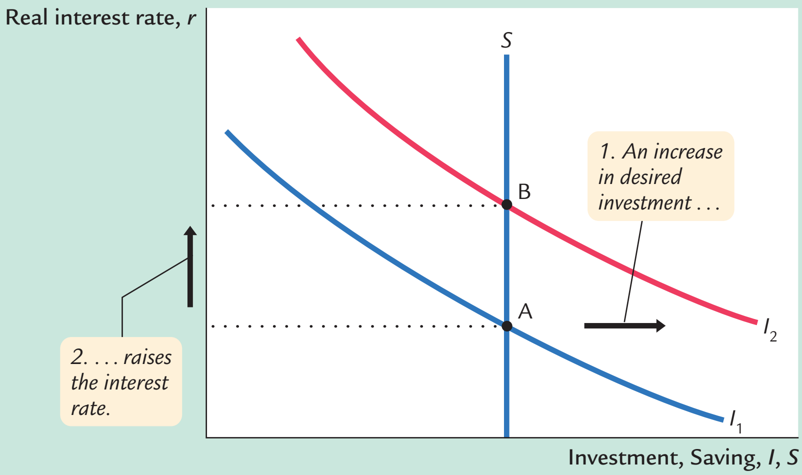
Investment demand may also change because the government encourages or discourages investment through the tax laws. For example, suppose that the government increases personal income taxes and uses the extra revenue to provide tax cuts for those who invest in new capital. Such a change in the tax laws makes more investment projects profitable and, like a technological innovation, increases the demand for investment goods.

Figure 3-10 shows the effects of an increase in investment demand. At any given interest rate, the demand for investment goods (and also for loanable funds) is higher. This increase in demand is represented by a shift in the investment schedule to the right. The economy moves from the old equilibrium, point A, to the new equilibrium, point B.

The surprising implication of Figure 3-10 is that the equilibrium amount of investment is unchanged. Under our assumptions, the fixed level of saving determines the amount of investment; in other words, there is a fixed supply of loanable funds. An increase in investment demand merely raises the equilibrium interest rate.

We would reach a different conclusion, however, if we modified our simple consumption function and allowed consumption (and its flip side, saving) to

figure 3-10

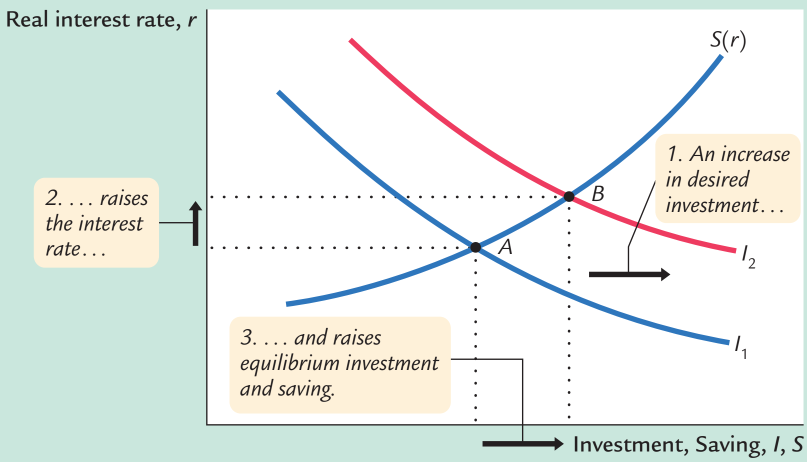


An Increase in the Demand for Investment An increase in the demand for investment goods shifts the investment schedule to the right. At any given interest rate, the amount of investment is greater. The equilibrium moves from point A to point B. Because the amount of saving is fixed, the increase in investment demand raises the interest rate while leaving the equilibrium amount of investment unchanged.

depend on the interest rate. Because the interest rate is the return to saving (as well as the cost of borrowing), a higher interest rate might reduce consumption and increase saving. If so, the saving schedule would be upward sloping, rather than vertical.

With an upward-sloping saving schedule, an increase in investment demand would raise both the equilibrium interest rate and the equilibrium quantity of investment. Figure 3-11 shows such a change. The increase in the interest rate causes households to consume less and save more. The decrease in consumption frees resources for investment.

figure 3-11



An Increase in Investment Demand When Saving Depends on the Interest Rate When saving is positively related to the interest rate, a rightward shift in the investment schedule increases the interest rate and the amount of investment. The higher interest rate induces people to increase saving, which in turn allows investment to increase.

FYI The Identification Problem

In our model, investment depends on the interest rate. The higher the interest rate, the fewer investment projects there are that are profitable. The investment schedule therefore slopes downward.

Economists who look at macroeconomic data, however, usually fail to find an obvious association between investment and interest rates. In years when interest rates are high, investment is not always low. In years when interest rates are low, investment is not always high.

How do we interpret this finding? Does it mean that investment does not depend on the interest rate? Does it suggest that our model of saving, investment, and the interest rate is inconsistent with how the economy actually functions?

Luckily, we do not have to discard our model. The inability to find an empirical relationship between investment and interest rates is an example of the *identification problem*. The identification problem arises when variables are related in more than one way. When we look at data, we are observing a combination of these different relationships, and it is difficult to "identify" any one of them.

To understand this problem more concretely, consider the relationships among saving, investment, and the interest rate. Suppose, on the one hand, that all changes in the interest rate resulted from changes in saving—that is, from shifts in the saving schedule. Then, as shown in the left-hand side of panel (a) in Figure 3-12, all changes would represent movement along a fixed investment schedule. As the right-hand side of panel (a) shows, the data would trace out this investment schedule. Thus, we would observe a negative relationship between investment and interest rates.

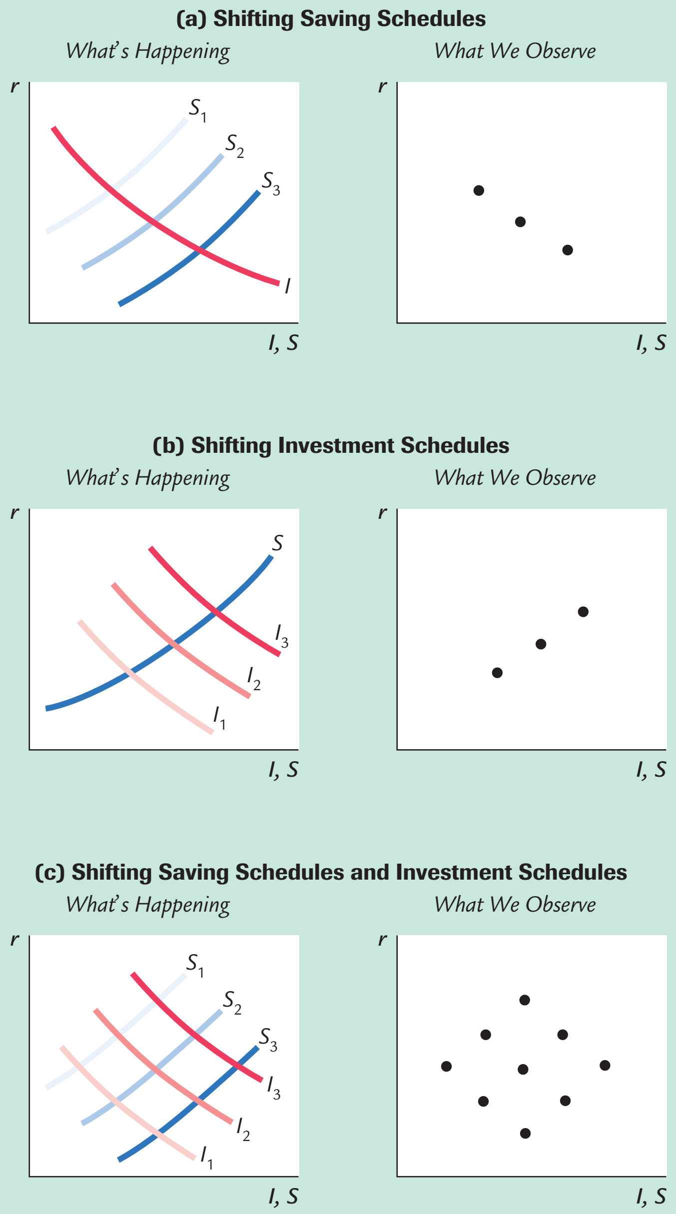
Suppose, on the other hand, that all changes in the interest rate resulted from technological innovations—that is, from shifts in the investment schedule. Then, as shown in panel (b), all changes would represent movements in the investment schedule along a fixed saving schedule. As the right-hand side of panel (b) shows, the data would reflect this saving schedule. Thus, we would observe a positive relationship between investment and interest rates.

In the real world, interest rates change sometimes because of shifts in the saving schedule and sometimes because of shifts in the investment schedule. In this mixed case, as shown in panel (c), a plot of the data would reveal no recognizable relation between interest rates and the quantity of investment, just as economists observe in actual data. The moral of the story is simple and is applicable to many other situations: the empirical relationship we expect to observe depends crucially on which exogenous variables we think are changing.

3-5 Conclusion

In this chapter we have developed a model that explains the production, distribution, and allocation of the economy's output of goods and services. Because the model incorporates all the interactions illustrated in the circular flow diagram in Figure 3-1, it is sometimes called a *general equilibrium model*. The model emphasizes how prices adjust to equilibrate supply and demand. Factor prices equilibrate factor markets. The interest rate equilibrates the supply and demand for goods and services (or, equivalently, the supply and demand for loanable funds).

figure 3-12



Identifying the Investment Function When we look at data on interest rates *r* and investment *I*, what we find depends on which exogenous variables are changing. In panel (a), the saving schedule is shifting, perhaps because of changes in fiscal policy; we would observe a negative correlation between *r* and *I*. In panel (b), the investment schedule is shifting, perhaps because of technological innovations; we would observe a positive correlation between *r* and *I*. In the more realistic situation shown in panel (c), both schedules are shifting. In the data, we would observe no correlation between *r* and *I*, which is in fact what researchers typically find.

Throughout the chapter, we have discussed various applications of the model. The model can explain how income is divided among the factors of production and how factor prices depend on factor supplies. We have also used the model to discuss how fiscal policy alters the allocation of output among its alternative uses—consumption, investment, and government purchases—and how it affects the equilibrium interest rate.

At this point it is useful to review some of the simplifying assumptions we have made in this chapter. In the following chapters we relax some of these assumptions in order to address a greater range of questions.

- We have ignored the role of money, the asset with which goods and services are bought and sold. In Chapter 4 we discuss how money affects the economy and the influence of monetary policy.
- We have assumed that there is no trade with other countries. In Chapter 5 we consider how international interactions affect our conclusions.
- We have assumed that the labor force is fully employed. In Chapter 6 we examine the reasons for unemployment and see how public policy influences the level of unemployment.
- We have assumed that the capital stock, the labor force, and the production technology are fixed. In Chapters 7 and 8 we see how changes over time in each of these lead to growth in the economy's output of goods and services.
- We have ignored the role of short-run sticky prices. In Chapters 9 through 13, we develop a model of short-run fluctuations that includes sticky prices. We then discuss how the model of short-run fluctuations relates to the model of national income developed in this chapter.

Before going on to these chapters, go back to the beginning of this one and make sure you can answer the four groups of questions about national income that begin the chapter.

Summary

1. The factors of production and the production technology determine the economy's output of goods and services. An increase in one of the factors of production or a technological advance raises output.
2. Competitive, profit-maximizing firms hire labor until the marginal product of labor equals the real wage. Similarly, these firms rent capital until the marginal product of capital equals the real rental price. Therefore, each factor of production is paid its marginal product. If the production function has constant returns to scale, all output is used to compensate the inputs.
3. The economy's output is used for consumption, investment, and government purchases. Consumption depends positively on disposable income. Investment depends negatively on the real interest rate. Government purchases and taxes are the exogenous variables of fiscal policy.
4. The real interest rate adjusts to equilibrate the supply and demand for the economy's output—or, equivalently, to equilibrate the supply of loanable funds (saving) and the demand for loanable funds (investment). A decrease in national saving, perhaps because of an increase in government purchases or a

decrease in taxes, reduces the equilibrium amount of investment and raises the interest rate. An increase in investment demand, perhaps because of a technological innovation or a tax incentive for investment, also raises the interest rate. An increase in investment demand increases the quantity of investment only if higher interest rates stimulate additional saving.

KEY CONCEPTS

Factors of production

Production function

Constant returns to scale

Factor prices

Competition

Marginal product of labor (*MPL*)

Diminishing marginal product

Real wage

Marginal product of capital (*MPK*)

Real rental price of capital

Economic profit versus accounting profit

Disposable income

Consumption function

Marginal propensity to consume (*MPC*)

Nominal interest rate

Real interest rate

National saving (saving)

Private saving

Public saving

Loanable funds

Crowding out

QUESTIONS FOR REVIEW

1. What determines the amount of output an economy produces?

2. Explain how a competitive, profit-maximizing firm decides how much of each factor of production to demand.

3. What is the role of constant returns to scale in the distribution of income?

4. What determines consumption and investment?

5. Explain the difference between government purchases and transfer payments. Give two examples of each.

6. What makes the demand for the economy's output of goods and services equal the supply?

7. Explain what happens to consumption, investment, and the interest rate when the government increases taxes.

PROBLEMS AND APPLICATIONS

1. Use the neoclassical theory of distribution to predict the impact on the real wage and the real rental price of capital of each of the following events:

a. A wave of immigration increases the labor force.

b. An earthquake destroys some of the capital stock.

c. A technological advance improves the production function.

2. If a 10-percent increase in both capital and labor causes output to increase by less than 10 percent, the production function is said to exhibit *decreasing returns to scale*. If it causes output to increase by more than 10 percent, the production function is said to exhibit *increasing returns to scale*. Why might a production function exhibit decreasing or increasing returns to scale?

3. According to the neoclassical theory of distribution, the real wage earned by any worker equals that worker's marginal productivity. Let's use this insight to examine the incomes of two groups of workers: farmers and barbers.

a. Over the past century, the productivity of farmers has risen substantially because of technological progress. According to the neoclassical theory, what should have happened to their real wage?

b. In what units is the real wage discussed in part (a) measured?

c. Over the same period, the productivity of barbers has remained constant. What should have happened to their real wage?

d. In what units is the real wage in part (c) measured?

e. Suppose workers can move freely between being farmers and being barbers. What does this mobility imply for the wages of farmers and barbers?

f. What do your previous answers imply for the price of haircuts relative to the price of food?

g. Who benefits from technological progress in farming—farmers or barbers?

4. The government raises taxes by \$100 billion. If the marginal propensity to consume is 0.6, what happens to the following? Do they rise or fall? By what amounts?

a. Public saving.

b. Private saving.

c. National saving.

d. Investment.

5. Suppose that an increase in consumer confidence raises consumers' expectations of future income and thus the amount they want to consume today. This might be interpreted as an upward shift in the consumption function. How does this shift affect investment and the interest rate?

6. Consider an economy described by the following equations:

$$Y = C + I + G,$$
$$Y = 5{,}000,$$
$$G = 1{,}000,$$
$$T = 1{,}000,$$
$$C = 250 + 0.75(Y - T),$$
$$I = 1{,}000 - 50r.$$

a. In this economy, compute private saving, public saving, and national saving.

b. Find the equilibrium interest rate.

c. Now suppose that G rises to 1,250. Compute private saving, public saving, and national saving.

d. Find the new equilibrium interest rate.

7. Suppose that the government increases taxes and government purchases by equal amounts. What happens to the interest rate and investment in response to this balanced-budget change? Does your answer depend on the marginal propensity to consume?

8. When the government subsidizes investment, such as with an investment tax credit, the subsidy often applies to only some types of investment. This question asks you to consider the effect of such a change. Suppose there are two types of investment in the economy: business investment and residential investment. And suppose that the government institutes an investment tax credit only for business investment.

a. How does this policy affect the demand curve for business investment? The demand curve for residential investment?

b. Draw the economy's supply and demand for loanable funds. How does this policy affect the supply and demand for loanable funds? What happens to the equilibrium interest rate?

c. Compare the old and the new equilibrium. How does this policy affect the total quantity of investment? The quantity of business investment? The quantity of residential investment?

9. If consumption depended on the interest rate, how would that affect the conclusions reached in this chapter about the effects of fiscal policy?

APPENDIX

The Cobb–Douglas Production Function

What production function describes how actual economies turn capital and labor into GDP? The answer to this question came from a historic collaboration between a U.S. senator and a mathematician.

Paul Douglas was a U.S. senator from Illinois from 1949 to 1966. In 1927, however, when he was still a professor of economics, he noticed a surprising fact: the division of national income between capital and labor had been roughly constant over a long period. In other words, as the economy grew more prosperous over time, the total income of workers and the total income of capital owners grew at almost exactly the same rate. This observation caused Douglas to wonder what conditions lead to constant factor shares.

Douglas asked Charles Cobb, a mathematician, what production function, if any, would produce constant factor shares if factors always earned their marginal products. The production function would need to have the property that

$$\text{Capital Income} = MPK \times K = \alpha Y$$

and

$$\text{Labor Income} = MPL \times L = (1 - \alpha)\ Y,$$

where α is a constant between zero and one that measures capital's share of income. That is, α determines what share of income goes to capital and what share goes to labor. Cobb showed that the function with this property is

$$Y = F(K, L) = AK^{\alpha}L^{1-\alpha},$$

where A is a parameter greater than zero that measures the productivity of the available technology. This function became known as the *Cobb–Douglas production function*.

Let's take a closer look at some of the properties of this production function. First, the Cobb–Douglas production function has constant returns to scale. That is, if capital and labor are increased by the same proportion, then output increases by that proportion as well.[5]

---

[5] *Mathematical note:* To prove that the Cobb–Douglas production function has constant returns to scale, examine what happens when we multiply capital and labor by a constant z:

$$F(zK, zL) = A(zK)^{\alpha}(zL)^{1-\alpha}.$$

Expanding terms on the right,

$$F(zK, zL) = Az^{\alpha}K^{\alpha}z^{1-\alpha}L^{1-\alpha}.$$

(*footnote continues*)

Next, consider the marginal products for the Cobb–Douglas production function. The marginal product of labor is[6]

$$MPL = (1 - \alpha)\, AK^{\alpha}L^{-\alpha},$$

and the marginal product of capital is

$$MPK = \alpha AK^{\alpha-1}L^{1-\alpha}.$$

From these equations, recalling that α is between zero and one, we can see what causes the marginal products of the two factors to change. An increase in the amount of capital raises the *MPL* and reduces the *MPK*. Similarly, an increase in the amount of labor reduces the *MPL* and raises the *MPK*. A technological advance that increases the parameter A raises the marginal product of both factors proportionately.

The marginal products for the Cobb–Douglas production function can also be written as[7]

$$MPL = (1 - \alpha)Y/L.$$
$$MPK = \alpha Y/K.$$

The *MPL* is proportional to output per worker, and the *MPK* is proportional to output per unit of capital. Y/L is called *average labor productivity*, and Y/K is called *average capital productivity*. If the production function is Cobb–Douglas, then the marginal productivity of a factor is proportional to its average productivity.

We can now verify that if factors earn their marginal products, then the parameter α indeed tells us how much income goes to labor and how much goes to capital. The total wage bill, which we have seen is $MPL \times L$, is simply $(1 - \alpha)Y$.

Rearranging to bring like terms together, we get

$$F(zK, zL) = z^{\alpha}z^{1-\alpha}AK^{\alpha}L^{1-\alpha}.$$

Since $z^{\alpha}z^{1-\alpha} = z$, our function becomes

$$F(zK, zL) = zAK^{\alpha}L^{1-\alpha}.$$

But $AK^{\alpha}L^{1-\alpha} = F(K, L)$. Thus,

$$F(zK, zL) = zF(K, L) = zY.$$

Hence, the amount of output Y increases by the same factor z, which implies that this production function has constant returns to scale.

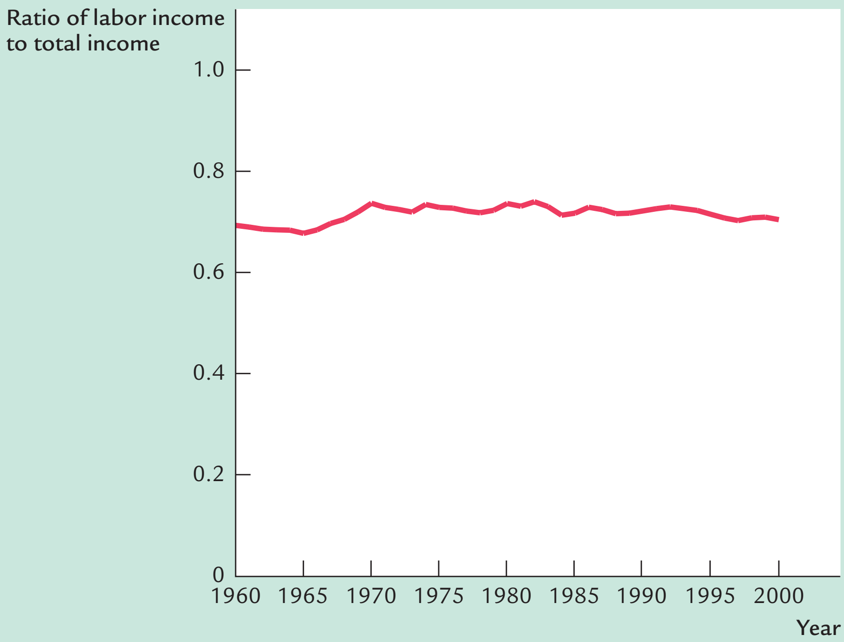
[6] *Mathematical note:* Obtaining the formulas for the marginal products from the production function requires a bit of calculus. To find the *MPL*, differentiate the production function with respect to L. This is done by multiplying by the exponent $(1 - \alpha)$, and then subtracting 1 from the old exponent to obtain the new exponent, $-\alpha$. Similarly, to obtain the *MPK*, differentiate the production function with respect to K.

[7] *Mathematical note:* To check these expressions for the marginal products, substitute in the production function for Y to show that these expressions are equivalent to the earlier formulas for the marginal products.

Therefore, $(1 - \alpha)$ is labor's share of output. Similarly, the total return to capital, $MPK \times K$, is αY, and α is capital's share of output. The ratio of labor income to capital income is a constant, $(1 - \alpha)/\alpha$, just as Douglas observed. The factor shares depend only on the parameter α, not on the amounts of capital or labor or on the state of technology as measured by the parameter A.

More recent U.S. data are also consistent with the Cobb–Douglas production function. Figure 3-13 shows the ratio of labor income to total income in the United States from 1960 to 2000. Despite the many changes in the economy over the past four decades, this ratio has remained about 0.7. This division of income is easily explained by a Cobb–Douglas production function in which the parameter α is about 0.3.

figure 3-13



The Ratio of Labor Income to Total Income Labor income has remained about 0.7 of total income over a long period of time. This approximate constancy of factor shares is evidence for the Cobb–Douglas production function. (This figure is produced from U.S. national income accounts data. Labor income is compensation of employees. Total income is the sum of labor income, corporate profits, net interest, rental income, and depreciation. Proprietors' income is excluded from these calculations, because it is a combination of labor income and capital income.)

Source: U.S. Department of Commerce.

MORE PROBLEMS AND APPLICATIONS

1. Suppose that the production function is Cobb–Douglas with parameter $\alpha = 0.3$.

a. What fractions of income do capital and labor receive?

b. Suppose that immigration raises the labor force by 10 percent. What happens to total output (in percent)? The rental price of capital? The real wage?

c. Suppose that a gift of capital from abroad raises the capital stock by 10 percent. What happens to total output (in percent)? The rental price of capital? The real wage?

d. Suppose that a technological advance raises the value of the parameter A by 10 percent. What happens to total output (in percent)? The rental price of capital? The real wage?

2. (This problem requires the use of calculus.) Consider a Cobb–Douglas production function with three inputs. K is capital (the number of machines), L is labor (the number of workers), and H is human capital (the number of college degrees among the workers). The production function is

$$Y = K^{1/3}L^{1/3}H^{1/3}.$$

a. Derive an expression for the marginal product of labor. How does an increase in the amount of human capital affect the marginal product of labor?

b. Derive an expression for the marginal product of human capital. How does an increase in the amount of human capital affect the marginal product of human capital?

c. What is the income share paid to labor? What is the income share paid to human capital? In the national income accounts of this economy, what share of total income do you think workers would appear to receive? (*Hint:* Consider where the return to human capital shows up.)

d. An unskilled worker earns the marginal product of labor, whereas a skilled worker earns the marginal product of labor plus the marginal product of human capital. Using your answers to (a) and (b), find the ratio of the skilled wage to the unskilled wage. How does an increase in the amount of human capital affect this ratio? Explain.

e. Some people advocate government funding of college scholarships as a way of creating a more egalitarian society. Others argue that scholarships help only those who are able to go to college. Do your answers to the preceding questions shed light on this debate?

CHAPTER FOUR

Money and Inflation

> *There is no subtler, no surer means of overturning the existing basis of society than to debauch the currency. The process engages all the hidden forces of economic law on the side of destruction, and does it in a manner which not one man in a million is able to diagnose.*
>
> — *John Maynard Keynes*

In 1970 the *New York Times* cost 15 cents, the median price of a single-family home was $23,400, and the average wage in manufacturing was $3.36 per hour. In 2000 the *Times* cost 75 cents, the price of a home was $166,000, and the average wage was $14.26 per hour. This overall increase in prices is called **inflation**, and it is the subject of this chapter.

The rate of inflation—the percentage change in the overall level of prices—varies greatly over time and across countries. In the United States, according to the consumer price index, prices rose an average of 2.4 percent per year in the 1960s, 7.1 percent per year in the 1970s, 5.5 percent per year in the 1980s, and 3.0 percent in the 1990s. Even when the U.S inflation problem became severe during the 1970s, it was nothing compared to the episodes of extraordinarily high inflation, called **hyperinflation**, that other countries have experienced from time to time. A classic example is Germany in 1923, when prices rose an average of 500 percent *per month*.

In this chapter we examine the classical theory of the causes, effects, and social costs of inflation. The theory is "classical" in the sense that it assumes that prices are flexible. As we first discussed in Chapter 1, most economists believe this assumption describes the behavior of the economy in the long run. By contrast, many prices are thought to be sticky in the short run, and beginning in Chapter 9, we incorporate this fact into our analysis. Yet, for now, we ignore short-run price stickiness. As we will see, the classical theory of inflation not only provides a good description of the long run, it also provides a useful foundation for the short-run analysis we develop later.

The "hidden forces of economic law" that lead to inflation are not as mysterious as Keynes claims in the quotation that opens this chapter. Inflation is simply an increase in the average level of prices, and a price is the rate at which money is exchanged for a good or a service. To understand inflation, therefore, we must understand money—what it is, what affects its supply and demand, and what influence it has on the economy. Thus, Section 4-1 begins our analysis of inflation by discussing the economist's concept of "money" and how, in most modern economies, the government controls the quantity of money in the hands of the public. Section 4-2 shows that the quantity of money determines the price level and that the rate of growth in the quantity of money determines the rate of inflation.

Inflation in turn has numerous effects of its own on the economy. Section 4-3 discusses the revenue that the government raises by printing money, sometimes called the *inflation tax*. Section 4-4 examines how inflation affects the nominal interest rate. Section 4-5 discusses how the nominal interest rate in turn affects the quantity of money people wish to hold and, thereby, the price level.

After completing our analysis of the causes and effects of inflation, in Section 4-6 we address what is perhaps the most important question about inflation: Is it a major social problem? Does inflation amount to "overturning the existing basis of society," as the chapter's opening quotation suggests?

Finally, in Section 4-7, we discuss the extreme case of hyperinflation. Hyperinflations are interesting to examine because they show clearly the causes, effects, and costs of inflation. Just as seismologists learn much by studying earthquakes, economists learn much by studying how hyperinflations begin and end.

4-1 What Is Money?

When we say that a person has a lot of money, we usually mean that he or she is wealthy. By contrast, economists use the term *money* in a more specialized way. To an economist, money does not refer to all wealth but only to one type of it: **money** is the stock of assets that can be readily used to make transactions. Roughly speaking, the dollars in the hands of the public make up the nation's stock of money.

The Functions of Money

Money has three purposes. It is a store of value, a unit of account, and a medium of exchange.

As a **store of value**, money is a way to transfer purchasing power from the present to the future. If I work today and earn $100, I can hold the money and spend it tomorrow, next week, or next month. Of course, money is an imperfect store of value: if prices are rising, the amount you can buy with any given quantity of money is falling. Even so, people hold money because they can trade the money for goods and services at some time in the future.

As a **unit of account**, money provides the terms in which prices are quoted and debts are recorded. Microeconomics teaches us that resources are allocated according to relative prices—the prices of goods relative to other goods—yet stores post their prices in dollars and cents. A car dealer tells you that a car costs $20,000, not 400 shirts (even though it may amount to the same thing). Similarly, most debts require the debtor to deliver a specified number of dollars in the future, not a specified amount of some commodity. Money is the yardstick with which we measure economic transactions.

As a **medium of exchange**, money is what we use to buy goods and services. "This note is legal tender for all debts, public and private" is printed on the U.S. dollar. When we walk into stores, we are confident that the shopkeepers will accept our money in exchange for the items they are selling. The ease with which money is converted into other things—goods and services—is sometimes called money's *liquidity*.

To better understand the functions of money, try to imagine an economy without it: a barter economy. In such a world, trade requires the *double coincidence of wants*—the unlikely happenstance of two people each having a good that the other wants at the right time and place to make an exchange. A barter economy permits only simple transactions.

Money makes more indirect transactions possible. A professor uses her salary to buy books; the book publisher uses its revenue from the sale of books to buy paper; the paper company uses its revenue from the sale of paper to pay the lumberjack; the lumberjack uses his income to send his child to college; and the college uses its tuition receipts to pay the salary of the professor. In a complex, modern economy, trade is often indirect and requires the use of money.

The Types of Money

Money takes many forms. In the U.S. economy we make transactions with an item whose sole function is to act as money: dollar bills. These pieces of green paper with small portraits of famous Americans would have little value if they were not widely accepted as money. Money that has no intrinsic value is called **fiat money** because it is established as money by government decree, or fiat.

Although fiat money is the norm in most economies today, most societies in the past have used for money a commodity with some intrinsic value. Money of this sort is called **commodity money**. The most widespread example of commodity money is gold. When people use gold as money (or use paper money that is redeemable for gold), the economy is said to be on a **gold standard**. Gold is a form of commodity money because it can be used for various purposes—jewelry, dental fillings, and so on—as well as for transactions. The gold standard was common throughout the world during the late nineteenth century.

Drawing by Bernard Schoenbaum; © 1979 The New Yorker Magazine, Inc.

"And how would you like your funny money?"

CASE STUDY

Money in a POW Camp

An unusual form of commodity money developed in some Nazi prisoner of war (POW) camps during World War II. The Red Cross supplied the prisoners with various goods—food, clothing, cigarettes, and so on. Yet these rations were allocated without close attention to personal preferences, so the allocations were often inefficient. One prisoner may have preferred chocolate, while another may have preferred cheese, and a third may have wanted a new shirt. The differing tastes and endowments of the prisoners led them to trade with one another.

Barter proved to be an inconvenient way to allocate these resources, however, because it required the double coincidence of wants. In other words, a barter system was not the easiest way to ensure that each prisoner received the goods he valued most. Even the limited economy of the POW camp needed some form of money to facilitate transactions.

Eventually, cigarettes became the established "currency" in which prices were quoted and with which trades were made. A shirt, for example, cost about 80 cigarettes. Services were also quoted in cigarettes: some prisoners offered to do other prisoners' laundry for 2 cigarettes per garment. Even nonsmokers were happy to accept cigarettes in exchange, knowing they could trade the cigarettes in the future for some good they did enjoy. Within the POW camp the cigarette became the store of value, the unit of account, and the medium of exchange.[1]

How Fiat Money Evolves

It is not surprising that some form of commodity money arises to facilitate exchange: people are willing to accept a commodity currency such as gold because it has intrinsic value. The development of fiat money, however, is more perplexing. What would make people begin to value something that is intrinsically useless?

To understand how the evolution from commodity money to fiat money takes place, imagine an economy in which people carry around bags of gold. When a purchase is made, the buyer measures out the appropriate amount of gold. If the seller is convinced that the weight and purity of the gold are right, the buyer and seller make the exchange.

The government might first get involved in the monetary system to help people reduce transaction costs. Using raw gold as money is costly because it takes time to verify the purity of the gold and to measure the correct quantity. To reduce these costs, the government can mint gold coins of known purity and weight. The coins are easier to use than gold bullion because their values are widely recognized.

The next step is for the government to accept gold from the public in exchange for gold certificates—pieces of paper that can be redeemed for a certain

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[1] R. A. Radford, "The Economic Organisation of a P.O.W. Camp," *Economica* (November 1945): 189–201. The use of cigarettes as money is not limited to this example. In the Soviet Union in the late 1980s, packs of Marlboros were preferred to the ruble in the large underground economy.

quantity of gold. If people believe the government's promise to redeem the paper bills for gold, the bills are just as valuable as the gold itself. In addition, because the bills are lighter than gold (and gold coins), they are easier to use in transactions. Eventually, no one carries gold around at all, and these gold-backed government bills become the monetary standard.

Finally, the gold backing becomes irrelevant. If no one ever bothers to redeem the bills for gold, no one cares if the option is abandoned. As long as everyone continues to accept the paper bills in exchange, they will have value and serve as money. Thus, the system of commodity money evolves into a system of fiat money. Notice that in the end, the use of money in exchange is a social convention: everyone values fiat money because they expect everyone else to value it.

CASE STUDY

Money and Social Conventions on the Island of Yap

The economy of Yap, a small island in the Pacific, once had a type of money that was something between commodity and fiat money. The traditional medium of exchange in Yap was *fei*, stone wheels up to 12 feet in diameter. These stones had holes in the center so that they could be carried on poles and used for exchange.

Large stone wheels are not a convenient form of money. The stones were heavy, so it took substantial effort for a new owner to take his *fei* home after completing a transaction. Although the monetary system facilitated exchange, it did so at great cost.

Eventually, it became common practice for the new owner of the *fei* not to bother to take physical possession of the stone. Instead, the new owner accepted a claim to the *fei* without moving it. In future bargains, he traded this claim for goods that he wanted. Having physical possession of the stone became less important than having legal claim to it.

This practice was put to a test when a valuable stone was lost at sea during a storm. Because the owner lost his money by accident rather than through negligence, everyone agreed that his claim to the *fei* remained valid. Even generations later, when no one alive had ever seen this stone, the claim to this *fei* was still valued in exchange.[2]

How the Quantity of Money Is Controlled

The quantity of money available is called the **money supply**. In an economy that uses commodity money, the money supply is the quantity of that commodity. In an economy that uses fiat money, such as most economies today, the government controls the supply of money: legal restrictions give the government a monopoly on the printing of money. Just as the level of taxation and the level of government purchases are policy instruments of the government, so is the supply of money. The control over the money supply is called **monetary policy**.

[2] Norman Angell, *The Story of Money* (New York: Frederick A. Stokes Company, 1929), 88–89.

In the United States and many other countries, monetary policy is delegated to a partially independent institution called the **central bank**. The central bank of the United States is the **Federal Reserve**—often called *the Fed*. If you look at a U.S. dollar bill, you will see that it is called a *Federal Reserve Note*. Decisions over monetary policy are made by the Federal Open Market Committee. This committee is made up of members of the Federal Reserve Board, who are appointed by the president and confirmed by Congress, together with the presidents of the regional Federal Reserve Banks. The Federal Open Market Committee meets about every six weeks to discuss and set monetary policy.

The primary way in which the Fed controls the supply of money is through **open-market operations**—the purchase and sale of government bonds. When the Fed wants to increase the money supply, it uses some of the dollars it has to buy government bonds from the public. Because these dollars leave the Fed and enter into the hands of the public, the purchase increases the quantity of money in circulation. Conversely, when the Fed wants to decrease the money supply, it sells some government bonds from its own portfolio. This open-market sale of bonds takes some dollars out of the hands of the public and, thus, decreases the quantity of money in circulation.

In Chapter 18 we discuss in detail how the Fed controls the supply of money. For our current discussion, these details are not crucial. It is sufficient to assume that the Fed (or any other central bank) directly controls the supply of money.

How the Quantity of Money Is Measured

One goal of this chapter is to determine how the money supply affects the economy; we turn to that problem in the next section. As background for that analysis, let's first discuss how economists measure the quantity of money.

Because money is the stock of assets used for transactions, the quantity of money is the quantity of those assets. In simple economies, this quantity is easy to measure. In the POW camp, the quantity of money was the quantity of cigarettes in the camp. But how can we measure the quantity of money in more complex economies such as ours? The answer is not obvious, because no single asset is used for all transactions. People can use various assets, such as cash or checks, to make transactions, although some assets are more convenient than others. This ambiguity leads to numerous measures of the quantity of money.

The most obvious asset to include in the quantity of money is **currency**, the sum of outstanding paper money and coins. Most day-to-day transactions use currency as the medium of exchange.

A second type of asset used for transactions is **demand deposits**, the funds people hold in their checking accounts. If most sellers accept personal checks, assets in a checking account are almost as convenient as currency. In both cases, the assets are in a form ready to facilitate a transaction. Demand deposits are, therefore, added to currency when measuring the quantity of money.

Once we admit the logic of including demand deposits in the measured money stock, many other assets become candidates for inclusion. Funds in savings accounts, for example, can be easily transferred into checking accounts; these assets are almost as convenient for transactions. Money market mutual funds allow investors to write checks against their accounts, although restrictions sometimes apply with regard to the size of the check or the number of checks written. Since these assets can be easily used for transactions, they should arguably be included in the quantity of money.

table 4-1

The Measures of Money

Symbol	Assets Included	Amount in March 2001 (billions of dollars)
C	Currency	$ 539
*M*1	Currency plus demand deposits, traveler's checks, and other checkable deposits	1,111
*M*2	*M*1 plus retail money market mutual fund balances, saving deposits (including money market deposit accounts), and small time deposits	5,100
*M*3	*M*2 plus large time deposits, repurchase agreements, Eurodollars, and institution-only money market mutual fund balances	7,326

Source: Federal Reserve.

Because it is hard to judge which assets should be included in the money stock, various measures are available. Table 4-1 presents the four measures of the money stock that the Federal Reserve calculates for the U.S. economy, together with a list of which assets are included in each measure. From the smallest to the largest, they are designated *C*, *M*1, *M*2, and *M*3. The most common measures for studying the effects of money on the economy are *M*1 and *M*2. There is no consensus, however, about which measure of the money stock is best. Disagreements about monetary policy sometimes arise because different measures of money are moving in different directions.

4-2 The Quantity Theory of Money

Having defined what money is and described how it is controlled and measured, we can now examine how the quantity of money affects the economy. To do this, we must see how the quantity of money is related to other economic variables, such as prices and incomes.

Transactions and the Quantity Equation

People hold money to buy goods and services. The more money they need for such transactions, the more money they hold. Thus, the quantity of money in the economy is related to the number of dollars exchanged in transactions.

The link between transactions and money is expressed in the following equation, called the **quantity equation**:

$$\begin{array}{ccccccc} \text{Money} & \times & \text{Velocity} & = & \text{Price} & \times & \text{Transactions} \\ M & \times & V & = & P & \times & T. \end{array}$$

Let's examine each of the four variables in this equation.

The right-hand side of the quantity equation tells us about transactions. T represents the total number of transactions during some period of time, say, a year. In other words, T is the number of times in a year that goods or services are exchanged for money. P is the price of a typical transaction—the number of dollars exchanged. The product of the price of a transaction and the number of transactions, PT, equals the number of dollars exchanged in a year.

The left-hand side of the quantity equation tells us about the money used to make the transactions. M is the quantity of money. V is called the **transactions velocity of money** and measures the rate at which money circulates in the economy. In other words, velocity tells us the number of times a dollar bill changes hands in a given period of time.

For example, suppose that 60 loaves of bread are sold in a given year at \$0.50 per loaf. Then T equals 60 loaves per year, and P equals \$0.50 per loaf. The total number of dollars exchanged is

$$PT = \$0.50/\text{loaf} \times 60 \text{ loaves/year} = \$30/\text{year}.$$

The right-hand side of the quantity equation equals \$30 per year, which is the dollar value of all transactions.

Suppose further that the quantity of money in the economy is \$10. By rearranging the quantity equation, we can compute velocity as

$$\begin{aligned} V &= PT/M \\ &= (\$30/\text{year})/(\$10) \\ &= 3 \text{ times per year.} \end{aligned}$$

That is, for \$30 of transactions per year to take place with \$10 of money, each dollar must change hands 3 times per year.

The quantity equation is an *identity*: the definitions of the four variables make it true. The equation is useful because it shows that if one of the variables changes, one or more of the others must also change to maintain the equality. For example, if the quantity of money increases and the velocity of money stays unchanged, then either the price or the number of transactions must rise.

From Transactions to Income

When studying the role of money in the economy, economists usually use a slightly different version of the quantity equation than the one just introduced. The problem with the first equation is that the number of transactions is difficult to measure. To solve this problem, the number of transactions T is replaced by the total output of the economy Y.

Transactions and output are related, because the more the economy produces, the more goods are bought and sold. They are not the same, however. When one person sells a used car to another person, for example, they make a transaction using money, even though the used car is not part of current output. Nonetheless, the dollar value of transactions is roughly proportional to the dollar value of output.

If Y denotes the amount of output and P denotes the price of one unit of output, then the dollar value of output is PY. We encountered measures for these variables when we discussed the national income accounts in Chapter 2: Y is real GDP, P is the GDP deflator, and PY is nominal GDP. The quantity equation becomes

$$\begin{array}{ccccccc} \text{Money} & \times & \text{Velocity} & = & \text{Price} & \times & \text{Output} \\ M & \times & V & = & P & \times & Y. \end{array}$$

Because Y is also total income, V in this version of the quantity equation is called the **income velocity of money**. The income velocity of money tells us the number of times a dollar bill enters someone's income in a given period of time. This version of the quantity equation is the most common, and it is the one we use from now on.

The Money Demand Function and the Quantity Equation

When we analyze how money affects the economy, it is often useful to express the quantity of money in terms of the quantity of goods and services it can buy. This amount, M/P, is called **real money balances**.

Real money balances measure the purchasing power of the stock of money. For example, consider an economy that produces only bread. If the quantity of money is \$10, and the price of a loaf is \$0.50, then real money balances are 20 loaves of bread. That is, at current prices, the stock of money in the economy is able to buy 20 loaves.

A **money demand function** is an equation that shows what determines the quantity of real money balances people wish to hold. A simple money demand function is

$$(M/P)^{\mathrm{d}} = kY,$$

where k is a constant that tells us how much money people want to hold for every dollar of income. This equation states that the quantity of real money balances demanded is proportional to real income.

The money demand function is like the demand function for a particular good. Here the "good" is the convenience of holding real money balances. Just as owning an automobile makes it easier for a person to travel, holding money makes it easier to make transactions. Therefore, just as higher income leads to a greater demand for automobiles, higher income also leads to a greater demand for real money balances.

This money demand function offers another way to view the quantity equation. To see this, add to the money demand function the condition that the demand for real money balances $(M/P)^d$ must equal the supply M/P. Therefore,

$$M/P = kY.$$

A simple rearrangement of terms changes this equation into

$$M(1/k) = PY,$$

which can be written as

$$MV = PY,$$

where $V = 1/k$. This simple mathematics shows the link between the demand for money and the velocity of money. When people want to hold a lot of money for each dollar of income (k is large), money changes hands infrequently (V is small). Conversely, when people want to hold only a little money (k is small), money changes hands frequently (V is large). In other words, the money demand parameter k and the velocity of money V are opposite sides of the same coin.

The Assumption of Constant Velocity

The quantity equation can be viewed as a definition: it defines velocity V as the ratio of nominal GDP, PY, to the quantity of money M. Yet if we make the additional assumption that the velocity of money is constant, then the quantity equation becomes a useful theory of the effects of money, called the **quantity theory of money**.

As with many of the assumptions in economics, the assumption of constant velocity is only an approximation to reality. Velocity does change if the money demand function changes. For example, when automatic teller machines were introduced, people could reduce their average money holdings, which meant a fall in the money demand parameter k and an increase in velocity V. Nonetheless, experience shows that the assumption of constant velocity provides a good approximation in many situations. Let's therefore assume that velocity is constant and see what this assumption implies about the effects of the money supply on the economy.

Once we assume that velocity is constant, the quantity equation can be seen as a theory of what determines nominal GDP. The quantity equation says

$$M\bar{V} = PY,$$

where the bar over V means that velocity is fixed. Therefore, a change in the quantity of money (M) must cause a proportionate change in nominal GDP (PY). That is, if velocity is fixed, the quantity of money determines the dollar value of the economy's output.

Money, Prices, and Inflation

We now have a theory to explain what determines the economy's overall level of prices. The theory has three building blocks:

1. The factors of production and the production function determine the level of output Y. We borrow this conclusion from Chapter 3.
2. The money supply determines the nominal value of output, PY. This conclusion follows from the quantity equation and the assumption that the velocity of money is fixed.
3. The price level P is then the ratio of the nominal value of output, PY, to the level of output Y.

In other words, the productive capability of the economy determines real GDP, the quantity of money determines nominal GDP, and the GDP deflator is the ratio of nominal GDP to real GDP.

This theory explains what happens when the Fed changes the supply of money. Because velocity is fixed, any change in the supply of money leads to a proportionate change in nominal GDP. Because the factors of production and the production function have already determined real GDP, the change in nominal GDP must represent a change in the price level. Hence, the quantity theory implies that the price level is proportional to the money supply.

Because the inflation rate is the percentage change in the price level, this theory of the price level is also a theory of the inflation rate. The quantity equation, written in percentage-change form, is

$$\%\text{ Change in } M + \%\text{ Change in } V = \%\text{ Change in } P + \%\text{ Change in } Y.$$

Consider each of these four terms. First, the percentage change in the quantity of money M is under the control of the central bank. Second, the percentage change in velocity V reflects shifts in money demand; we have assumed that velocity is constant, so the percentage change in velocity is zero. Third, the percentage change in the price level P is the rate of inflation; this is the variable in the equation that we would like to explain. Fourth, the percentage change in output Y depends on growth in the factors of production and on technological progress, which for our present purposes we can take as given. This analysis tells us that (except for a constant that depends on exogenous growth in output) the growth in the money supply determines the rate of inflation.

Thus, the quantity theory of money states that the central bank, which controls the money supply, has ultimate control over the rate of inflation. If the central bank keeps the money supply stable, the price level will be stable. If the central bank increases the money supply rapidly, the price level will rise rapidly.

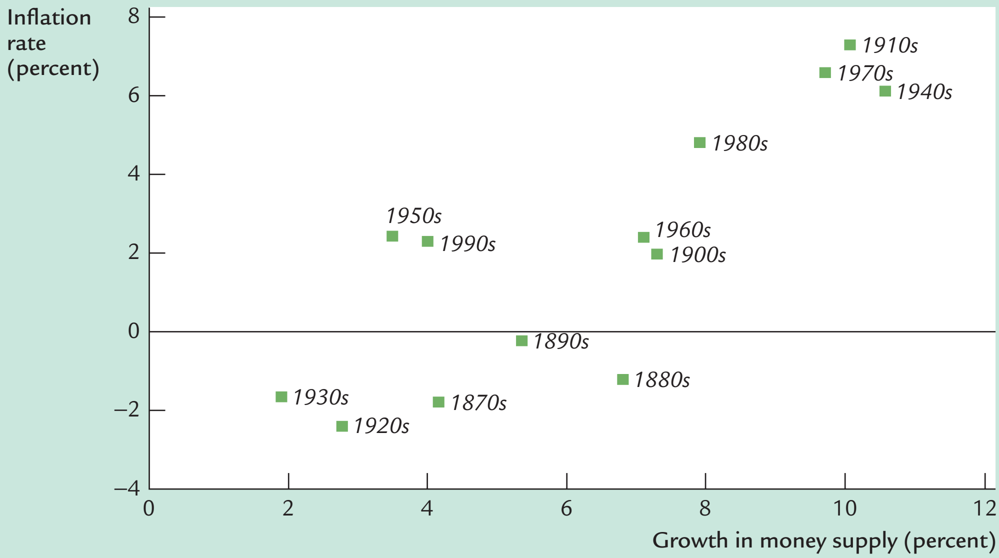
CASE STUDY

Inflation and Money Growth

"Inflation is always and everywhere a monetary phenomenon." So wrote Milton Friedman, the great economist who won the Nobel Prize in economics in 1976. The quantity theory of money leads us to agree that the growth in the quantity of money is the primary determinant of the inflation rate. Yet Friedman's claim is empirical, not theoretical. To evaluate his claim, and to judge the usefulness of our theory, we need to look at data on money and prices.

Friedman, together with fellow economist Anna Schwartz, wrote two treatises on monetary history that documented the sources and effects of changes in the quantity of money over the past century.[3] Figure 4-1 uses some of their data and

figure 4-1



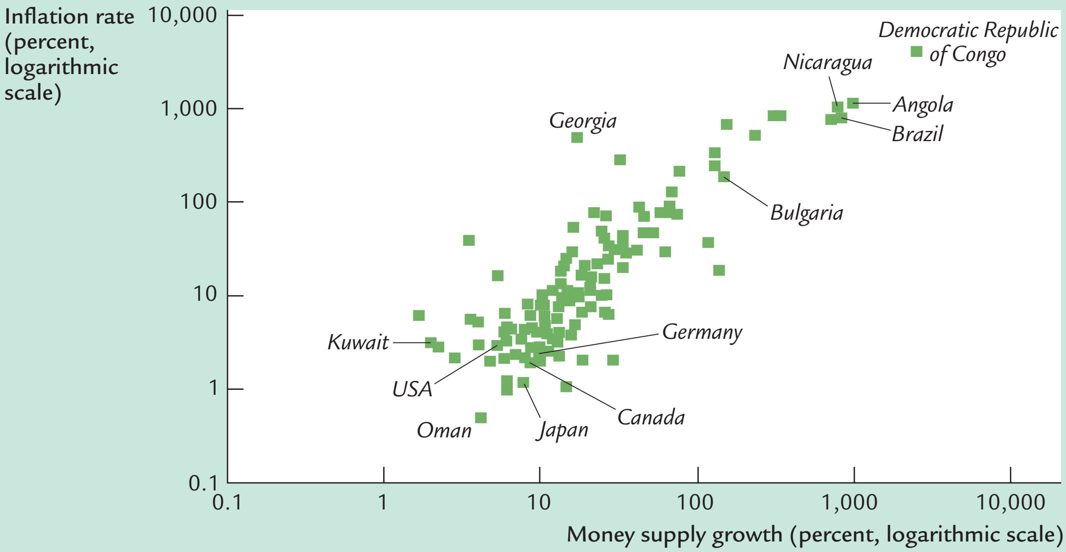
Historical Data on U.S. Inflation and Money Growth In this scatterplot of money growth and inflation, each point represents a decade. The horizontal axis shows the average growth in the money supply (as measured by *M2*) over the decade, and the vertical axis shows the average rate of inflation (as measured by the GDP deflator). The positive correlation between money growth and inflation is evidence for the quantity theory's prediction that high money growth leads to high inflation.

Source: For the data through the 1960s: Milton Friedman and Anna J. Schwartz, *Monetary Trends in the United States and the United Kingdom: Their Relation to Income, Prices, and Interest Rates, 1867–1975* (Chicago: University of Chicago Press, 1982). For recent data: U.S. Department of Commerce, Federal Reserve Board.

[3] Milton Friedman and Anna J. Schwartz, *A Monetary History of the United States, 1867–1960* (Princeton, NJ: Princeton University Press, 1963); Milton Friedman and Anna J. Schwartz, *Monetary Trends in the United States and the United Kingdom: Their Relation to Income, Prices, and Interest Rates, 1867–1975* (Chicago: University of Chicago Press, 1982).

plots the average rate of money growth and the average rate of inflation in the United States over each decade since the 1870s. The data verify the link between inflation and growth in the quantity of money. Decades with high money growth tend to have high inflation, and decades with low money growth tend to have low inflation.

figure 4-2



International Data on Inflation and Money Growth In this scatterplot, each point represents a country. The horizontal axis shows the average growth in the money supply (as measured by currency plus demand deposits) during the 1990s, and the vertical axis shows the average rate of inflation (as measured by the GDP deflator). Once again, the positive correlation is evidence for the quantity theory's prediction that high money growth leads to high inflation.

Source: International Financial Statistics.

Figure 4-2 examines the same question with international data. It shows the average rate of inflation and the average rate of money growth in more than 100 countries during the 1990s. Again, the link between money growth and inflation is clear. Countries with high money growth tend to have high inflation, and countries with low money growth tend to have low inflation.

If we looked at monthly data on money growth and inflation, rather than data for 10-year periods, we would not see as close a connection between these two variables. This theory of inflation works best in the long run, not in the short run. We examine the short-run impact of changes in the quantity of money when we turn to economic fluctuations in Part IV of this book.

4-3 Seigniorage: The Revenue From Printing Money

So far, we have seen how growth in the money supply causes inflation. But what might ever induce the government to increase the money supply? Here we examine one answer to this question.

Let's start with an indisputable fact: all governments spend money. Some of this spending is to buy goods and services (such as roads and police), and some is to provide transfer payments (for the poor and elderly, for example). A government can finance its spending in three ways. First, it can raise revenue through taxes, such as personal and corporate income taxes. Second, it can borrow from the public by selling government bonds. Third, it can print money.

The revenue raised through the printing of money is called **seigniorage**. The term comes from *seigneur,* the French word for "feudal lord." In the Middle Ages, the lord had the exclusive right on his manor to coin money. Today this right belongs to the central government, and it is one source of revenue.

When the government prints money to finance expenditure, it increases the money supply. The increase in the money supply, in turn, causes inflation. Printing money to raise revenue is like imposing an *inflation tax*.

At first it may not be obvious that inflation can be viewed as a tax. After all, no one receives a bill for this tax—the government merely prints the money it needs. Who then pays the inflation tax? The answer is the holders of money. As prices rise, the real value of the money in your wallet falls. When the government prints new money for its use, it makes the old money in the hands of the public less valuable. Thus, inflation is like a tax on holding money.

The amount raised by printing money varies from country to country. In the United States, the amount has been small: seigniorage has usually accounted for less than 3 percent of government revenue. In Italy and Greece, seigniorage has often been more than 10 percent of government revenue.[4] In countries experiencing hyperinflation, seigniorage is often the government's chief source of revenue—indeed, the need to print money to finance expenditure is a primary cause of hyperinflation.

CASE STUDY

Paying for the American Revolution

Although seigniorage has not been a major source of revenue for the U.S. government in recent history, the situation was very different two centuries ago. Beginning in 1775 the Continental Congress needed to find a way to finance the Revolution, but it had limited ability to raise revenue through taxation. It, therefore, relied on the printing of fiat money to help pay for the war.

The Continental Congress's reliance on seigniorage increased over time. In 1775 new issues of continental currency were about $6 million. This amount

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[4] Stanley Fischer, "Seigniorage and the Case for a National Money," *Journal of Political Economy* 90 (April 1982): 295–313.

increased to \$19 million in 1776, \$13 million in 1777, \$63 million in 1778, and \$125 million in 1779.

Not surprisingly, this rapid growth in the money supply led to massive inflation. At the end of the war, the price of gold measured in continental dollars was more than 100 times its level of only a few years earlier. The large quantity of the continental currency made the continental dollar nearly worthless. This experience also gave birth to a once-popular expression: people used to say something was "not worth a continental," meaning that the item had little real value.

4-4 Inflation and Interest Rates

As we first discussed in Chapter 3, interest rates are among the most important macroeconomic variables. In essence, they are the prices that link the present and the future. Here we discuss the relationship between inflation and interest rates.

Two Interest Rates: Real and Nominal

Suppose you deposit your savings in a bank account that pays 8 percent interest annually. Next year, you withdraw your savings and the accumulated interest. Are you 8 percent richer than you were when you made the deposit a year earlier?

The answer depends on what "richer" means. Certainly, you have 8 percent more dollars than you had before. But if prices have risen, so that each dollar buys less, then your purchasing power has not risen by 8 percent. If the inflation rate was 5 percent, then the amount of goods you can buy has increased by only 3 percent. And if the inflation rate was 10 percent, then your purchasing power has fallen by 2 percent.

Economists call the interest rate that the bank pays the **nominal interest rate** and the increase in your purchasing power the **real interest rate**. If i denotes the nominal interest rate, r the real interest rate, and π the rate of inflation, then the relationship among these three variables can be written as

$$r = i - \pi.$$

The real interest rate is the difference between the nominal interest rate and the rate of inflation.[5]

The Fisher Effect

Rearranging the terms in our equation for the real interest rate, we can show that the nominal interest rate is the sum of the real interest rate and the inflation rate:

$$i = r + \pi.$$

[5] *Mathematical note:* This equation relating the real interest rate, nominal interest rate, and inflation rate is only an approximation. The exact formula is $(1 + r) = (1 + i)/(1 + \pi)$. The approximation in the text is reasonably accurate as long as r, i, and π are relatively small (say, less than 20 percent per year).

The equation written in this way is called the **Fisher equation**, after economist Irving Fisher (1867–1947). It shows that the nominal interest rate can change for two reasons: because the real interest rate changes or because the inflation rate changes.

Once we separate the nominal interest rate into these two parts, we can use this equation to develop a theory that explains the nominal interest rate. Chapter 3 showed that the real interest rate adjusts to equilibrate saving and investment. The quantity theory of money shows that the rate of money growth determines the rate of inflation. The Fisher equation then tells us to add the real interest rate and the inflation rate together to determine the nominal interest rate.

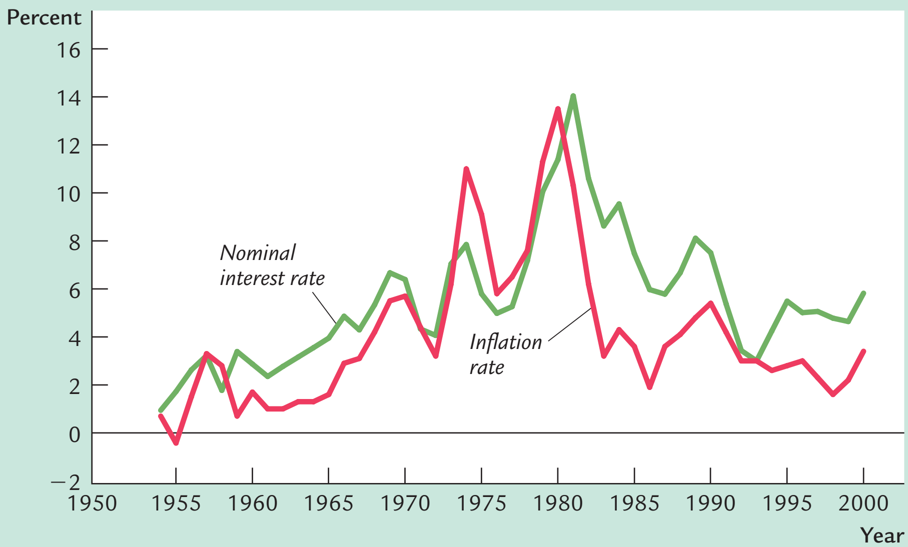
The quantity theory and the Fisher equation together tell us how money growth affects the nominal interest rate. *According to the quantity theory, an increase in the rate of money growth of 1 percent causes a 1-percent increase in the rate of inflation. According to the Fisher equation, a 1-percent increase in the rate of inflation in turn causes a 1-percent increase in the nominal interest rate.* The one-for-one relation between the inflation rate and the nominal interest rate is called the **Fisher effect**.

CASE STUDY

Inflation and Nominal Interest Rates

How useful is the Fisher effect in explaining interest rates? To answer this question we look at two types of data on inflation and nominal interest rates.

figure 4-3

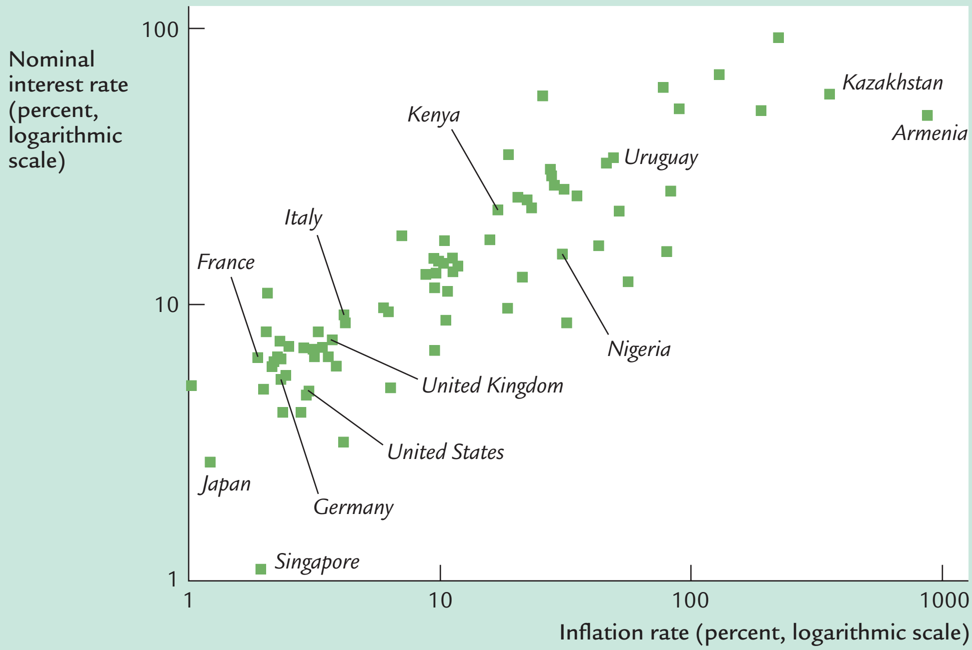


Inflation and Nominal Interest Rates Over Time This figure plots the nominal interest rate (on three-month Treasury bills) and the inflation rate (as measured by the CPI) in the United States since 1954. It shows the Fisher effect: higher inflation leads to a higher nominal interest rate.

Source: Federal Reserve and U.S. Department of Labor.

Figure 4-3 shows the variation over time in the nominal interest rate and the inflation rate in the United States. You can see that the Fisher effect has done a good job explaining fluctuations in the nominal interest rate over the past half century. When inflation is high, nominal interest rates are typically high, and when inflation is low, nominal interest rates are typically low as well.

figure 4-4



Inflation and Nominal Interest Rates Across Countries This scatterplot exhibits the average nominal interest rate on short-term Treasury bills and the average inflation rate in 77 countries during the 1990s. The positive correlation between the inflation rate and the nominal interest rate is evidence for the Fisher effect.

Source: International Financial Statistics.

Similar support for the Fisher effect comes from examining the variation across countries. As Figure 4-4 shows, a nation's inflation rate and its nominal interest rate are related. Countries with high inflation tend to have high nominal interest rates as well, and countries with low inflation tend to have low nominal interest rates.

The link between inflation and interest rates is well known to Wall Street investment firms. Because bond prices move inversely with interest rates, one can get rich by predicting correctly the direction in which interest rates will move. Many Wall Street firms hire *Fed watchers* to monitor monetary policy and news about inflation in order to anticipate changes in interest rates.

Two Real Interest Rates: *Ex Ante* and *Ex Post*

When a borrower and lender agree on a nominal interest rate, they do not know what the inflation rate over the term of the loan will be. Therefore, we must distinguish between two concepts of the real interest rate: the real interest rate the borrower and lender expect when the loan is made, called the ***ex ante* real interest rate**, and the real interest rate actually realized, called the ***ex post* real interest rate**.

Although borrowers and lenders cannot predict future inflation with certainty, they do have some expectation of the inflation rate. Let π denote actual future inflation and π^e the expectation of future inflation. The *ex ante* real interest rate is $i - \pi^e$, and the *ex post* real interest rate is $i - \pi$. The two real interest rates differ when actual inflation π differs from expected inflation π^e.

How does this distinction between actual and expected inflation modify the Fisher effect? Clearly, the nominal interest rate cannot adjust to actual inflation, because actual inflation is not known when the nominal interest rate is set. The nominal interest rate can adjust only to expected inflation. The Fisher effect is more precisely written as

$$i = r + \pi^e.$$

The *ex ante* real interest rate r is determined by equilibrium in the market for goods and services, as described by the model in Chapter 3. The nominal interest rate i moves one-for-one with changes in expected inflation π^e.

CASE STUDY

Nominal Interest Rates in the Nineteenth Century

Although recent data show a positive relationship between nominal interest rates and inflation rates, this finding is not universal. In data from the late nineteenth and early twentieth centuries, high nominal interest rates did not accompany high inflation. The apparent absence of any Fisher effect during this time puzzled Irving Fisher. He suggested that inflation "caught merchants napping."

How should we interpret the absence of an apparent Fisher effect in nineteenth-century data? Does this period of history provide evidence against the adjustment of nominal interest rates to inflation? Recent research suggests that this period has little to tell us about the validity of the Fisher effect. The reason is that the Fisher effect relates the nominal interest rate to expected inflation and, according to this research, inflation at this time was largely unexpected.

Although expectations are not observable, we can draw inferences about them by examining the persistence of inflation. In recent experience, inflation has been very persistent: when it is high one year, it tends to be high the next year as well. Therefore, when people have observed high inflation, it has been rational for them to expect high inflation in the future. By contrast, during the nineteenth century, when the gold standard was in effect, inflation had little persistence. High inflation in one year was just as likely to be followed the next year by low inflation as by high inflation. Therefore, high inflation did not imply high expected inflation and did not lead to high nominal interest rates. So, in a sense, Fisher was right to say that inflation "caught merchants napping."[6]

4-5 The Nominal Interest Rate and the Demand for Money

The quantity theory is based on a simple money demand function: it assumes that the demand for real money balances is proportional to income. Although the quantity theory is a good place to start when analyzing the effects of money on the economy, it is not the whole story. Here we add another determinant of the quantity of money demanded—the nominal interest rate.

The Cost of Holding Money

The money you hold in your wallet does not earn interest. If, instead of holding that money, you used it to buy government bonds or deposited it in a savings account, you would earn the nominal interest rate. The nominal interest rate is the opportunity cost of holding money: it is what you give up by holding money rather than bonds.

Another way to see that the cost of holding money equals the nominal interest rate is by comparing the real returns on alternative assets. Assets other than money, such as government bonds, earn the real return r. Money earns an expected real return of $-\pi^e$, because its real value declines at the rate of inflation. When you hold money, you give up the difference between these two returns. Thus, the cost of holding money is $r - (-\pi^e)$, which the Fisher equation tells us is the nominal interest rate i.

Just as the quantity of bread demanded depends on the price of bread, the quantity of money demanded depends on the price of holding money. Hence, the demand for real money balances depends both on the level of income and on the nominal interest rate. We write the general money demand function as

$$(M/P)^d = L(i, Y).$$

The letter L is used to denote money demand because money is the economy's most liquid asset (the asset most easily used to make transactions). This equation states that the demand for the liquidity of real money balances is a function of

[6] Robert B. Barsky, "The Fisher Effect and the Forecastability and Persistence of Inflation," *Journal of Monetary Economics* 19 (January 1987): 3–24.

income and the nominal interest rate. The higher the level of income Y, the greater the demand for real money balances. The higher the nominal interest rate i, the lower the demand for real money balances.

Future Money and Current Prices

Money, prices, and interest rates are now related in several ways. Figure 4-5 illustrates the linkages we have discussed. As the quantity theory of money explains, money supply and money demand together determine the equilibrium price level. Changes in the price level are, by definition, the rate of inflation. Inflation, in turn, affects the nominal interest rate through the Fisher effect. But now, because the nominal interest rate is the cost of holding money, the nominal interest rate feeds back to affect the demand for money.

Consider how the introduction of this last link affects our theory of the price level. First, equate the supply of real money balances M/P to the demand $L(i, Y)$:

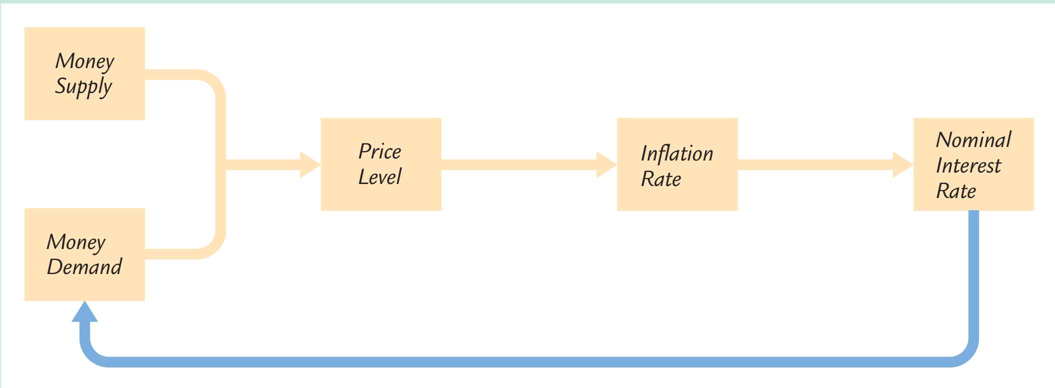
$$M/P = L(i, Y).$$

Next, use the Fisher equation to write the nominal interest rate as the sum of the real interest rate and expected inflation:

$$M/P = L(r + \pi^e, Y).$$

This equation states that the level of real money balances depends on the expected rate of inflation.

figure 4-5



The Linkages Among Money, Prices, and Interest Rates This figure illustrates the relationships among money, prices, and interest rates. Money supply and money demand determine the price level. Changes in the price level determine the inflation rate. The inflation rate influences the nominal interest rate. Because the nominal interest rate is the cost of holding money, it may affect money demand. This last link (shown as a blue line) is omitted from the basic quantity theory of money.

The last equation tells a more sophisticated story than the quantity theory about the determination of the price level. The quantity theory of money says that today's money supply determines today's price level. This conclusion remains partly true: if the nominal interest rate and the level of output are held constant, the price level moves proportionately with the money supply. Yet the nominal interest rate is not constant; it depends on expected inflation, which in turn depends on growth in the money supply. The presence of the nominal interest rate in the money demand function yields an additional channel through which money supply affects the price level.

This general money demand equation implies that the price level depends not only on today's money supply but also on the money supply expected in the future. To see why, suppose the Fed announces that it will raise the money supply in the future, but it does not change the money supply today. This announcement causes people to expect higher money growth and higher inflation. Through the Fisher effect, this increase in expected inflation raises the nominal interest rate. The higher nominal interest rate reduces the demand for real money balances. Because the quantity of money has not changed, the reduced demand for real money balances leads to a higher price level. Hence, higher expected money growth in the future leads to a higher price level today.

The effect of money on prices is complex. The appendix to this chapter works out the mathematics relating the price level to current and future money. The conclusion of the analysis is that the price level depends on a weighted average of the current money supply and the money supply expected to prevail in the future.

4-6 The Social Costs of Inflation

Our discussion of the causes and effects of inflation does not tell us much about the social problems that result from inflation. We turn to those problems now.

The Layman's View and the Classical Response

If you ask the average person why inflation is a social problem, he will probably answer that inflation makes him poorer. "Each year my boss gives me a raise, but prices go up and that takes some of my raise away from me." The implicit assumption in this statement is that if there were no inflation, he would get the same raise and be able to buy more goods.

This complaint about inflation is a common fallacy. As we know from Chapter 3, the purchasing power of labor—the real wage—depends on the marginal productivity of labor, not on how much money the government chooses to print. If the government reduced inflation by slowing the rate of money growth, workers would not see their real wage increasing more rapidly. Instead, when inflation slowed, firms would increase the prices of their products less each year and, as a result, would give their workers smaller raises.

According to the classical theory of money, a change in the overall price level is like a change in the units of measurement. It is as if we switched from measuring distances in feet to measuring them in inches: numbers get larger, but nothing really changes. Imagine that tomorrow morning you wake up and find that, for some reason, all dollar figures in the economy have been multiplied by ten. The price of everything you buy has increased tenfold, but so has your wage and the value of your savings. What difference would this make? All numbers would have an extra zero at the end, but nothing else would change. Your economic well-being depends on relative prices, not the overall price level.

Why, then, is a persistent increase in the price level a social problem? It turns out that the costs of inflation are subtle. Indeed, economists disagree about the size of the social costs. To the surprise of many laymen, some economists argue that the costs of inflation are small—at least for the moderate rates of inflation that most countries have experienced in recent years.[7]

CASE STUDY

What Economists and the Public Say About Inflation

As we have been discussing, laymen and economists hold very different views about the costs of inflation. Economist Robert Shiller has documented this difference of opinion in a survey of the two groups. The survey results are striking, for they show how the study of economics changes a person's attitudes.

In one question, Shiller asked people whether their "biggest gripe about inflation" was that "inflation hurts my real buying power, it makes me poorer." Of the general public, 77 percent agreed with this statement, compared to only 12 percent of economists. Shiller also asked people whether they agreed with the following statement: "When I see projections about how many times more a college education will cost, or how many times more the cost of living will be in coming decades, I feel a sense of uneasiness; these inflation projections really make me worry that my own income will not rise as much as such costs will." Among the general public, 66 percent said they fully agreed with this statement, while only 5 percent of economists agreed with it.

Survey respondents were asked to judge the seriousness of inflation as a policy problem: "Do you agree that preventing high inflation is an important national priority, as important as preventing drug abuse or preventing deterioration in the quality of our schools?" Fifty-two percent of laymen, but only 18 percent of economists, fully agreed with this view. Apparently, inflation worries the public much more than it does the economics profession.

[7] See, for example, Chapter 2 of Alan Blinder, *Hard Heads, Soft Hearts: Tough-Minded Economics for a Just Society* (Reading, MA: Addison Wesley, 1987).

The public's distaste for inflation may be psychological. Shiller asked those surveyed if they agreed with the following statement: "I think that if my pay went up I would feel more satisfaction in my job, more sense of fulfillment, even if prices went up just as much." Of the public, 49 percent fully or partly agreed with this statement, compared to 8 percent of economists.

Do these survey results mean that laymen are wrong and economists are right about the costs of inflation? Not necessarily. But economists do have the advantage of having given the issue more thought. So let's now consider what some of the costs of inflation might be.[8]

The Costs of Expected Inflation

Consider first the case of expected inflation. Suppose that every month the price level rose by 1 percent. What would be the social costs of such a steady and predictable 12-percent annual inflation?

One cost is the distortion of the inflation tax on the amount of money people hold. As we have already discussed, a higher inflation rate leads to a higher nominal interest rate, which in turn leads to lower real money balances. If people are to hold lower money balances on average, they must make more frequent trips to the bank to withdraw money—for example, they might withdraw $50 twice a week rather than $100 once a week. The inconvenience of reducing money holding is metaphorically called the **shoe-leather cost** of inflation, because walking to the bank more often causes one's shoes to wear out more quickly.

A second cost of inflation arises because high inflation induces firms to change their posted prices more often. Changing prices is sometimes costly: for example, it may require printing and distributing a new catalog. These costs are called **menu costs**, because the higher the rate of inflation, the more often restaurants have to print new menus.

A third cost of inflation arises because firms facing menu costs change prices infrequently; therefore, the higher the rate of inflation, the greater the variability in relative prices. For example, suppose a firm issues a new catalog every January. If there is no inflation, then the firm's prices relative to the overall price level are constant over the year. Yet if inflation is 1 percent per month, then from the beginning to the end of the year the firm's relative prices fall by 12 percent. Sales from this catalog will tend to be low early in the year (when its prices are relatively high) and high later in the year (when its prices are relatively low). Hence, when inflation induces variability in relative prices, it leads to microeconomic inefficiencies in the allocation of resources.

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[8] Robert J. Shiller, "Why Do People Dislike Inflation?" in Christina D. Romer and David H. Romer, eds., *Reducing Inflation: Motivation and Strategy* (Chicago: University of Chicago Press, 1997).

A fourth cost of inflation results from the tax laws. Many provisions of the tax code do not take into account the effects of inflation. Inflation can alter individuals' tax liability, often in ways that lawmakers did not intend.

One example of the failure of the tax code to deal with inflation is the tax treatment of capital gains. Suppose you buy some stock today and sell it a year from now at the same real price. It would seem reasonable for the government not to levy a tax, because you have earned no real income from this investment. Indeed, if there is no inflation, a zero tax liability would be the outcome. But suppose the rate of inflation is 12 percent and you initially paid $100 per share for the stock; for the real price to be the same a year later, you must sell the stock for $112 per share. In this case the tax code, which ignores the effects of inflation, says that you have earned $12 per share in income, and the government taxes you on this capital gain. The problem, of course, is that the tax code measures income as the nominal rather than the real capital gain. In this example, and in many others, inflation distorts how taxes are levied.

A fifth cost of inflation is the inconvenience of living in a world with a changing price level. Money is the yardstick with which we measure economic transactions. When there is inflation, that yardstick is changing in length. To continue the analogy, suppose that Congress passed a law specifying that a yard would equal 36 inches in 2002, 35 inches in 2003, 34 inches in 2004, and so on. Although the law would result in no ambiguity, it would be highly inconvenient. When someone measured a distance in yards, it would be necessary to specify whether the measurement was in 2002 yards or 2003 yards; to compare distances measured in different years, one would need to make an "inflation" correction. Similarly, the dollar is a less useful measure when its value is always changing.

For example, a changing price level complicates personal financial planning. One important decision that all households face is how much of their income to consume today and how much to save for retirement. A dollar saved today and invested at a fixed nominal interest rate will yield a fixed dollar amount in the future. Yet the real value of that dollar amount—which will determine the retiree's living standard—depends on the future price level. Deciding how much to save would be much simpler if people could count on the price level in 30 years being similar to its level today.

The Costs of Unexpected Inflation

Unexpected inflation has an effect that is more pernicious than any of the costs of steady, anticipated inflation: it arbitrarily redistributes wealth among individuals. You can see how this works by examining long-term loans. Most loan agreements specify a nominal interest rate, which is based on the rate of inflation expected at the time of the agreement. If inflation turns out differently from what was expected, the *ex post* real return that the debtor pays to the creditor differs from what both parties anticipated. On the one hand, if inflation turns out to be higher than expected, the debtor wins and the creditor loses because the debtor repays the loan with less valuable dollars. On the other hand, if inflation turns out to be lower than expected, the creditor wins and the debtor loses because the repayment is worth more than the two parties anticipated.

Consider, for example, a person taking out a mortgage in 1960. At the time, a 30-year mortgage had an interest rate of about 6 percent per year. This rate was based on a low rate of expected inflation—inflation over the previous decade had averaged only 2.5 percent. The creditor probably expected to receive a real return of about 3.5 percent, and the debtor expected to pay this real return. In fact, over the life of the mortgage, the inflation rate averaged 5 percent, so the *ex post* real return was only 1 percent. This unanticipated inflation benefited the debtor at the expense of the creditor.

Unanticipated inflation also hurts individuals on fixed pensions. Workers and firms often agree on a fixed nominal pension when the worker retires (or even earlier). Because the pension is deferred earnings, the worker is essentially providing the firm a loan: the worker provides labor services to the firm while young but does not get fully paid until old age. Like any creditor, the worker is hurt when inflation is higher than anticipated. Like any debtor, the firm is hurt when inflation is lower than anticipated.

These situations provide a clear argument against variable inflation. The more variable the rate of inflation, the greater the uncertainty that both debtors and creditors face. Because most people are *risk averse*—they dislike uncertainty—the unpredictability caused by highly variable inflation hurts almost everyone.

Given these effects of uncertain inflation, it is puzzling that nominal contracts are so prevalent. One might expect debtors and creditors to protect themselves from this uncertainty by writing contracts in real terms—that is, by indexing to some measure of the price level. In economies with high and variable inflation, indexation is often widespread; sometimes this indexation takes the form of writing contracts using a more stable foreign currency. In economies with moderate inflation, such as the United States, indexation is less common. Yet even in the United States, some long-term obligations are indexed. For example, Social Security benefits for the elderly are adjusted annually in response to changes in the consumer price index. And in 1997, the U.S. federal government issued inflation-indexed bonds for the first time.

Finally, in thinking about the costs of inflation, it is important to note a widely documented but little understood fact: high inflation is variable inflation. That is, countries with high average inflation also tend to have inflation rates that change greatly from year to year. The implication is that if a country decides to pursue a high-inflation monetary policy, it will likely have to accept highly variable inflation as well. As we have just discussed, highly variable inflation increases uncertainty for both creditors and debtors by subjecting them to arbitrary and potentially large redistributions of wealth.

CASE STUDY

The Free Silver Movement, the Election of 1896, and the Wizard of Oz

The redistributions of wealth caused by unexpected changes in the price level are often a source of political turmoil, as evidenced by the Free Silver movement in the late nineteenth century. From 1880 to 1896 the price level in the

United States fell 23 percent. This deflation was good for creditors, primarily the bankers of the Northeast, but it was bad for debtors, primarily the farmers of the South and West. One proposed solution to this problem was to replace the gold standard with a bimetallic standard, under which both gold and silver could be minted into coin. The move to a bimetallic standard would increase the money supply and stop the deflation.

The silver issue dominated the presidential election of 1896. William McKinley, the Republican nominee, campaigned on a platform of preserving the gold standard. William Jennings Bryan, the Democratic nominee, supported the bimetallic standard. In a famous speech, Bryan proclaimed, "You shall not press down upon the brow of labor this crown of thorns, you shall not crucify mankind upon a cross of gold." Not surprisingly, McKinley was the candidate of the conservative eastern establishment, while Bryan was the candidate of the southern and western populists.

This debate over silver found its most memorable expression in a children's book, *The Wizard of Oz*. Written by a midwestern journalist, L. Frank Baum, just after the 1896 election, it tells the story of Dorothy, a girl lost in a strange land far from her home in Kansas. Dorothy (representing traditional American values) makes three friends: a scarecrow (the farmer), a tin woodman (the industrial worker), and a lion whose roar exceeds his might (William Jennings Bryan). Together, the four of them make their way along a perilous yellow brick road (the gold standard), hoping to find the Wizard who will help Dorothy return home. Eventually they arrive in Oz (Washington), where everyone sees the world through green glasses (money). The Wizard (William McKinley) tries to be all things to all people but turns out to be a fraud. Dorothy's problem is solved only when she learns about the magical power of her silver slippers.[9]

Although the Republicans won the election of 1896 and the United States stayed on a gold standard, the Free Silver advocates got the inflation that they wanted. Around the time of the election, gold was discovered in Alaska, Australia, and South Africa. In addition, gold refiners devised the cyanide process, which facilitated the extraction of gold from ore. These developments led to increases in the money supply and in prices. From 1896 to 1910 the price level rose 35 percent.

One Benefit of Inflation

So far, we have discussed the many costs of inflation. These costs lead many economists to conclude that monetary policymakers should aim for zero inflation. Yet there is another side to the story. Some economists believe that a little bit of inflation—say, 2 or 3 percent per year—can be a good thing.

[9] The movie made 40 years later hid much of the allegory by changing Dorothy's slippers from silver to ruby. For more on this topic, see Henry M. Littlefield, "The Wizard of Oz: Parable on Populism," *American Quarterly* 16 (Spring 1964): 47–58; and Hugh Rockoff, "The Wizard of Oz as a Monetary Allegory," *Journal of Political Economy* 98 (August 1990): 739–760.

FYI Keynes (and Lenin) on the Cost of Inflation

The great economist John Maynard Keynes was no friend of inflation, as this chapter's opening quotation indicates. Here is the more complete passage from his famous book, *The Economic Consequences of the Peace*, in which Keynes predicted (correctly) that the treaty imposed on Germany after World War I would lead to economic hardship and renewed international tensions:

> Lenin is said to have declared that the best way to destroy the Capitalist System was to debauch the currency. By a continuing process of inflation, governments can confiscate, secretly and unobserved, an important part of the wealth of their citizens. By this method they not only confiscate, but they confiscate *arbitrarily*; and, while the process impoverishes many, it actually enriches some. The sight of this arbitrary rearrangement of riches strikes not only at security, but at confidence in the equity of the existing distribution of wealth. Those to whom the system brings windfalls, beyond their deserts and even beyond their expectations or desires, become "profiteers," who are the object of the hatred of the bourgeoisie, whom the inflationism has impoverished, not less than of the proletariat. As the inflation proceeds and the real value of the currency fluctuates wildly from month to month, all permanent relations between debtors and creditors, which form the ultimate foundation of capitalism, become so utterly disordered as to be almost meaningless; and the process of wealth-getting degenerates into a gamble and a lottery.
>
> Lenin was certainly right. There is no subtler, no surer means of overturning the existing basis of society than to debauch the currency. The process engages all the hidden forces of economic law on the side of destruction, and does it in a manner which not one man in a million is able to diagnose.[10]

History has given ample support to this assessment. A recent example occurred in Russia in 1998, where many citizens saw high rates of inflation wipe out their ruble-denominated savings. And, as Lenin would have predicted, this inflation put the country's burgeoning capitalist system in serious jeopardy.

The argument for moderate inflation starts with the observation that cuts in nominal wages are rare: firms are reluctant to cut their workers' nominal wages, and workers are reluctant to accept such cuts. A 2-percent wage cut in a zero-inflation world is, in real terms, the same as a 3-percent raise with 5-percent inflation, but workers do not always see it that way. The 2-percent wage cut may seem like an insult, whereas the 3-percent raise is, after all, still a raise. Empirical studies confirm that nominal wages rarely fall.

This fact suggests that some inflation may make labor markets work better. The supply and demand for different kinds of labor are always changing. Sometimes an increase in supply or decrease in demand leads to a fall in the equilibrium real wage for a group of workers. If nominal wages can't be cut, then the only way to cut real wages is to allow inflation to do the job. Without inflation, the real wage will be stuck above the equilibrium level, resulting in higher unemployment.

For this reason, some economists argue that inflation "greases the wheels" of labor markets. Only a little inflation is needed: an inflation rate of 2 percent

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[10] John Maynard Keynes, *The Economic Consequences of the Peace* (London: Macmillan, 1920): 219–220.

lets real wages fall by 2 percent per year, or 20 percent per decade, without cuts in nominal wages. Such automatic reductions in real wages are impossible with zero inflation.[11]

4-7 Hyperinflation

Hyperinflation is often defined as inflation that exceeds 50 percent per month, which is just over 1 percent per day. Compounded over many months, this rate of inflation leads to very large increases in the price level. An inflation rate of 50 percent per month implies a more than 100-fold increase in the price level over a year, and a more than 2-million-fold increase over three years. Here we consider the costs and causes of such extreme inflation.

The Costs of Hyperinflation

Although economists debate whether the costs of moderate inflation are large or small, no one doubts that hyperinflation extracts a high toll on society. The costs are qualitatively the same as those we discussed earlier. When inflation reaches extreme levels, however, these costs are more apparent because they are so severe.

The shoeleather costs associated with reduced money holding, for instance, are serious under hyperinflation. Business executives devote much time and energy to cash management when cash loses its value quickly. By diverting this time and energy from more socially valuable activities, such as production and investment decisions, hyperinflation makes the economy run less efficiently.

Menu costs also become larger under hyperinflation. Firms have to change prices so often that normal business practices, such as printing and distributing catalogs with fixed prices, become impossible. In one restaurant during the German hyperinflation of the 1920s, a waiter would stand up on a table every 30 minutes to call out the new prices.

Similarly, relative prices do not do a good job of reflecting true scarcity during hyperinflations. When prices change frequently by large amounts, it is hard for customers to shop around for the best price. Highly volatile and rapidly rising prices can alter behavior in many ways. According to one report, when patrons entered a pub during the German hyperinflation, they would often buy two pitchers of beer. Although the second pitcher would lose value by getting warm over time, it would lose value less rapidly than the money left sitting in the patron's wallet.

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[11] For a recent paper examining this benefit of inflation, see George A. Akerlof, William T. Dickens, and George L. Perry, "The Macroeconomics of Low Inflation," *Brookings Papers on Economic Activity*, 1996:1, pp. 1–76.

Tax systems are also distorted by hyperinflation—but in ways that are quite different than under moderate inflation. In most tax systems there is a delay between the time a tax is levied and the time the tax is paid to the government. In the United States, for example, taxpayers are required to make estimated income tax payments every three months. This short delay does not matter much under low inflation. By contrast, during hyperinflation, even a short delay greatly reduces real tax revenue. By the time the government gets the money it is due, the money has fallen in value. As a result, once hyperinflations start, the real tax revenue of the government often falls substantially.

Finally, no one should underestimate the sheer inconvenience of living with hyperinflation. When carrying money to the grocery store is as burdensome as carrying the groceries back home, the monetary system is not doing its best to facilitate exchange. The government tries to overcome this problem by adding more and more zeros to the paper currency, but often it cannot keep up with the exploding price level.

Eventually, these costs of hyperinflation become intolerable. Over time, money loses its role as a store of value, unit of account, and medium of exchange. Barter becomes more common. And more stable unofficial monies—cigarettes or the U.S. dollar—start to replace the official money.

CASE STUDY

Life During the Bolivian Hyperinflation

The following article from the *Wall Street Journal* shows what life was like during the Bolivian hyperinflation of 1985.[12] What costs of inflation does this article emphasize?

Precarious Peso—Amid Wild Inflation, Bolivians Concentrate on Swapping Currency

LA PAZ, Bolivia—When Edgar Miranda gets his monthly teacher's pay of 25 million pesos, he hasn't a moment to lose. Every hour, pesos drop in value. So, while his wife rushes to market to lay in a month's supply of rice and noodles, he is off with the rest of the pesos to change them into black-market dollars.

Mr. Miranda is practicing the First Rule of Survival amid the most out-of-control inflation in the world today. Bolivia is a case study of how runaway inflation undermines a society. Price increases are so huge that the figures build up almost beyond comprehension. In one six-month period, for example, prices soared at an annual rate of 38,000%. By official count, however, last year's inflation reached 2,000%, and this year's is expected to hit 8,000%—though other estimates range many times higher. In any event, Bolivia's rate dwarfs Israel's 370% and Argentina's 1,100%—two other cases of severe inflation.

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[12] Reprinted by permission of the *Wall Street Journal,* © August 13, 1985, page 1, Dow Jones & Company, Inc. All rights reserved worldwide.

It is easier to comprehend what happens to the 38-year-old Mr. Miranda's pay if he doesn't quickly change it into dollars. The day he was paid 25 million pesos, a dollar cost 500,000 pesos. So he received $50. Just days later, with the rate at 900,000 pesos, he would have received $27.

"We think only about today and converting every peso into dollars," says Ronald MacLean, the manager of a gold-mining firm. "We have become myopic."

And intent on survival. Civil servants won't hand out a form without a bribe. Lawyers, accountants, hairdressers, even prostitutes have almost given up working to become money-changers in the streets. Workers stage repeated strikes and steal from their bosses. The bosses smuggle production abroad, take out phony loans, duck taxes—anything to get dollars for speculation.

The production at the state mines, for example, dropped to 12,000 tons last year from 18,000. The miners pad their wages by smuggling out the richest ore in their lunch pails, and the ore goes by a contraband network into neighboring Peru. Without a major tin mine, Peru now exports some 4,000 metric tons of tin a year.

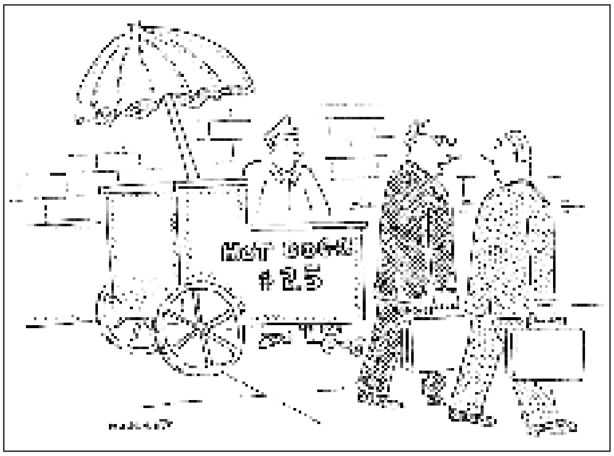
"We don't produce anything. We are all currency speculators," a heavy-equipment dealer in La Paz says. "People don't know what's good and bad anymore. We have become an amoral society. . . ."

It is an open secret that practically all of the black-market dollars come from the illegal cocaine trade with the U.S. Cocaine traffickers earn an estimated $1 billion a year. . . .

But meanwhile the country is suffering from inflation largely because the government's revenues cover a mere 15% of its expenditures and its deficit has widened to nearly 25% of the country's total annual output. The revenues are hurt by a lag in tax payments, and taxes aren't being collected largely because of widespread theft and bribery.

The Causes of Hyperinflation

Why do hyperinflations start, and how do they end? This question can be answered at different levels.



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"I told you the Fed should have tightened."

The most obvious answer is that hyperinflations are caused by excessive growth in the supply of money. When the central bank prints money, the price level rises. When it prints money rapidly enough, the result is hyperinflation. To stop the hyperinflation, the central bank must reduce the rate of money growth.

This answer is incomplete, however, for it leaves open the question of why central banks in hyperinflating economies choose to print so much money. To address this deeper question, we must turn our attention from monetary to fiscal policy. Most hyperinflations begin when the government has inadequate tax revenue to pay for its spending. Although the government might prefer to finance this budget deficit by issuing debt, it may find itself unable to borrow, perhaps because lenders view the government as a bad credit risk. To cover the deficit, the government turns to the only mechanism at its disposal—the printing press. The result is rapid money growth and hyperinflation.

Once the hyperinflation is under way, the fiscal problems become even more severe. Because of the delay in collecting tax payments, real tax revenue falls as inflation rises. Thus, the government's need to rely on seigniorage is self-reinforcing. Rapid money creation leads to hyperinflation, which leads to a larger budget deficit, which leads to even more rapid money creation.

The ends of hyperinflations almost always coincide with fiscal reforms. Once the magnitude of the problem becomes apparent, the government musters the political will to reduce government spending and increase taxes. These fiscal reforms reduce the need for seigniorage, which allows a reduction in money growth. Hence, even if inflation is always and everywhere a monetary phenomenon, the end of hyperinflation is often a fiscal phenomenon as well.[13]

CASE STUDY

Hyperinflation in Interwar Germany

After World War I, Germany experienced one of history's most spectacular examples of hyperinflation. At the war's end, the Allies demanded that Germany pay substantial reparations. These payments led to fiscal deficits in Germany, which the German government eventually financed by printing large quantities of money.

Panel (a) of Figure 4-6 shows the quantity of money and the general price level in Germany from January 1922 to December 1924. During this period both money and prices rose at an amazing rate. For example, the price of a daily newspaper rose from 0.30 marks in January 1921 to 1 mark in May 1922, to 8 marks in October 1922, to 100 marks in February 1923, and to 1,000 marks in September 1923. Then, in the fall of 1923, prices took off: the newspaper sold for 2,000 marks on October 1, 20,000 marks on October 15, 1 million marks on October 29, 15 million marks on November 9, and 70 million marks on November 17. In December 1923 the money supply and prices abruptly stabilized.[14]

Just as fiscal problems caused the German hyperinflation, a fiscal reform ended it. At the end of 1923, the number of government employees was cut by one-third, and the reparations payments were temporarily suspended and eventually

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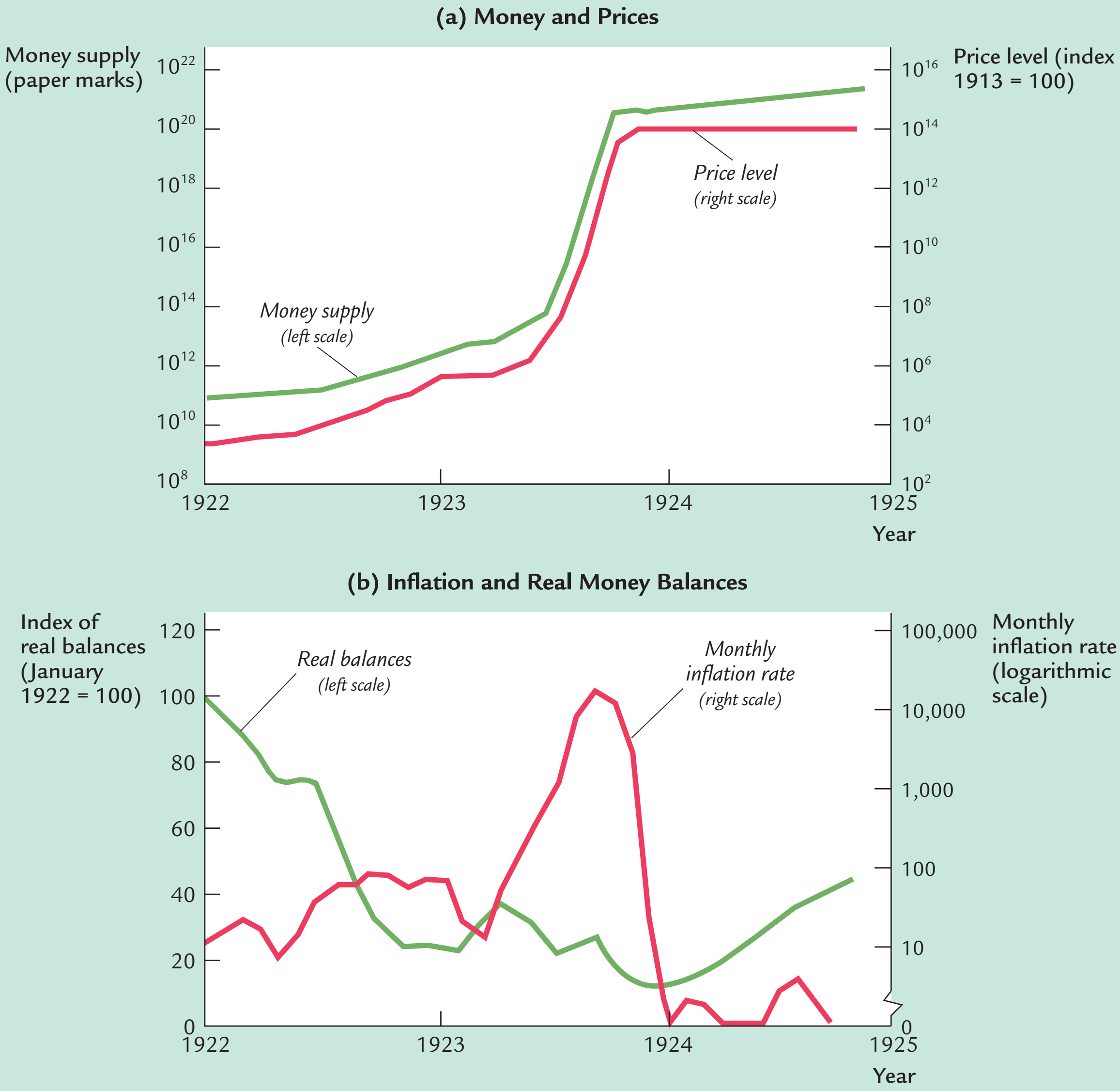
[13] For more on these issues, see Thomas J. Sargent, "The End of Four Big Inflations," in Robert Hall, ed., *Inflation* (Chicago: University of Chicago Press, 1983), 41–98; and Rudiger Dornbusch and Stanley Fischer, "Stopping Hyperinflations: Past and Present," *Weltwirtschaftliches Archiv* 122 (April 1986): 1–47.

[14] The data on newspaper prices are from Michael Mussa, "Sticky Individual Prices and the Dynamics of the General Price Level," *Carnegie-Rochester Conference on Public Policy* 15 (Autumn 1981): 261–296.

figure 4-6



Money and Prices in Interwar Germany Panel (a) shows the money supply and the price level in Germany from January 1922 to December 1924. The immense increases in the money supply and the price level provide a dramatic illustration of the effects of printing large amounts of money. Panel (b) shows inflation and real money balances. As inflation rose, real money balances fell. When the inflation ended at the end of 1923, real money balances rose.

Source: Adapted from Thomas J. Sargent, "The End of Four Big Inflations," in Robert Hall, ed., *Inflation* (Chicago: University of Chicago Press, 1983): 41–98.

reduced. At the same time, a new central bank, the Rentenbank, replaced the old central bank, the Reichsbank. The Rentenbank was committed to not financing the government by printing money.

According to our theoretical analysis of money demand, an end to a hyperinflation should lead to an increase in real money balances as the cost of holding money falls. Panel (b) of Figure 4-6 shows that real money balances in Germany did fall as inflation increased, and then increased again as inflation fell. Yet the increase in real money balances was not immediate. Perhaps the adjustment of real money balances to the cost of holding money is a gradual process. Or perhaps it took time for people in Germany to believe that the inflation had ended, so that expected inflation fell more gradually than actual inflation.

4-8 Conclusion: The Classical Dichotomy

We have finished our discussion of money and inflation. Let's now step back and examine a key assumption that has been implicit in our discussion.

In Chapter 3, we explained many macroeconomic variables. Some of these variables were *quantities*, such as real GDP and the capital stock; others were *relative prices*, such as the real wage and the real interest rate. But all of these variables had one thing in common—they measured a physical (rather than a monetary) quantity. Real GDP is the quantity of goods and services produced in a given year, and the capital stock is the quantity of machines and structures available at a given time. The real wage is the quantity of output a worker earns for each hour of work, and the real interest rate is the quantity of output a person earns in the future by lending one unit of output today. All variables measured in physical units, such as quantities and relative prices, are called **real variables**.

In this chapter we examined **nominal variables**—variables expressed in terms of money. The economy has many nominal variables, such as the price level, the inflation rate, and the dollar wage a person earns.

At first it may seem surprising that we were able to explain real variables without introducing nominal variables or the existence of money. In Chapter 3 we studied the level and allocation of the economy's output without mentioning the price level or the rate of inflation. Our theory of the labor market explained the real wage without explaining the nominal wage.

Economists call this theoretical separation of real and nominal variables the **classical dichotomy**. It is the hallmark of classical macroeconomic theory. The classical dichotomy is an important insight, because it simplifies economic theory. In particular, it allows us to examine real variables, as we have done, while ignoring nominal variables. The classical dichotomy arises because, in classical economic theory, changes in the money supply do not influence real variables. This irrelevance of money for real variables is called **monetary neutrality**. For many purposes—in particular for studying long-run issues—monetary neutrality is approximately correct.

Yet monetary neutrality does not fully describe the world in which we live. Beginning in Chapter 9, we discuss departures from the classical model and monetary neutrality. These departures are crucial for understanding many macroeconomic phenomena, such as short-run economic fluctuations.

Summary

1. Money is the stock of assets used for transactions. It serves as a store of value, a unit of account, and a medium of exchange. Different sorts of assets are used as money: commodity money systems use an asset with intrinsic value, whereas fiat money systems use an asset whose sole function is to serve as money. In modern economies, a central bank such as the Federal Reserve is responsible for controlling the supply of money.
2. The quantity theory of money assumes that the velocity of money is stable and concludes that nominal GDP is proportional to the stock of money. Because the factors of production and the production function determine real GDP, the quantity theory implies that the price level is proportional to the quantity of money. Therefore, the rate of growth in the quantity of money determines the inflation rate.
3. Seigniorage is the revenue that the government raises by printing money. It is a tax on money holding. Although seigniorage is quantitatively small in most economies, it is often a major source of government revenue in economies experiencing hyperinflation.
4. The nominal interest rate is the sum of the real interest rate and the inflation rate. The Fisher effect says that the nominal interest rate moves one-for-one with expected inflation.
5. The nominal interest rate is the opportunity cost of holding money. Thus, one might expect the demand for money to depend on the nominal interest rate. If it does, then the price level depends on both the current quantity of money and the quantities of money expected in the future.
6. The costs of expected inflation include shoeleather costs, menu costs, the cost of relative price variability, tax distortions, and the inconvenience of making inflation corrections. In addition, unexpected inflation causes arbitrary redistributions of wealth between debtors and creditors. One possible benefit of inflation is that it improves the functioning of labor markets by allowing real wages to reach equilibrium levels without cuts in nominal wages.
7. During hyperinflations, most of the costs of inflation become severe. Hyperinflations typically begin when governments finance large budget deficits by printing money. They end when fiscal reforms eliminate the need for seigniorage.
8. According to classical economic theory, money is neutral: the money supply does not affect real variables. Therefore, classical theory allows us to study

how real variables are determined without any reference to the money supply. The equilibrium in the money market then determines the price level and, as a result, all other nominal variables. This theoretical separation of real and nominal variables is called the classical dichotomy.

KEY CONCEPTS

Inflation
Hyperinflation
Money
Store of value
Unit of account
Medium of exchange
Fiat money
Commodity money
Gold standard
Money supply
Monetary policy
Central bank
Federal Reserve
Open-market operations
Currency
Demand deposits
Quantity equation
Transactions velocity of money
Income velocity of money
Real money balances
Money demand function
Quantity theory of money
Seigniorage
Nominal and real interest rates
Fisher equation and Fisher effect
Ex ante and *ex post* real interest rates
Shoeleather costs
Menu costs
Real and nominal variables
Classical dichotomy
Monetary neutrality

QUESTIONS FOR REVIEW

1. Describe the functions of money.
2. What is fiat money? What is commodity money?
3. Who controls the money supply and how?
4. Write the quantity equation and explain it.
5. What does the assumption of constant velocity imply?
6. Who pays the inflation tax?
7. If inflation rises from 6 to 8 percent, what happens to real and nominal interest rates according to the Fisher effect?
8. List all the costs of inflation you can think of, and rank them according to how important you think they are.
9. Explain the roles of monetary and fiscal policy in causing and ending hyperinflations.
10. Define the terms "real variable" and "nominal variable," and give an example of each.

PROBLEMS AND APPLICATIONS

1. What are the three functions of money? Which of the functions do the following items satisfy? Which do they not satisfy?
   a. A credit card
   b. A painting by Rembrandt
   c. A subway token
2. In the country of Wiknam, the velocity of money is constant. Real GDP grows by 5 percent per year, the money stock grows by 14 percent per year, and the nominal interest rate is 11 percent. What is the real interest rate?
3. A newspaper article written by the Associated Press in 1994 reported that the U.S. economy

was experiencing a low rate of inflation. It said that "low inflation has a downside: 45 million recipients of Social Security and other benefits will see their checks go up by just 2.8 percent next year."

a. Why does inflation affect the increase in Social Security and other benefits?

b. Is this effect a cost of inflation as the article suggests? Why or why not?

4. Suppose you are advising a small country (such as Bermuda) on whether to print its own money or to use the money of its larger neighbor (such as the United States). What are the costs and benefits of a national money? Does the relative political stability of the two countries have any role in this decision?

5. During World War II, both Germany and England had plans for a paper weapon: they each printed the other's currency, with the intention of dropping large quantities by airplane. Why might this have been an effective weapon?

6. Calvin Coolidge once said that "inflation is repudiation." What might he have meant by this? Do you agree? Why or why not? Does it matter whether the inflation is expected or unexpected?

7. Some economic historians have noted that during the period of the gold standard, gold discoveries were most likely to occur after a long deflation. (The discoveries of 1896 are an example.) Why might this be true?

8. Suppose that consumption depends on the level of real money balances (on the grounds that real money balances are part of wealth). Show that if real money balances depend on the nominal interest rate, then an increase in the rate of money growth affects consumption, investment, and the real interest rate. Does the nominal interest rate adjust more than one-for-one or less than one-for-one to expected inflation?

This deviation from the classical dichotomy and the Fisher effect is called the "Mundell–Tobin effect." How might you decide whether the Mundell–Tobin effect is important in practice?

9. Use the Internet to identify a country that has had high inflation over the past year and another country that has had low inflation. (*Hint*: One useful Web site is www.economist.com) For these two countries, find the rate of money growth and the current level of the nominal interest rate. Relate your findings to the theories presented in this chapter.

APPENDIX

The Cagan Model: How Current and Future Money Affect the Price Level

In this chapter we showed that if the quantity of real money balances demanded depends on the cost of holding money, the price level depends on both the current money supply and the future money supply. This appendix develops the *Cagan model* to show more explicitly how this works.[15]

To keep the math as simple as possible, we posit a money demand function that is linear in the natural logarithms of all the variables. The money demand function is

$$m_t - p_t = -\gamma(p_{t+1} - p_t), \tag{A1}$$

where m_t is the log of the quantity of money at time t, p_t is the log of the price level at time t, and γ is a parameter that governs the sensitivity of money demand to the rate of inflation. By the property of logarithms, $m_t - p_t$ is the log of real money balances, and $p_{t+1} - p_t$ is the inflation rate between period t and period $t + 1$. This equation states that if inflation goes up by 1 percentage point, real money balances fall by γ percent.

We have made a number of assumptions in writing the money demand function in this way. First, by excluding the level of output as a determinant of money demand, we are implicitly assuming that it is constant. Second, by including the rate of inflation rather than the nominal interest rate, we are assuming that the real interest rate is constant. Third, by including actual inflation rather than expected inflation, we are assuming perfect foresight. All of these assumptions are to keep the analysis as simple as possible.

We want to solve Equation A1 to express the price level as a function of current and future money. To do this, note that Equation A1 can be rewritten as

$$p_t = \left(\frac{1}{1+\gamma}\right) m_t + \left(\frac{\gamma}{1+\gamma}\right) p_{t+1}. \tag{A2}$$

This equation states that the current price level p_t is a weighted average of the current money supply m_t and the next period's price level p_{t+1}. The next period's price level will be determined the same way as this period's price level:

$$p_{t+1} = \left(\frac{1}{1+\gamma}\right) m_{t+1} + \left(\frac{\gamma}{1+\gamma}\right) p_{t+2}. \tag{A3}$$

Now substitute Equation A3 for p_{t+1} in Equation A2 to obtain

$$p_t = \frac{1}{1+\gamma} m_t + \frac{\gamma}{(1+\gamma)^2} m_{t+1} + \frac{\gamma^2}{(1+\gamma)^2} p_{t+2}. \tag{A4}$$

[15] This model is derived from Phillip Cagan, "The Monetary Dynamics of Hyperinflation," in Milton Friedman, ed., *Studies in the Quantity Theory of Money* (Chicago: University of Chicago Press, 1956).

Equation A4 states that the current price level is a weighted average of the current money supply, the next period's money supply, and the following period's price level. Once again, the price level in $t + 2$ is determined as in Equation A2:

$$p_{t+2} = \left(\frac{1}{1+\gamma}\right) m_{t+2} + \left(\frac{\gamma}{1+\gamma}\right) p_{t+3}. \tag{A5}$$

Now substitute Equation A5 into Equation A4 to obtain

$$p_t = \frac{1}{1+\gamma} m_t + \frac{\gamma}{(1+\gamma)^2} m_{t+1} + \frac{\gamma^2}{(1+\gamma)^3} m_{t+2} + \frac{\gamma^3}{(1+\gamma)^3} p_{t+3}. \tag{A6}$$

By now you see the pattern. We can continue to use Equation A2 to substitute for the future price level. If we do this an infinite number of times, we find

$$p_t = \left(\frac{1}{1+\gamma}\right) \left[m_t + \left(\frac{\gamma}{1+\gamma}\right) m_{t+1} + \left(\frac{\gamma}{1+\gamma}\right)^2 m_{t+2} + \left(\frac{\gamma}{1+\gamma}\right)^3 m_{t+3} + \cdots\right], \tag{A7}$$

where $\cdots$ indicates an infinite number of analogous terms. According to Equation A7, the current price level is a weighted average of the current money supply and all future money supplies.

Note the importance of γ, the parameter governing the sensitivity of real money balances to inflation. The weights on the future money supplies decline geometrically at rate $\gamma/(1 + \gamma)$. If γ is small, then $\gamma/(1 + \gamma)$ is small, and the weights decline quickly. In this case, the current money supply is the primary determinant of the price level. (Indeed, if γ equals zero, then we obtain the quantity theory of money: the price level is proportional to the current money supply, and the future money supplies do not matter at all.) If γ is large, then $\gamma/(1 + \gamma)$ is close to 1, and the weights decline slowly. In this case, the future money supplies play a key role in determining today's price level.

Finally, let's relax the assumption of perfect foresight. If the future is not known with certainty, then we should write the money demand function as

$$m_t - p_t = -\gamma(Ep_{t+1} - p_t), \tag{A8}$$

where Ep_{t+1} is the expected price level. Equation A8 states that real money balances depend on expected inflation. By following steps similar to those preceding, we can show that

$$p_t = \left(\frac{1}{1+\gamma}\right) \left[m_t + \left(\frac{\gamma}{1+\gamma}\right) Em_{t+1} + \left(\frac{\gamma}{1+\gamma}\right)^2 Em_{t+2} + \left(\frac{\gamma}{1+\gamma}\right)^3 Em_{t+3} + \cdots\right]. \tag{A9}$$

Equation A9 states that the price level depends on the current money supply and expected future money supplies.

Some economists use this model to argue that *credibility* is important for ending hyperinflation. Because the price level depends on both current and expected future money, inflation depends on both current and expected future money growth. Therefore, to end high inflation, both money growth and expected money growth must fall. Expectations, in turn, depend on credibility—the perception that the central bank is committed to a new, more stable policy.

How can a central bank achieve credibility in the midst of hyperinflation? Credibility is often achieved by removing the underlying cause of the hyperinflation—the need for seigniorage. Thus, a credible fiscal reform is often necessary for a credible change in monetary policy. This fiscal reform might take the form of reducing government spending and making the central bank more independent from the government. Reduced spending decreases the need for seigniorage, while increased independence allows the central bank to resist government demands for seigniorage.

MORE PROBLEMS AND APPLICATIONS

1. In the Cagan model, if the money supply is expected to grow at some constant rate μ (so that $Em_{t+s} = m_t + s\mu$), then Equation A9 can be shown to imply that $p_t = m_t + \gamma\mu$.

a. Interpret this result.

b. What happens to the price level p_t when the money supply m_t changes, holding the money growth rate μ constant?

c. What happens to the price level p_t when the money growth rate μ changes, holding the current money supply m_t constant?

d. If a central bank is about to reduce the rate of money growth μ but wants to hold the price level p_t constant, what should it do with m_t? Can you see any practical problems that might arise in following such a policy?

e. How do your previous answers change in the special case where money demand does not depend on the expected rate of inflation (so that $\gamma = 0$)?

CHAPTER FIVE

The Open Economy

> *No nation was ever ruined by trade.*
>
> *— Benjamin Franklin*

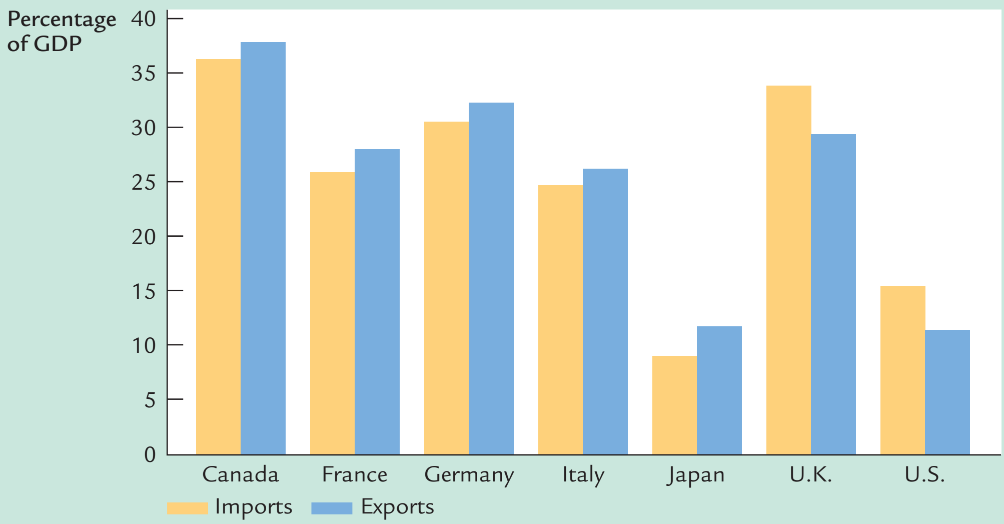
Even if you never leave your home town, you are an active participant in a global economy. When you go to the grocery store, for instance, you might choose between apples grown locally and grapes grown in Chile. When you make a deposit into your local bank, the bank might lend those funds to your next-door neighbor or to a Japanese company building a factory outside Tokyo. Because our economy is integrated with many others around the world, consumers have more goods and services from which to choose, and savers have more opportunities to invest their wealth.

In previous chapters we simplified our analysis by assuming a closed economy. In actuality, however, most economies are open: they export goods and services abroad, they import goods and services from abroad, and they borrow and lend in world financial markets. Figure 5-1 gives some sense of the importance of these international interactions by showing imports and exports as a percentage of GDP for seven major industrial countries. As the figure shows, imports and exports in the United States are more than 10 percent of GDP. Trade is even more important for many other countries—in Canada and the United Kingdom, for instance, imports and exports are about a third of GDP. In these countries, international trade is central to analyzing economic developments and formulating economic policies.

This chapter begins our study of open-economy macroeconomics. We begin in Section 5-1 with questions of measurement. To understand how the open economy works, we must understand the key macroeconomic variables that measure the interactions among countries. Accounting identities reveal a key insight: the flow of goods and services across national borders is always matched by an equivalent flow of funds to finance capital accumulation.

In Section 5-2 we examine the determinants of these international flows. We develop a model of the small open economy that corresponds to our model of the closed economy in Chapter 3. The model shows the factors that determine whether a country is a borrower or a lender in world markets, and how policies at home and abroad affect the flows of capital and goods.

figure 5-1



Imports and Exports as a Percentage of Output: 2000 While international trade is important for the United States, it is even more vital for other countries.

Source: OECD.

In Section 5-3 we extend the model to discuss the prices at which a country makes exchanges in world markets. We examine what determines the price of domestic goods relative to foreign goods. We also examine what determines the rate at which the domestic currency trades for foreign currencies. Our model shows how protectionist trade policies—policies designed to protect domestic industries from foreign competition—influence the amount of international trade and the exchange rate.

5-1 The International Flows of Capital and Goods

The key macroeconomic difference between open and closed economies is that, in an open economy, a country's spending in any given year need not equal its output of goods and services. A country can spend more than it produces by borrowing from abroad, or it can spend less than it produces and lend the difference to foreigners. To understand this more fully, let's take another look at national income accounting, which we first discussed in Chapter 2.

The Role of Net Exports

Consider the expenditure on an economy's output of goods and services. In a closed economy, all output is sold domestically, and expenditure is divided into three components: consumption, investment, and government purchases. In an open economy, some output is sold domestically and some is exported to be sold abroad. We can divide expenditure on an open economy's output Y into four components:

- C^d, consumption of domestic goods and services,
- I^d, investment in domestic goods and services,
- G^d, government purchases of domestic goods and services,
- EX, exports of domestic goods and services.

The division of expenditure into these components is expressed in the identity

$$Y = C^d + I^d + G^d + EX.$$

The sum of the first three terms, $C^d + I^d + G^d$, is domestic spending on domestic goods and services. The fourth term, EX, is foreign spending on domestic goods and services.

We now want to make this identity more useful. To do this, note that domestic spending on all goods and services is the sum of domestic spending on domestic goods and services and on foreign goods and services. Hence, total consumption C equals consumption of domestic goods and services C^d plus consumption of foreign goods and services C^f; total investment I equals investment in domestic goods and services I^d plus investment in foreign goods and services I^f; and total government purchases G equals government purchases of domestic goods and services G^d plus government purchases of foreign goods and services G^f. Thus,

$$C = C^d + C^f,$$
$$I = I^d + I^f,$$
$$G = G^d + G^f.$$

We substitute these three equations into the identity above:

$$Y = (C - C^f) + (I - I^f) + (G - G^f) + EX.$$

We can rearrange to obtain

$$Y = C + I + G + EX - (C^f + I^f + G^f).$$

The sum of domestic spending on foreign goods and services $(C^f + I^f + G^f)$ is expenditure on imports (IM). We can thus write the national income accounts identity as

$$Y = C + I + G + EX - IM.$$

Because spending on imports is included in domestic spending $(C + I + G)$, and because goods and services imported from abroad are not part of a country's output, this equation subtracts spending on imports. Defining **net exports** to be exports minus imports ($NX = EX - IM$), the identity becomes

$$Y = C + I + G + NX.$$

This equation states that expenditure on domestic output is the sum of consumption, investment, government purchases, and net exports. This is the most common form of the national income accounts identity; it should be familiar from Chapter 2.

The national income accounts identity shows how domestic output, domestic spending, and net exports are related. In particular,

$$\begin{array}{ccccc} NX & = & Y & - & (C + I + G) \\ \text{Net Exports} & = & \text{Output} & - & \text{Domestic Spending.} \end{array}$$

This equation shows that in an open economy, domestic spending need not equal the output of goods and services. *If output exceeds domestic spending, we export the difference: net exports are positive. If output falls short of domestic spending, we import the difference: net exports are negative.*

International Capital Flows and the Trade Balance

In an open economy, as in the closed economy we discussed in Chapter 3, financial markets and goods markets are closely related. To see the relationship, we must rewrite the national income accounts identity in terms of saving and investment. Begin with the identity

$$Y = C + I + G + NX.$$

Subtract C and G from both sides to obtain

$$Y - C - G = I + NX.$$

Recall from Chapter 3 that $Y - C - G$ is national saving S, the sum of private saving, $Y - T - C$, and public saving, $T - G$. Therefore,

$$S = I + NX.$$

Subtracting I from both sides of the equation, we can write the national income accounts identity as

$$S - I = NX.$$

This form of the national income accounts identity shows that an economy's net exports must always equal the difference between its saving and its investment.

Let's look more closely at each part of this identity. The easy part is the right-hand side, NX, which is our net export of goods and services. Another name for net exports is the **trade balance**, because it tells us how our trade in goods and services departs from the benchmark of equal imports and exports.

The left-hand side of the identity is the difference between domestic saving and domestic investment, $S - I$, which we'll call **net capital outflow**. (It's sometimes called *net foreign investment*.) If net capital outflow is positive, our saving exceeds our investment, and we are lending the excess to foreigners. If the net capital outflow is negative, our investment exceeds our saving, and we are financing this extra investment by borrowing from abroad. Thus, net capital outflow equals the amount that domestic residents are lending abroad minus the amount that foreigners are lending to us. It reflects the international flow of funds to finance capital accumulation.

The national income accounts identity shows that net capital outflow always equals the trade balance. That is,

$$\begin{array}{ccc} \text{Net Capital Outflow} & = & \text{Trade Balance} \\ S - I & = & NX. \end{array}$$

If $S - I$ and NX are positive, we have a **trade surplus**. In this case, we are net lenders in world financial markets, and we are exporting more goods than we are importing. If $S - I$ and NX are negative, we have a **trade deficit**. In this case, we are net borrowers in world financial markets, and we are importing more goods than we are exporting. If $S - I$ and NX are exactly zero, we are said to have **balanced trade** because the value of imports equals the value of exports.

The national income accounts identity shows that the international flow of funds to finance capital accumulation and the international flow of goods and services are two sides of the same coin. On the one hand, if our saving exceeds our investment, the saving that is not invested domestically is used to make loans to foreigners. Foreigners require these loans because we are providing them with more goods and services than they are providing us. That is, we are running a trade surplus. On the other hand, if our investment exceeds our saving, the extra investment must be financed by borrowing from abroad. These foreign loans enable us to import more

table 5-1

International Flows of Goods and Capital: Summary

This table shows the three outcomes that an open economy can experience.

Trade Surplus	Balanced Trade	Trade Deficit
Exports > Imports	Exports = Imports	Exports < Imports
Net Exports > 0	Net Exports = 0	Net Exports < 0
$Y > C + I + G$	$Y = C + I + G$	$Y < C + I + G$
Savings > Investment	Saving = Investment	Saving < Investment
Net Capital Outflow > 0	Net Capital Outflow = 0	Net Capital Outflow < 0

FYI International Flows of Goods and Capital: An Example

The equality of net exports and net capital outflow is an identity: it must hold by the way the numbers are added up. But it is easy to miss the intuition behind this important relationship. The best way to understand it is to consider an example.

Imagine that Bill Gates sells a copy of the Windows operating system to a Japanese consumer for 5,000 yen. Because Mr. Gates is a U.S. resident, the sale represents an export of the United States. Other things equal, U.S. net exports rise. What else happens to make the identity hold? It depends on what Mr. Gates does with the 5,000 yen.

Suppose Mr. Gates decides to stuff the 5,000 yen in his mattress. In this case, Mr. Gates has allocated some of his saving to an investment in the Japanese economy (in the form of the Japanese currency) rather than to an investment in the U.S. economy. Thus, U.S. saving exceeds U.S. investment. The rise in U.S. net exports is matched by a rise in the U.S. net capital outflow.

If Mr. Gates wants to invest in Japan, however, he is unlikely to make currency his asset of choice. He might use the 5,000 yen to buy some stock in, say, the Sony Corporation, or he might buy a bond issued by the Japanese government. In either case, some of U.S. saving is flowing abroad. Once again, the U.S. net capital outflow exactly balances U.S. net exports.

The opposite situation occurs in Japan. When the Japanese consumer buys a copy of the Windows operating system, Japan's purchases of goods and services ($C + I + G$) rise, but there is no change in what Japan has produced (Y). The transaction reduces Japan's saving ($S = Y - C - G$) for a given level of investment (I). While the U.S. experiences a net capital outflow, Japan experiences a net capital inflow.

Now let's change the example. Suppose that instead of investing his 5,000 yen in a Japanese asset, Mr. Gates uses it to buy something made in Japan, such as a Sony Walkman. In this case, imports into the United State rise. Together, the Windows export and the Walkman import represent balanced trade between Japan and the United States. Because exports and imports rise equally, net exports and net capital outflow are both unchanged.

A final possibility is that Mr. Gates exchanges his 5,000 yen for U.S. dollars at a local bank. But this doesn't change the situation: the bank now has to do something with the 5,000 yen. It can buy Japanese assets (a U.S. net capital outflow); it can buy a Japanese good (a U.S. import); or it can sell the yen to another American who wants to make such a transaction. If you follow the money, you can see that, in the end, U.S. net exports must equal U.S. net capital outflow.

goods and services than we export. That is, we are running a trade deficit. Table 5-1 summarizes these lessons.

Note that the international flow of capital can take many forms. It is easiest to assume—as we have done so far—that when we run a trade deficit, foreigners make loans to us. This happens, for example, when the Japanese buy the debt issued by U.S. corporations or by the U.S. government. But the flow of capital can also take the form of foreigners buying domestic assets, such as when a citizen of Germany buys stock from an American on the New York Stock Exchange. Whether foreigners are buying domestically issued debt or domestically owned assets, they are obtaining a claim to the future returns to domestic capital. In both cases, foreigners end up owning some of the domestic capital stock.

5-2 Saving and Investment in a Small Open Economy

So far in our discussion of the international flows of goods and capital, we have merely rearranged accounting identities. That is, we have defined some of the variables that measure transactions in an open economy, and we have shown the links among these variables that follow from their definitions. Our next step is to develop a model that explains the behavior of these variables. We can then use the model to answer questions such as how the trade balance responds to changes in policy.

Capital Mobility and the World Interest Rate

In a moment we present a model of the international flows of capital and goods. Because the trade balance equals the net capital outflow, which in turn equals saving minus investment, our model focuses on saving and investment. To develop this model, we use some elements that should be familiar from Chapter 3, but in contrast to the Chapter 3 model, we do not assume that the real interest rate equilibrates saving and investment. Instead, we allow the economy to run a trade deficit and borrow from other countries, or to run a trade surplus and lend to other countries.

If the real interest rate does not adjust to equilibrate saving and investment in this model, what *does* determine the real interest rate? We answer this question here by considering the simple case of a **small open economy** with perfect capital mobility. By "small" we mean that this economy is a small part of the world market and thus, by itself, can have only a negligible effect on the world interest rate. By "perfect capital mobility" we mean that residents of the country have full access to world financial markets. In particular, the government does not impede international borrowing or lending.

Because of this assumption of perfect capital mobility, the interest rate in our small open economy, r, must equal the **world interest rate** r^*, the real interest rate prevailing in world financial markets:

$$r = r^*.$$

Residents of the small open economy need never borrow at any interest rate above r^*, because they can always get a loan at r^* from abroad. Similarly, residents of this economy need never lend at any interest rate below r^* because they can always earn r^* by lending abroad. Thus, the world interest rate determines the interest rate in our small open economy.

Let us discuss for a moment what determines the world real interest rate. In a closed economy, the equilibrium of domestic saving and domestic investment determines the interest rate. Barring interplanetary trade, the world economy is a closed economy. Therefore, the equilibrium of world saving and world investment determines the world interest rate. Our small open economy has a negligible effect on the world real interest rate because, being a small part of the world, it has a negligible effect on world saving and world investment. Hence, our small open economy takes the world interest rate as exogenously given.

The Model

To build the model of the small open economy, we take three assumptions from Chapter 3:

- The economy's output Y is fixed by the factors of production and the production function. We write this as

$$Y = \bar{Y} = F(\bar{K}, \bar{L}).$$

- Consumption C is positively related to disposable income $Y - T$. We write the consumption function as

$$C = C(Y - T).$$

- Investment I is negatively related to the real interest rate r. We write the investment function as

$$I = I(r).$$

These are the three key parts of our model. If you do not understand these relationships, review Chapter 3 before continuing.

We can now return to the accounting identity and write it as

$$\begin{aligned} NX &= (Y - C - G) - I \\ NX &= S - I. \end{aligned}$$

Substituting our three assumptions from Chapter 3 and the condition that the interest rate equals the world interest rate, we obtain

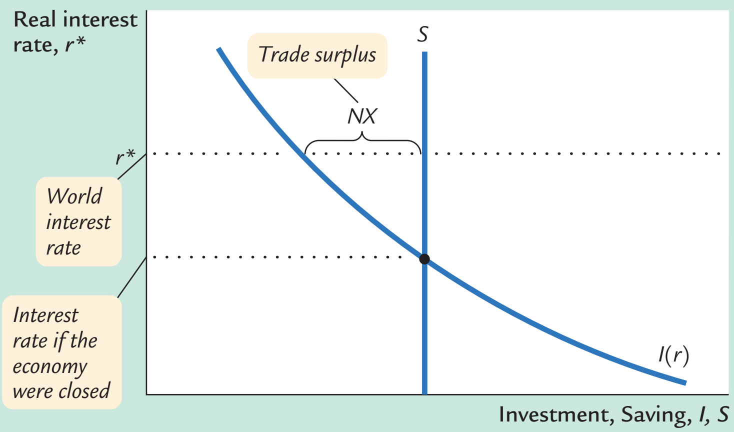
$$\begin{aligned} NX &= [\bar{Y} - C(\bar{Y} - T) - G] - I(r^*) \\ &= \qquad\quad \bar{S} \qquad\qquad\quad - I(r^*). \end{aligned}$$

This equation shows what determines saving S and investment I—and thus the trade balance NX. Remember that saving depends on fiscal policy: lower government purchases G or higher taxes T raise national saving. Investment depends on the world real interest rate r^*: high interest rates make some investment projects unprofitable. Therefore, the trade balance depends on these variables as well.

In Chapter 3 we graphed saving and investment as in Figure 5-2. In the closed economy studied in that chapter, the real interest rate adjusts to equilibrate saving and investment—that is, the real interest rate is found where the saving and investment curves cross. In the small open economy, however, the real interest rate equals the world real interest rate. *The trade balance is determined by the difference between saving and investment at the world interest rate.*

At this point, you might wonder about the mechanism that causes the trade balance to equal the net capital outflow. The determinants of the capital flows are

figure 5-2



Saving and Investment in a Small Open Economy In a closed economy, the real interest rate adjusts to equilibrate saving and investment. In a small open economy, the interest rate is determined in world financial markets. The difference between saving and investment determines the trade balance. Here there is a trade surplus, because at the world interest rate, saving exceeds investment.

easy to understand. When saving falls short of investment, investors borrow from abroad; when saving exceeds investment, the excess is lent to other countries. But what causes those who import and export to behave in a way that ensures that the international flow of goods exactly balances this international flow of capital? For now we leave this question unanswered, but we return to it in Section 5-3 when we discuss the determination of exchange rates.

How Policies Influence the Trade Balance

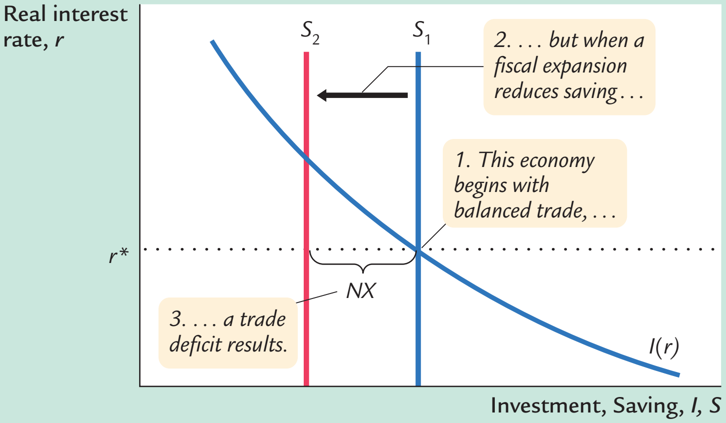
Suppose that the economy begins in a position of balanced trade. That is, at the world interest rate, investment I equals saving S, and net exports NX equal zero. Let's use our model to predict the effects of government policies at home and abroad.

Fiscal Policy at Home Consider first what happens to the small open economy if the government expands domestic spending by increasing government purchases. The increase in G reduces national saving, because $S = Y - C - G$. With an unchanged world real interest rate, investment remains the same. Therefore, saving falls below investment, and some investment must now be financed by borrowing from abroad. Because $NX = S - I$, the fall in S implies a fall in NX. The economy now runs a trade deficit.

The same logic applies to a decrease in taxes. A tax cut lowers T, raises disposable income $Y - T$, stimulates consumption, and reduces national saving. (Even though some of the tax cut finds its way into private saving, public saving falls by the full amount of the tax cut; in total, saving falls.) Because $NX = S - I$, the reduction in national saving in turn lowers NX.

Figure 5-3 illustrates these effects. A fiscal-policy change that increases private consumption C or public consumption G reduces national saving $(Y - C - G)$ and, therefore, shifts the vertical line that represents saving from S_1 to S_2. Because NX is the distance between the saving schedule and the investment schedule at the world interest rate, this shift reduces NX. *Hence, starting from balanced trade, a change in fiscal policy that reduces national saving leads to a trade deficit.*

figure 5-3



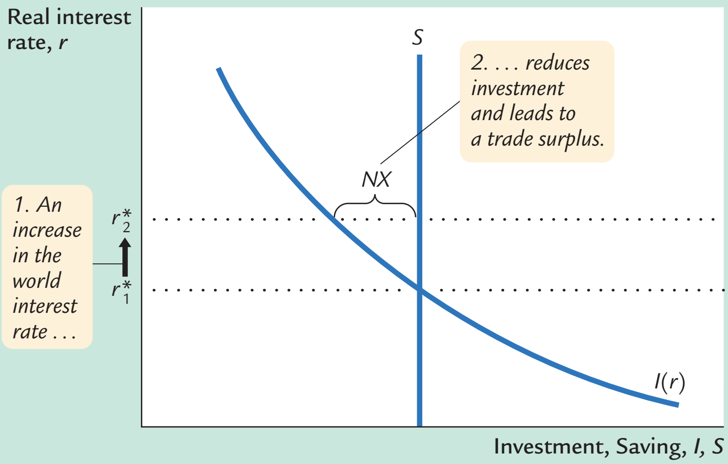
A Fiscal Expansion at Home in a Small Open Economy An increase in government purchases or a reduction in taxes reduces national saving and thus shifts the saving schedule to the left, from S_1 to S_2. The result is a trade deficit.

Fiscal Policy Abroad Consider now what happens to a small open economy when foreign governments increase their government purchases. If these foreign countries are a small part of the world economy, then their fiscal change has a negligible impact on other countries. But if these foreign countries are a large part of the world economy, their increase in government purchases reduces world saving and causes the world interest rate to rise.

The increase in the world interest rate raises the cost of borrowing and, thus, reduces investment in our small open economy. Because there has been no change in domestic saving, saving S now exceeds investment I, and some of our saving begins to flow abroad. Since $NX = S - I$, the reduction in I must also increase NX. Hence, reduced saving abroad leads to a trade surplus at home.

Figure 5-4 illustrates how a small open economy starting from balanced trade responds to a foreign fiscal expansion. Because the policy change is occurring

figure 5-4

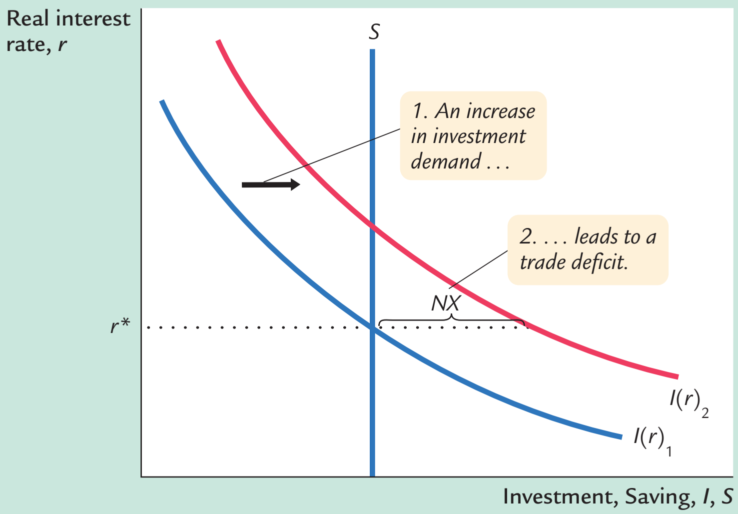


A Fiscal Expansion Abroad in a Small Open Economy A fiscal expansion in a foreign economy large enough to influence world saving and investment raises the world interest rate from r_1^* to r_2^*. The higher world interest rate reduces investment in this small open economy, causing a trade surplus.

abroad, the domestic saving and investment schedules remain the same. The only change is an increase in the world interest rate from r_1^* to r_2^*. The trade balance is the difference between the saving and investment schedules; because saving exceeds investment at r_2^*, there is a trade surplus. *Hence, an increase in the world interest rate due to a fiscal expansion abroad leads to a trade surplus.*

Shifts in Investment Demand Consider what happens to our small open economy if its investment schedule shifts outward—that is, if the demand for investment goods at every interest rate increases. This shift would occur if, for example, the government changed the tax laws to encourage investment by providing an investment tax credit. Figure 5-5 illustrates the impact of a shift in the investment schedule. At a given world interest rate, investment is now higher. Because saving is unchanged, some investment must now be financed by borrowing from abroad, which means the net capital outflow is negative. Put differently, because $NX = S - I$, the increase in I implies a decrease in NX. *Hence, an outward shift in the investment schedule causes a trade deficit.*

figure 5-5



A Shift in the Investment Schedule in a Small Open Economy An outward shift in the investment schedule from $I(r)_1$ to $I(r)_2$ increases the amount of investment at the world interest rate r^*. As a result, investment now exceeds saving, which means the economy is borrowing from abroad and running a trade deficit.

Evaluating Economic Policy

Our model of the open economy shows that the flow of goods and services measured by the trade balance is inextricably connected to the international flow of funds for capital accumulation. The net capital outflow is the difference between domestic saving and domestic investment. Thus, the impact of economic policies on the trade balance can always be found by examining their impact on domestic saving and domestic investment. Policies that increase investment or decrease saving tend to cause a trade deficit, and policies that decrease investment or increase saving tend to cause a trade surplus.

Our analysis of the open economy has been positive, not normative. That is, our analysis of how economic policies influence the international flows of capital and goods has not told us whether these policies are desirable. Evaluating economic policies and their impact on the open economy is a frequent topic of debate among economists and policymakers.

When a country runs a trade deficit, policymakers must confront the question of whether it represents a national problem. Most economists view a trade deficit not as a problem in itself, but perhaps as a symptom of a problem. A trade deficit could be a reflection of low saving. In a closed economy, low saving leads to low investment and a smaller future capital stock. In an open economy, low saving leads to a trade deficit and a growing foreign debt, which eventually must be repaid. In both cases, high current consumption leads to lower future consumption, implying that future generations bear the burden of low national saving.

Yet trade deficits are not always a reflection of economic malady. When poor rural economies develop into modern industrial economies, they sometimes finance their high levels of investment with foreign borrowing. In these cases, trade deficits are a sign of economic development. For example, South Korea ran large trade deficits throughout the 1970s, and it became one of the success stories of economic growth. The lesson is that one cannot judge economic performance from the trade balance alone. Instead, one must look at the underlying causes of the international flows.

CASE STUDY

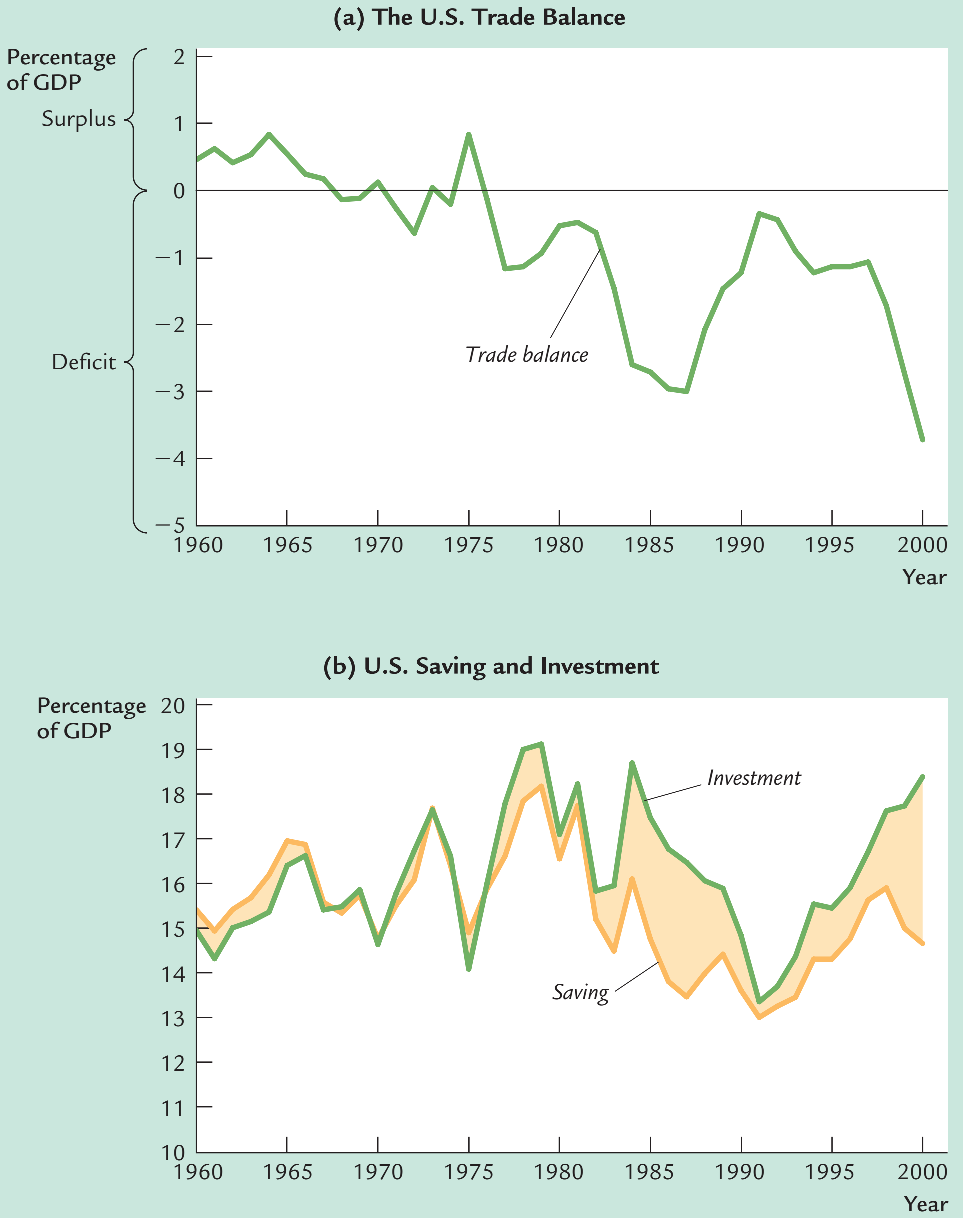
The U.S. Trade Deficit

During the 1980s and 1990s, the United States ran large trade deficits. Panel (a) of Figure 5-6 documents this experience by showing net exports as a percentage of GDP. The exact size of the trade deficit fluctuated over time, but it was large throughout these two decades. In 2000, the trade deficit was $371 billion, or 3.7 percent of GDP. As accounting identities require, this trade deficit had to be financed by borrowing from abroad (or, equivalently, by selling U.S. assets abroad). During this period, the United States went from being the world's largest creditor to the world's largest debtor.

What caused the U.S. trade deficit? There is no single explanation. But to understand some of the forces at work, it helps to look at national saving and domestic investment, as shown in panel (b) of the figure. Keep in mind that the trade deficit is the difference between saving and investment.

The start of the trade deficit coincided with a fall in national saving. This development can be explained by the expansionary fiscal policy in the 1980s. With the support of President Reagan, the U.S. Congress passed legislation in 1981 that substantially cut personal income taxes over the next three years. Because these tax cuts were not met with equal cuts in government spending, the federal budget went into deficit. These budget deficits were among the largest ever experienced in a period of peace and prosperity, and they continued long after Reagan left office. According to our model, such a policy should reduce national

figure 5-6



The Trade Balance, Saving, and Investment: The U.S. Experience Panel (a) shows the trade balance as a percentage of GDP. Positive numbers represent a surplus, and negative numbers represent a deficit. Panel (b) shows national saving and investment as a percentage of GDP since 1960. The trade balance equals saving minus investment.

Source: U.S. Department of Commerce.

saving, thereby causing a trade deficit. And, in fact, that is exactly what happened. Because the government budget and trade balance went into deficit at roughly the same time, these shortfalls were called the *twin deficits*.

Things started to change in the 1990s, when the U.S. federal government got its fiscal house in order. The first President Bush and President Clinton both signed tax increases, while Congress kept a lid on spending. In addition to these policy changes, rapid productivity growth in the late 1990s raised incomes and, thus, further increased tax revenue. These developments moved the U.S. federal budget from deficit to surplus, which in turn caused national saving to rise.

In contrast to what our model predicts, the increase in national saving did not coincide with a shrinking trade deficit, because domestic investment rose at the same time. The likely explanation is that the boom in information technology caused an expansionary shift in the U.S. investment function. Even though fiscal policy was pushing the trade deficit toward surplus, the investment boom was an even stronger force pushing the trade balance toward deficit.

The history of the U.S. trade deficit shows that this statistic, by itself, does not tell us much about what is happening in the economy. We have to look deeper at saving, investment, and the policies and events that cause them to change over time.

5-3 Exchange Rates

Having examined the international flows of capital and of goods and services, we now extend the analysis by considering the prices that apply to these transactions. The *exchange rate* between two countries is the price at which residents of those countries trade with each other. In this section we first examine precisely what the exchange rate measures, and we then discuss how exchange rates are determined.

Nominal and Real Exchange Rates

Economists distinguish between two exchange rates: the nominal exchange rate and the real exchange rate. Let's discuss each in turn and see how they are related.

The Nominal Exchange Rate The **nominal exchange rate** is the relative price of the currency of two countries. For example, if the exchange rate between the U.S. dollar and the Japanese yen is 120 yen per dollar, then you can exchange one dollar for 120 yen in world markets for foreign currency. A Japanese who wants to obtain dollars would pay 120 yen for each dollar he bought. An American who wants to obtain yen would get 120 yen for each dollar he paid. When people refer to "the exchange rate" between two countries, they usually mean the nominal exchange rate.

FYI How Newspapers Report the Exchange Rate

You can find nominal exchange rates reported daily in many newspapers. Here's how they are reported in the *Wall Street Journal*.

Notice that each exchange rate is reported in two ways. On this Thursday, 1 dollar bought 116.29 yen, and 1 yen bought 0.008599 dollars. We can say the exchange rate is 116.29 yen per dollar, or we can say the exchange rate is 0.008599 dollars per yen. Because 0.008599 equals 1/116.29, these two ways of expressing the exchange rate are equivalent. This book always expresses the exchange rate in units of foreign currency per dollar.

The exchange rate on this Thursday of 116.29 yen per dollar was down from 117.67 yen per dollar on Wednesday. Such a fall in the exchange rate is called a *depreciation* of the dollar; a rise in the exchange rate is called an *appreciation*. When the domestic currency depreciates, it buys less of the foreign currency; when it appreciates, it buys more.

CURRENCY TRADING

Thursday, September 20, 2001

EXCHANGE RATES

The foreign exchange mid-range rates below apply to trading among banks in amounts of $1 million and more, as quoted at 4 p.m. Eastern time by Rueters and other sources. Retail transactions provide fewer units of foreign currency per dollar. Rates for the 12 Euro currency countries are derived from the latest dollar-euro rate using the exchange ratios set 1/1/99.

	U.S. $ EQUIV.		CURRENCY PER U.S. $	
Country	**Thu**	**Wed**	**Thu**	**Wed**
Argentina (Peso)	1.0002	1.0003	.9998	.9997
Australia (Dollar)	.4932	.4931	2.0274	2.0278
Austria (Schilling)	.06740	.06735	14.837	14.848
Bahrain (Dinar)	2.6525	2.6518	.3770	.3771
Belgium (Franc)	.0230	.0230	43.4955	43.5284
Brazil (Real)	.3612	.3699	2.7685	2.7035
Britain (Pound)	1.4671	1.4684	.6816	.6810
1-month forward	1.4648	1.4658	.6827	.6822
3-months forward	1.4603	1.4615	.6848	.6842
6-months forward	1.4540	1.4549	.6878	.6873
Canada (Dollar)	.6364	.6376	1.5713	1.5683
1-month forward	.6359	.6371	1.5725	1.5696
3-months forward	.6354	.6365	1.5739	1.5712
6-months forward	.6348	.6359	1.5752	1.5725
Chile (Peso)	.001440	.001449	694.55	690.15
China (Renminbi)	.1208	.1208	8.2766	8.2766
Colombia (Peso)	.0004269	.0004264	2342.50	2345.00
Czech. Rep. (Koruna)				
Commercial rate	.02704	.02716	36.985	36.822
Denmark (Krone)	.1246	.1245	8.0260	8.0315
Ecuador (US Dollar)-e	1.0000	1.0000	1.0000	1.0000
Finland (Markka)	.1560	.1559	6.4108	6.4157
France (Franc)	.1414	.1413	7.0727	7.0780
1-month forward	.1413	.1412	7.0794	7.0846
3-months forward	.1410	.1409	7.0921	7.0970
6-months forward	.1407	.1406	7.1088	7.1146
Germany (Mark)	.4742	.4738	2.1088	2.1104
1-month forward	.4738	.4734	2.1108	2.1124
3-months forward	.4729	.4726	2.1146	2.1161
6-months forward	.4718	.4714	2.1196	2.1214
Greece (Drachma)	.002722	.002720	367.41	367.70
Hong Kong (Dollar)	.1282	.1282	7.7995	7.7992
Hungary (Forint)	.003589	.003592	278.67	278.40
India (Rupee)	.02084	.02083	47.980	48.010
Indonesia (Rupiah)	.0001059	.0001041	9445	9605
Ireland (Punt)	1.1776	1.1767	.8492	.8498
Israel (Shekel)	.2297	.2304	4.3541	4.3400
Italy (Lira)	.0004790	.0004786	2087.74	2089.31
Japan (Yen)	.008599	.008498	116.29	117.67
1-month forward	.008618	.008517	116.04	117.41
3-months forward	.008655	.008553	115.53	116.92
6-months forward	.008707	.008603	114.85	116.23
Jordan (Dinar)	1.4069	1.4069	.7108	.7108
Kuwait (Dinar)	3.2830	3.2841	.3046	.3045
Lebanon (Pound)	.0006604	.0006604	1514.25	1514.25
Malaysia (Ringgit)-b	.2632	.2632	3.8000	3.8000
Malta (Lira)	2.779	2.2774	.4390	.4391
Mexico (Peso)				
Floating rate	.1055	.1060	9.4825	9.4325
Netherlands (Guilder)	.4209	.4205	2.3761	2.3779
New Zealand (Dollar)	.4128	.4122	2.4225	2.4260
Norway (Krone)	.1169	.1169	8.5530	8.5551
Pakistan (Rupee)	.01559	.01559	64.150	64.150
Peru (new Sol)	.2857	.2857	3.5005	3.5003
Philippines (Peso)	.01949	.01946	51.300	51.375
Poland (Zloty)-d	.2404	.2382	4.1600	4.1975
Portugal (Escudo)	.004626	.004623	216.16	216.33
Russia (Ruble)-a	.03399	.03397	29.422	29.442
Saudi Arabia (Riyal)	.2666	.2666	3.7508	3.7505
Singapore (Dollar)	.5758	.5749	1.7368	1.7395
Slovak Rep. (Koruna)	.02116	.02118	47.253	47.219
South Africa (Rand)	.1149	.1156	8.6998	8.6478
South Korea (Won)	.0007734	.0007740	1293.00	1292.00
Spain (Peseta)	.005574	.005570	179.40	179.54
Sweden (Krona)	.0942	.0952	10.6178	10.5030
Switzerland (Franc)	.6303	.6260	1.5865	1.5974
1-month forward	.6302	.6259	1.5867	1.5977
3-months forward	.6301	.6258	1.5870	1.5980
6-months forward	.6303	.6259	1.5866	1.5977
Taiwan (Dollar)	.02894	.02895	34.560	34.540
Thailand (Baht)	.02266	.02265	44.140	44.150
Turkey (Lira)-f	.00000066	.00000066	1520000	1504000
United Arab (Dirham)	.2723	.2723	3.6730	3.6728
Uruguay (New Peso)				
Financial	.07278	.07278	13.740	13.740
Venezuela (Bolivar)	.001345	.001345	743.25	743.25
SDR	1.2945	1.2950	.7725	.7722
Euro	.9275	.9268	1.0782	1.0790

Special Drawing Rights (SDR) are based on exchange rates for the U.S., German, British, French, and Japanese currencies. Source: International Monetary Fund.

a-Russian Central Bank rate. b-Government rate. d-Floating rate; trading band suspended on 4/11/00. e-Adopted U.S. dollar as of 9/11/00. f-Floating rate, eff. Feb. 22.

Source: Wall Street Journal, Friday, September 21, 2001. Reprinted by permission of the *Wall Street Journal*,

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The Real Exchange Rate The **real exchange rate** is the relative price of the goods of two countries. That is, the real exchange rate tells us the rate at which we can trade the goods of one country for the goods of another. The real exchange rate is sometimes called the *terms of trade.*

To see the relation between the real and nominal exchange rates, consider a single good produced in many countries: cars. Suppose an American car costs \$10,000 and a similar Japanese car costs 2,400,000 yen. To compare the prices of the two cars, we must convert them into a common currency. If a dollar is worth 120 yen, then the American car costs 1,200,000 yen. Comparing the price of the American car (1,200,000 yen) and the price of the Japanese car (2,400,000 yen), we conclude that the American car costs one-half of what the Japanese car costs. In other words, at current prices, we can exchange two American cars for one Japanese car.

We can summarize our calculation as follows:

$$\text{Real Exchange Rate} = \frac{(120 \text{ yen/dollar}) \times (10{,}000 \text{ dollars/American Car})}{(2{,}400{,}000 \text{ yen/Japanese Car})}$$

$$= 0.5 \ \frac{\text{Japanese Car}}{\text{American Car}}.$$

At these prices and this exchange rate, we obtain one-half of a Japanese car per American car. More generally, we can write this calculation as

$$\text{Real Exchange Rate} = \frac{\text{Nominal Exchange Rate} \times \text{Price of Domestic Good}}{\text{Price of Foreign Good}}.$$

The rate at which we exchange foreign and domestic goods depends on the prices of the goods in the local currencies and on the rate at which the currencies are exchanged.

This calculation of the real exchange rate for a single good suggests how we should define the real exchange rate for a broader basket of goods. Let e be the nominal exchange rate (the number of yen per dollar), P be the price level in the United States (measured in dollars), and P^* be the price level in Japan (measured in yen). Then the real exchange rate ϵ is

$$\begin{array}{ccccc} \text{Real} & & \text{Nominal} & & \text{Ratio of} \\ \text{Exchange} & = & \text{Exchange} & \times & \text{Price} \\ \text{Rate} & & \text{Rate} & & \text{Levels} \\ \epsilon & = & e & \times & (P/P^*). \end{array}$$

The real exchange rate between two countries is computed from the nominal exchange rate and the price levels in the two countries. *If the real exchange rate is high, foreign goods are relatively cheap, and domestic goods are relatively expensive. If the real exchange rate is low, foreign goods are relatively expensive, and domestic goods are relatively cheap.*

The Real Exchange Rate and the Trade Balance

What macroeconomic influence does the real exchange rate exert? To answer this question, remember that the real exchange rate is nothing more than a relative price. Just as the relative price of hamburgers and pizza determines which you choose for lunch, the relative price of domestic and foreign goods affects the demand for these goods.

Drawing by Matteson; © 1988 The New Yorker Magazine, Inc.

"How about Nebraska? The dollar's still strong in Nebraska."

Suppose first that the real exchange rate is low. In this case, because domestic goods are relatively cheap, domestic residents will want to purchase few imported goods: they will buy Fords rather than Toyotas, drink Coors rather than Heineken, and vacation in Florida rather than Europe. For the same reason, foreigners will want to buy many of our goods. As a result of both of these actions, the quantity of our net exports demanded will be high.

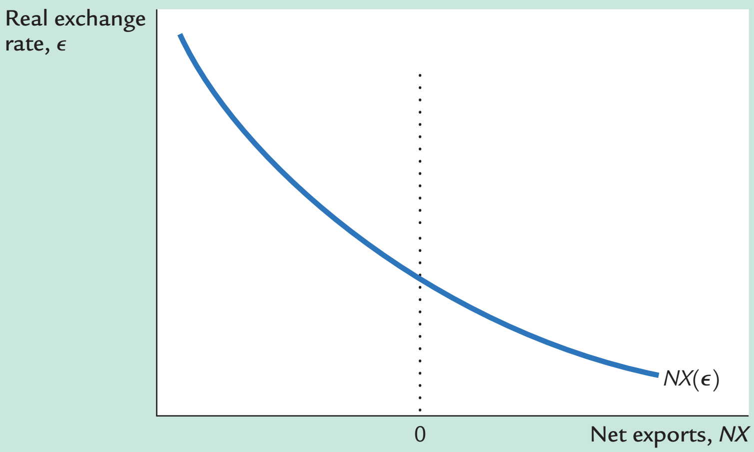
The opposite occurs if the real exchange rate is high. Because domestic goods are expensive relative to foreign goods, domestic residents will want to buy many imported goods, and foreigners will want to buy few of our goods. Therefore, the quantity of our net exports demanded will be low.

We write this relationship between the real exchange rate and net exports as

$$NX = NX(\epsilon).$$

This equation states that net exports are a function of the real exchange rate. Figure 5-7 illustrates this negative relationship between the trade balance and the real exchange rate.

figure 5-7



Net Exports and the Real Exchange Rate The figure shows the relationship between the real exchange rate and net exports: the lower the real exchange rate, the less expensive are domestic goods relative to foreign goods, and thus the greater are our net exports. Note that a portion of the horizontal axis measures negative values of *NX:* because imports can exceed exports, net exports can be less than zero.

The Determinants of the Real Exchange Rate

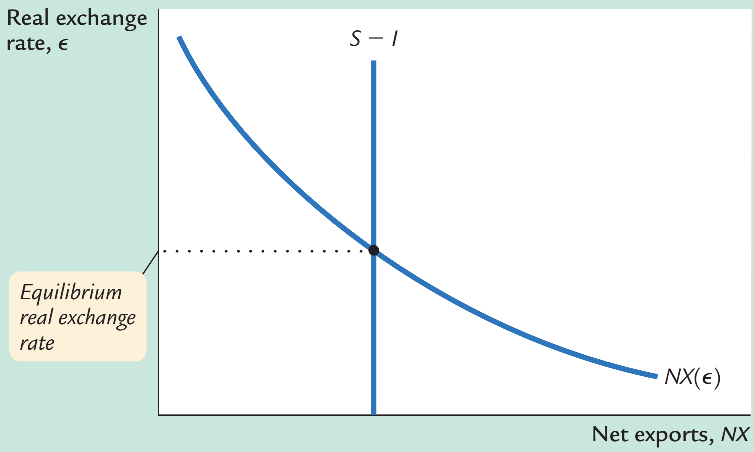
We now have all the pieces needed to construct a model that explains what factors determine the real exchange rate. In particular, we combine the relationship between net exports and the real exchange rate we just discussed with the model of the trade balance we developed earlier in the chapter. We can summarize the analysis as follows:

- The real exchange rate is related to net exports. When the real exchange rate is lower, domestic goods are less expensive relative to foreign goods, and net exports are greater.
- The trade balance (net exports) must equal the net capital outflow, which in turn equals saving minus investment. Saving is fixed by the consumption function and fiscal policy; investment is fixed by the investment function and the world interest rate.

Figure 5-8 illustrates these two conditions. The line showing the relationship between net exports and the real exchange rate slopes downward because a low real exchange rate makes domestic goods relatively inexpensive. The line representing the excess of saving over investment, $S - I$, is vertical because neither saving nor investment depends on the real exchange rate. The crossing of these two lines determines the equilibrium exchange rate.

Figure 5-8 looks like an ordinary supply-and-demand diagram. In fact, you can think of this diagram as representing the supply and demand for foreign-currency exchange. The vertical line, $S - I$, represents the net capital outflow and thus the supply of dollars to be exchanged into foreign currency and invested abroad. The downward-sloping line, NX, represents the net demand for dollars coming from foreigners who want dollars to buy our goods. *At the equilibrium real exchange rate, the supply of dollars available from the net capital outflow balances the demand for dollars by foreigners buying our net exports.*

figure 5-8



How the Real Exchange Rate Is Determined The real exchange rate is determined by the intersection of the vertical line representing saving minus investment and the downward-sloping net-exports schedule. At this intersection, the quantity of dollars supplied for the flow of capital abroad equals the quantity of dollars demanded for the net export of goods and services.

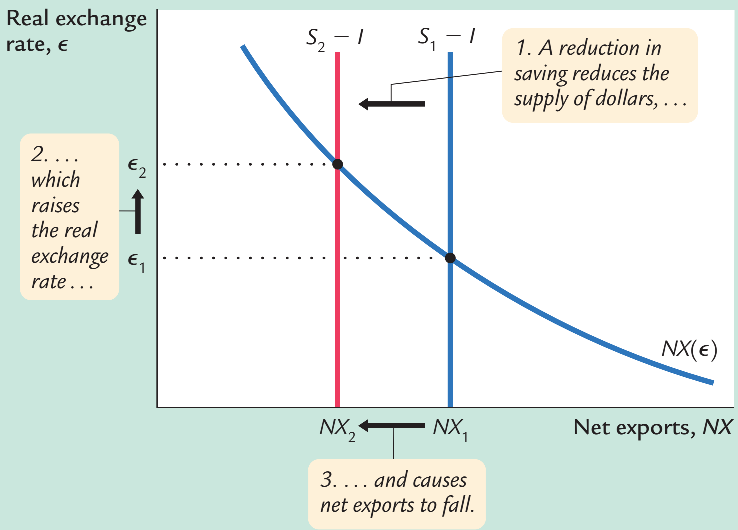
How Policies Influence the Real Exchange Rate

We can use this model to show how the changes in economic policy we discussed earlier affect the real exchange rate.

Fiscal Policy at Home What happens to the real exchange rate if the government reduces national saving by increasing government purchases or cutting taxes? As we discussed earlier, this reduction in saving lowers $S - I$ and thus NX. That is, the reduction in saving causes a trade deficit.

Figure 5-9 shows how the equilibrium real exchange rate adjusts to ensure that NX falls. The change in policy shifts the vertical $S - I$ line to the left, lowering the supply of dollars to be invested abroad. The lower supply causes the equilibrium real exchange rate to rise from ϵ_1 to ϵ_2—that is, the dollar becomes more valuable. Because of the rise in the value of the dollar, domestic goods become more expensive relative to foreign goods, which causes exports to fall and imports to rise. The change in exports and the change in imports both act to reduce net exports.

figure 5-9

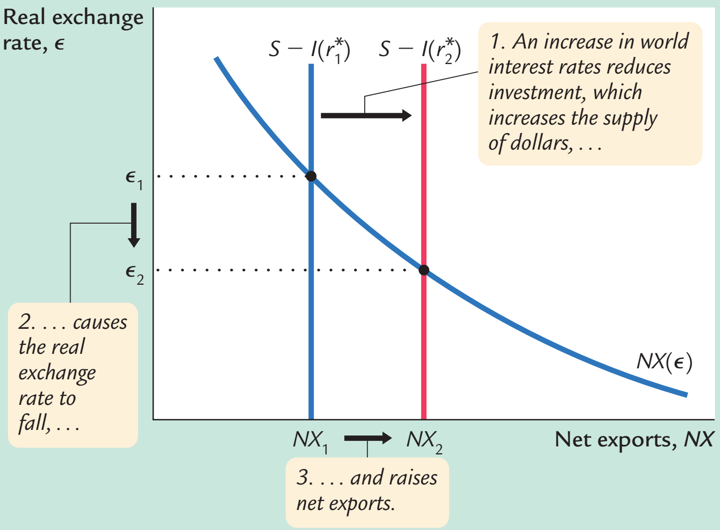


The Impact of Expansionary Fiscal Policy at Home on the Real Exchange Rate Expansionary fiscal policy at home, such as an increase in government purchases or a cut in taxes, reduces national saving. The fall in saving reduces the supply of dollars to be exchanged into foreign currency, from $S_1 - I$ to $S_2 - I$. This shift raises the equilibrium real exchange rate from ϵ_1 to ϵ_2.

Fiscal Policy Abroad What happens to the real exchange rate if foreign governments increase government purchases or cut taxes? This change in fiscal policy reduces world saving and raises the world interest rate. The increase in the world interest rate reduces domestic investment I, which raises $S - I$ and thus NX. That is, the increase in the world interest rate causes a trade surplus.

Figure 5-10 shows that this change in policy shifts the vertical $S - I$ line to the right, raising the supply of dollars to be invested abroad. The equilibrium real exchange rate falls. That is, the dollar becomes less valuable, and domestic goods become less expensive relative to foreign goods.

figure 5-10

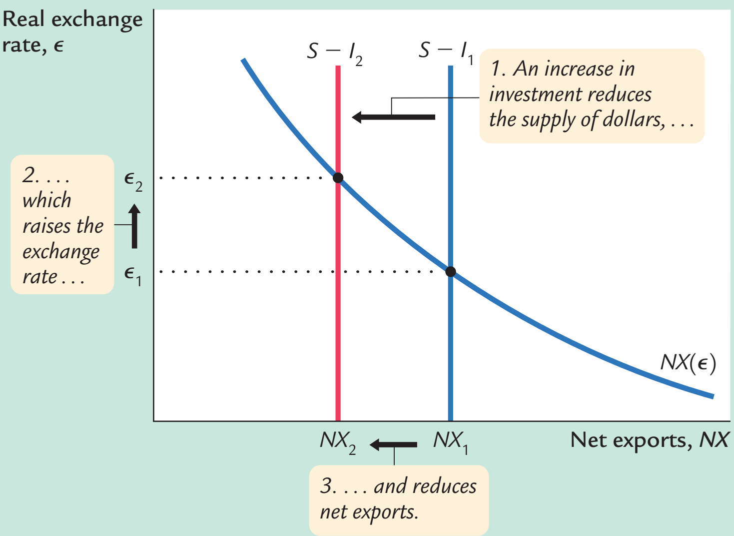


The Impact of Expansionary Fiscal Policy Abroad on the Real Exchange Rate Expansionary fiscal policy abroad reduces world saving and raises the world interest rate from r_1^* to r_2^*. The increase in the world interest rate reduces investment at home, which in turn raises the supply of dollars to be exchanged into foreign currencies. As a result, the equilibrium real exchange rate falls from ϵ_1 to ϵ_2.

Shifts in Investment Demand What happens to the real exchange rate if investment demand at home increases, perhaps because Congress passes an investment tax credit? At the given world interest rate, the increase in investment demand leads to higher investment. A higher value of I means lower values of $S - I$ and NX. That is, the increase in investment demand causes a trade deficit.

Figure 5-11 shows that the increase in investment demand shifts the vertical $S - I$ line to the left, reducing the supply of dollars to be invested abroad. The

figure 5-11



The Impact of an Increase in Investment Demand on the Real Exchange Rate An increase in investment demand raises the quantity of domestic investment from I_1 to I_2. As a result, the supply of dollars to be exchanged into foreign currencies falls from $S - I_1$ to $S - I_2$. This fall in supply raises the equilibrium real exchange rate from ϵ_1 to ϵ_2.

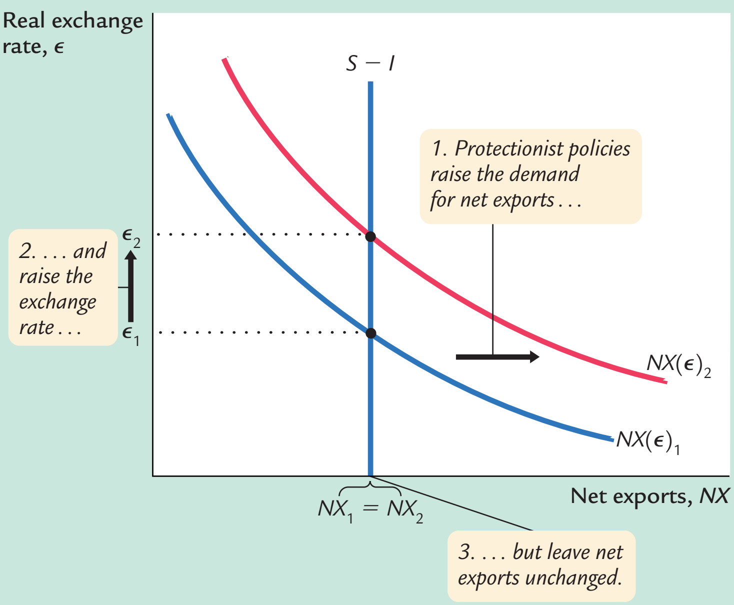
equilibrium real exchange rate rises. Hence, when the investment tax credit makes investing in the United States more attractive, it also increases the value of the U.S. dollars necessary to make these investments. When the dollar appreciates, domestic goods become more expensive relative to foreign goods, and net exports fall.

The Effects of Trade Policies

Now that we have a model that explains the trade balance and the real exchange rate, we have the tools to examine the macroeconomic effects of trade policies. Trade policies, broadly defined, are policies designed to influence directly the amount of goods and services exported or imported. Most often, trade policies take the form of protecting domestic industries from foreign competition—either by placing a tax on foreign imports (a tariff) or restricting the amount of goods and services that can be imported (a quota).

As an example of a protectionist trade policy, consider what would happen if the government prohibited the import of foreign cars. For any given real exchange rate, imports would now be lower, implying that net exports (exports minus imports) would be higher. Thus, the net-exports schedule shifts outward, as in Figure 5-12. To see the effects of the policy, we compare the old equilibrium and the new equilibrium. In the new equilibrium, the real exchange rate is higher, and net exports are unchanged. Despite the shift in the net-exports schedule, the equilibrium level of net exports remains the same, because the protectionist policy does not alter either saving or investment.

figure 5-12



The Impact of Protectionist Trade Policies on the Real Exchange Rate A protectionist trade policy, such as a ban on imported cars, shifts the net-exports schedule from $NX(\epsilon)_1$ to $NX(\epsilon)_2$, which raises the real exchange rate from ϵ_1 to ϵ_2. Notice that, despite the shift in the net-exports schedule, the equilibrium level of net exports is unchanged.

This analysis shows that protectionist trade policies do not affect the trade balance. This surprising conclusion is often overlooked in the popular debate over trade policies. Because a trade deficit reflects an excess of imports over exports, one might guess that reducing imports—such as by prohibiting the import of foreign cars—would reduce a trade deficit. Yet our model shows that protectionist policies lead only to an appreciation of the real exchange rate. The increase in the price of domestic goods relative to foreign goods tends to lower net exports by stimulating imports and depressing exports. Thus, the appreciation offsets the increase in net exports that is directly attributable to the trade restriction.

Although protectionist trade policies do not alter the trade balance, they do affect the amount of trade. As we have seen, because the real exchange rate appreciates, the goods and services we produce become more expensive relative to foreign goods and services. We therefore export less in the new equilibrium. Because net exports are unchanged, we must import less as well. (The appreciation of the exchange rate does stimulate imports to some extent, but this only partly offsets the decrease in imports caused by the trade restriction.) Thus, protectionist policies reduce both the quantity of imports and the quantity of exports.

This fall in the total amount of trade is the reason economists almost always oppose protectionist policies. International trade benefits all countries by allowing each country to specialize in what it produces best and by providing each country with a greater variety of goods and services. Protectionist policies diminish these gains from trade. Although these policies benefit certain groups within society—for example, a ban on imported cars helps domestic car producers—society on average is worse off when policies reduce the amount of international trade.

The Determinants of the Nominal Exchange Rate

Having seen what determines the real exchange rate, we now turn our attention to the nominal exchange rate—the rate at which the currencies of two countries trade. Recall the relationship between the real and the nominal exchange rate:

$$\begin{array}{ccccc} \text{Real} & & \text{Nominal} & & \text{Ratio of} \\ \text{Exchange} & = & \text{Exchange} & \times & \text{Price} \\ \text{Rate} & & \text{Rate} & & \text{Levels} \\ \epsilon & = & e & \times & (P/P^*). \end{array}$$

We can write the nominal exchange rate as

$$e = \epsilon \times (P^*/P).$$

This equation shows that the nominal exchange rate depends on the real exchange rate and the price levels in the two countries. Given the value of the real exchange rate, if the domestic price level P rises, then the nominal exchange rate e will fall: because a dollar is worth less, a dollar will buy fewer yen. However, if the Japanese price level P^* rises, then the nominal exchange rate will increase: because the yen is worth less, a dollar will buy more yen.

It is instructive to consider changes in exchange rates over time. The exchange rate equation can be written

$$\%\ \text{Change in } e = \%\ \text{Change in } \epsilon + \%\ \text{Change in } P^* - \%\ \text{Change in } P.$$

The percentage change in ϵ is the change in the real exchange rate. The percentage change in P is the domestic inflation rate π, and the percentage change in P^* is the foreign country's inflation rate π^*. Thus, the percentage change in the nominal exchange rate is

$$\%\ \text{Change in } e = \%\ \text{Change in } \epsilon + (\pi^* - \pi)$$

$$\begin{matrix}\text{Percentage Change in} \\ \text{Nominal Exchange Rate}\end{matrix} = \begin{matrix}\text{Percentage Change in} \\ \text{Real Exchange Rate}\end{matrix} + \begin{matrix}\text{Difference in} \\ \text{Inflation Rates.}\end{matrix}$$

This equation states that the percentage change in the nominal exchange rate between the currencies of two countries equals the percentage change in the real exchange rate plus the difference in their inflation rates. *If a country has a high rate of inflation relative to the United States, a dollar will buy an increasing amount of the foreign currency over time. If a country has a low rate of inflation relative to the United States, a dollar will buy a decreasing amount of the foreign currency over time.*

This analysis shows how monetary policy affects the nominal exchange rate. We know from Chapter 4 that high growth in the money supply leads to high inflation. Here, we have just seen that one consequence of high inflation is a depreciating currency: high π implies falling e. In other words, just as growth in the amount of money raises the price of goods measured in terms of money, it also tends to raise the price of foreign currencies measured in terms of the domestic currency.

CASE STUDY

Inflation and Nominal Exchange Rates

If we look at data on exchange rates and price levels of different countries, we quickly see the importance of inflation for explaining changes in the nominal exchange rate. The most dramatic examples come from periods of very high inflation. For example, the price level in Mexico rose by 2,300 percent from 1983 to 1988. Because of this inflation, the number of pesos a person could buy with a U.S. dollar rose from 144 in 1983 to 2,281 in 1988.

The same relationship holds true for countries with more moderate inflation. Figure 5-13 is a scatterplot showing the relationship between inflation and the exchange rate for 15 countries. On the horizontal axis is the difference between each country's average inflation rate and the average inflation rate of the United

figure 5-13

Inflation Differentials and the Exchange Rate This scatterplot shows the relationship between inflation and the nominal exchange rate. The horizontal axis shows the country's average inflation rate minus the U.S. average inflation rate over the period 1972–2000. The vertical axis is the average percentage change in the country's exchange rate (per U.S. dollar) over that period. This figure shows that countries with relatively high inflation tend to have depreciating currencies and that countries with relatively low inflation tend to have appreciating currencies.

Source: International Financial Statistics.

States ($\pi^* - \pi$). On the vertical axis is the average percentage change in the exchange rate between each country's currency and the U.S. dollar (% change in e). The positive relationship between these two variables is clear in this figure. Countries with relatively high inflation tend to have depreciating currencies (you can buy more of them for your dollars over time), and countries with relatively low inflation tend to have appreciating currencies (you can buy less of them for your dollars over time).

As an example, consider the exchange rate between German marks and U.S. dollars. Both Germany and the United States have experienced inflation over the past twenty years, so both the mark and the dollar buy fewer goods than they once did. But, as Figure 5-13 shows, inflation in Germany has been lower than inflation in the United States. This means that the value of the mark has fallen less than the value of the dollar. Therefore, the number of German marks you can buy with a U.S. dollar has been falling over time.

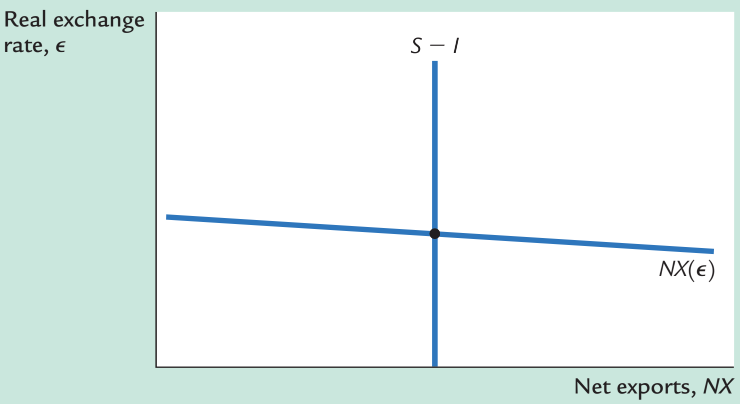
The Special Case of Purchasing-Power Parity

A famous hypothesis in economics, called the *law of one price*, states that the same good cannot sell for different prices in different locations at the same time. If a bushel of wheat sold for less in New York than in Chicago, it would be profitable to buy wheat in New York and then sell it in Chicago. Astute arbitrageurs would take advantage of such an opportunity and, thereby, would increase the demand for wheat in New York and increase the supply in Chicago. This would drive the price up in New York and down in Chicago—thereby ensuring that prices are equalized in the two markets.

The law of one price applied to the international marketplace is called **purchasing-power parity**. It states that if international arbitrage is possible, then a dollar (or any other currency) must have the same purchasing power in every country. The argument goes as follows. If a dollar could buy more wheat domestically than abroad, there would be opportunities to profit by buying wheat domestically and selling it abroad. Profit-seeking arbitrageurs would drive up the domestic price of wheat relative to the foreign price. Similarly, if a dollar could buy more wheat abroad than domestically, the arbitrageurs would buy wheat abroad and sell it domestically, driving down the domestic price relative to the foreign price. Thus, profit-seeking by international arbitrageurs causes wheat prices to be the same in all countries.

We can interpret the doctrine of purchasing-power parity using our model of the real exchange rate. The quick action of these international arbitrageurs implies that net exports are highly sensitive to small movements in the real exchange rate. A small decrease in the price of domestic goods relative to foreign goods—that is, a small decrease in the real exchange rate—causes arbitrageurs to buy goods domestically and sell them abroad. Similarly, a small increase in the relative price of domestic goods causes arbitrageurs to import goods from abroad. Therefore, as in Figure 5-14, the net-exports schedule is very flat at the real exchange rate that equalizes purchasing power among countries: any small

figure 5-14



Purchasing-Power Parity The law of one price applied to the international marketplace suggests that net exports are highly sensitive to small movements in the real exchange rate. This high sensitivity is reflected here with a very flat net-exports schedule.

movement in the real exchange rate leads to a large change in net exports. This extreme sensitivity of net exports guarantees that the equilibrium real exchange rate is always close to the level ensuring purchasing-power parity.

Purchasing-power parity has two important implications. First, because the net-exports schedule is flat, changes in saving or investment do not influence the real or nominal exchange rate. Second, because the real exchange rate is fixed, all changes in the nominal exchange rate result from changes in price levels.

Is this doctrine of purchasing-power parity realistic? Most economists believe that, despite its appealing logic, purchasing-power parity does not provide a completely accurate description of the world. First, many goods are not easily traded. A haircut can be more expensive in Tokyo than in New York, yet there is no room for international arbitrage because it is impossible to transport haircuts. Second, even tradable goods are not always perfect substitutes. Some consumers prefer Toyotas, and others prefer Fords. Thus, the relative price of Toyotas and Fords can vary to some extent without leaving any profit opportunities. For these reasons, real exchange rates do in fact vary over time.

Although the doctrine of purchasing-power parity does not describe the world perfectly, it does provide a reason why movement in the real exchange rate will be limited. There is much validity to its underlying logic: the farther the real exchange rate drifts from the level predicted by purchasing-power parity, the greater the incentive for individuals to engage in international arbitrage in goods. Although we cannot rely on purchasing-power parity to eliminate all changes in the real exchange rate, this doctrine does provide a reason to expect that fluctuations in the real exchange rate will typically be small or temporary.[1]

CASE STUDY

The Big Mac Around the World

The doctrine of purchasing-power parity says that after we adjust for exchange rates, we should find that goods sell for the same price everywhere. Conversely, it says that the exchange rate between two currencies should depend on the price levels in the two countries.

To see how well this doctrine works, *The Economist*, an international newsmagazine, regularly collects data on the price of a good sold in many countries: the McDonald's Big Mac hamburger. According to purchasing-power parity, the price of a Big Mac should be closely related to the country's nominal exchange rate. The higher the price of a Big Mac in the local currency, the higher the exchange rate (measured in units of local currency per U.S. dollar) should be.

Table 5-2 presents the international prices in 2000, when a Big Mac sold for $2.51 in the United States. With these data we can use the doctrine of purchasing-power parity to predict nominal exchange rates. For example, because a Big Mac

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[1] To learn more about purchasing-power parity, see Kenneth A. Froot and Kenneth Rogoff, "Perspectives on PPP and Long-Run Real Exchange Rates," in Gene M. Grossman and Kenneth Rogoff, eds., *Handbook of International Economics*, vol. 3 (Amsterdam: North-Holland, 1995).

table 5-2

Big Mac Prices and the Exchange Rate: An Application of Purchasing-Power Parity

			Exchange Rate (per U.S. dollar)	
Country	Currency	Price of a Big Mac	Predicted	Actual
Indonesia	Rupiah	14,500	5,777	7,945
Italy	Lira	4,500	1,793	2,088
South Korea	Won	3,000	1,195	1,108
Chile	Peso	1,260	502	514
Spain	Peseta	375	149	179
Hungary	Forint	339	135	279
Japan	Yen	294	117	106
Taiwan	Dollar	70.0	27.9	30.6
Thailand	Baht	55.0	21.9	38.0
Czech Rep.	Crown	54.37	21.7	39.1
Russia	Ruble	39.50	15.7	28.5
Denmark	Crown	24.75	9.86	8.04
Sweden	Crown	24.0	9.56	8.84
Mexico	Peso	20.9	8.33	9.41
France	Franc	18.5	7.37	7.07
Israel	Shekel	14.5	5.78	4.05
China	Yuan	9.90	3.94	8.28
South Africa	Rand	9.0	3.59	6.72
Switzerland	Franc	5.90	2.35	1.70
Poland	Zloty	5.50	2.19	4.30
Germany	Mark	4.99	1.99	2.11
Malaysia	Dollar	4.52	1.80	3.80
New Zealand	Dollar	3.40	1.35	2.01
Singapore	Dollar	3.20	1.27	1.70
Brazil	Real	2.95	1.18	1.79
Canada	Dollar	2.85	1.14	1.47
Australia	Dollar	2.59	1.03	1.68
United States	Dollar	2.51	1.00	1.00
Argentina	Peso	2.50	1.00	1.00
Britain	Pound	1.90	0.76	0.63

Note: The predicted exchange rate is the exchange rate that would make the price of a Big Mac in that country equal to its price in the United States.
Source: *The Economist*, April 29, 2000, 75.

cost 294 yen in Japan, we would predict that the exchange rate between the dollar and the yen was 294/2.51, or 117, yen per dollar. At this exchange rate, a Big Mac would have cost the same in Japan and the United States.

Table 5-2 shows the predicted and actual exchange rates for 30 countries, ranked by the predicted exchange rate. You can see that the evidence on purchasing-power parity is mixed. As the last two columns show, the actual and predicted exchange rate are usually in the same ballpark. Our theory predicts, for instance, that a U.S. dollar should buy the greatest number of Indonesian rupiahs and fewest British pounds, and this turns out to be true. In the case of Japan, the predicted exchange rate of 117 yen per dollar is close to the actual exchange rate of 106. Yet the theory's predictions are far from exact and, in many cases, are off by 30 percent or more. Hence, although the theory of purchasing-power parity provides a rough guide to the level of exchange rates, it does not explain exchange rates completely.

5-4 Conclusion: The United States as a Large Open Economy

In this chapter we have seen how a small open economy works. We have examined the determinants of the international flow of funds for capital accumulation and the international flow of goods and services. We have also examined the determinants of a country's real and nominal exchange rates. Our analysis shows how various policies—monetary policies, fiscal policies, and trade policies—affect the trade balance and the exchange rate.

The economy we have studied is "small" in the sense that its interest rate is fixed by world financial markets. That is, we have assumed that this economy does not affect the world interest rate, and that the economy can borrow and lend at the world interest rate in unlimited amounts. This assumption contrasts with the assumption we made when we studied the closed economy in Chapter 3. In the closed economy, the domestic interest rate equilibrates domestic saving and domestic investment, implying that policies that influence saving or investment alter the equilibrium interest rate.

Which of these analyses should we apply to an economy such as the United States? The answer is a little of both. The United States is neither so large nor so isolated that it is immune to developments occurring abroad. The large trade deficits of the 1980s and 1990s show the importance of international financial markets for funding U.S. investment. Hence, the closed-economy analysis of Chapter 3 cannot by itself fully explain the impact of policies on the U.S. economy.

Yet the U.S. economy is not so small and so open that the analysis of this chapter applies perfectly either. First, the United States is large enough that it can influence world financial markets. For example, large U.S. budget deficits were often blamed for the high real interest rates that prevailed throughout the world in the 1980s. Second, capital may not be perfectly mobile across countries. If individuals prefer holding their wealth in domestic rather than foreign assets, funds for capital accumulation will not flow freely to equate interest rates in all countries. For these two reasons, we cannot directly apply our model of the small open economy to the United States.

When analyzing policy for a country such as the United States, we need to combine the closed-economy logic of Chapter 3 and the small-open-economy logic of this chapter. The appendix to this chapter builds a model of an economy between these two extremes. In this intermediate case, there is international borrowing and lending, but the interest rate is not fixed by world financial markets. Instead, the more the economy borrows from abroad, the higher the interest rate it must offer foreign investors. The results, not surprisingly, are a mixture of the two polar cases we have already examined.

Consider, for example, a reduction in national saving caused by a fiscal expansion. As in the closed economy, this policy raises the real interest rate and crowds out domestic investment. As in the small open economy, it also reduces the net capital outflow, leading to a trade deficit and an appreciation of the exchange rate. Hence, although the model of the small open economy examined here does not precisely describe an economy such as the United States, it does provide approximately the right answer to how policies affect the trade balance and the exchange rate.

Summary

1. Net exports are the difference between exports and imports. They are equal to the difference between what we produce and what we demand for consumption, investment, and government purchases.
2. The net capital outflow is the excess of domestic saving over domestic investment. The trade balance is the amount received for our net exports of goods and services. The national income accounts identity shows that the net capital outflow always equals the trade balance.
3. The impact of any policy on the trade balance can be determined by examining its impact on saving and investment. Policies that raise saving or lower investment lead to a trade surplus, and policies that lower saving or raise investment lead to a trade deficit.
4. The nominal exchange rate is the rate at which people trade the currency of one country for the currency of another country. The real exchange rate is the rate at which people trade the goods produced by the two countries. The real exchange rate equals the nominal exchange rate multiplied by the ratio of the price levels in the two countries.
5. Because the real exchange rate is the price of domestic goods relative to foreign goods, an appreciation of the real exchange rate tends to reduce net exports. The equilibrium real exchange rate is the rate at which the quantity of net exports demanded equals the net capital outflow.
6. The nominal exchange rate is determined by the real exchange rate and the price levels in the two countries. Other things equal, a high rate of inflation leads to a depreciating currency.

KEY CONCEPTS

Net exports
Trade balance
Net capital outflow
Trade surplus and trade deficit
Balanced trade
Small open economy
World interest rate
Nominal exchange rate
Real exchange rate
Purchasing-power parity

QUESTIONS FOR REVIEW

1. What are the net capital outflow and the trade balance? Explain how they are related.

2. Define the nominal exchange rate and the real exchange rate.

3. If a small open economy cuts defense spending, what happens to saving, investment, the trade balance, the interest rate, and the exchange rate?

4. If a small open economy bans the import of Japanese VCRs, what happens to saving, investment, the trade balance, the interest rate, and the exchange rate?

5. If Germany has low inflation and Italy has high inflation, what will happen to the exchange rate between the German mark and the Italian lira?

PROBLEMS AND APPLICATIONS

1. Use the model of the small open economy to predict what would happen to the trade balance, the real exchange rate, and the nominal exchange rate in response to each of the following events.

a. A fall in consumer confidence about the future induces consumers to spend less and save more.

b. The introduction of a stylish line of Toyotas makes some consumers prefer foreign cars over domestic cars.

c. The introduction of automatic teller machines reduces the demand for money.

2. Consider an economy described by the following equations:

$$Y = C + I + G + NX,$$
$$Y = 5{,}000,$$
$$G = 1{,}000,$$
$$T = 1{,}000,$$
$$C = 250 + 0.75(Y - T),$$
$$I = 1{,}000 - 50r,$$
$$NX = 500 - 500\epsilon,$$
$$r = r^* = 5.$$

a. In this economy, solve for national saving, investment, the trade balance, and the equilibrium exchange rate.

b. Suppose now that G rises to 1,250. Solve for national saving, investment, the trade balance, and the equilibrium exchange rate. Explain what you find.

c. Now suppose that the world interest rate rises from 5 to 10 percent. (G is again 1,000). Solve for national saving, investment, the trade balance, and the equilibrium exchange rate. Explain what you find.

3. The country of Leverett is a small open economy. Suddenly, a change in world fashions makes the exports of Leverett unpopular.

a. What happens in Leverett to saving, investment, net exports, the interest rate, and the exchange rate?

b. The citizens of Leverett like to travel abroad. How will this change in the exchange rate affect them?

c. The fiscal policymakers of Leverett want to adjust taxes to maintain the exchange rate at its previous level. What should they do? If they do this, what are the overall effects on saving, investment, net exports, and the interest rate?

4. What will happen to the trade balance and the real exchange rate of a small open economy when government purchases increase, such as during a war? Does your answer depend on whether this is a local war or a world war?

5. In 1995, President Clinton considered placing a 100-percent tariff on the import of Japanese luxury cars. Discuss the economics and politics of such a policy. In particular, how would the policy affect the U.S. trade deficit? How would it affect the exchange rate? Who would be hurt by such a policy? Who would benefit?

6. Suppose that some foreign countries begin to subsidize investment by instituting an investment tax credit.

   a. What happens to world investment demand as a function of the world interest rate?

   b. What happens to the world interest rate?

   c. What happens to investment in our small open economy?

   d. What happens to our trade balance?

   e. What happens to our real exchange rate?

7. "Traveling in Italy is much cheaper now than it was ten years ago," says a friend. "Ten years ago, a dollar bought 1,000 lire; this year, a dollar buys 1,500 lire."

   Is your friend right or wrong? Given that total inflation over this period was 25 percent in the United States and 100 percent in Italy, has it become more or less expensive to travel in Italy? Write your answer using a concrete example—such as a cup of American coffee versus a cup of Italian espresso—that will convince your friend.

8. You read in a newspaper that the nominal interest rate is 12 percent per year in Canada and 8 percent per year in the United States. Suppose that the real interest rates are equalized in the two countries and that purchasing-power parity holds.

   a. Using the Fisher equation (discussed in Chapter 4), what can you infer about expected inflation in Canada and in the United States?

   b. What can you infer about the expected change in the exchange rate between the Canadian dollar and the U.S. dollar?

   c. A friend proposes a get-rich-quick scheme: borrow from a U.S. bank at 8 percent, deposit the money in a Canadian bank at 12 percent, and make a 4 percent profit. What's wrong with this scheme?

APPENDIX

The Large Open Economy

When analyzing policy for a country such as the United States, we need to combine the closed-economy logic of Chapter 3 and the small-open-economy logic of this chapter. This appendix presents a model of an economy between these two extremes, called the *large open economy*.

Net Capital Outflow

The key difference between the small and large open economies is the behavior of the net capital outflow. In the model of the small open economy, capital flows freely into or out of the economy at a fixed world interest rate r^*. The model of the large open economy makes a different assumption about international capital flows. To understand that assumption, keep in mind that the net capital outflow is the amount that domestic investors lend abroad minus the amount that foreign investors lend here.

Imagine that you are a domestic investor—such as the portfolio manager of a university endowment—deciding where to invest your funds. You could invest domestically (for example, by making loans to U.S. companies), or you could invest abroad (by making loans to foreign companies). Many factors may affect your decision, but surely one of them is the interest rate you can earn. The higher the interest rate you can earn domestically, the less attractive you would find foreign investment.

Investors abroad face a similar decision. They have a choice between investing in their home country or lending to someone in the United States. The higher the interest rate in the United States, the more willing foreigners are to lend to U.S. companies and to buy U.S. assets.

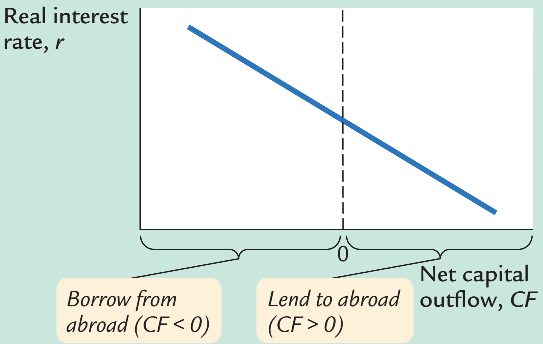
Thus, because of the behavior of both domestic and foreign investors, the net flow of capital to other countries, which we'll denote as *CF*, is negatively related to the domestic real interest rate r. As the interest rate rises, less of our saving flows abroad, and more funds for capital accumulation flow in from other countries. We write this as

$$CF = CF(r).$$

This equation states that the net capital outflow is a function of the domestic interest rate. Figure 5-15 on page 146 illustrates this relationship. Notice that *CF* can be either positive or negative, depending on whether the economy is a lender or borrower in world financial markets.

To see how this *CF* function relates to our previous models, consider Figure 5-16 on page 146. This figure shows two special cases: a vertical *CF* function and a horizontal *CF* function.

figure 5-15

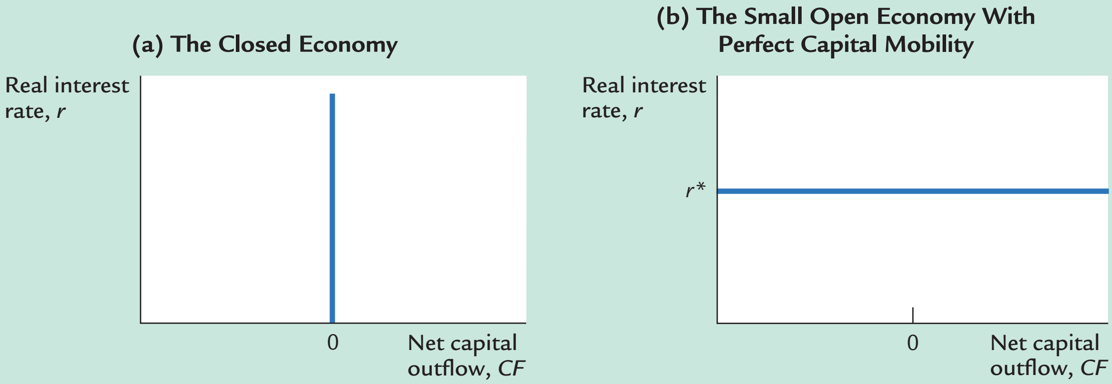


How the Net Capital Outflow Depends on the Interest Rate A higher domestic interest rate discourages domestic investors from lending abroad and encourages foreign investors to lend here. Therefore, net capital outflow *CF* is negatively related to the interest rate.

The closed economy is the special case shown in panel (a) of Figure 5-16. In the closed economy, there is no international borrowing or lending, and the interest rate adjusts to equilibrate domestic saving and investment. This means that $CF = 0$ at all interest rates. This situation would arise if investors here and abroad were unwilling to hold foreign assets, regardless of the return. It might also arise if the government prohibited its citizens from transacting in foreign financial markets, as some governments do.

The small open economy with perfect capital mobility is the special case shown in panel (b) of Figure 5-16. In this case, capital flows freely into and out of the country at the fixed world interest rate r^*. This situation would arise if investors here and abroad bought whatever asset yielded the highest

figure 5-16



Two Special Cases In the closed economy, shown in panel (a), the net capital outflow is zero for all interest rates. In the small open economy with perfect capital mobility, shown in panel (b), the net capital outflow is perfectly elastic at the world interest rate r^*.

return, and if this economy were too small to affect the world interest rate. The economy's interest rate would be fixed at the interest rate prevailing in world financial markets.

Why isn't the interest rate of a large open economy such as the United States fixed by the world interest rate? There are two reasons. The first is that the United States is large enough to influence world financial markets. The more the United States lends abroad, the greater the supply of loans in the world economy is, and the lower interest rates become around the world. The more the United States borrows from abroad (that is, the more negative *CF* becomes), the higher world interest rates are. We use the label "large open economy" because this model applies to an economy large enough to affect world interest rates.

There is, however, a second reason that the interest rate in an economy may not be fixed by the world interest rate: capital may not be perfectly mobile. That is, investors here and abroad may prefer to hold their wealth in domestic rather than foreign assets. Such a preference for domestic assets could arise because of imperfect information about foreign assets or because of government impediments to international borrowing and lending. In either case, funds for capital accumulation will not flow freely to equalize interest rates in all countries. Instead, the net capital outflow will depend on domestic interest rates relative to foreign interest rates. U.S. investors will lend abroad only if U.S. interest rates are comparatively low, and foreign investors will lend in the United States only if U.S. interest rates are comparatively high. The large-open-economy model, therefore, may apply even to a small economy if capital does not flow freely into and out of the economy.

Hence, either because the large open economy affects world interest rates, or because capital is imperfectly mobile, or perhaps for both reasons, the *CF* function slopes downward. Except for this new downward-sloping *CF* function, the model of the large open economy resembles the model of the small open economy. We put all the pieces together in the next section.

The Model

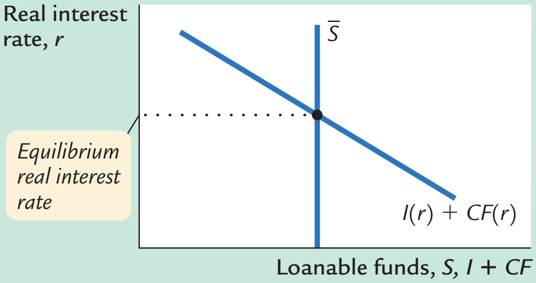
To understand how the large open economy works, we need to consider two key markets: the market for loanable funds (where the interest rate is determined) and the market for foreign exchange (where the exchange rate is determined). The interest rate and the exchange rate are two prices that guide the allocation of resources.

The Market for Loanable Funds An open economy's saving S is used in two ways: to finance domestic investment I and to finance the net capital outflow CF. We can write

$$S = I + CF.$$

Consider how these three variables are determined. National saving is fixed by the level of output, fiscal policy, and the consumption function. Investment

figure 5-17



The Market for Loanable Funds in the Large Open Economy At the equilibrium interest rate, the supply of loanable funds from saving S balances the demand for loanable funds from domestic investment I and capital investments abroad CF.

and net capital outflow both depend on the domestic real interest rate. We can write

$$\bar{S} = I(r) + CF(r).$$

Figure 5-17 shows the market for loanable funds. The supply of loanable funds is national saving. The demand for loanable funds is the sum of the demand for domestic investment and the demand for foreign investment (net capital outflow). The interest rate adjusts to equilibrate supply and demand.

The Market for Foreign Exchange Next, consider the relationship between the net capital outflow and the trade balance. The national income accounts identity tells us

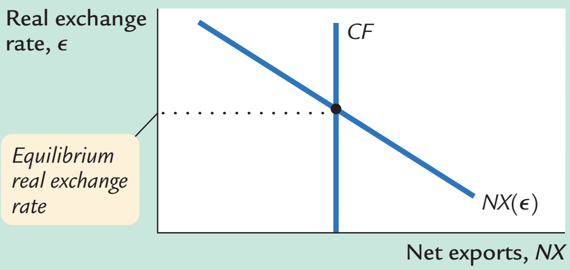
$$NX = S - I.$$

Because NX is a function of the real exchange rate, and because $CF = S - I$, we can write

$$NX(\epsilon) = CF.$$

Figure 5-18 shows the equilibrium in the market for foreign exchange. Once again, the real exchange rate is the price that equilibrates the trade balance and the net capital outflow.

figure 5-18



The Market for Foreign-Currency Exchange in the Large Open Economy At the equilibrium exchange rate, the supply of dollars from the net capital outflow, CF, balances the demand for dollars from our net exports of goods and services, NX.

The last variable we should consider is the nominal exchange rate. As before, the nominal exchange rate is the real exchange rate times the ratio of the price levels:

$$e = \epsilon \times (P^*/P).$$

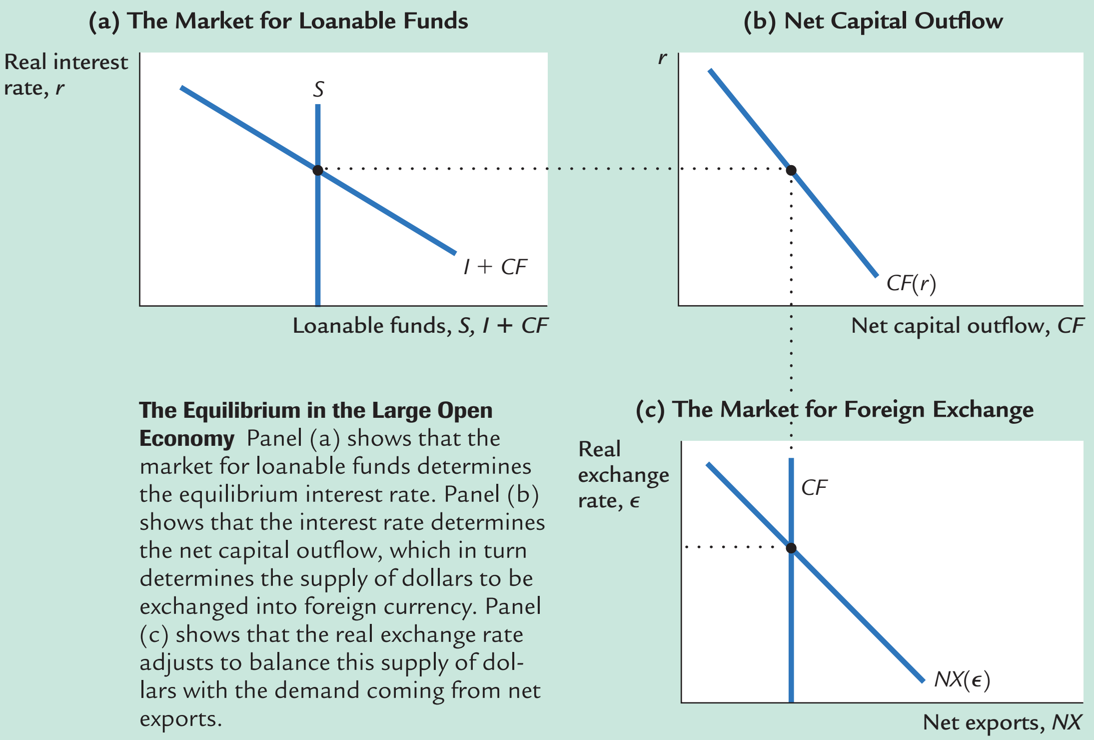
The real exchange rate is determined as in Figure 5-18, and the price levels are determined by monetary policies here and abroad, as we discussed in Chapter 4. Forces that move the real exchange rate or the price levels also move the nominal exchange rate.

Policies in the Large Open Economy

We can now consider how economic policies influence the large open economy. Figure 5-19 shows the three diagrams we need for the analysis. Panel (a) shows the equilibrium in the market for loanable funds; panel (b) shows the relationship between the equilibrium interest rate and the net capital outflow; and panel (c) shows the equilibrium in the market for foreign exchange.

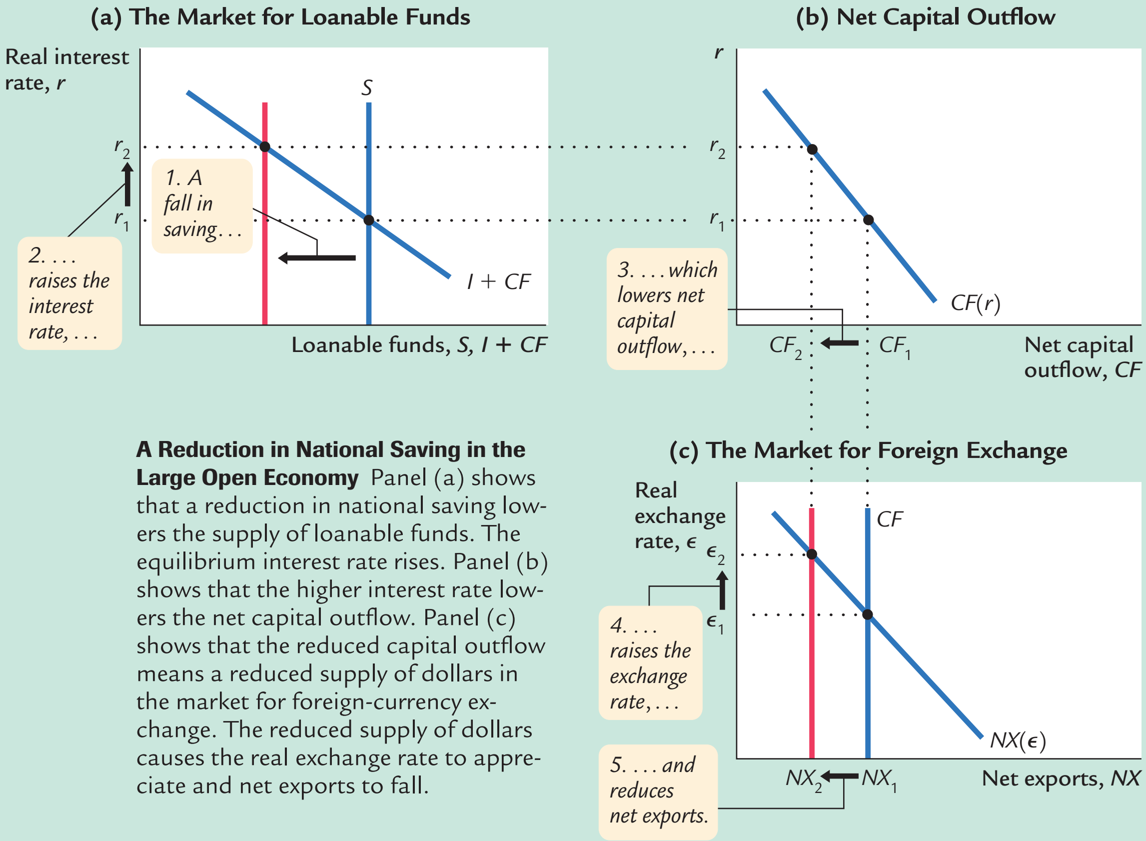
Fiscal Policy at Home Consider the effects of expansionary fiscal policy—an increase in government purchases or a decrease in taxes. Figure 5-20 shows what

figure 5-19



The Equilibrium in the Large Open Economy Panel (a) shows that the market for loanable funds determines the equilibrium interest rate. Panel (b) shows that the interest rate determines the net capital outflow, which in turn determines the supply of dollars to be exchanged into foreign currency. Panel (c) shows that the real exchange rate adjusts to balance this supply of dollars with the demand coming from net exports.

figure 5-20



A Reduction in National Saving in the Large Open Economy Panel (a) shows that a reduction in national saving lowers the supply of loanable funds. The equilibrium interest rate rises. Panel (b) shows that the higher interest rate lowers the net capital outflow. Panel (c) shows that the reduced capital outflow means a reduced supply of dollars in the market for foreign-currency exchange. The reduced supply of dollars causes the real exchange rate to appreciate and net exports to fall.

happens. The policy reduces national saving S, thereby reducing the supply of loanable funds and raising the equilibrium interest rate r. The higher interest rate reduces both domestic investment I and the net capital outflow CF. The fall in the net capital outflow reduces the supply of dollars to be exchanged into foreign currency. The exchange rate appreciates, and net exports fall.

Note that the impact of fiscal policy in this model combines its impact in the closed economy and its impact in the small open economy. As in the closed economy, a fiscal expansion in a large open economy raises the interest rate and crowds out investment. As in the small open economy, a fiscal expansion causes a trade deficit and an appreciation in the exchange rate.

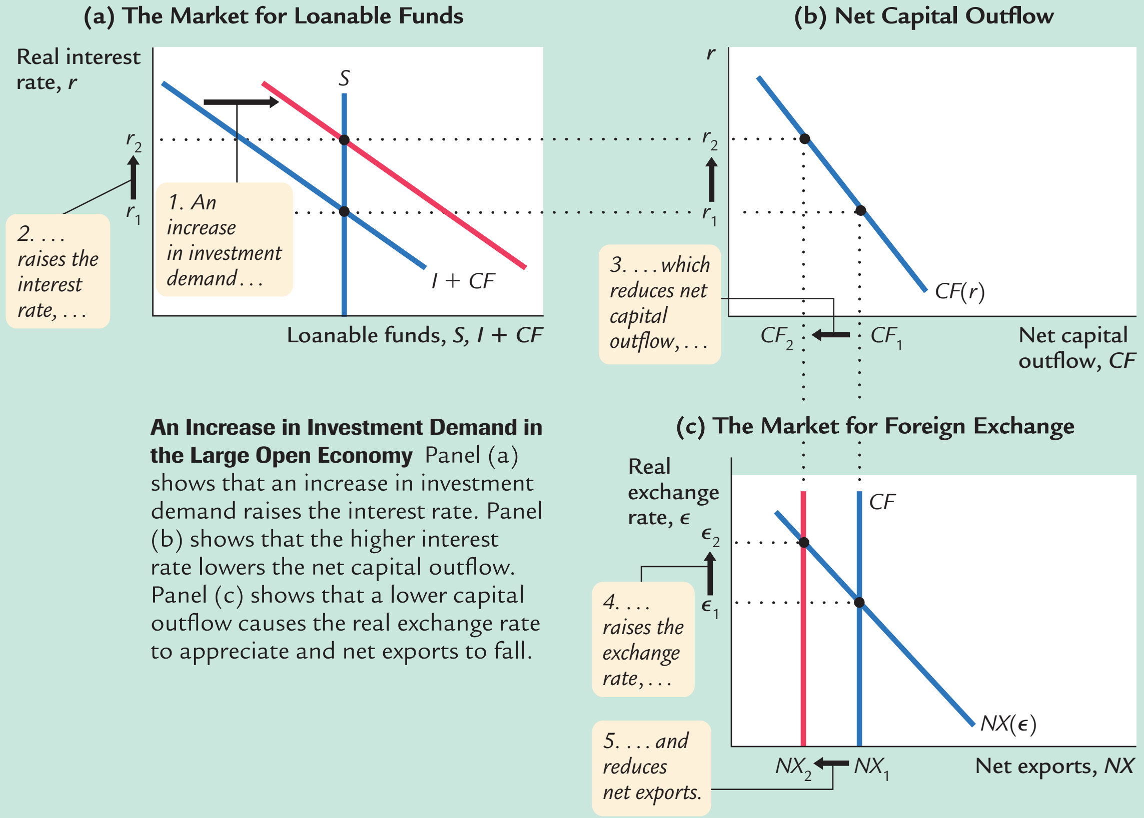
One way to see how the three types of economy are related is to consider the identity

$$S = I + NX.$$

In all three cases, expansionary fiscal policy reduces national saving S. In the closed economy, the fall in S coincides with an equal fall in I, and NX stays constant at zero. In the small open economy, the fall in S coincides with an equal fall in *NX*, and *I* remains constant at the level fixed by the world interest rate. The large open economy is the intermediate case: both *I* and *NX* fall, each by less than the fall in *S*.

Shifts in Investment Demand Suppose that the investment demand schedule shifts outward, perhaps because Congress passes an investment tax credit. Figure 5-21 shows the effect. The demand for loanable funds rises, raising the equilibrium interest rate. The higher interest rate reduces the net capital outflow: Americans make fewer loans abroad, and foreigners make more loans to Americans. The fall in the net capital outflow reduces the supply of dollars in the market for foreign exchange. The exchange rate appreciates, and net exports fall.

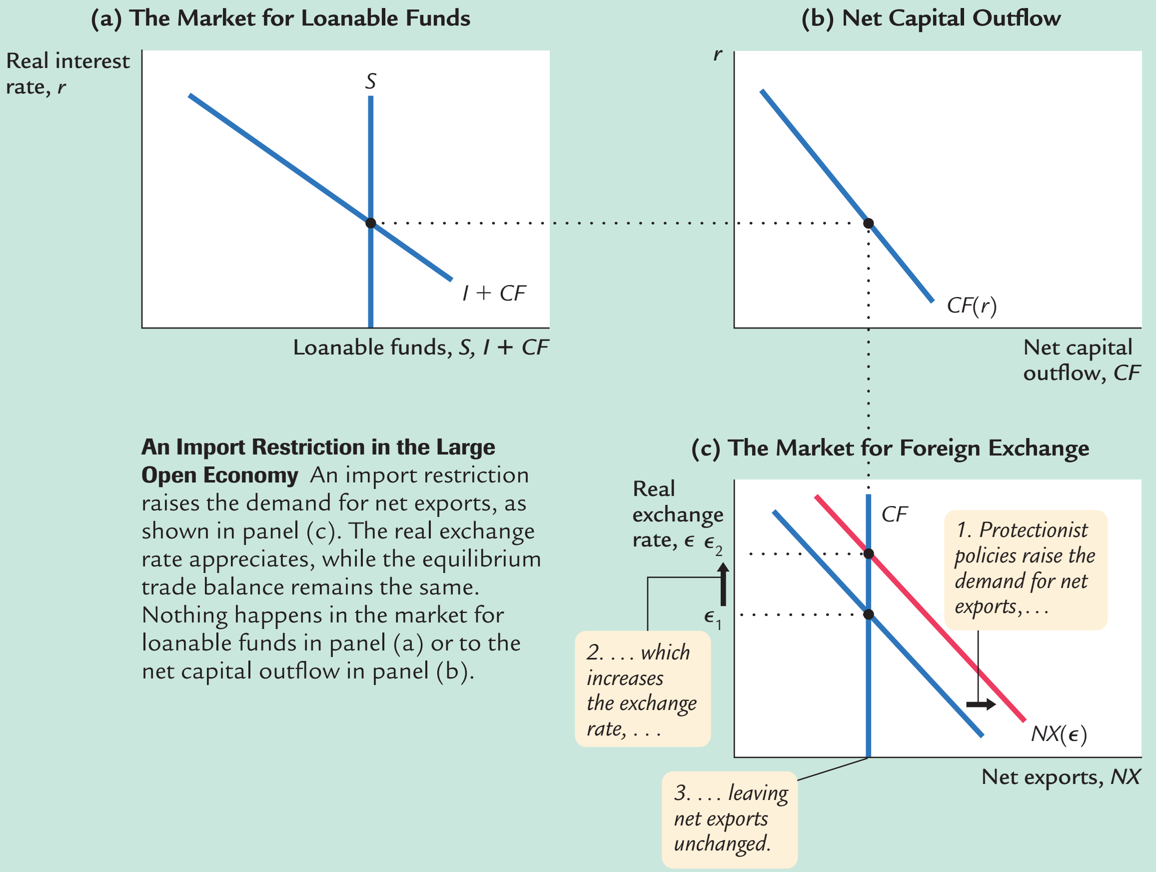
figure 5-21



An Increase in Investment Demand in the Large Open Economy Panel (a) shows that an increase in investment demand raises the interest rate. Panel (b) shows that the higher interest rate lowers the net capital outflow. Panel (c) shows that a lower capital outflow causes the real exchange rate to appreciate and net exports to fall.

Trade Policies Figure 5-22 shows the effect of a trade restriction, such as an import quota. The reduced demand for imports shifts the net-exports schedule outward in panel (c). Because nothing has changed in the market for loanable funds, the interest rate remains the same, which in turn implies that the net capital outflow remains the same. The shift in the net-exports schedule causes the exchange rate to appreciate. The rise in the exchange rate makes U.S. goods

figure 5-22



An Import Restriction in the Large Open Economy An import restriction raises the demand for net exports, as shown in panel (c). The real exchange rate appreciates, while the equilibrium trade balance remains the same. Nothing happens in the market for loanable funds in panel (a) or to the net capital outflow in panel (b).

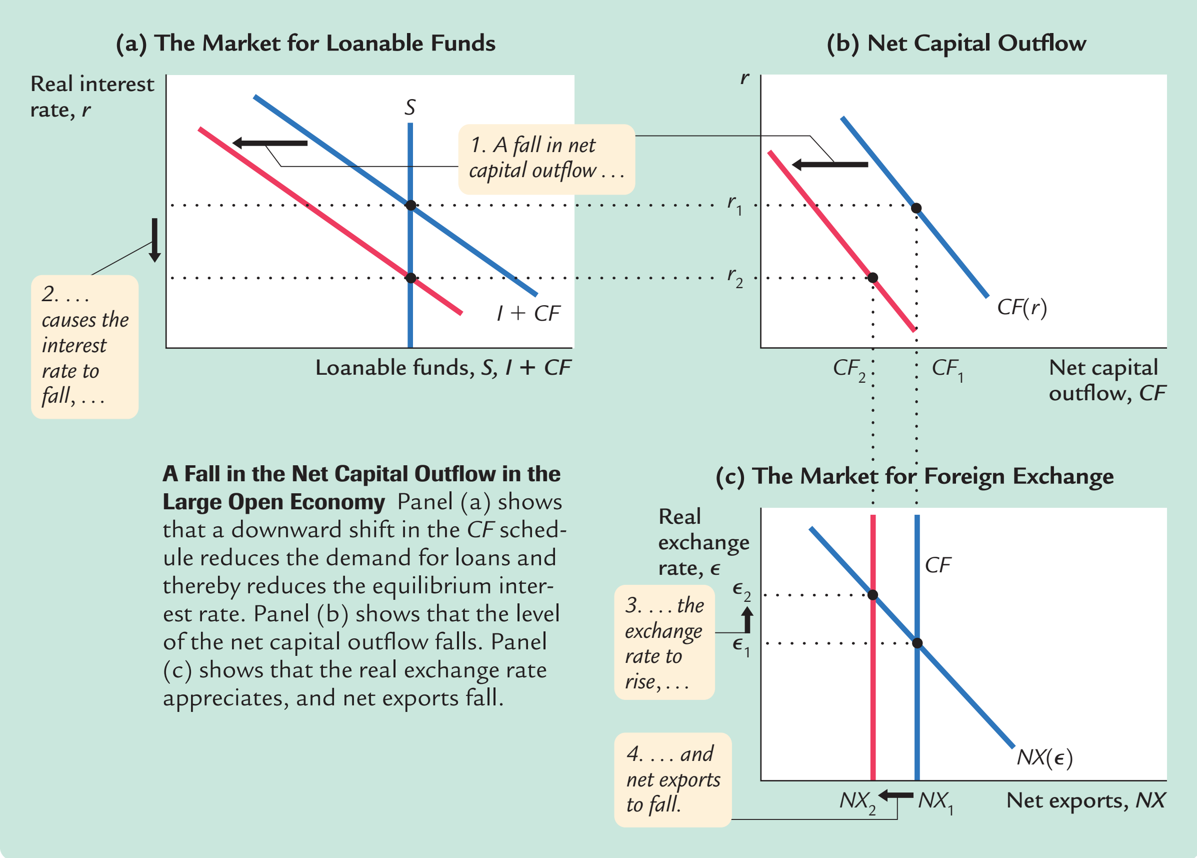
expensive relative to foreign goods, which depresses exports and stimulates imports. In the end, the trade restriction does not affect the trade balance.

Shifts in Net Capital Outflow There are various reasons that the *CF* schedule might shift. One reason is fiscal policy abroad. For example, suppose that Germany pursues a fiscal policy that raises German saving. This policy reduces the German interest rate. The lower German interest rate discourages American investors from lending in Germany and encourages German investors to lend in the United States. For any given U.S. interest rate, the U.S. net capital outflow falls.

Another reason the *CF* schedule might shift is political instability abroad. Suppose that a war or revolution breaks out in another country. Investors around the world will try to withdraw their assets from that country and seek a "safe haven" in a stable country such as the United States. The result is a reduction in the U.S. net capital outflow.

Figure 5-23 shows the impact of a shift in the *CF* schedule. The reduced demand for loanable funds lowers the equilibrium interest rate. The lower interest

figure 5-23



A Fall in the Net Capital Outflow in the Large Open Economy Panel (a) shows that a downward shift in the *CF* schedule reduces the demand for loans and thereby reduces the equilibrium interest rate. Panel (b) shows that the level of the net capital outflow falls. Panel (c) shows that the real exchange rate appreciates, and net exports fall.

rate tends to raise net capital outflow, but because this only partly mitigates the shift in the *CF* schedule, *CF* still falls. The reduced level of net capital outflow reduces the supply of dollars in the market for foreign exchange. The exchange rate appreciates, and net exports fall.

Conclusion

How different are large and small open economies? Certainly, policies affect the interest rate in a large open economy, unlike in a small open economy. But, in other ways, the two models yield similar conclusions. In both large and small open economies, policies that raise saving or lower investment lead to trade surpluses. Similarly, policies that lower saving or raise investment lead to trade deficits. In both economies, protectionist trade policies cause the exchange rate to appreciate and do not influence the trade balance. Because the results are so similar, for most questions one can use the simpler model of the small open economy, even if the economy being examined is not really small.

MORE PROBLEMS AND APPLICATIONS

1. If a war broke out abroad, it would affect the U.S. economy in many ways. Use the model of the large open economy to examine each of the following effects of such a war. What happens in the United States to saving, investment, the trade balance, the interest rate, and the exchange rate? (To keep things simple, consider each of the following effects separately.)

a. The U.S. government, fearing it may need to enter the war, increases its purchases of military equipment.

b. Other countries raise their demand for high-tech weapons, a major export of the United States.

c. The war makes U.S. firms uncertain about the future, and the firms delay some investment projects.

d. The war makes U.S. consumers uncertain about the future, and the consumers save more in response.

e. Americans become apprehensive about traveling abroad, so more of them spend their vacations in the United States.

f. Foreign investors seek a safe haven for their portfolios in the United States.

2. On September 21, 1995, "House Speaker Newt Gingrich threatened to send the United States into default on its debt for the first time in the nation's history, to force the Clinton Administration to balance the budget on Republican terms" (*New York Times*, September 22, 1995, A1). That same day, the interest rate on 30-year U.S. government bonds rose from 6.46 to 6.55 percent, and the dollar fell in value from 102.7 to 99.0 yen. Use the model of the large open economy to explain this event.

CHAPTER 6 SIX

Unemployment

> *A man willing to work, and unable to find work, is perhaps the saddest sight that fortune's inequality exhibits under the sun.*
>
> *— Thomas Carlyle*

Unemployment is the macroeconomic problem that affects people most directly and severely. For most people, the loss of a job means a reduced living standard and psychological distress. It is no surprise that unemployment is a frequent topic of political debate and that politicians often claim that their proposed policies would help create jobs.

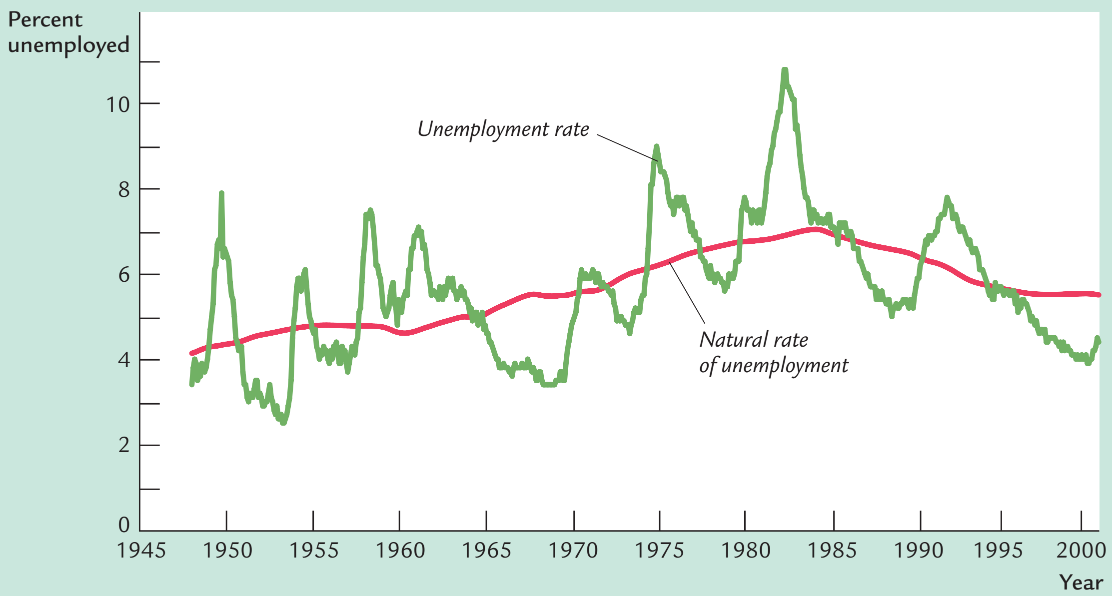
Economists study unemployment to identify its causes and to help improve the public policies that affect the unemployed. Some of these policies, such as job-training programs, assist people in finding employment. Others, such as unemployment insurance, alleviate some of the hardships that the unemployed face. Still other policies affect the prevalence of unemployment inadvertently. Laws mandating a high minimum wage, for instance, are widely thought to raise unemployment among the least skilled and experienced members of the labor force. By showing the effects of various policies, economists help policymakers evaluate their options.

Our discussions of the labor market so far have ignored unemployment. In particular, the model of national income in Chapter 3 was built with the assumption that the economy was always at full employment. In reality, of course, not everyone in the labor force has a job all the time: all free-market economies experience some unemployment.

Figure 6-1 shows the rate of unemployment—the percentage of the labor force unemployed—in the United States since 1948. Although the rate of unemployment fluctuates from year to year, it never gets even close to zero. The average is between 5 and 6 percent, meaning that about 1 out of every 18 people wanting a job does not have one.

In this chapter we begin our study of unemployment by discussing why there is always some unemployment and what determines its level. We do not study what determines the year-to-year fluctuations in the rate of unemployment until Part IV of this book, where we examine short-run economic fluctuations. Here we examine the determinants of the **natural rate of unemployment**—the average rate of unemployment around which the economy fluctuates. The natural

figure 6-1



The Unemployment Rate and the Natural Rate of Unemployment in the United States There is always some unemployment. The natural rate of unemployment is the average level around which the unemployment rate fluctuates. (The natural rate of unemployment for any particular year is estimated here by averaging all the unemployment rates from ten years earlier to ten years later. Future unemployment rates are set at 5.5 percent.)

rate is the rate of unemployment toward which the economy gravitates in the long run, given all the labor-market imperfections that impede workers from instantly finding jobs.

6-1 Job Loss, Job Finding, and the Natural Rate of Unemployment

Every day some workers lose or quit their jobs, and some unemployed workers are hired. This perpetual ebb and flow determines the fraction of the labor force that is unemployed. In this section we develop a model of labor-force dynamics that shows what determines the natural rate of unemployment.[1]

We start with some notation. Let L denote the labor force, E the number of employed workers, and U the number of unemployed workers. Because every

[1] Robert E. Hall, "A Theory of the Natural Rate of Unemployment and the Duration of Unemployment," *Journal of Monetary Economics* 5 (April 1979): 153–169.

worker is either employed or unemployed, the labor force is the sum of the employed and the unemployed:

$$L = E + U.$$

In this notation, the rate of unemployment is U/L.

To see what determines the unemployment rate, we assume that the labor force L is fixed and focus on the transition of individuals in the labor force between employment and unemployment. This is illustrated in Figure 6-2. Let s denote the rate of job separation, the fraction of employed individuals who lose their job each month. Let f denote the rate of job finding, the fraction of unemployed individuals who find a job each month. Together, the rate of job separation s and the rate of job finding f determine the rate of unemployment.

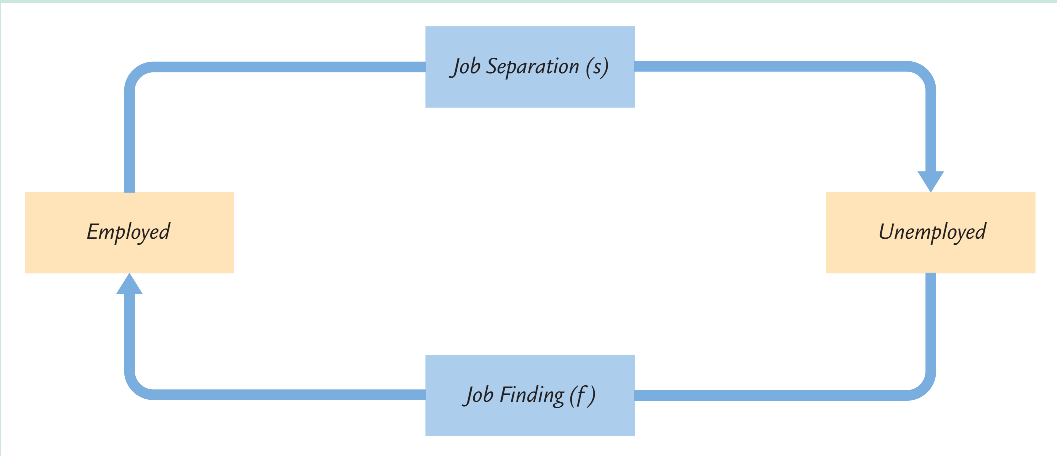
If the unemployment rate is neither rising nor falling—that is, if the labor market is in a steady state—then the number of people finding jobs must equal the number of people losing jobs. The number of people finding jobs is fU and the number of people losing jobs is sE, so we can write the steady-state condition as

$$fU = sE.$$

We can use this equation to find the steady-state unemployment rate. From an earlier equation, we know that $E = L - U$; that is, the number of employed equals the labor force minus the number of unemployed. If we substitute $(L - U)$ for E in the steady-state condition, we find

$$fU = s(L - U).$$

figure 6-2



The Transitions Between Employment and Unemployment In every period, a fraction s of the employed lose their jobs, and a fraction f of the unemployed find jobs. The rates of job separation and job finding determine the rate of unemployment.

To get closer to solving for the unemployment rate, divide both sides of this equation by L to obtain

$$f\frac{U}{L} = s\left(1 - \frac{U}{L}\right).$$

Now we can solve for U/L to find

$$\frac{U}{L} = \frac{s}{s+f}.$$

This equation shows that the steady-state rate of unemployment U/L depends on the rates of job separation s and job finding f. The higher the rate of job separation, the higher the unemployment rate. The higher the rate of job finding, the lower the unemployment rate.

Here's a numerical example. Suppose that 1 percent of the employed lose their jobs each month ($s = 0.01$). This means that on average jobs last 100 months, or about 8 years. Suppose further that about 20 percent of the unemployed find a job each month ($f = 0.20$), so that spells of unemployment last 5 months on average. Then the steady-state rate of unemployment is

$$\frac{U}{L} = \frac{0.01}{0.01 + 0.20}$$
$$= 0.0476.$$

The rate of unemployment in this example is about 5 percent.

This model of the natural rate of unemployment has an obvious but important implication for public policy. *Any policy aimed at lowering the natural rate of unemployment must either reduce the rate of job separation or increase the rate of job finding. Similarly, any policy that affects the rate of job separation or job finding also changes the natural rate of unemployment.*

Although this model is useful in relating the unemployment rate to job separation and job finding, it fails to answer a central question: Why is there unemployment in the first place? If a person could always find a job quickly, then the rate of job finding would be very high and the rate of unemployment would be near zero. This model of the unemployment rate assumes that job finding is not instantaneous, but it fails to explain why. In the next two sections, we examine two underlying reasons for unemployment: job search and wage rigidity.

6-2 Job Search and Frictional Unemployment

One reason for unemployment is that it takes time to match workers and jobs. The equilibrium model of the aggregate labor market discussed in Chapter 3 assumes that all workers and all jobs are identical, and therefore that all workers are equally well suited for all jobs. If this were true and the labor market were in equilibrium, then a job loss would not cause unemployment: a laid-off worker would immediately find a new job at the market wage.

In fact, workers have different preferences and abilities, and jobs have different attributes. Furthermore, the flow of information about job candidates and job vacancies is imperfect, and the geographic mobility of workers is not instantaneous. For all these reasons, searching for an appropriate job takes time and effort, and this tends to reduce the rate of job finding. Indeed, because different jobs require different skills and pay different wages, unemployed workers may not accept the first job offer they receive. The unemployment caused by the time it takes workers to search for a job is called **frictional unemployment**.

Some frictional unemployment is inevitable in a changing economy. For many reasons, the types of goods that firms and households demand vary over time. As the demand for goods shifts, so does the demand for the labor that produces those goods. The invention of the personal computer, for example, reduced the demand for typewriters and, as a result, for labor by typewriter manufacturers. At the same time, it increased the demand for labor in the electronics industry. Similarly, because different regions produce different goods, the demand for labor may be rising in one part of the country and falling in another. A decline in the price of oil may cause the demand for labor to fall in oil-producing states such as Texas, but because cheap oil makes driving less expensive, it increases the demand for labor in auto-producing states such as Michigan. Economists call a change in the composition of demand among industries or regions a **sectoral shift**. Because sectoral shifts are always occurring, and because it takes time for workers to change sectors, there is always frictional unemployment.

Sectoral shifts are not the only cause of job separation and frictional unemployment. In addition, workers find themselves unexpectedly out of work when their firms fail, when their job performance is deemed unacceptable, or when their particular skills are no longer needed. Workers also may quit their jobs to change careers or to move to different parts of the country. As long as the supply and demand for labor among firms is changing, frictional unemployment is unavoidable.

Public Policy and Frictional Unemployment

Many public policies seek to decrease the natural rate of unemployment by reducing frictional unemployment. Government employment agencies disseminate information about job vacancies in order to match jobs and workers more efficiently. Publicly funded retraining programs are designed to ease the transition of workers from declining to growing industries. If these programs succeed at increasing the rate of job finding, they decrease the natural rate of unemployment.

Other government programs inadvertently increase the amount of frictional unemployment. One of these is **unemployment insurance**. Under this program, unemployed workers can collect a fraction of their wages for a certain period after losing their jobs. Although the precise terms of the program differ from year to year and from state to state, a typical worker covered by unemployment insurance in the United States receives 50 percent of his or her former wages for 26 weeks. In many European countries, unemployment-insurance programs are even more generous.

By softening the economic hardship of unemployment, unemployment insurance increases the amount of frictional unemployment and raises the natural rate. The unemployed who receive unemployment-insurance benefits are less pressed to search for new employment and are more likely to turn down unattractive job offers. Both of these changes in behavior reduce the rate of job finding. In addition, because workers know that their incomes are partially protected by unemployment insurance, they are less likely to seek jobs with stable employment prospects and are less likely to bargain for guarantees of job security. These behavioral changes raise the rate of job separation.

That unemployment insurance raises the natural rate of unemployment does not necessarily imply that the policy is ill advised. The program has the benefit of reducing workers' uncertainty about their incomes. Moreover, inducing workers to reject unattractive job offers may lead to a better matching between workers and jobs. Evaluating the costs and benefits of different systems of unemployment insurance is a difficult task that continues to be a topic of much research.

Economists who study unemployment insurance often propose reforms that would reduce the amount of unemployment. One common proposal is to require a firm that lays off a worker to bear the full cost of that worker's unemployment benefits. Such a system is called *100 percent experience rated*, because the rate that each firm pays into the unemployment-insurance system fully reflects the unemployment experience of its own workers. Most current programs are *partially experience rated*. Under this system, when a firm lays off a worker, it is charged for only part of the worker's unemployment benefits; the remainder comes from the program's general revenue. Because a firm pays only a fraction of the cost of the unemployment it causes, it has an incentive to lay off workers when its demand for labor is temporarily low. By reducing that incentive, the proposed reform may reduce the prevalence of temporary layoffs.

CASE STUDY

Unemployment Insurance and the Rate of Job Finding

Many studies have examined the effect of unemployment insurance on job search. The most persuasive studies use data on the experiences of unemployed individuals, rather than economy-wide rates of unemployment. Individual data often yield sharp results that are open to few alternative explanations.

One study followed the experience of individual workers as they used up their eligibility for unemployment-insurance benefits. It found that when unemployed workers become ineligible for benefits, they are more likely to find new jobs. In particular, the probability of a person finding a new job more than doubles when his or her benefits run out. One possible explanation is that an absence of benefits increases the search effort of unemployed workers. Another possibility is that workers without benefits are more likely to accept job offers that would otherwise be declined because of low wages or poor working conditions.[2]

Additional evidence on how economic incentives affect job search comes from an experiment that the state of Illinois ran in 1985. Randomly selected new claimants for unemployment insurance were each offered a $500 bonus if they found employment within 11 weeks. The subsequent experience of this group was compared to that of a control group not offered the incentive. The average duration of unemployment for the group offered the $500 bonus was 17.0 weeks, compared to 18.3 weeks for the control group. Thus, the bonus reduced the average spell of unemployment by 7 percent, suggesting that more effort was devoted to job search. This experiment shows clearly that the incentives provided by the unemployment-insurance system affect the rate of job finding.[3]

6-3 Real-Wage Rigidity and Structural Unemployment

A second reason for unemployment is **wage rigidity**—the failure of wages to adjust until labor supply equals labor demand. In the equilibrium model of the labor market, as outlined in Chapter 3, the real wage adjusts to equilibrate supply and demand. Yet wages are not always flexible. Sometimes the real wage is stuck above the market-clearing level.

Figure 6-3 shows why wage rigidity leads to unemployment. When the real wage is above the level that equilibrates supply and demand, the quantity of labor supplied exceeds the quantity demanded. Firms must in some way ration the scarce jobs among workers. Real-wage rigidity reduces the rate of job finding and raises the level of unemployment.

The unemployment resulting from wage rigidity and job rationing is called **structural unemployment**. Workers are unemployed not because they are actively searching for the jobs that best suit their individual skills but because, at the going wage, the supply of labor exceeds the demand. These workers are simply waiting for jobs to become available.

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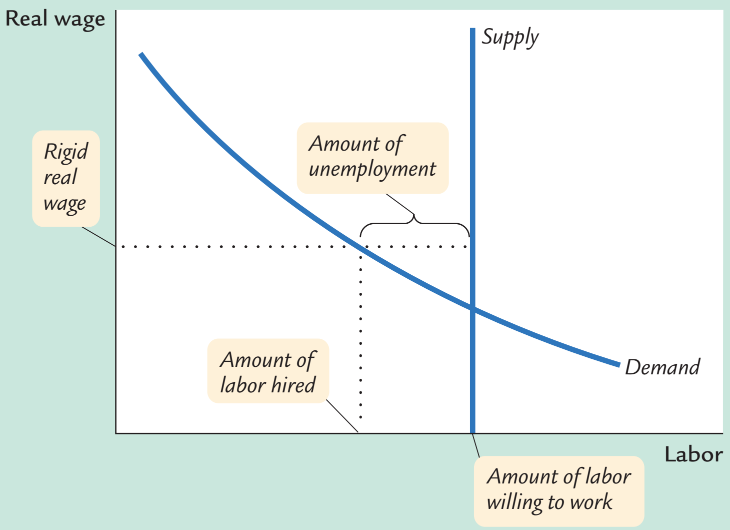
[2] Lawrence F. Katz and Bruce D. Meyer, "Unemployment Insurance, Recall Expectations, and Unemployment Outcomes," *Quarterly Journal of Economics* 105 (November 1990): 973–1002.

[3] Stephen A. Woodbury and Robert G. Spiegelman, "Bonuses to Workers and Employers to Reduce Unemployment: Randomized Trials in Illinois," *American Economic Review* 77 (September 1987): 513–530.

figure 6-3



Real-Wage Rigidity Leads to Job Rationing If the real wage is stuck above the equilibrium level, then the supply of labor exceeds the demand. The result is unemployment.

To understand wage rigidity and structural unemployment, we must examine why the labor market does not clear. When the real wage exceeds the equilibrium level and the supply of workers exceeds the demand, we might expect firms to lower the wages they pay. Structural unemployment arises because firms fail to reduce wages despite an excess supply of labor. We now turn to three causes of this wage rigidity: minimum-wage laws, the monopoly power of unions, and efficiency wages.

Minimum-Wage Laws

The government causes wage rigidity when it prevents wages from falling to equilibrium levels. Minimum-wage laws set a legal minimum on the wages that firms pay their employees. Since the passage of the Fair Labor Standards Act of 1938, the U.S. federal government has enforced a minimum wage that usually has been between 30 and 50 percent of the average wage in manufacturing. For most workers, this minimum wage is not binding, because they earn well above the minimum. Yet for some workers, especially the unskilled and inexperienced, the minimum wage raises their wage above its equilibrium level. It therefore reduces the quantity of their labor that firms demand.

Economists believe that the minimum wage has its greatest impact on teenage unemployment. The equilibrium wages of teenagers tend to be low for two reasons. First, because teenagers are among the least skilled and least experienced members of the labor force, they tend to have low marginal productivity. Second, teenagers often take some of their "compensation" in the form of on-the-job training rather than direct pay. An apprenticeship is a classic example of training offered in place of wages. For both these reasons, the wage at which the supply of teenage workers equals the demand is low. The minimum wage is therefore more often binding for teenagers than for others in the labor force.

Many economists have studied the impact of the minimum wage on teenage employment. These researchers compare the variation in the minimum wage over time with the variation in the number of teenagers with jobs. These studies find that a 10-percent increase in the minimum wage reduces teenage employment by 1 to 3 percent.[4]

The minimum wage is a perennial source of political debate. Advocates of a higher minimum wage view it as a means of raising the income of the working poor. Certainly, the minimum wage provides only a meager standard of living: in the United States, two adults working full time at minimum-wage jobs would just exceed the official poverty level for a family of four. Although minimum-wage advocates often admit that the policy causes unemployment for some workers, they argue that this cost is worth bearing to raise others out of poverty.

Opponents of a higher minimum wage claim that it is not the best way to help the working poor. They contend not only that the increased labor costs would raise unemployment but also that the minimum wage is poorly targeted. Many minimum-wage earners are teenagers from middle-class homes working for discretionary spending money. Of the approximately 3 million workers who earn the minimum wage, more than one-third are teenagers.

To mitigate the effects on teenage unemployment, some economists and policymakers have long advocated exempting young workers from the regular minimum wage. This would permit a lower wage for teenagers, thereby reducing their unemployment and enabling them to get training and job experience. Opponents of this exemption argue that it gives firms an incentive to substitute teenagers for unskilled adults, thereby raising unemployment among that group. A limited exemption of this kind was tried from 1991 to 1993. Because of many restrictions on its use, however, it had only limited effect and, therefore, was not renewed by Congress.

Many economists and policymakers believe that tax credits are a better way to increase the incomes of the working poor. The *earned income tax credit* is an amount that poor working families are allowed to subtract from the taxes they owe. For a family with a very low income, the credit exceeds its taxes, and the family receives a payment from the government. Unlike the minimum wage, the earned income tax credit does not raise labor costs to firms and, therefore, does not reduce the quantity of labor that firms demand. It has the disadvantage, however, of reducing the government's tax revenue.

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[4] Charles Brown, "Minimum Wage Laws: Are They Overrated?" *Journal of Economic Perspectives* 2 (Summer 1988): 133–146.

CASE STUDY

A Revisionist View of the Minimum Wage

Although most economists believe that increases in the minimum wage reduce employment among workers with little skill and experience, some recent studies question this conclusion. Three respected labor economists—David Card, Lawrence Katz, and Alan Krueger—examined several instances of minimum-wage changes in order to determine the magnitude of the employment response. What they found was startling.

One study examined hiring by fast-food restaurants in New Jersey when New Jersey raised the state minimum wage. Fast-food restaurants are a natural type of firm to examine because they employ many low-wage workers. To control for other effects, such as overall economic conditions, the New Jersey restaurants were compared to similar restaurants across the river in Pennsylvania. Pennsylvania did not raise its minimum wage at the same time. According to standard theory, employment in New Jersey restaurants should have fallen relative to employment in Pennsylvania restaurants. In contrast to this hypothesis, the data showed that employment *rose* in the New Jersey restaurants.

How is this seemingly perverse result possible? One explanation is that firms have some market power in the labor market. As you may have learned in courses in microeconomics, a monopsony firm buys less labor at a lower wage than a competitive firm would. In essence, the firm reduces employment in order to depress the wage it has to pay. A minimum wage prevents the monopsony firm from following this strategy and so (up to a point) can increase employment.

This new view of the minimum wage is controversial. Critics have questioned the reliability of the data used in the New Jersey study. Some studies using other data sources have reached the traditional conclusion that the minimum wage depresses employment. Moreover, most economists are skeptical of the monopsony explanation, because most firms compete with many other firms for workers. Yet this new view has directly affected the policy debate. Lawrence Katz was the first chief economist in the Department of Labor during the Clinton administration. He was followed in this job by Alan Krueger. It is therefore not surprising that President Clinton supported increases in the national minimum wage.[5]

Unions and Collective Bargaining

A second cause of wage rigidity is the monopoly power of unions. Table 6-1 shows the importance of unions in 12 major countries. In the United States, only 16 percent of workers belong to unions. In most European countries, unions play a much larger role.

[5] To read more about this new view of the minimum wage, see David Card and Alan Krueger, *Myth and Measurement: The New Economics of the Minimum Wage* (Princeton, N.J.: Princeton University Press, 1995); and Lawrence Katz and Alan Krueger, "The Effects of the Minimum Wage on the Fast-Food Industry," *Industrial and Labor Relations Review* 46 (October 1992): 6–21.

table 6-1

Union Membership as a Percentage of Employment

Country	Percentage Union Workers	Country	Percentage Union Workers
Sweden	84	Germany	33
Denmark	75	Netherlands	28
Italy	47	Switzerland	28
United Kingdom	41	Japan	26
Australia	34	United States	16
Canada	33	France	11

Source: Clara Chang and Constance Sorrentino, "Union Membership Statistics in 12 Countries," *Monthly Labor Review* (December 1991): 46–53.

The wages of unionized workers are determined not by the equilibrium of supply and demand but by collective bargaining between union leaders and firm management. Often, the final agreement raises the wage above the equilibrium level and allows the firm to decide how many workers to employ. The result is a reduction in the number of workers hired, a lower rate of job finding, and an increase in structural unemployment.

Unions can also influence the wages paid by firms whose workforces are not unionized because the threat of unionization can keep wages above the equilibrium level. Most firms dislike unions. Unions not only raise wages but also increase the bargaining power of labor on many other issues, such as hours of employment and working conditions. A firm may choose to pay its workers high wages to keep them happy in order to discourage them from forming a union.

The unemployment caused by unions and by the threat of unionization is an instance of conflict between different groups of workers—**insiders** and **outsiders**. Those workers already employed by a firm, the insiders, typically try to keep their firm's wages high. The unemployed, the outsiders, bear part of the cost of higher wages because at a lower wage they might be hired. These two groups inevitably have conflicting interests. The effect of any bargaining process on wages and employment depends crucially on the relative influence of each group.

The conflict between insiders and outsiders is resolved differently in different countries. In some countries, such as the United States, wage bargaining takes place at the level of the firm or plant. In other countries, such as Sweden, wage bargaining takes place at the national level—with the government often playing a key role. Despite a highly unionized labor force, Sweden has not experienced extraordinarily high unemployment throughout its history. One possible explanation is that the centralization of wage bargaining and the role of the government in the bargaining process give more influence to the outsiders, which keeps wages closer to the equilibrium level.

Efficiency Wages

Efficiency-wage theories propose a third cause of wage rigidity in addition to minimum-wage laws and unionization. These theories hold that high wages make workers more productive. The influence of wages on worker efficiency may explain the failure of firms to cut wages despite an excess supply of labor. Even though a wage reduction would lower a firm's wage bill, it would also—if these theories are correct—lower worker productivity and the firm's profits.

Economists have proposed various theories to explain how wages affect worker productivity. One efficiency-wage theory, which is applied mostly to poorer countries, holds that wages influence nutrition. Better-paid workers can afford a more nutritious diet, and healthier workers are more productive. A firm may decide to pay a wage above the equilibrium level to maintain a healthy workforce. Obviously, this consideration is not important for employers in wealthy countries, such as the United States and most of Europe, because the equilibrium wage is well above the level necessary to maintain good health.

A second efficiency-wage theory, which is more relevant for developed countries, holds that high wages reduce labor turnover. Workers quit jobs for many reasons—to accept better positions at other firms, to change careers, or to move to other parts of the country. The more a firm pays its workers, the greater their incentive to stay with the firm. By paying a high wage, a firm reduces the frequency of quits, thereby decreasing the time spent hiring and training new workers.

A third efficiency-wage theory holds that the average quality of a firm's workforce depends on the wage it pays its employees. If a firm reduces its wage, the best employees may take jobs elsewhere, leaving the firm with inferior employees who have fewer alternative opportunities. Economists recognize this unfavorable sorting as an example of *adverse selection*—the tendency of people with more information (in this case, the workers, who know their own outside opportunities) to self-select in a way that disadvantages people with less information (the firm). By paying a wage above the equilibrium level, the firm may reduce adverse selection, improve the average quality of its workforce, and thereby increase productivity.

A fourth efficiency-wage theory holds that a high wage improves worker effort. This theory posits that firms cannot perfectly monitor their employees' work effort, and that employees must themselves decide how hard to work. Workers can choose to work hard, or they can choose to shirk and risk getting caught and fired. Economists recognize this possibility as an example of *moral hazard*—the tendency of people to behave inappropriately when their behavior is imperfectly monitored. The firm can reduce the problem of moral hazard by paying a high wage. The higher the wage, the greater the cost to the worker of getting fired. By paying a higher wage, a firm induces more of its employees not to shirk and thus increases their productivity.

Although these four efficiency-wage theories differ in detail, they share a common theme: because a firm operates more efficiently if it pays its workers a high wage, the firm may find it profitable to keep wages above the level that balances supply and demand. The result of this higher-than-equilibrium wage is a lower rate of job finding and greater unemployment.[6]

CASE STUDY

Henry Ford's $5 Workday

In 1914 the Ford Motor Company started paying its workers $5 per day. The prevailing wage at the time was between $2 and $3 per day, so Ford's wage was well above the equilibrium level. Not surprisingly, long lines of job seekers waited outside the Ford plant gates hoping for a chance to earn this high wage.

What was Ford's motive? Henry Ford later wrote, "We wanted to pay these wages so that the business would be on a lasting foundation. We were building for the future. A low wage business is always insecure. . . . The payment of five dollars a day for an eight hour day was one of the finest cost cutting moves we ever made."

From the standpoint of traditional economic theory, Ford's explanation seems peculiar. He was suggesting that *high* wages imply *low* costs. But perhaps Ford had discovered efficiency-wage theory. Perhaps he was using the high wage to increase worker productivity.

Evidence suggests that paying such a high wage did benefit the company. According to an engineering report written at the time, "The Ford high wage does away with all the inertia and living force resistance. . . . The workingmen are absolutely docile, and it is safe to say that since the last day of 1913, every single day has seen major reductions in Ford shops' labor costs." Absenteeism fell by 75 percent, suggesting a large increase in worker effort. Alan Nevins, a historian who studied the early Ford Motor Company, wrote, "Ford and his associates freely declared on many occasions that the high wage policy had turned out to be good business. By this they meant that it had improved the discipline of the workers, given them a more loyal interest in the institution, and raised their personal efficiency."[7]

6-4 Patterns of Unemployment

So far we have developed the theory behind the natural rate of unemployment. We began by showing that the economy's steady-state unemployment rate depends on the rates of job separation and job finding. Then we discussed two reasons why job finding is not instantaneous: the process of job search (which leads to frictional unemployment) and wage rigidity (which leads to structural unemployment). Wage rigidity, in turn, arises from minimum-wage laws, unionization, and efficiency wages.

With these theories as background, we now examine some additional facts about unemployment. These facts will help us evaluate our theories and assess public policies aimed at reducing unemployment.

[6] For more extended discussions of efficiency wages, see Janet Yellen, "Efficiency Wage Models of Unemployment," *American Economic Review Papers and Proceedings* (May 1984): 200–205; and Lawrence Katz, "Efficiency Wages: A Partial Evaluation," *NBER Macroeconomics Annual* (1986): 235–276.

[7] Jeremy I. Bulow and Lawrence H. Summers, "A Theory of Dual Labor Markets With Application to Industrial Policy, Discrimination, and Keynesian Unemployment," *Journal of Labor Economics* 4 (July 1986): 376–414; and Daniel M. G. Raff and Lawrence H. Summers, "Did Henry Ford Pay Efficiency Wages?" *Journal of Labor Economics* 5 (October 1987, Part 2): S57–S86.

The Duration of Unemployment

When a person becomes unemployed, is the spell of unemployment likely to be short or long? The answer to this question is important because it indicates the reasons for the unemployment and what policy response is appropriate. On the one hand, if most unemployment is short term, one might argue that it is frictional and perhaps unavoidable. Unemployed workers may need some time to search for the job that is best suited to their skills and tastes. On the other hand, long-term unemployment cannot easily be attributed to the time it takes to match jobs and workers: we would not expect this matching process to take many months. Long-term unemployment is more likely to be structural unemployment. Thus, data on the duration of unemployment can affect our view about the reasons for unemployment.

The answer to our question turns out to be subtle. The data show that most spells of unemployment are short but that most weeks of unemployment are attributable to the long-term unemployed. Consider the data for a typical year, 1974, during which the unemployment rate was 5.6 percent. In that year, 60 percent of the spells of unemployment ended within one month, yet 69 percent of the weeks of unemployment occurred in spells that lasted two or more months.[8]

To see how both these facts can be true, consider the following example. Suppose that 10 people are unemployed for part of a given year. Of these 10 people, 8 are unemployed for 1 month, and 2 are unemployed for 12 months, totaling 32 months of unemployment. In this example, most spells of unemployment are short: 8 of the 10 unemployment spells, or 80 percent, end in 1 month. Yet most months of unemployment are attributable to the long-term unemployed: 24 of the 32 months of unemployment, or 75 percent, are experienced by the 2 workers who are unemployed for 12 months. Depending on whether we look at spells of unemployment or months of unemployment, most unemployment can appear to be short term or long term.

This evidence on the duration of unemployment has an important implication for public policy. If the goal is to lower substantially the natural rate of unemployment, policies must aim at the long-term unemployed, because these individuals account for a large amount of unemployment. Yet policies must be carefully targeted, because the long-term unemployed constitute a small minority of those who become unemployed. Most people who become unemployed find work within a short time.

Variation in the Unemployment Rate Across Demographic Groups

The rate of unemployment varies substantially across different groups within the population. Table 6-2 presents the U.S. unemployment rates for different demographic groups in 2000, when the overall unemployment rate was 4.0 percent.

This table shows that younger workers have much higher unemployment rates than older ones. To explain this difference, recall our model of the natural rate of

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[8] Kim B. Clark and Lawrence H. Summers, "Labor Market Dynamics and Unemployment: A Reconsideration," *Brookings Papers on Economic Activity* (1979:1): 13–72.

table 6-2

Unemployment Rate by Demographic Group: 2000

Age	White Male	White Female	Black Male	Black Female
16–19	12.3	10.4	26.4	23.0
20 and over	2.8	3.1	7.0	6.3

Source: U.S. Department of Labor.

unemployment. The model isolates two possible causes for a high rate of unemployment: a low rate of job finding and a high rate of job separation. When economists study data on the transition of individuals between employment and unemployment, they find that those groups with high unemployment tend to have high rates of job separation. They find less variation across groups in the rate of job finding. For example, employed white males are four times more likely to become unemployed if they are teenagers than if they are middle-aged; once someone is unemployed, the rate of job finding is not closely related to age.

These findings help explain the higher unemployment rates for younger workers. Younger workers have only recently entered the labor market, and they are often uncertain about their career plans. It may be best for them to try different types of jobs before making a long-term commitment to a specific occupation. If so, we should expect a higher rate of job separation and a higher rate of frictional unemployment for this group.

Another fact that stands out from Table 6-2 is that unemployment rates are much higher for blacks than for whites. This phenomenon is not well understood. Data on transitions between employment and unemployment show that the higher unemployment rates for blacks, and especially for black teenagers, arise because of both higher rates of job separation and lower rates of job finding. Possible reasons for the lower rates of job finding include less access to informal job-finding networks and discrimination by employers.

Trends in U.S. Unemployment

Over the past half century, the natural rate of unemployment in the United States has not been stable. If you look back at Figure 6-1, you will see that unemployment averaged below 5 percent in the 1950s and 1960s, rose to over 6 percent in the 1970s and 1980s, and then drifted back below 5 percent in the 1990s. Although economists do not have a conclusive explanation for these changes, they have proposed several hypotheses.

Demographics One explanation stresses the changing composition of the U.S. labor force. After World War II, birthrates rose dramatically: the number of births rose from 2.9 million in 1945 to a peak of 4.3 million in 1957, before falling back to 3.1 million in 1973. This rise in births in the 1950s led to a rise in the number of young workers in the 1970s. Younger workers have higher unemployment rates, however, so when the baby-boom generation entered the labor force, they increased the average level of unemployment. Then as the baby-boom workers aged, the average age of the labor force increased, lowering the average unemployment rate in the 1990s.

This demographic change, however, cannot fully explain the trends in unemployment because similar trends are apparent for fixed demographic groups. For example, for men between the ages of 25 and 54, the average unemployment rate rose from 3.0 percent in the 1960s to 6.1 percent in the 1980s. Thus, although demographic changes may be part of the story of rising unemployment over this period, there must be other explanations of the long-term trend as well.

Sectoral Shifts A second explanation is based on changes in the prevalence of sectoral shifts. The greater the amount of sectoral reallocation, the greater the rate of job separation and the higher the level of frictional unemployment. One source of sectoral shifts during the 1970s and early 1980s was the great volatility in oil prices caused by OPEC, the international oil cartel. These large changes in oil prices may have required reallocating labor between more-energy-intensive and less-energy-intensive sectors. If so, oil-price volatility may have increased unemployment during this period. Although this explanation is hard to evaluate, it is consistent with recent developments: the fall in unemployment during the 1990s coincided with increased stability in oil prices.

Productivity A third explanation for the trends in unemployment emphasizes the link between unemployment and productivity. As Chapter 8 discusses more fully, the 1970s experienced a slowdown in productivity growth, and the 1990s experienced a pickup in productivity growth. These productivity changes roughly coincide with changes in unemployment. Perhaps slowing productivity during the 1970s raised the natural rate of unemployment, and accelerating productivity during the 1990s growth lowered it.

Why such an effect would occur, however, is not obvious. In standard theories of the labor market, higher productivity means greater labor demand and thus higher real wages, but unemployment is unchanged. This prediction is consistent with the long-term data, which show consistent upward trends in productivity and real wages but no trend in unemployment. Yet suppose that workers are slow to catch on to news about productivity. When productivity changes, workers may only gradually alter the real wages they ask from their employers, making real wages sluggish in response to labor demand. An acceleration in productivity growth, such as that experienced during the 1990s, will increase labor demand and, with a sluggish real wage, reduce the amount of unemployment.

In the end, the trends in the unemployment rate remain a mystery. The proposed explanations are plausible, but none seems conclusive on its own. Perhaps there is no single answer. The upward drift in the unemployment rate in the 1970s and 1980s and the downward drift in the 1990s may be the result of several unrelated developments.[9]

[9] On the role of demographics, see Robert Shimer, "Why Is the U.S. Unemployment Rate So Much Lower?" *NBER Macroeconomics Annual* 13 (1998). On the role of sectoral shifts, see David M. Lilien, "Sectoral Shifts and Cyclical Unemployment," *Journal of Political Economy* 90 (August 1982): 777–793. On the role of productivity, see Laurence Ball and Robert Moffitt, "Productivity Growth and the Phillips Curve," *NBER Working Paper No. 8421*, August 2001.

Transitions Into and Out of the Labor Force

So far we have ignored an important aspect of labor-market dynamics: the movement of individuals into and out of the labor force. Our model of the natural rate of unemployment assumes that the size of the labor force is fixed. In this case, the sole reason for unemployment is job separation, and the sole reason for leaving unemployment is job finding.

In fact, changes in the labor force are important. About one-third of the unemployed have only recently entered the labor force. Some of these entrants are young workers still looking for their first jobs; others have worked before but temporarily left the labor force. In addition, not all unemployment ends with job finding: almost half of all spells of unemployment end in the unemployed person's withdrawal from the labor market.

Individuals entering and leaving the labor force make unemployment statistics more difficult to interpret. On the one hand, some individuals calling themselves unemployed may not be seriously looking for jobs and perhaps should best be viewed as out of the labor force. Their "unemployment" may not represent a social problem. On the other hand, some individuals may want jobs but, after unsuccessful searches, have given up looking. These **discouraged workers** are counted as being out of the labor force and do not show up in unemployment statistics. Even though their joblessness is unmeasured, it may nonetheless be a social problem.

Because of these and many other issues that complicate the interpretation of the unemployment data, the Bureau of Labor Statistics calculates several measures of labor underutilization. Table 6-3 gives the definitions and their values as

table 6-3

Alternative Measures of Labor Underutilization

Definition		Percentage in March 2001
U-1	Persons unemployed 15 weeks or longer, as a percentage of the civilian labor force (includes only very long term unemployed)	1.2 %
U-2	Job losers and persons who have completed temporary jobs, as a percentage of the civilian labor force (excludes job leavers)	2.4
U-3	Total unemployed, as a percentage of the civilian labor force (official unemployment rate)	4.6
U-4	Total unemployed, plus discouraged workers, as a percentage of the civilian labor force plus discouraged workers	4.8
U-5	Total unemployed plus all marginally attached workers, as a percentage of the civilian labor force plus all marginally attached workers	5.3
U-6	Total unemployed, plus all marginally attached workers, plus total employed part time for economic reasons, as a percentage of the civilian labor force plus all marginally attached workers	7.6

Note: Marginally attached workers are persons who currently are neither working nor looking for work but indicate that they want and are available for a job and have looked for work sometime in the recent past. *Discouraged workers*, a subset of the marginally attached, have given a job-market related reason for not currently looking for a job. *Persons employed part time for economic reasons* are those who want and are available for full-time work but have had to settle for a part-time schedule.
Source: U.S. Department of Labor.

of March 2001. The measures range from 1.2 to 7.6 percent, depending on the characteristics one uses to classify a worker as not fully employed.

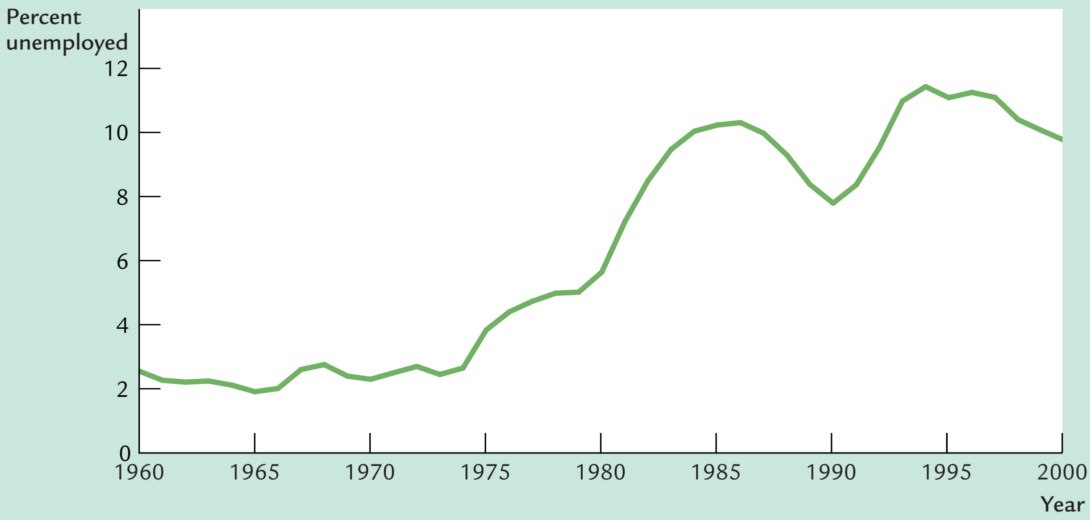
The Rise in European Unemployment

Although our discussion has focused largely on the United States, one puzzling question about unemployment concerns recent developments in Europe. Figure 6-4 shows the rate of unemployment in the countries that make up the European Community—Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, and the United Kingdom. As you can see, the rate of unemployment in these countries has risen substantially: it averaged less than 3 percent in the 1960s and more than 10 percent in recent years.

What is the cause of rising European unemployment? No one knows for sure, but there is a leading theory. Many economists believe that the problem can be traced to generous benefits for unemployed workers, coupled with a technologically driven fall in the demand for unskilled workers relative to skilled workers.

There is no question that most European countries have generous programs for those without jobs. These programs go by various names: social insurance, the welfare state, or simply "the dole." Many countries allow the unemployed to

figure 6-4



Unemployment in the European Community This figure shows the unemployment rate in the 15 countries that make up the European Community. The figure shows that the European unemployment rate has risen substantially since 1980.

Source: OECD.

collect benefits indefinitely, rather than for only a short period of time as in the United States. Studies have shown that countries with more generous benefits tend to have higher rates of unemployment. In some sense, those living on the dole are really out of the labor force: given the employment opportunities available, taking a job is less attractive than remaining without work. Yet these people are often counted as unemployed in government statistics.

There is also no question that the demand for unskilled workers has fallen relative to the demand for skilled workers. This change in demand is probably attributable to changes in technology: computers, for example, increase the demand for workers who can use them and reduce the demand for those who cannot. In the United States, this change in demand has been reflected in wages rather than unemployment: over the past two decades, the wages of unskilled workers have fallen substantially relative to the wages of skilled workers. In Europe, however, the welfare state provides unskilled workers with an alternative to working for low wages. As the wages of unskilled workers fall, more workers view the dole as their best available option. The result is higher unemployment.

This diagnosis of high European unemployment does not suggest an easy remedy. Reducing the magnitude of government benefits for the unemployed would encourage workers to get off the dole and accept low-wage jobs. But it would also exacerbate economic inequality—the very problem that welfare-state policies were designed to address.[10]

CASE STUDY

The Secrets to Happiness

Why are some people more satisfied with their lives than others? This is a deep and difficult question, most often left to philosophers and psychologists. But part of the answer is macroeconomic. Recent research has shown that people are happier when they are living in a country with low inflation and low unemployment.

From 1975 to 1991, a survey called the Euro-Barometer Survey Series asked 264,710 people living in 12 European countries about their happiness and overall satisfaction with life. One question asked, "On the whole, are you very satisfied, fairly satisfied, not very satisfied, or not at all satisfied with the life you lead?" To see what determines happiness, the answers to this question were correlated with individual and macroeconomic variables. Other things being equal, people are more satisfied with their lives if they are rich, educated, married, in school, self-employed, retired, female, and young or old (as opposed to middle-aged).

[10] For more discussion of these issues, see Paul Krugman, "Past and Prospective Causes of High Unemployment," in *Reducing Unemployment: Current Issues and Policy Options*, Federal Reserve Bank of Kansas City, August 1994.

They are less satisfied if they are unemployed, divorced, or living with adolescent children. (Some of these correlations may reflect the effects, rather than causes, of happiness: for example, a happy person may find it easier than an unhappy one to keep a job and a spouse.)

Beyond these individual characteristics, the economy's overall rates of unemployment and inflation also play a significant role in explaining reported happiness. An increase in the unemployment rate of 4 percentage points is large enough to move 11 percent of the population down from one life-satisfaction category to another. The overall unemployment rate reduces satisfaction even after controlling for an individual's employment status. That is, the employed in a high-unemployment nation are less happy than their counterparts in a low-unemployment nation, perhaps because they are more worried about job loss or perhaps out of sympathy with their fellow citizens.

High inflation is also associated with lower life satisfaction, although the effect is not as large. A 1.7-percentage-point increase in inflation reduces happiness by about as much as a 1-percentage-point increase in unemployment. The commonly cited "misery index," which is the sum of the inflation and unemployment rates, apparently gives too much weight to inflation relative to unemployment.[11]

6-5 Conclusion

Unemployment represents wasted resources. Unemployed workers have the potential to contribute to national income but are not doing so. Those searching for jobs to suit their skills are happy when the search is over, and those waiting for jobs in firms that pay above-equilibrium wages are happy when positions open up.

Unfortunately, neither frictional unemployment nor structural unemployment can be easily reduced. The government cannot make job search instantaneous, and it cannot easily bring wages closer to equilibrium levels. Zero unemployment is not a plausible goal for free-market economies.

Yet public policy is not powerless in the fight to reduce unemployment. Job-training programs, the unemployment-insurance system, the minimum wage, and the laws governing collective bargaining are often topics of political debate. The policies we choose are likely to have important effects on the economy's natural rate of unemployment.

[11] Rafael Di Tella, Robert J. MacCulloch, and Andrew J. Oswald, "Preferences Over Inflation and Unemployment: Evidence From Surveys of Happiness," *American Economic Review* 91 (March 2001): 335–341.

Summary

1. The natural rate of unemployment is the steady-state rate of unemployment. It depends on the rate of job separation and the rate of job finding.

2. Because it takes time for workers to search for the job that best suits their individual skills and tastes, some frictional unemployment is inevitable. Various government policies, such as unemployment insurance, alter the amount of frictional unemployment.

3. Structural unemployment results when the real wage remains above the level that equilibrates labor supply and labor demand. Minimum-wage legislation is one cause of wage rigidity. Unions and the threat of unionization are another. Finally, efficiency-wage theories suggest that, for various reasons, firms may find it profitable to keep wages high despite an excess supply of labor.

4. Whether we conclude that most unemployment is short term or long term depends on how we look at the data. Most spells of unemployment are short. Yet most weeks of unemployment are attributable to the small number of long-term unemployed.

5. The unemployment rates among demographic groups differ substantially. In particular, the unemployment rates for younger workers are much higher than for older workers. This results from a difference in the rate of job separation rather than from a difference in the rate of job finding.

6. The natural rate of unemployment in the United States has exhibited long-term trends. In particular, it rose from the 1950s to the 1970s and then started drifting downward again in the 1990s. Various explanations have been proposed, including the changing demographic composition of the labor force, changes in the prevalence of sectoral shifts, and changes in the rate of productivity growth.

7. Individuals who have recently entered the labor force, including both new entrants and reentrants, make up about one-third of the unemployed. Transitions into and out of the labor force make unemployment statistics more difficult to interpret.

KEY CONCEPTS

Natural rate of unemployment
Frictional unemployment
Sectoral shift
Unemployment insurance
Wage rigidity
Structural unemployment
Insiders versus outsiders
Efficiency wages
Discouraged workers

QUESTIONS FOR REVIEW

1. What determines the natural rate of unemployment?
2. Describe the difference between frictional unemployment and structual unemployment.
3. Give three explanations why the real wage may remain above the level that equilibrates labor supply and labor demand.
4. Is most unemployment long term or short term? Explain your answer.
5. How do economists explain the high natural rate of unemployment in the 1970s and 1980s? How do they explain the fall in the natural rate in the 1990s?

PROBLEMS AND APPLICATIONS

1. Answer the following questions about your own experience in the labor force:
   a. When you or one of your friends is looking for a part-time job, how many weeks does it typically take? After you find a job, how many weeks does it typically last?
   b. From your estimates, calculate (in a rate per week) your rate of job finding f and your rate of job separation s. (*Hint:* If f is the rate of job finding, then the average spell of unemployment is $1/f$.)
   c. What is the natural rate of unemployment for the population you represent?
2. In this chapter we saw that the steady-state rate of unemployment is $U/L = s/(s + f)$. Suppose that the unemployment rate does not begin at this level. Show that unemployment will evolve over time and reach this steady state. (*Hint:* Express the change in the number of unemployed as a function of s, f, and U. Then show that if unemployment is above the natural rate, unemployment falls, and if unemployment is below the natural rate, unemployment rises.)
3. The residents of a certain dormitory have collected the following data: People who live in the dorm can be classified as either involved in a relationship or uninvolved. Among involved people, 10 percent experience a breakup of their relationship every month. Among uninvolved people, 5 percent will enter into a relationship every month. What is the steady-state fraction of residents who are uninvolved?
4. Suppose that Congress passes legislation making it more difficult for firms to fire workers. (An example is a law requiring severance pay for fired workers.) If this legislation reduces the rate of job separation without affecting the rate of job finding, how would the natural rate of unemployment change? Do you think that it is plausible that the legislation would not affect the rate of job finding? Why or why not?
5. Consider an economy with the following Cobb–Douglas production function:

$$Y = K^{1/3}L^{2/3}.$$

   The economy has 1,000 units of capital and a labor force of 1,000 workers.
   a. Derive the equation describing labor demand in this economy as a function of the real wage and the capital stock. (*Hint*: Review the appendix to Chapter 3.)
   b. If the real wage can adjust to equilibrate labor supply and labor demand, what is the real wage? In this equilibrium, what are employment, output, and the total amount earned by workers?
   c. Now suppose that Congress, concerned about the welfare of the working class, passes a law requiring firms to pay workers a real wage of 1 unit of output. How does this wage compare to the equilibrium wage?
   d. Congress cannot dictate how many workers firms hire at the mandated wage. Given this fact, what are the effects of this law? Specifi-

cally, what happens to employment, output, and the total amount earned by workers?

e. Will Congress succeed in its goal of helping the working class? Explain.

f. Do you think that this analysis provides a good way of thinking about a minimum-wage law? Why or why not?

6. Suppose that a country experiences a reduction in productivity—that is, an adverse shock to the production function.

a. What happens to the labor demand curve?

b. How would this change in productivity affect the labor market—that is, employment, unemployment, and real wages—if the labor market were always in equilibrium?

c. How would this change in productivity affect the labor market if unions prevented real wages from falling?

7. In any city at any time, some of the stock of usable office space is vacant. This vacant office space is unemployed capital. How would you explain this phenomenon? Is it a social problem?

part III

Growth Theory: The Economy in the Very Long Run

CHAPTER SEVEN

Economic Growth I

The question of growth is nothing new but a new disguise for an age-old issue, one which has always intrigued and preoccupied economics: the present versus the future.

— *James Tobin*

If you have ever spoken with your grandparents about what their lives were like when they were young, most likely you learned an important lesson about economics: material standards of living have improved substantially over time for most families in most countries. This advance comes from rising incomes, which have allowed people to consume greater quantities of goods and services.

To measure economic growth, economists use data on gross domestic product, which measures the total income of everyone in the economy. The real GDP of the United States today is more than three times its 1950 level, and real GDP per person is more than twice its 1950 level. In any given year, we can also observe large differences in the standard of living among countries. Table 7-1 shows income per person in 1999 of the world's 12 most populous countries. The United States tops the list with an income of $31,910 per person. Nigeria has an income per person of only $770—less than 3 percent of the figure for the United States.

Our goal in this part of the book is to understand what causes these differences in income over time and across countries. In Chapter 3 we identified the factors of production—capital and labor—and the production technology as the sources of the economy's output and, thus, of its total income. Differences in income, then, must come from differences in capital, labor, and technology.

Our primary task is to develop a theory of economic growth called the **Solow growth model**. Our analysis in Chapter 3 enabled us to describe how the economy produces and uses its output at one point in time. The analysis was static—a snapshot of the economy. To explain why our national income grows, and why some economies grow faster than others, we must broaden our analysis so that it describes changes in the economy over time. By developing such a model, we make our analysis dynamic—more like a movie than a photograph. The Solow growth model shows how saving, population growth, and

table 7-1

International Differences in the Standard of Living: 1999

Country	Income per Person (in U.S. dollars)	Country	Income per Person (in U.S. dollars)
United States	$31,910	China	3,550
Japan	25,170	Indonesia	2,660
Germany	23,510	India	2,230
Mexico	8,070	Pakistan	1,860
Russia	6,990	Bangladesh	1,530
Brazil	6,840	Nigeria	770

Source: World Bank.

technological progress affect the level of an economy's output and its growth over time. In this chapter we analyze the roles of saving and population growth. In the next chapter we introduce technological progress.[1]

7-1 The Accumulation of Capital

The Solow growth model is designed to show how growth in the capital stock, growth in the labor force, and advances in technology interact in an economy, and how they affect a nation's total output of goods and services. We build this model in steps. Our first step is to examine how the supply and demand for goods determine the accumulation of capital. In this first step, we assume that the labor force and technology are fixed. We then relax these assumptions by introducing changes in the labor force later in this chapter and by introducing changes in technology in the next.

The Supply and Demand for Goods

The supply and demand for goods played a central role in our static model of the closed economy in Chapter 3. The same is true for the Solow model. By considering the supply and demand for goods, we can see what determines how much output is produced at any given time and how this output is allocated among alternative uses.

[1] The Solow growth model is named after economist Robert Solow and was developed in the 1950s and 1960s. In 1987 Solow won the Nobel Prize in economics for his work in economic growth. The model was introduced in Robert M. Solow, "A Contribution to the Theory of Economic Growth," *Quarterly Journal of Economics* (February 1956): 65–94.

The Supply of Goods and the Production Function The supply of goods in the Solow model is based on the now-familiar production function, which states that output depends on the capital stock and the labor force:

$$Y = F(K, L).$$

The Solow growth model assumes that the production function has constant returns to scale. This assumption is often considered realistic, and as we will see shortly, it helps simplify the analysis. Recall that a production function has constant returns to scale if

$$zY = F(zK, zL)$$

for any positive number z. That is, if we multiply both capital and labor by z, we also multiply the amount of output by z.

Production functions with constant returns to scale allow us to analyze all quantities in the economy relative to the size of the labor force. To see that this is true, set $z = 1/L$ in the preceding equation to obtain

$$Y/L = F(K/L, 1).$$

This equation shows that the amount of output per worker Y/L is a function of the amount of capital per worker K/L. (The number "1" is, of course, constant and thus can be ignored.) The assumption of constant returns to scale implies that the size of the economy—as measured by the number of workers—does not affect the relationship between output per worker and capital per worker.

Because the size of the economy does not matter, it will prove convenient to denote all quantities in per-worker terms. We designate these with lowercase letters, so $y = Y/L$ is output per worker, and $k = K/L$ is capital per worker. We can then write the production function as

$$y = f(k),$$

where we define $f(k) = F(k,1)$. Figure 7-1 illustrates this production function.

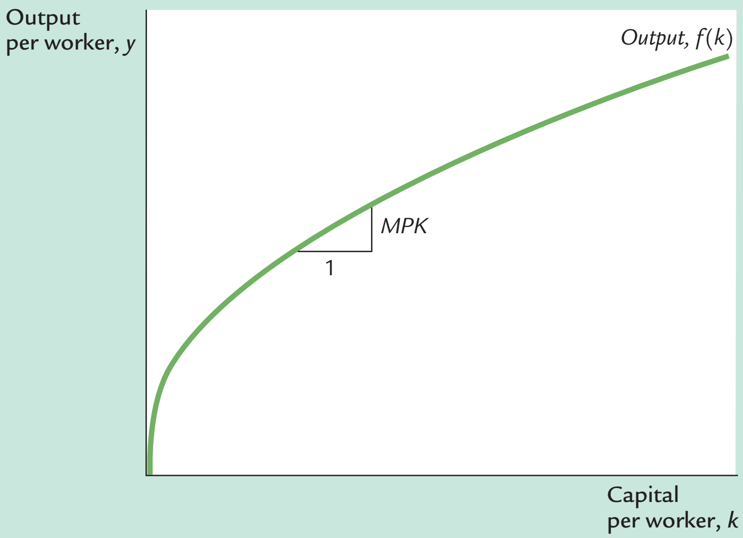
The slope of this production function shows how much extra output a worker produces when given an extra unit of capital. This amount is the marginal product of capital MPK. Mathematically, we write

$$MPK = f(k + 1) - f(k).$$

Note that in Figure 7-1, as the amount of capital increases, the production function becomes flatter, indicating that the production function exhibits diminishing marginal product of capital. When k is low, the average worker has only a little capital to work with, so an extra unit of capital is very useful and produces a lot of additional output. When k is high, the average worker has a lot of capital, so an extra unit increases production only slightly.

The Demand for Goods and the Consumption Function The demand for goods in the Solow model comes from consumption and investment. In other

figure 7-1



The Production Function The production function shows how the amount of capital per worker k determines the amount of output per worker $y = f(k)$. The slope of the production function is the marginal product of capital: if k increases by 1 unit, y increases by *MPK* units. The production function becomes flatter as k increases, indicating diminishing marginal product of capital.

words, output per worker y is divided between consumption per worker c and investment per worker i:

$$y = c + i.$$

This equation is the per-worker version of the national income accounts identity for an economy. Notice that it omits government purchases (which for present purposes we can ignore) and net exports (because we are assuming a closed economy).

The Solow model assumes that each year people save a fraction s of their income and consume a fraction $(1 - s)$. We can express this idea with a consumption function with the simple form

$$c = (1 - s)y,$$

where s, the saving rate, is a number between zero and one. Keep in mind that various government policies can potentially influence a nation's saving rate, so one of our goals is to find what saving rate is desirable. For now, however, we just take the saving rate s as given.

To see what this consumption function implies for investment, substitute $(1 - s)y$ for c in the national income accounts identity:

$$y = (1 - s)y + i.$$

Rearrange the terms to obtain

$$i = sy.$$

This equation shows that investment equals saving, as we first saw in Chapter 3. Thus, the rate of saving s is also the fraction of output devoted to investment.

We have now introduced the two main ingredients of the Solow model—the production function and the consumption function—which describe the economy at any moment in time. For any given capital stock k, the production function $y = f(k)$ determines how much output the economy produces, and the saving rate s determines the allocation of that output between consumption and investment.

Growth in the Capital Stock and the Steady State

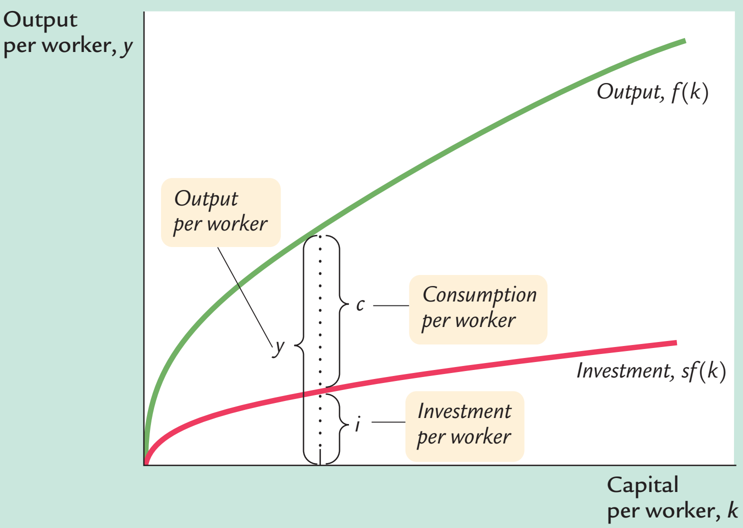
At any moment, the capital stock is a key determinant of the economy's output, but the capital stock can change over time, and those changes can lead to economic growth. In particular, two forces influence the capital stock: investment and depreciation. *Investment* refers to the expenditure on new plant and equipment, and it causes the capital stock to rise. *Depreciation* refers to the wearing out of old capital, and it causes the capital stock to fall. Let's consider each of these in turn.

As we have already noted, investment per worker i equals sy. By substituting the production function for y, we can express investment per worker as a function of the capital stock per worker:

$$i = sf(k).$$

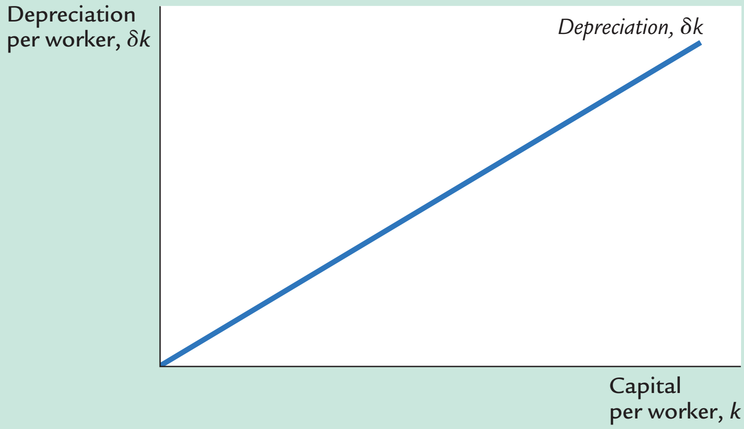
This equation relates the existing stock of capital k to the accumulation of new capital i. Figure 7-2 shows this relationship. This figure illustrates how, for any value of k, the amount of output is determined by the production function $f(k)$, and the allocation of that output between consumption and saving is determined by the saving rate s.

figure 7-2



Output, Consumption, and Investment The saving rate s determines the allocation of output between consumption and investment. For any level of capital k, output is $f(k)$, investment is $sf(k)$, and consumption is $f(k) - sf(k)$.

figure 7-3



Depreciation A constant fraction δ of the capital stock wears out every year. Depreciation is therefore proportional to the capital stock.

To incorporate depreciation into the model, we assume that a certain fraction δ of the capital stock wears out each year. Here δ (the lowercase Greek letter delta) is called the *depreciation rate*. For example, if capital lasts an average of 25 years, then the depreciation rate is 4 percent per year ($\delta = 0.04$). The amount of capital that depreciates each year is δk. Figure 7-3 shows how the amount of depreciation depends on the capital stock.

We can express the impact of investment and depreciation on the capital stock with this equation:

$$\begin{array}{ccccc} \text{Change in Capital Stock} & = & \text{Investment} & - & \text{Depreciation} \\ \Delta k & = & i & - & \delta k, \end{array}$$

where Δk is the change in the capital stock between one year and the next. Because investment i equals $sf(k)$, we can write this as

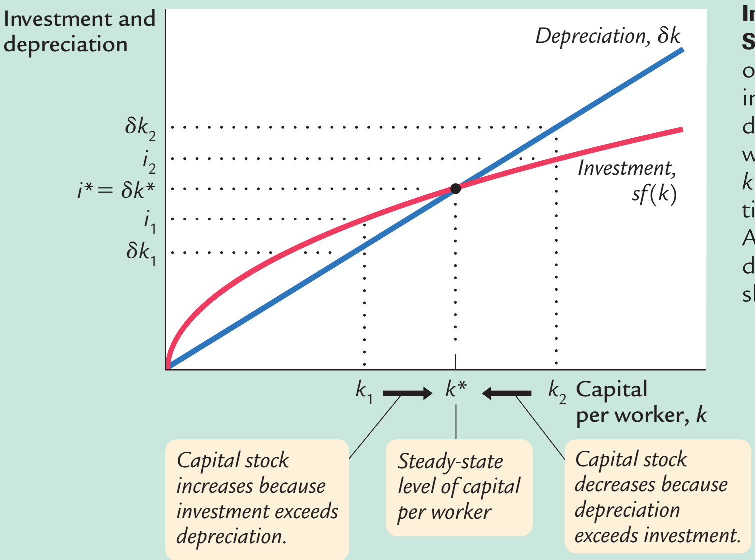
$$\Delta k = sf(k) - \delta k.$$

Figure 7-4 graphs the terms of this equation—investment and depreciation—for different levels of the capital stock k. The higher the capital stock, the greater the amounts of output and investment. Yet the higher the capital stock, the greater also the amount of depreciation.

As Figure 7-4 shows, there is a single capital stock k^* at which the amount of investment equals the amount of depreciation. If the economy ever finds itself at this level of the capital stock, the capital stock will not change because the two forces acting on it—investment and depreciation—just balance. That is, at k^*, $\Delta k = 0$, so the capital stock k and output $f(k)$ are steady over time (rather than growing or shrinking). We therefore call k^* the **steady-state** level of capital.

The steady state is significant for two reasons. As we have just seen, an economy at the steady state will stay there. In addition, and just as important, an economy not at the steady state will go there. That is, regardless of the level of capital

figure 7-4



Investment, Depreciation, and the Steady State The steady-state level of capital k^* is the level at which investment equals depreciation, indicating that the amount of capital will not change over time. Below k^*, investment exceeds depreciation, so the capital stock grows. Above k^*, investment is less than depreciation, so the capital stock shrinks.

with which the economy begins, it ends up with the steady-state level of capital. In this sense, *the steady state represents the long-run equilibrium of the economy*.

To see why an economy always ends up at the steady state, suppose that the economy starts with less than the steady-state level of capital, such as level k_1 in Figure 7-4. In this case, the level of investment exceeds the amount of depreciation. Over time, the capital stock will rise and will continue to rise—along with output $f(k)$—until it approaches the steady state k^*.

Similarly, suppose that the economy starts with more than the steady-state level of capital, such as level k_2. In this case, investment is less than depreciation: capital is wearing out faster than it is being replaced. The capital stock will fall, again approaching the steady-state level. Once the capital stock reaches the steady state, investment equals depreciation, and there is no pressure for the capital stock to either increase or decrease.

Approaching the Steady State: A Numerical Example

Let's use a numerical example to see how the Solow model works and how the economy approaches the steady state. For this example, we assume that the production function is[2]

$$Y = K^{1/2}L^{1/2}.$$

[2] If you read the appendix to Chapter 3, you will recognize this as the Cobb–Douglas production function with the parameter α equal to 1/2.

To derive the per-worker production function $f(k)$, divide both sides of the production function by the labor force L:

$$\frac{Y}{L} = \frac{K^{1/2}L^{1/2}}{L}.$$

Rearrange to obtain

$$\frac{Y}{L} = \left(\frac{K}{L}\right)^{1/2}.$$

Because $y = Y/L$ and $k = K/L$, this becomes

$$y = k^{1/2}.$$

This equation can also be written as

$$y = \sqrt{k}.$$

This form of the production function states that output per worker is equal to the square root of the amount of capital per worker.

To complete the example, let's assume that 30 percent of output is saved (s = 0.3), that 10 percent of the capital stock depreciates every year ($\delta = 0.1$), and that the economy starts off with 4 units of capital per worker ($k = 4$). Given these numbers, we can now examine what happens to this economy over time.

We begin by looking at the production and allocation of output in the first year. According to the production function, the 4 units of capital per worker produce 2 units of output per worker. Because 30 percent of output is saved and invested and 70 percent is consumed, $i = 0.6$ and $c = 1.4$. Also, because 10 percent of the capital stock depreciates, $\delta k = 0.4$. With investment of 0.6 and depreciation of 0.4, the change in the capital stock is $\Delta k = 0.2$. The second year begins with 4.2 units of capital per worker.

Table 7-2 shows how the economy progresses year by year. Every year, new capital is added and output grows. Over many years, the economy approaches a steady state with 9 units of capital per worker. In this steady state, investment of 0.9 exactly offsets depreciation of 0.9, so that the capital stock and output are no longer growing.

Following the progress of the economy for many years is one way to find the steady-state capital stock, but there is another way that requires fewer calculations. Recall that

$$\Delta k = sf(k) - \delta k.$$

This equation shows how k evolves over time. Because the steady state is (by definition) the value of k at which $\Delta k = 0$, we know that

$$0 = sf(k^*) - \delta k^*,$$

or, equivalently,

$$\frac{k^*}{f(k^*)} = \frac{s}{\delta}.$$

table 7-2

Approaching the Steady State: A Numerical Example

Assumptions: $y = \sqrt{k}$; $s = 0.3$; $\delta = 0.1$; initial $k = 4.0$

Year	k	y	c	i	δk	Δk
1	4.000	2.000	1.400	0.600	0.400	0.200
2	4.200	2.049	1.435	0.615	0.420	0.195
3	4.395	2.096	1.467	0.629	0.440	0.189
4	4.584	2.141	1.499	0.642	0.458	0.184
5	4.768	2.184	1.529	0.655	0.477	0.178
. . .						
10	5.602	2.367	1.657	0.710	0.560	0.150
. . .						
25	7.321	2.706	1.894	0.812	0.732	0.080
. . .						
100	8.962	2.994	2.096	0.898	0.896	0.002
. . .						
∞	9.000	3.000	2.100	0.900	0.900	0.000

This equation provides a way of finding the steady-state level of capital per worker, k^*. Substituting in the numbers and production function from our example, we obtain

$$\frac{k^*}{\sqrt{k^*}} = \frac{0.3}{0.1}.$$

Now square both sides of this equation to find

$$k^* = 9.$$

The steady-state capital stock is 9 units per worker. This result confirms the calculation of the steady state in Table 7-2.

CASE STUDY

The Miracle of Japanese and German Growth

Japan and Germany are two success stories of economic growth. Although today they are economic superpowers, in 1945 the economies of both countries were in shambles. World War II had destroyed much of their capital stocks. In the decades after the war, however, these two countries experienced some of the most rapid growth rates on record. Between 1948 and 1972, output per person grew at 8.2 percent per year in Japan and 5.7 percent per year in Germany, compared to only 2.2 percent per year in the United States.

Are the postwar experiences of Japan and Germany so surprising from the standpoint of the Solow growth model? Consider an economy in steady state. Now suppose that a war destroys some of the capital stock. (That is, suppose the capital stock drops from k^* to k_1 in Figure 7-4.) Not surprisingly, the level of output immediately falls. But if the saving rate—the fraction of output devoted to saving and investment—is unchanged, the economy will then experience a period of high growth. Output grows because, at the lower capital stock, more capital is added by investment than is removed by depreciation. This high growth continues until the economy approaches its former steady state. Hence, although destroying part of the capital stock immediately reduces output, it is followed by higher-than-normal growth. The "miracle" of rapid growth in Japan and Germany, as it is often described in the business press, is what the Solow model predicts for countries in which war has greatly reduced the capital stock.

How Saving Affects Growth

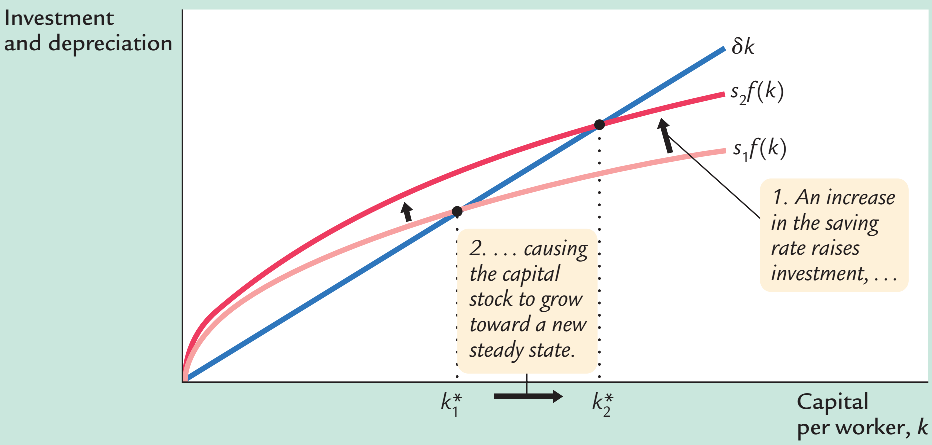
The explanation of Japanese and German growth after World War II is not quite as simple as suggested in the preceding case study. Another relevant fact is that both Japan and Germany save and invest a higher fraction of their output than the United States. To understand more fully the international differences in economic performance, we must consider the effects of different saving rates.

Consider what happens to an economy when its saving rate increases. Figure 7-5 shows such a change. The economy is assumed to begin in a steady state with saving rate s_1 and capital stock k_1^*. When the saving rate increases from s_1 to s_2, the $sf(k)$ curve shifts upward. At the initial saving rate s_1 and the initial capital stock k_1^*, the amount of investment just offsets the amount of depreciation. Immediately after the saving rate rises, investment is higher, but the capital stock and depreciation are unchanged. Therefore, investment exceeds depreciation. The capital stock will gradually rise until the economy reaches the new steady state k_2^*, which has a higher capital stock and a higher level of output than the old steady state.

The Solow model shows that the saving rate is a key determinant of the steady-state capital stock. *If the saving rate is high, the economy will have a large capital stock and a high level of output. If the saving rate is low, the economy will have a small capital stock and a low level of output.* This conclusion sheds light on many discussions of fiscal policy. As we saw in Chapter 3, a government budget deficit can reduce national saving and crowd out investment. Now we can see that the long-run consequences of a reduced saving rate are a lower capital stock and lower national income. This is why many economists are critical of persistent budget deficits.

What does the Solow model say about the relationship between saving and economic growth? Higher saving leads to faster growth in the Solow model, but

figure 7-5



An Increase in the Saving Rate An increase in the saving rate s implies that the amount of investment for any given capital stock is higher. It therefore shifts the saving function upward. At the initial steady state k_1^*, investment now exceeds depreciation. The capital stock rises until the economy reaches a new steady state k_2^* with more capital and output.

only temporarily. An increase in the rate of saving raises growth only until the economy reaches the new steady state. If the economy maintains a high saving rate, it will maintain a large capital stock and a high level of output, but it will not maintain a high rate of growth forever.

Now that we understand how saving affects growth, we can more fully explain the impressive economic performances of Germany and Japan after World War II. Not only were their initial capital stocks low because of the war, but their steady-state capital stocks were high because of their high saving rates. Both of these facts help explain the rapid growth of these two countries in the 1950s and 1960s.

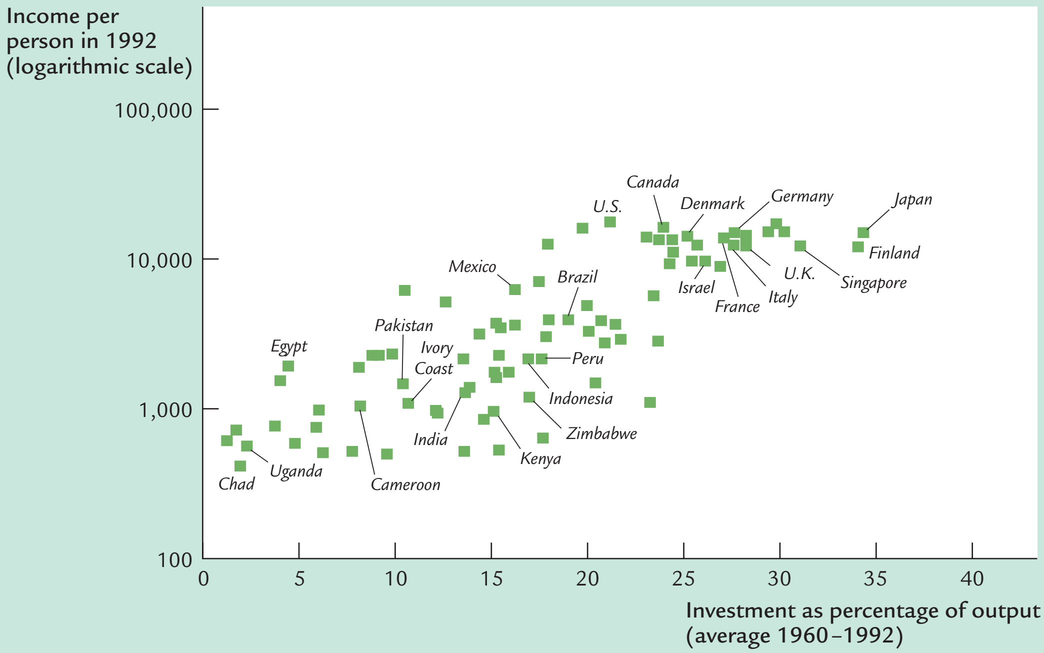
CASE STUDY

Saving and Investment Around the World

We started this chapter with an important question: Why are some countries so rich while others are mired in poverty? Our analysis has taken us a step closer to the answer. According to the Solow model, if a nation devotes a large fraction of its income to saving and investment, it will have a high steady-state capital stock and a high level of income. If a nation saves and invests only a small fraction of its income, its steady-state capital and income will be low.

Let's now look at some data to see if this theoretical result in fact helps explain the large international variation in standards of living. Figure 7-6 is a scatterplot of data from 84 countries. (The figure includes most of the world's economies. It excludes major oil-producing countries and countries that were communist during much of this period, because their experiences are explained by their special

figure 7-6



International Evidence on Investment Rates and Income per Person This scatterplot shows the experience of 84 countries, each represented by a single point. The horizontal axis shows the country's rate of investment, and the vertical axis shows the country's income per person. High investment is associated with high income per person, as the Solow model predicts.

Source: Robert Summers and Alan Heston, Supplement (Mark 5.6) to "The Penn World Table (Mark 5): An Expanded Set of International Comparisons 1950–1988," *Quarterly Journal of Economics* (May 1991): 327–368.

circumstances.) The data show a positive relationship between the fraction of output devoted to investment and the level of income per person. That is, countries with high rates of investment, such as the United States and Japan, usually have high incomes, whereas countries with low rates of investment, such as Uganda and Chad, have low incomes. Thus, the data are consistent with the Solow model's prediction that the investment rate is a key determinant of whether a country is rich or poor.

The strong correlation shown in this figure is an important fact, but it raises as many questions as it resolves. One might naturally ask, why do rates of saving and investment vary so much from country to country? There are many potential answers, such as tax policy, retirement patterns, the development of financial markets, and cultural differences. In addition, political stability may play a role: not surprisingly, rates of saving and investment tend to be low in countries with frequent wars, revolutions, and coups. Saving and investment also tend to be low in countries with poor political institutions, as measured by estimates of official corruption. A final interpretation of the evidence in Figure 7-6 is reverse causation:

perhaps high levels of income somehow foster high rates of saving and investment. Unfortunately, there is no consensus among economists about which of the many possible explanations is most important.

The association between investment rates and income per person is strong, and it is an important clue as to why some countries are rich and others poor, but it is not the whole story. The correlation between these two variables is far from perfect. Mexico and Zimbabwe, for instance, have had similar investment rates, but income per person is more than three times higher in Mexico. There must be other determinants of living standards beyond saving and investment. We therefore return to the international differences later in the chapter to see what other variables enter the picture.

7-2 The Golden Rule Level of Capital

So far, we have used the Solow model to examine how an economy's rate of saving and investment determines its steady-state levels of capital and income. This analysis might lead you to think that higher saving is always a good thing, for it always leads to greater income. Yet suppose a nation had a saving rate of 100 percent. That would lead to the largest possible capital stock and the largest possible income. But if all of this income is saved and none is ever consumed, what good is it?

This section uses the Solow model to discuss what amount of capital accumulation is optimal from the standpoint of economic well-being. In the next chapter, we discuss how government policies influence a nation's saving rate. But first, in this section, we present the theory behind these policy decisions.

Comparing Steady States

To keep our analysis simple, let's assume that a policymaker can set the economy's saving rate at any level. By setting the saving rate, the policymaker determines the economy's steady state. What steady state should the policymaker choose?

When choosing a steady state, the policymaker's goal is to maximize the well-being of the individuals who make up the society. Individuals themselves do not care about the amount of capital in the economy, or even the amount of output. They care about the amount of goods and services they can consume. Thus, a benevolent policymaker would want to choose the steady state with the highest level of consumption. The steady-state value of k that maximizes consumption is called the **Golden Rule level of capital** and is denoted k^*_{gold}.[3]

How can we tell whether an economy is at the Golden Rule level? To answer this question, we must first determine steady-state consumption per worker. Then we can see which steady state provides the most consumption.

[3] Edmund Phelps, "The Golden Rule of Accumulation: A Fable for Growthmen," *American Economic Review* 51 (September 1961): 638–643.

To find steady-state consumption per worker, we begin with the national income accounts identity

$$y = c + i$$

and rearrange it as

$$c = y - i.$$

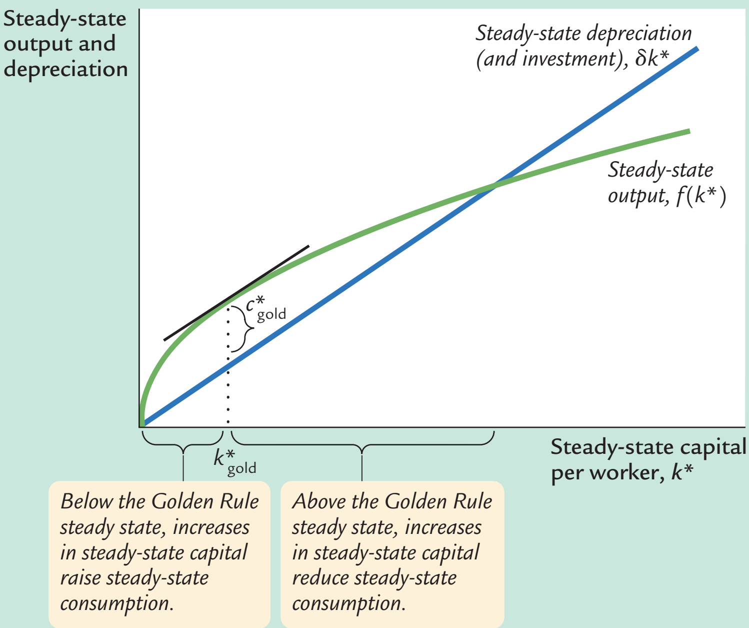
Consumption is simply output minus investment. Because we want to find steady-state consumption, we substitute steady-state values for output and investment. Steady-state output per worker is $f(k^*)$, where k^* is the steady-state capital stock per worker. Furthermore, because the capital stock is not changing in the steady state, investment is equal to depreciation δk^*. Substituting $f(k^*)$ for y and δk^* for i, we can write steady-state consumption per worker as

$$c^* = f(k^*) - \delta k^*.$$

According to this equation, steady-state consumption is what's left of steady-state output after paying for steady-state depreciation. This equation shows that an increase in steady-state capital has two opposing effects on steady-state consumption. On the one hand, more capital means more output. On the other hand, more capital also means that more output must be used to replace capital that is wearing out.

Figure 7-7 graphs steady-state output and steady-state depreciation as a function of the steady-state capital stock. Steady-state consumption is the gap between

figure 7-7



Steady-State Consumption The economy's output is used for consumption or investment. In the steady state, investment equals depreciation. Therefore, steady-state consumption is the difference between output $f(k^*)$ and depreciation δk^*. Steady-state consumption is maximized at the Golden Rule steady state. The Golden Rule capital stock is denoted k^*_{gold}, and the Golden Rule consumption is denoted c^*_{gold}.

output and depreciation. This figure shows that there is one level of the capital stock—the Golden Rule level k^*_{gold}—that maximizes consumption.

When comparing steady states, we must keep in mind that higher levels of capital affect both output and depreciation. If the capital stock is below the Golden Rule level, an increase in the capital stock raises output more than depreciation, so that consumption rises. In this case, the production function is steeper than the δk^* line, so the gap between these two curves—which equals consumption—grows as k^* rises. By contrast, if the capital stock is above the Golden Rule level, an increase in the capital stock reduces consumption, since the increase in output is smaller than the increase in depreciation. In this case, the production function is flatter than the δk^* line, so the gap between the curves—consumption—shrinks as k^* rises. At the Golden Rule level of capital, the production function and the δk^* line have the same slope, and consumption is at its greatest level.

We can now derive a simple condition that characterizes the Golden Rule level of capital. Recall that the slope of the production function is the marginal product of capital MPK. The slope of the δk^* line is δ. Because these two slopes are equal at k^*_{gold}, the Golden Rule is described by the equation

$$MPK = \delta.$$

At the Golden Rule level of capital, the marginal product of capital equals the depreciation rate.

To make the point somewhat differently, suppose that the economy starts at some steady-state capital stock k^* and that the policymaker is considering increasing the capital stock to $k^* + 1$. The amount of extra output from this increase in capital would be $f(k^* + 1) - f(k^*)$, which is the marginal product of capital MPK. The amount of extra depreciation from having 1 more unit of capital is the depreciation rate δ. Thus, the net effect of this extra unit of capital on consumption is $MPK - \delta$. If $MPK - \delta > 0$, then increases in capital increase consumption, so k^* must be below the Golden Rule level. If $MPK - \delta < 0$, then increases in capital decrease consumption, so k^* must be above the Golden Rule level. Therefore, the following condition describes the Golden Rule:

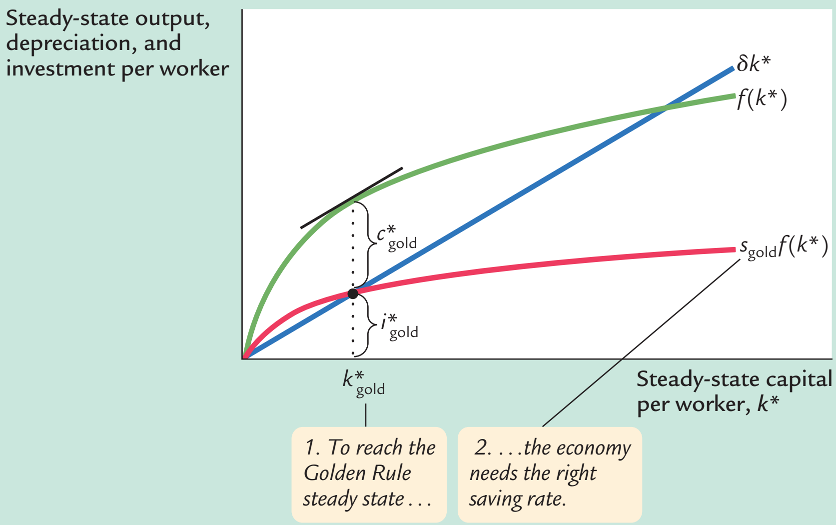
$$MPK - \delta = 0.$$

At the Golden Rule level of capital, the marginal product of capital net of depreciation ($MPK - \delta$) equals zero. As we will see, a policymaker can use this condition to find the Golden Rule capital stock for an economy.[4]

Keep in mind that the economy does not automatically gravitate toward the Golden Rule steady state. If we want any particular steady-state capital stock, such as the Golden Rule, we need a particular saving rate to support it. Figure 7-8

[4] *Mathematical note*: Another way to derive the condition for the Golden Rule uses a bit of calculus. Recall that $c^* = f(k^*) - \delta k^*$. To find the k^* that maximizes c^*, differentiate to find $dc^*/dk^* = f'(k^*) - \delta$ and set this derivative equal to zero. Noting that $f'(k^*)$ is the marginal product of capital, we obtain the Golden Rule condition in the text.

figure 7-8



The Saving Rate and the Golden Rule There is only one saving rate that produces the Golden Rule level of capital k^*_{gold}. Any change in the saving rate would shift the $sf(k)$ curve and would move the economy to a steady state with a lower level of consumption.

shows the steady state if the saving rate is set to produce the Golden Rule level of capital. If the saving rate is higher than the one used in this figure, the steady-state capital stock will be too high. If the saving rate is lower, the steady-state capital stock will be too low. In either case, steady-state consumption will be lower than it is at the Golden Rule steady state.

Finding the Golden Rule Steady State: A Numerical Example

Consider the decision of a policymaker choosing a steady state in the following economy. The production function is the same as in our earlier example:

$$y = \sqrt{k}.$$

Output per worker is the square root of capital per worker. Depreciation δ is again 10 percent of capital. This time, the policymaker chooses the saving rate s and thus the economy's steady state.

To see the outcomes available to the policymaker, recall that the following equation holds in the steady state:

$$\frac{k^*}{f(k^*)} = \frac{s}{\delta}.$$

In this economy, this equation becomes

$$\frac{k^*}{\sqrt{k^*}} = \frac{s}{0.1}.$$

Squaring both sides of this equation yields a solution for the steady-state capital stock. We find

$$k^* = 100s^2.$$

Using this result, we can compute the steady-state capital stock for any saving rate.

Table 7-3 presents calculations showing the steady states that result from various saving rates in this economy. We see that higher saving leads to a higher capital stock, which in turn leads to higher output and higher depreciation. Steady-state consumption, the difference between output and depreciation, first rises with higher saving rates and then declines. Consumption is highest when the saving rate is 0.5. Hence, a saving rate of 0.5 produces the Golden Rule steady state.

table 7-3

Finding the Golden Rule Steady State: A Numerical Example

Assumptions: $y = \sqrt{k}$; $\delta = 0.1$

s	k^*	y^*	δk^*	c^*	MPK	$MPK - \delta$
0.0	0.0	0.0	0.0	0.0	∞	∞
0.1	1.0	1.0	0.1	0.9	0.500	0.400
0.2	4.0	2.0	0.4	1.6	0.250	0.150
0.3	9.0	3.0	0.9	2.1	0.167	0.067
0.4	16.0	4.0	1.6	2.4	0.125	0.025
0.5	**25.0**	**5.0**	**2.5**	**2.5**	**0.100**	**0.000**
0.6	36.0	6.0	3.6	2.4	0.083	–0.017
0.7	49.0	7.0	4.9	2.1	0.071	–0.029
0.8	64.0	8.0	6.4	1.6	0.062	–0.038
0.9	81.0	9.0	8.1	0.9	0.056	–0.044
1.0	100.0	10.0	10.0	0.0	0.050	–0.050

Recall that another way to identify the Golden Rule steady state is to find the capital stock at which the net marginal product of capital ($MPK - \delta$) equals zero. For this production function, the marginal product is[5]

$$MPK = \frac{1}{2\sqrt{k}}.$$

[5] *Mathematical note:* To derive this formula, note that the marginal product of capital is the derivative of the production function with respect to k.

Using this formula, the last two columns of Table 7-3 present the values of *MPK* and $MPK - \delta$ in the different steady states. Note that the net marginal product of capital is exactly zero when the saving rate is at its Golden Rule value of 0.5. Because of diminishing marginal product, the net marginal product of capital is greater than zero whenever the economy saves less than this amount, and it is less than zero whenever the economy saves more.

This numerical example confirms that the two ways of finding the Golden Rule steady state—looking at steady-state consumption or looking at the marginal product of capital—give the same answer. If we want to know whether an actual economy is currently at, above, or below its Golden Rule capital stock, the second method is usually more convenient, because estimates of the marginal product of capital are easy to come by. By contrast, evaluating an economy with the first method requires estimates of steady-state consumption at many different saving rates; such information is hard to obtain. Thus, when we apply this kind of analysis to the U.S. economy in the next chapter, we will find it useful to examine estimates of the marginal product of capital.

The Transition to the Golden Rule Steady State

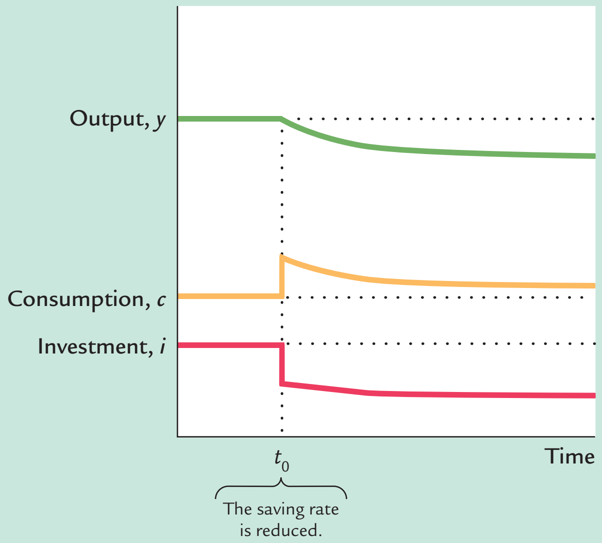
Let's now make our policymaker's problem more realistic. So far, we have been assuming that the policymaker can simply choose the economy's steady state and jump there immediately. In this case, the policymaker would choose the steady state with highest consumption—the Golden Rule steady state. But now suppose that the economy has reached a steady state other than the Golden Rule. What happens to consumption, investment, and capital when the economy makes the transition between steady states? Might the impact of the transition deter the policymaker from trying to achieve the Golden Rule?

We must consider two cases: the economy might begin with more capital than in the Golden Rule steady state, or with less. It turns out that the two cases offer very different problems for policymakers. (As we will see in the next chapter, the second case—too little capital—describes most actual economies, including that of the United States.)

Starting With Too Much Capital We first consider the case in which the economy begins at a steady state with more capital than it would have in the Golden Rule steady state. In this case, the policymaker should pursue policies aimed at reducing the rate of saving in order to reduce the capital stock. Suppose that these policies succeed and that at some point—call it time t_0—the saving rate falls to the level that will eventually lead to the Golden Rule steady state.

Figure 7-9 shows what happens to output, consumption, and investment when the saving rate falls. The reduction in the saving rate causes an immediate increase in consumption and a decrease in investment. Because investment and depreciation were equal in the initial steady state, investment will now be less than depreciation, which means the economy is no longer in a steady state. Gradually, the capital stock falls, leading to reductions in output, consumption, and investment. These variables continue to fall until the economy reaches the new steady state. Because we are assuming that the new steady state is the Golden

figure 7-9



Reducing Saving When Starting With More Capital Than in the Golden Rule Steady State This figure shows what happens over time to output, consumption, and investment when the economy begins with more capital than the Golden Rule level and the saving rate is reduced. The reduction in the saving rate (at time t_0) causes an immediate increase in consumption and an equal decrease in investment. Over time, as the capital stock falls, output, consumption, and investment fall together. Because the economy began with too much capital, the new steady state has a higher level of consumption than the initial steady state.

Rule steady state, consumption must be higher than it was before the change in the saving rate, even though output and investment are lower.

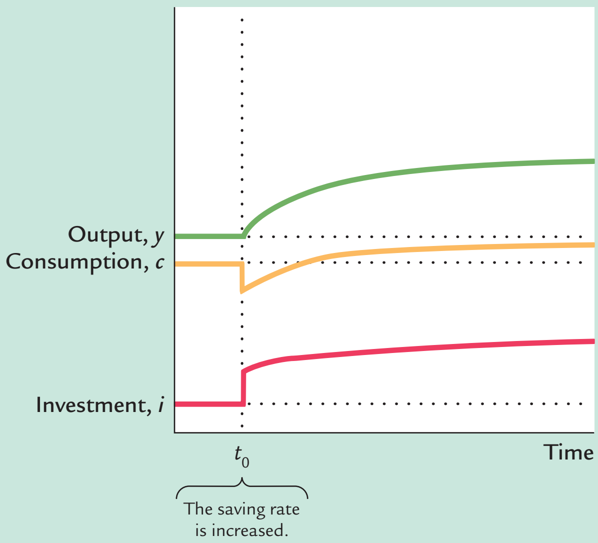
Note that, compared to the old steady state, consumption is higher not only in the new steady state but also along the entire path to it. When the capital stock exceeds the Golden Rule level, reducing saving is clearly a good policy, for it increases consumption at every point in time.

Starting With Too Little Capital When the economy begins with less capital than in the Golden Rule steady state, the policymaker must raise the saving rate to reach the Golden Rule. Figure 7-10 shows what happens. The increase in the saving rate at time t_0 causes an immediate fall in consumption and a rise in investment. Over time, higher investment causes the capital stock to rise. As capital accumulates, output, consumption, and investment gradually increase, eventually approaching the new steady-state levels. Because the initial steady state was below the Golden Rule, the increase in saving eventually leads to a higher level of consumption than that which prevailed initially.

Does the increase in saving that leads to the Golden Rule steady state raise economic welfare? Eventually it does, because the steady-state level of consumption is higher. But achieving that new steady state requires an initial period of reduced consumption. Note the contrast to the case in which the economy begins above the Golden Rule. *When the economy begins above the Golden Rule, reaching the Golden Rule produces higher consumption at all points in time. When the economy begins below the Golden Rule, reaching the Golden Rule requires initially reducing consumption to increase consumption in the future.*

When deciding whether to try to reach the Golden Rule steady state, policymakers have to take into account that current consumers and future consumers are not always the same people. Reaching the Golden Rule achieves the highest

figure 7-10



Increasing Saving When Starting With Less Capital Than in the Golden Rule Steady State This figure shows what happens over time to output, consumption, and investment when the economy begins with less capital than the Golden Rule, and the saving rate is increased. The increase in the saving rate (at time t_0) causes an immediate drop in consumption and an equal jump in investment. Over time, as the capital stock grows, output, consumption, and investment increase together. Because the economy began with less capital than the Golden Rule, the new steady state has a higher level of consumption than the initial steady state.

steady-state level of consumption and thus benefits future generations. But when the economy is initially below the Golden Rule, reaching the Golden Rule requires raising investment and thus lowering the consumption of current generations. Thus, when choosing whether to increase capital accumulation, the policymaker faces a tradeoff among the welfare of different generations. A policymaker who cares more about current generations than about future generations may decide not to pursue policies to reach the Golden Rule steady state. By contrast, a policymaker who cares about all generations equally will choose to reach the Golden Rule. Even though current generations will consume less, an infinite number of future generations will benefit by moving to the Golden Rule.

Thus, optimal capital accumulation depends crucially on how we weigh the interests of current and future generations. The biblical Golden Rule tells us, "do unto others as you would have them do unto you." If we heed this advice, we give all generations equal weight. In this case, it is optimal to reach the Golden Rule level of capital—which is why it is called the "Golden Rule."

7-3 Population Growth

The basic Solow model shows that capital accumulation, by itself, cannot explain sustained economic growth: high rates of saving lead to high growth temporarily, but the economy eventually approaches a steady state in which capital and output are constant. To explain the sustained economic growth that we observe in most parts of the world, we must expand the Solow model to incorporate the other two sources of economic growth—population growth and technological progress. In this section we add population growth to the model.

Instead of assuming that the population is fixed, as we did in Sections 7-1 and 7-2, we now suppose that the population and the labor force grow at a constant rate n. For example, the U.S. population grows about 1 percent per year, so $n = 0.01$. This means that if 150 million people are working one year, then 151.5 million (1.01×150) are working the next year, and 153.015 million (1.01×151.5) the year after that, and so on.

The Steady State With Population Growth

How does population growth affect the steady state? To answer this question, we must discuss how population growth, along with investment and depreciation, influences the accumulation of capital per worker. As we noted before, investment raises the capital stock, and depreciation reduces it. But now there is a third force acting to change the amount of capital per worker: the growth in the number of workers causes capital per worker to fall.

We continue to let lowercase letters stand for quantities per worker. Thus, $k = K/L$ is capital per worker, and $y = Y/L$ is output per worker. Keep in mind, however, that the number of workers is growing over time.

The change in the capital stock per worker is

$$\Delta k = i - (\delta + n)k.$$

This equation shows how investment, depreciation, and population growth influence the per-worker capital stock. Investment increases k, whereas depreciation and population growth decrease k. We saw this equation earlier in this chapter for the special case of a constant population ($n = 0$).

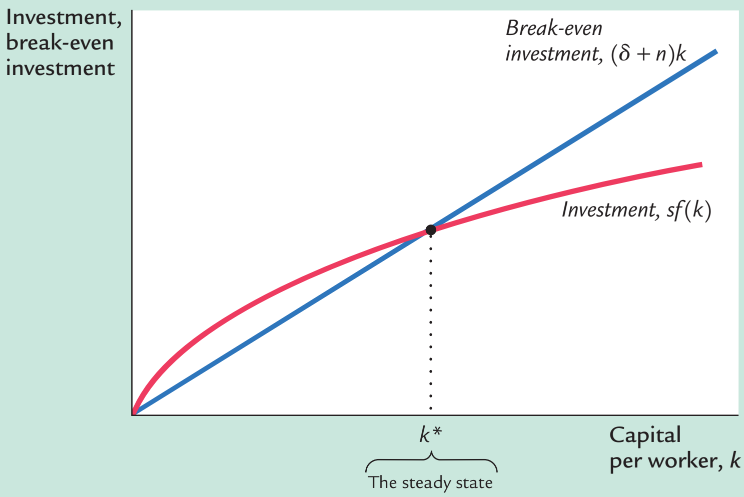
We can think of the term $(\delta + n)k$ as defining *break-even investment*—the amount of investment necessary to keep the capital stock per worker constant. Break-even investment includes the depreciation of existing capital, which equals δk. It also includes the amount of investment necessary to provide new workers with capital. The amount of investment necessary for this purpose is nk, because there are n new workers for each existing worker, and because k is the amount of capital for each worker. The equation shows that population growth reduces the accumulation of capital per worker much the way depreciation does. Depreciation reduces k by wearing out the capital stock, whereas population growth reduces k by spreading the capital stock more thinly among a larger population of workers.[6]

Our analysis with population growth now proceeds much as it did previously. First, we substitute $sf(k)$ for i. The equation can then be written as

$$\Delta k = sf(k) - (\delta + n)k.$$

[6] *Mathematical note*: Formally deriving the equation for the change in k requires a bit of calculus. Note that the change in k per unit of time is $dk/dt = d(K/L)/dt$. After applying the chain rule, we can write this as $dk/dt = (1/L)(dK/dt) - (K/L^2)(dL/dt)$. Now use the following facts to substitute in this equation: $dK/dt = I - \delta K$ and $(dL/dt)/L = n$. After a bit of manipulation, this produces the equation in the text.

figure 7-11



Population Growth in the Solow Model Like depreciation, population growth is one reason why the capital stock per worker shrinks. If n is the rate of population growth and δ is the rate of depreciation, then $(\delta + n)k$ is *break-even investment*—the amount of investment necessary to keep constant the capital stock per worker k. For the economy to be in a steady state, investment $sf(k)$ must offset the effects of depreciation and population growth $(\delta + n)k$. This is represented by the crossing of the two curves.

To see what determines the steady-state level of capital per worker, we use Figure 7-11, which extends the analysis of Figure 7-4 to include the effects of population growth. An economy is in a steady state if capital per worker k is unchanging. As before, we designate the steady-state value of k as k^*. If k is less than k^*, investment is greater than break-even investment, so k rises. If k is greater than k^*, investment is less than break-even investment, so k falls.

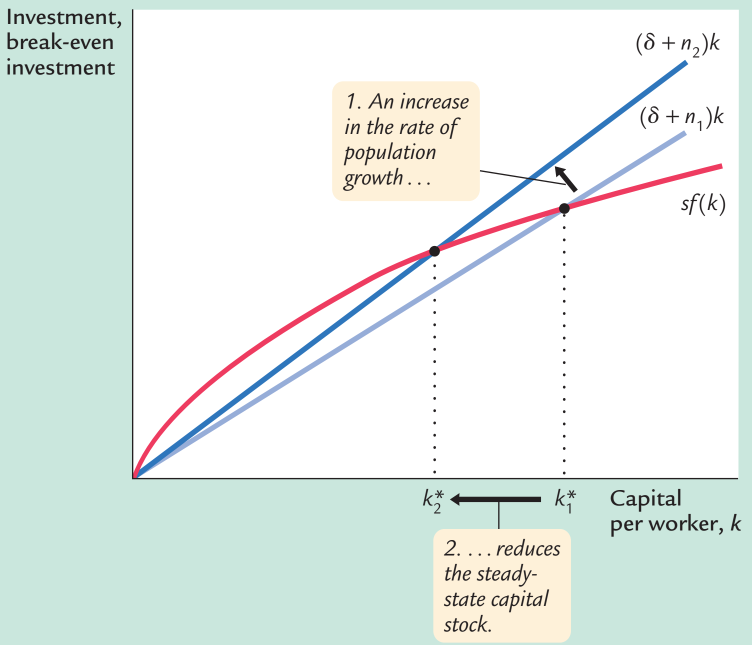
In the steady state, the positive effect of investment on the capital stock per worker exactly balances the negative effects of depreciation and population growth. That is, at k^*, $\Delta k = 0$ and $i^* = \delta k^* + nk^*$. Once the economy is in the steady state, investment has two purposes. Some of it (δk^*) replaces the depreciated capital, and the rest (nk^*) provides the new workers with the steady-state amount of capital.

The Effects of Population Growth

Population growth alters the basic Solow model in three ways. First, it brings us closer to explaining sustained economic growth. In the steady state with population growth, capital per worker and output per worker are constant. Because the number of workers is growing at rate n, however, *total* capital and *total* output must also be growing at rate n. Hence, although population growth cannot explain sustained growth in the standard of living (because output per worker is constant in the steady state), it can help explain sustained growth in total output.

Second, population growth gives us another explanation for why some countries are rich and others are poor. Consider the effects of an increase in population growth. Figure 7-12 shows that an increase in the rate of population growth from n_1 to n_2 reduces the steady-state level of capital per worker from k_1^* to k_2^*.

figure 7-12



The Impact of Population Growth An increase in the rate of population growth from n_1 to n_2 shifts the line representing population growth and depreciation upward. The new steady state k_2^* has a lower level of capital per worker than the initial steady state k_1^*. Thus, the Solow model predicts that economies with higher rates of population growth will have lower levels of capital per worker and therefore lower incomes.

Because k^* is lower, and because $y^* = f(k^*)$, the level of output per worker y^* is also lower. Thus, the Solow model predicts that countries with higher population growth will have lower levels of GDP per person.

Finally, population growth affects our criterion for determining the Golden Rule (consumption-maximizing) level of capital. To see how this criterion changes, note that consumption per worker is

$$c = y - i.$$

Because steady-state output is $f(k^*)$ and steady-state investment is $(\delta + n)k^*$, we can express steady-state consumption as

$$c^* = f(k^*) - (\delta + n)k^*.$$

Using an argument largely the same as before, we conclude that the level of k^* that maximizes consumption is the one at which

$$MPK = \delta + n,$$

or equivalently,

$$MPK - \delta = n.$$

In the Golden Rule steady state, the marginal product of capital net of depreciation equals the rate of population growth.

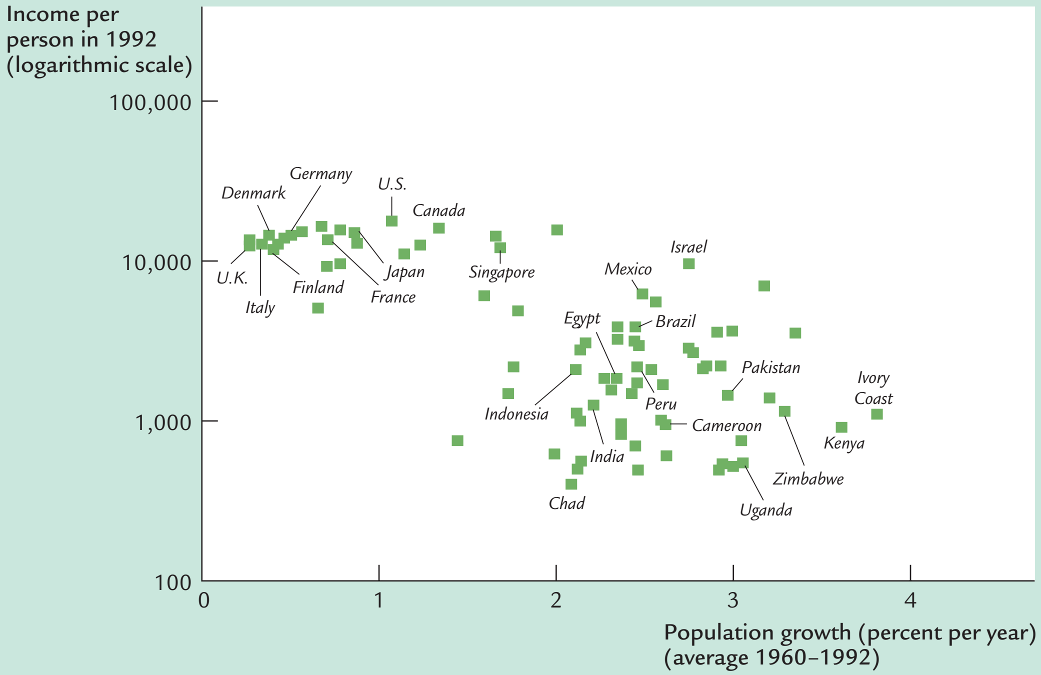
CASE STUDY

Population Growth Around the World

Let's return now to the question of why standards of living vary so much around the world. The analysis we have just completed suggests that population growth may be one of the answers. According to the Solow model, a nation with a high rate of population growth will have a low steady-state capital stock per worker and thus also a low level of income per worker. In other words, high population growth tends to impoverish a country because it is hard to maintain a high level of capital per worker when the number of workers is growing quickly. To see whether the evidence supports this conclusion, we again look at cross-country data.

Figure 7-13 is a scatterplot of data for the same 84 countries examined in the previous case study (and in Figure 7-6). The figure shows that countries with high rates of population growth tend to have low levels of income per person. The international evidence is consistent with our model's prediction that the rate of population growth is one determinant of a country's standard of living.

figure 7-13



International Evidence on Population Growth and Income per Person This figure is a scatterplot of data from 84 countries. It shows that countries with high rates of population growth tend to have low levels of income per person, as the Solow model predicts.

Source: Robert Summers and Alan Heston, Supplement (Mark 5.6) to "The Penn World Table (Mark 5): An Expanded Set of International Comparisons 1950–1988," *Quarterly Journal of Economics* (May 1991): 327–368.

This conclusion is not lost on policymakers. Those trying to pull the world's poorest nations out of poverty, such as the advisers sent to developing nations by the World Bank, often advocate reducing fertility by increasing education about birth-control methods and expanding women's job opportunities. Toward the same end, China has followed the totalitarian policy of allowing only one child per couple. These policies to reduce population growth should, if the Solow model is right, raise income per person in the long run.

In interpreting the cross-country data, however, it is important to keep in mind that correlation does not imply causation. The data show that low population growth is typically associated with high levels of income per person, and the Solow model offers one possible explanation for this fact, but other explanations are also possible. It is conceivable that high income encourages low population growth, perhaps because birth-control techniques are more readily available in richer countries. The international data can help us evaluate a theory of growth, such as the Solow model, because they show us whether the theory's predictions are borne out in the world. But often more than one theory can explain the same facts.

7-4 Conclusion

This chapter has started the process of building the Solow growth model. The model as developed so far shows how saving and population growth determine the economy's steady-state capital stock and its steady-state level of income per person. As we have seen, it sheds light on many features of actual growth experiences—why Germany and Japan grew so rapidly after being devastated by World War II, why countries that save and invest a high fraction of their output are richer than countries that save and invest a smaller fraction, and why countries with high rates of population growth are poorer than countries with low rates of population growth.

What the model cannot do, however, is explain the persistent growth in living standards we observe in most countries. In the model we now have, when the economy reaches its steady state, output per worker stops growing. To explain persistent growth, we need to introduce technological progress into the model. That is our first job in the next chapter.

Summary

1. The Solow growth model shows that in the long run, an economy's rate of saving determines the size of its capital stock and thus its level of production. The higher the rate of saving, the higher the stock of capital and the higher the level of output.
2. In the Solow model, an increase in the rate of saving causes a period of rapid growth, but eventually that growth slows as the new steady state is reached.

Thus, although a high saving rate yields a high steady-state level of output, saving by itself cannot generate persistent economic growth.

3. The level of capital that maximizes steady-state consumption is called the Golden Rule level. If an economy has more capital than in the Golden Rule steady state, then reducing saving will increase consumption at all points in time. By contrast, if the economy has less capital in the Golden Rule steady state, then reaching the Golden Rule requires increased investment and thus lower consumption for current generations.
4. The Solow model shows that an economy's rate of population growth is another long-run determinant of the standard of living. The higher the rate of population growth, the lower the level of output per worker.

KEY CONCEPTS

Solow growth model

Steady state

Golden Rule level of capital

QUESTIONS FOR REVIEW

1. In the Solow model, how does the saving rate affect the steady-state level of income? How does it affect the steady-state rate of growth?
2. Why might an economic policymaker choose the Golden Rule level of capital?
3. Might a policymaker choose a steady state with more capital than in the Golden Rule steady state? With less capital than in the Golden Rule steady state? Explain your answers.
4. In the Solow model, how does the rate of population growth affect the steady-state level of income? How does it affect the steady-state rate of growth?

PROBLEMS AND APPLICATIONS

1. Country A and country B both have the production function

$$Y = F(K, L) = K^{1/2}L^{1/2}.$$

   a. Does this production function have constant returns to scale? Explain.
   b. What is the per-worker production function, $y = f(k)$?
   c. Assume that neither country experiences population growth or technological progress and that 5 percent of capital depreciates each year. Assume further that country A saves 10 percent of output each year and country B saves 20 percent of output each year. Using your answer from part (b) and the steady-state condition that investment equals depreciation, find the steady-state level of capital per worker for each country. Then find the steady-state levels of income per worker and consumption per worker.
   d. Suppose that both countries start off with a capital stock per worker of 2. What are the levels of income per worker and consumption per worker? Remembering that the change in the capital stock is investment less depreciation, use a calculator to show how the capital stock per worker will evolve over time in both countries. For each year, calculate income per worker and consumption per worker. How many years will it be before the consumption in country B is higher than the consumption in country A?
2. In the discussion of German and Japanese postwar growth, the text describes what happens

when part of the capital stock is destroyed in a war. By contrast, suppose that a war does not directly affect the capital stock, but that casualties reduce the labor force.

a. What is the immediate impact on total output and on output per person?

b. Assuming that the saving rate is unchanged and that the economy was in a steady state before the war, what happens subsequently to output per worker in the postwar economy? Is the growth rate of output per worker after the war smaller or greater than normal?

3. Consider an economy described by the production function $Y = F(K, L) = K^{0.3}L^{0.7}$.

a. What is the per-worker production function?

b. Assuming no population growth or technological progress, find the steady-state capital stock per worker, output per worker, and consumption per worker as functions of the saving rate and the depreciation rate.

c. Assume that the depreciation rate is 10 percent per year. Make a table showing steady-state capital per worker, output per worker, and consumption per worker for saving rates of 0 percent, 10 percent, 20 percent, 30 percent, and so on. (You will need a calculator with an exponent key for this.) What saving rate maximizes output per worker? What saving rate maximizes consumption per worker?

d. (Harder) Use calculus to find the marginal product of capital. Add to your table the marginal product of capital net of depreciation for each of the saving rates. What does your table show?

4. The 1983 *Economic Report of the President* contained the following statement: "Devoting a larger share of national output to investment would help restore rapid productivity growth and rising living standards." Do you agree with this claim? Explain.

5. One view of the consumption function is that workers have high propensities to consume and capitalists have low propensities to consume. To explore the implications of this view, suppose that an economy consumes all wage income and saves all capital income. Show that if the factors of production earn their marginal product, this economy reaches the Golden Rule level of capital. (*Hint:* Begin with the identity that saving equals investment. Then use the steady-state condition that investment is just enough to keep up with depreciation and population growth, and the fact that saving equals capital income in this economy.)

6. Many demographers predict that the United States will have zero population growth in the twenty-first century, in contrast to average population growth of about 1 percent per year in the twentieth century. Use the Solow model to forecast the effect of this slowdown in population growth on the growth of total output and the growth of output per person. Consider the effects both in the steady state and in the transition between steady states.

7. In the Solow model, population growth leads to steady-state growth in total output, but not in output per worker. Do you think this would still be true if the production function exhibited increasing or decreasing returns to scale? Explain. (For the definitions of increasing and decreasing returns to scale, see Chapter 3, "Problems and Applications," Problem 2.)

8. Consider how unemployment would affect the Solow growth model. Suppose that output is produced according to the production function $Y = K^{\alpha}[(1 - u)L]^{1-\alpha}$, where K is capital, L is the labor force, and u is the natural rate of unemployment. The national saving rate is s, the labor force grows at rate n, and capital depreciates at rate δ.

a. Express output per worker ($y = Y/L$) as a function of capital per worker ($k = K/L$) and the natural rate of unemployment. Describe the steady state of this economy.

b. Suppose that some change in government policy reduces the natural rate of unemployment. Describe how this change affects output both immediately and over time. Is the steady-state effect on output larger or smaller than the immediate effect? Explain.

9. Choose two countries that interest you—one rich and one poor. What is the income per person in each country? Find some data on country characteristics that might help explain the difference in income: investment rates, population growth rates, educational attainment, and so on. (*Hint:* The Web site of the World Bank, www.worldbank.org, is one place to find such data.) How might you figure out which of these factors is most responsible for the observed income difference?

CHAPTER 8 EIGHT

Economic Growth II

Is there some action a government of India could take that would lead the Indian economy to grow like Indonesia's or Egypt's? If so, what, exactly? If not, what is it about the "nature of India" that makes it so? The consequences for human welfare involved in questions like these are simply staggering: Once one starts to think about them, it is hard to think about anything else.

— *Robert E. Lucas, Jr.*

This chapter continues our analysis of the forces governing long-run economic growth. With the basic version of the Solow growth model as our starting point, we take on four new tasks.

Our first task is to make the Solow model more general and more realistic. In Chapter 3 we saw that capital, labor, and technology are the key determinants of a nation's production of goods and services. In Chapter 7 we developed the Solow model to show how changes in capital (saving and investment) and changes in the labor force (population growth) affect the economy's output. We are now ready to add the third source of growth—changes in technology—into the mix.

Our second task is to examine how a nation's public policies can influence the level and growth of its standard of living. In particular, we address four questions: Should our society save more or save less? How can policy influence the rate of saving? Are there some types of investment that policy should especially encourage? How can policy increase the rate of technological progress? The Solow growth model provides the theoretical framework within which we consider each of these policy issues.

Our third task is to move from theory to empirics. That is, we consider how well the Solow model fits the facts. During the 1990s, a large literature examined the predictions of the Solow model and other models of economic growth. It turns out that the glass is both half full and half empty. The Solow model can shed much light on international growth experiences, but it is far from the last word on the subject.

Our fourth and final task is to consider what the Solow model leaves out. As we have discussed previously, models help us understand the world by simplifying it. After completing an analysis of a model, therefore, it is important to consider whether we have oversimplified matters. In the last section, we examine a new set of theories, called *endogenous growth theories*, that hope to explain the technological progress that the Solow model takes as exogenous.

8-1 Technological Progress in the Solow Model

So far, our presentation of the Solow model has assumed an unchanging relationship between the inputs of capital and labor and the output of goods and services. Yet the model can be modified to include exogenous technological progress, which over time expands society's ability to produce.

The Efficiency of Labor

To incorporate technological progress, we must return to the production function that relates total capital K and total labor L to total output Y. Thus far, the production function has been

$$Y = F(K, L).$$

We now write the production function as

$$Y = F(K, L \times E),$$

where E is a new (and somewhat abstract) variable called the **efficiency of labor**. The efficiency of labor is meant to reflect society's knowledge about production methods: as the available technology improves, the efficiency of labor rises. For instance, the efficiency of labor rose when assembly-line production transformed manufacturing in the early twentieth century, and it rose again when computerization was introduced in the the late twentieth century. The efficiency of labor also rises when there are improvements in the health, education, or skills of the labor force.

The term $L \times E$ measures the number of *effective workers*. It takes into account the number of workers L and the efficiency of each worker E. This new production function states that total output Y depends on the number of units of capital K and on the number of effective workers $L \times E$. Increases in the efficiency of labor E are, in effect, like increases in the labor force L.

The simplest assumption about technological progress is that it causes the efficiency of labor E to grow at some constant rate g. For example, if $g = 0.02$, then each unit of labor becomes 2 percent more efficient each year: output increases as if the labor force had increased by an additional 2 percent. This form of technological progress is called *labor augmenting*, and g is called the rate of **labor-augmenting technological progress**. Because the labor force L is growing at rate n, and the efficiency of each unit of labor E is growing at rate g, the number of effective workers $L \times E$ is growing at rate $n + g$.

The Steady State With Technological Progress

Expressing technological progress as labor augmenting makes it analogous to population growth. In Chapter 7 we analyzed the economy in terms of quantities per worker and allowed the number of workers to rise over time. Now we analyze the economy in terms of quantities per effective worker and allow the number of effective workers to rise.

To do this, we need to reconsider our notation. We now let $k = K/(L \times E)$ stand for capital per effective worker and $y = Y/(L \times E)$ stand for output per effective worker. With these definitions, we can again write $y = f(k)$.

This notation is not really as new as it seems. If we hold the efficiency of labor E constant at the arbitrary value of 1, as we have done implicitly up to now, then these new definitions of k and y reduce to our old ones. When the efficiency of labor is growing, however, we must keep in mind that k and y now refer to quantities per effective worker (not per actual worker).

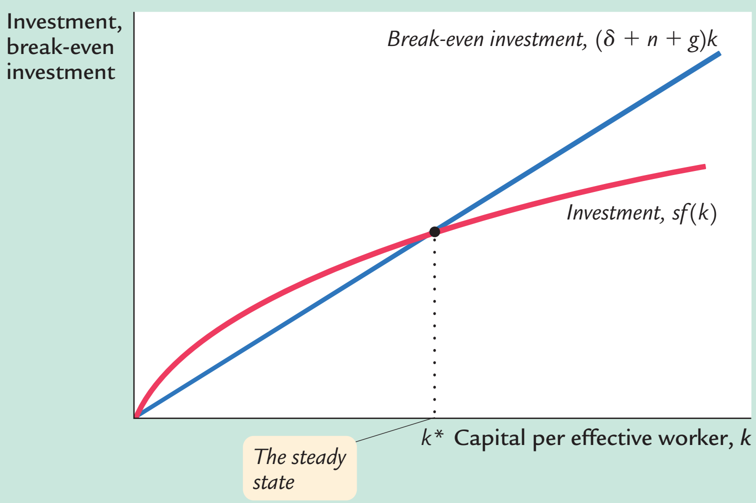
Our analysis of the economy proceeds just as it did when we examined population growth. The equation showing the evolution of k over time now changes to

$$\Delta k = sf(k) - (\delta + n + g)k.$$

As before, the change in the capital stock Δk equals investment $sf(k)$ minus break-even investment $(\delta + n + g)k$. Now, however, because $k = K/EL$, break-even investment includes three terms: to keep k constant, δk is needed to replace depreciating capital, nk is needed to provide capital for new workers, and gk is needed to provide capital for the new "effective workers" created by technological progress.

As shown in Figure 8-1, the inclusion of technological progress does not substantially alter our analysis of the steady state. There is one level of k, denoted

figure 8-1



Technological Progress and the Solow Growth Model Labor-augmenting technological progress at rate g affects the Solow growth model in much the same way as did population growth at rate n. Now that k is defined as the amount of capital per effective worker, increases in the number of effective workers because of technological progress tend to decrease k. In the steady state, investment $sf(k)$ exactly offsets the reductions in k attributable to depreciation, population growth, and technological progress.

k^*, at which capital per effective worker and output per effective worker are constant. As before, this steady state represents the long-run equilibrium of the economy.

The Effects of Technological Progress

Table 8-1 shows how four key variables behave in the steady state with technological progress. As we have just seen, capital per effective worker k is constant in the steady state. Because $y = f(k)$, output per effective worker is also constant. Remember, though, that the efficiency of each actual worker is growing at rate g. Hence, output per worker ($Y/L = y \times E$) also grows at rate g. Total output [$Y = y \times (E \times L)$] grows at rate $n + g$.

With the addition of technological progress, our model can finally explain the sustained increases in standards of living that we observe. That is, we have shown that technological progress can lead to sustained growth in output per worker. By contrast, a high rate of saving leads to a high rate of growth only until the steady state is reached. Once the economy is in steady state, the rate of growth of output per worker depends only on the rate of technological progress. *According to the Solow model, only technological progress can explain persistently rising living standards.*

The introduction of technological progress also modifies the criterion for the Golden Rule. The Golden Rule level of capital is now defined as the steady state that maximizes consumption per effective worker. Following the same arguments that we have used before, we can show that steady-state consumption per effective worker is

$$c^* = f(k^*) - (\delta + n + g)k^*.$$

Steady-state consumption is maximized if

$$MPK = \delta + n + g,$$

or

$$MPK - \delta = n + g.$$

That is, at the Golden Rule level of capital, the net marginal product of capital, $MPK - \delta$, equals the rate of growth of total output, $n + g$. Because actual

table 8-1

Steady-State Growth Rates in the Solow Model With Technological Progress

Variable	Symbol	Steady-State Growth Rate
Capital per effective worker	$k = K/(E \times L)$	0
Output per effective worker	$y = Y/(E \times L) = f(k)$	0
Output per worker	$Y/L = y \times E$	g
Total output	$Y = y \times (E \times L)$	$n + g$

economies experience both population growth and technological progress, we must use this criterion to evaluate whether they have more or less capital than at the Golden Rule steady state.

8-2 Policies to Promote Growth

Having used the Solow model to uncover the relationships among the different sources of economic growth, we can now use the theory to help guide our thinking about economic policy.

Evaluating the Rate of Saving

According to the Solow growth model, how much a nation saves and invests is a key determinant of its citizens' standard of living. So let's begin our policy discussion with a natural question: Is the rate of saving in the U.S. economy too low, too high, or about right?

As we have seen, the saving rate determines the steady-state levels of capital and output. One particular saving rate produces the Golden Rule steady state, which maximizes consumption per worker and thus economic well-being. The Golden Rule provides the benchmark against which we can compare the U.S. economy.

To decide whether the U.S. economy is at, above, or below the Golden Rule steady state, we need to compare the marginal product of capital net of depreciation ($MPK - \delta$) with the growth rate of total output ($n + g$). As we just established, at the Golden Rule steady state, $MPK - \delta = n + g$. If the economy is operating with less capital than in the Golden Rule steady state, then diminishing marginal product tells us that $MPK - \delta > n + g$. In this case, increasing the rate of saving will eventually lead to a steady state with higher consumption. However, if the economy is operating with too much capital, then $MPK - \delta < n + g$, and the rate of saving should be reduced.

To make this comparison for a real economy, such as the U.S. economy, we need an estimate of the growth rate ($n + g$) and an estimate of the net marginal product of capital ($MPK - \delta$). Real GDP in the United States grows an average of 3 percent per year, so $n + g = 0.03$. We can estimate the net marginal product of capital from the following three facts:

1. The capital stock is about 2.5 times one year's GDP.
2. Depreciation of capital is about 10 percent of GDP.
3. Capital income is about 30 percent of GDP.

Using the notation of our model (and the result from Chapter 3 that capital owners earn income of MPK for each unit of capital), we can write these facts as

1. $k = 2.5y$.
2. $\delta k = 0.1y$.
3. $MPK \times k = 0.3y$

We solve for the rate of depreciation δ by dividing equation 2 by equation 1:

$$\delta k/k = (0.1y)/(2.5y)$$
$$\delta = 0.04.$$

And we solve for the marginal product of capital MPK by dividing equation 3 by equation 1:

$$(MPK \times k)/k = (0.3y)/(2.5y)$$
$$MPK = 0.12$$

Thus, about 4 percent of the capital stock depreciates each year, and the marginal product of capital is about 12 percent per year. The net marginal product of capital, $MPK - \delta$, is about 8 percent per year.

We can now see that the return to capital ($MPK - \delta$ = 8 percent per year) is well in excess of the economy's average growth rate ($n + g$ = 3 percent per year). This fact, together with our previous analysis, indicates that the capital stock in the U.S. economy is well below the Golden Rule level. In other words, if the United States saved and invested a higher fraction of its income, it would grow more rapidly and eventually reach a steady state with higher consumption. This finding suggests that policymakers should want to increase the rate of saving and investment. In fact, for many years, increasing capital formation has been a high priority of economic policy.

Changing the Rate of Saving

The preceding calculations show that to move the U.S. economy toward the Golden Rule steady state, policymakers should increase national saving. But how can they do that? We saw in Chapter 3 that, as a matter of sheer accounting, higher national saving means higher public saving, higher private saving, or some combination of the two. Much of the debate over policies to increase growth centers on which of these options is likely to be most effective.

The most direct way in which the government affects national saving is through public saving—the difference between what the government receives in tax revenue and what it spends. When the government's spending exceeds its revenue, the government is said to run a *budget deficit*, which represents negative public saving. As we saw in Chapter 3, a budget deficit raises interest rates and crowds out investment; the resulting reduction in the capital stock is part of the burden of the national debt on future generations. Conversely, if the government spends less than it raises in revenue, it is said to run a *budget surplus*. It can then retire some of the national debt and stimulate investment.

The government also affects national saving by influencing private saving—the saving done by households and firms. In particular, how much people decide to save depends on the incentives they face, and these incentives are altered by a variety of public policies. Many economists argue that high tax rates on capital—including the corporate income tax, the federal income tax, the estate tax, and many state income and estate taxes—discourage private saving by reducing the rate of return that savers earn. However, tax-exempt retirement accounts, such as IRAs, are designed to encourage private saving by giving preferential treatment to income saved in these accounts.

Many disagreements among economists over public policy are rooted in different views about how much private saving responds to incentives. For example, suppose that the government were to expand the amount that people could put into tax-exempt retirement accounts. Would people respond to the increased incentive to save by saving more? Or would people merely transfer saving done in other forms into these accounts—reducing tax revenue and thus public saving without any stimulus to private saving? Clearly, the desirability of the policy depends on the answers to these questions. Unfortunately, despite much research on this issue, no consensus has emerged.

CASE STUDY

Should the Social Security System Be Reformed?

Although many government policies are designed to encourage saving, such as the preferential tax treatment given to pension plans and other retirement accounts, one important policy is often thought to reduce saving: the Social Security system. Social Security is a transfer system designed to maintain individuals' income in their old age. These transfers to the elderly are financed with a payroll tax on the working-age population. This system is thought to reduce private saving because it reduces individuals' need to provide for their own retirement.

To counteract the reduction in national saving attributed to Social Security, many economists have proposed reforms of the Social Security system. The system is now largely *pay-as-you-go*: most of the current tax receipts are paid out to the current elderly population. One suggestion is that Social Security should be *fully funded*. Under this plan, the government would put aside in a trust fund the payments a generation makes when it is young and working; the government would then pay out the principal and accumulated interest to this same generation when it is older and retired. Under a fully funded Social Security system, an increase in public saving would offset the reduction in private saving.

A closely related proposal is *privatization*, which means turning this government program for the elderly into a system of mandatory private savings accounts, much like private pension plans. In principle, the issues of funding and privatization are distinct. A fully funded system could be either public (in which case the government holds the funds) or private (in which case private financial institutions hold the funds). In practice, however, the issues are often linked. Some economists have argued that a fully funded public system is problematic. They note that such a system would end up holding a large share of the nation's wealth, which would increase the role of the government in allocating capital. In addition, they fear that a large publicly controlled fund would tempt politicians to cut taxes or increase spending, which could deplete the fund and cause the system to revert to pay-as-you-go status. History gives some support to this fear: the initial architects of Social Security wanted the system to accumulate a much larger trust fund than ever materialized.

These issues rose to prominence in the late 1990s as policymakers became aware that the current Social Security system was not sustainable. That is, the amount of revenue being raised by the payroll tax appeared insufficient to pay all the benefits being promised. According to most projections, this problem was to become acute as the large baby-boom generation retired during the early decades of the twenty-first century. Various solutions were proposed. One possibility was to maintain the current system with some combination of smaller benefits and higher taxes. Other possibilities included movements toward a fully funded system, perhaps also including private accounts. This issue was prominent in the presidential campaign of 2000, with candidate George W. Bush advocating a reform including private accounts. As this book was going to press, it was still unclear whether this reform would come to pass.[1]

Allocating the Economy's Investment

The Solow model makes the simplifying assumption that there is only one type of capital. In the world, of course, there are many types. Private businesses invest in traditional types of capital, such as bulldozers and steel plants, and newer types of capital, such as computers and robots. The government invests in various forms of public capital, called *infrastructure*, such as roads, bridges, and sewer systems.

In addition, there is *human capital*—the knowledge and skills that workers acquire through education, from early childhood programs such as Head Start to on-the-job training for adults in the labor force. Although the basic Solow model includes only physical capital and does not try to explain the efficiency of labor, in many ways human capital is analogous to physical capital. Like physical capital, human capital raises our ability to produce goods and services. Raising the level of human capital requires investment in the form of teachers, libraries, and student time. Recent research on economic growth has emphasized that human capital is at least as important as physical capital in explaining international differences in standards of living.[2]

Policymakers trying to stimulate economic growth must confront the issue of what kinds of capital the economy needs most. In other words, what kinds of capital yield the highest marginal products? To a large extent, policymakers can rely on the marketplace to allocate the pool of saving to alternative types of investment. Those industries with the highest marginal products of capital will naturally be most willing to borrow at market interest rates to finance new investment. Many economists advocate that the government should merely create a "level playing field" for different types of capital—for example, by ensuring that the tax system treats all forms of capital equally. The government can then rely on the market to allocate capital efficiently.

[1] To learn more about the debate over Social Security, see *Social Security Reform: Links to Saving, Investment, and Growth*, Steven A. Sass and Robert K. Triest, eds., Conference Series No. 41, Federal Reserve Bank of Boston, June 1997.

[2] N. Gregory Mankiw, David Romer, and David N. Weil, "A Contribution to the Empirics of Economic Growth," *Quarterly Journal of Economics* (May 1992): 407–437.

Other economists have suggested that the government should actively encourage particular forms of capital. Suppose, for instance, that technological advance occurs as a by-product of certain economic activities. This would happen if new and improved production processes are devised during the process of building capital (a phenomenon called *learning by doing*) and if these ideas become part of society's pool of knowledge. Such a by-product is called a *technological externality* (or a *knowledge spillover*). In the presence of such externalities, the social returns to capital exceed the private returns, and the benefits of increased capital accumulation to society are greater than the Solow model suggests.[3] Moreover, some types of capital accumulation may yield greater externalities than others. If, for example, installing robots yields greater technological externalities than building a new steel mill, then perhaps the government should use the tax laws to encourage investment in robots. The success of such an *industrial policy*, as it is sometimes called, requires that the government be able to measure the externalities of different economic activities so it can give the correct incentive to each activity.

Most economists are skeptical about industrial policies, for two reasons. First, measuring the externalities from different sectors is so difficult as to be virtually impossible. If policy is based on poor measurements, its effects might be close to random and, thus, worse than no policy at all. Second, the political process is far from perfect. Once the government gets in the business of rewarding specific industries with subsidies and tax breaks, the rewards are as likely to be based on political clout as on the magnitude of externalties.

One type of capital that necessarily involves the government is public capital. Local, state, and federal governments are always deciding whether to borrow to finance new roads, bridges, and transit systems. During his first presidential campaign, Bill Clinton argued that the United States had been investing too little in infrastructure. He claimed that a higher level of infrastructure investment would make the economy substantially more productive. Among economists, this claim had both defenders and critics. Yet all of them agree that measuring the marginal product of public capital is difficult. Private capital generates an easily measured rate of profit for the firm owning the capital, whereas the benefits of public capital are more diffuse.

Encouraging Technological Progress

The Solow model shows that sustained growth in income per worker must come from technological progress. The Solow model, however, takes technological progress as exogenous; it does not explain it. Unfortunately, the determinants of technological progress are not well understood.

Despite this limited understanding, many public policies are designed to stimulate technological progress. Most of these policies encourage the private sector to devote resources to technological innovation. For example, the patent system

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[3] Paul Romer, "Crazy Explanations for the Productivity Slowdown," *NBER Macroeconomics Annual* 2 (1987): 163–201.

gives a temporary monopoly to inventors of new products; the tax code offers tax breaks for firms engaging in research and development; and government agencies such as the National Science Foundation directly subsidize basic research in universities. In addition, as discussed above, proponents of industrial policy argue that the government should take a more active role in promoting specific industries that are key for rapid technological progress.

CASE STUDY

The Worldwide Slowdown in Economic Growth

Beginning in the early 1970s, world policymakers faced a perplexing problem—a global slowdown in economic growth. Table 8-2 presents data on the growth in real GDP per person for the seven major world economies. Growth in the United States fell from 2.2 percent to 1.5 percent, and other countries experienced similar or more severe declines. Accumulated over many years, even a small change in the rate of growth has a large effect on economic well-being. Real income in the United States today is about 20 percent lower than it would have been had growth remained at its previous level.

Why did this slowdown occur? Studies have shown that it was attributable to a fall in the rate at which the production function was improving over time. The appendix to this chapter explains how economists measure changes in the production function with a variable called *total factor productivity*, which is closely related to the efficiency of labor in the Solow model. There are, however, many hypotheses to explain this fall in productivity growth. Here are four of them.

Measurement Problems One possibility is that the productivity slowdown did not really occur and that it shows up in the data because the data are flawed. As you may recall from Chapter 2, one problem in measuring inflation is correcting for changes in the quality of goods and services. The same issue arises when measuring output and productivity. For instance, if technological advance leads to *more* computers being built, then the increase in output and productivity is easy to measure. But if technological advance leads to *faster* computers being built, then output and productivity have increased, but that increase is more subtle and harder to measure. Government statisticians try to correct for changes in quality, but despite their best efforts, the resulting data are far from perfect.

Unmeasured quality improvements mean that our standard of living is rising more rapidly than the official data indicate. This issue should make us suspicious of the data, but by itself it cannot explain the productivity slowdown. To explain a *slowdown* in growth, one must argue that the measurement problems got *worse*. There is some indication that this might be so. As history passes, fewer people work in industries with tangible and easily measured output, such as agriculture, and more work in industries with intangible and less easily measured output, such as medical services. Yet few economists believe that measurement problems were the full story.

Oil Prices When the productivity slowdown began around 1973, the obvious hypothesis to explain it was the large increase in oil prices caused by the actions of the OPEC oil cartel. The primary piece of evidence was the timing: productivity growth slowed at the same time that oil prices skyrocketed. Over time, however,

table 8-2

The Slowdown in Growth Around the World

	GROWTH IN OUTPUT PER PERSON (PERCENT PER YEAR)		
Country	**1948–1972**	**1972–1995**	**1995–2000**
Canada	2.9	1.8	2.7
France	4.3	1.6	2.2
West Germany	5.7	2.0	
Germany			1.7
Italy	4.9	2.3	4.7
Japan	8.2	2.6	1.1
United Kingdom	2.4	1.8	2.5
United States	2.2	1.5	2.9

Source: Angus Maddison, *Phases of Capitalist Development* (Oxford: Oxford University Press, 1982); and OECD National Accounts and International Financial Statistics.
Note: Data before 1995 for Germany refer to West Germany; after 1995, to the unified Germany.

this explanation has appeared less likely. One reason is that the accumulated shortfall in productivity seems too large to be explained by an increase in oil prices—oil is not that large a fraction of the typical firm's costs. In addition, if this explanation were right, productivity should have sped up when political turmoil in OPEC caused oil prices to plummet in 1986. Unfortunately, that did not happen.

Worker Quality Some economists suggest that the productivity slowdown might have been caused by changes in the labor force. In the early 1970s, the large baby-boom generation started leaving school and taking jobs. At the same time, changing social norms encouraged many women to leave full-time housework and enter the labor force. Both of these developments lowered the average level of experience among workers, which in turn lowered average productivity.

Other economists point to changes in worker quality as gauged by human capital. Although the educational attainment of the labor force continued to rise throughout this period, it was not increasing as rapidly as it did in the past. Moreover, declining performance on some standardized tests suggests that the quality of education was declining. If so, this could explain slowing productivity growth.

The Depletion of Ideas Still other economists suggest that the world started to run out of new ideas about how to produce in the early 1970s, pushing the economy into an age of slower technological progress. These economists often argue that the anomaly is not the period since 1970 but the preceding two decades. In the late 1940s, the economy had a large backlog of ideas that had not been fully implemented because of the Great Depression of the 1930s and World War II in the first half of 1940s. After the economy used up this backlog, the argument goes, a slowdown in productivity growth was likely. Indeed, although the growth rates in the 1970s, 1980s, and early 1990s were disappointing compared to those of the 1950s and 1960s, they were not lower than average growth rates from 1870 to 1950.

Which of these suspects is the culprit? All of them are plausible, but it is difficult to prove beyond a reasonable doubt that any one of them is guilty. The worldwide slowdown in economic growth that began in the mid-1970s remains a mystery.[4]

CASE STUDY

Information Technology and the New Economy

As any good doctor will tell you, sometimes a patient's illness goes away on its own, even if the doctor has failed to come up with a convincing diagnosis and remedy. This seems to be the outcome with the productivity slowdown discussed in the previous case study. Economists have not yet figured it out, but beginning in the middle of the 1990s, the problem disappeared. Economic growth took off, as shown in the third column of Table 8-2. In the United States, output per person accelerated from 1.5 to 2.9 percent per year. Commentators proclaimed we were living in a "new economy."

As with the slowdown in economic growth in the 1970s, the acceleration in the 1990s is hard to explain definitively. But part of the credit goes to advances in computer and information technology, including the Internet.

Observers of the computer industry often cite Moore's law, which states that the price of computing power falls by half every 18 months. This is not an inevitable law of nature but an empirical regularity describing the rapid technological progress this industry has enjoyed. In the 1980s and early 1990s, economists were surprised that the rapid progress in computing did not have a larger effect on the overall economy. Economist Robert Solow once quipped that "we can see the computer age everywhere but in the productivity statistics."

There are two reasons why the macroeconomic effects of the computer revolution might not have showed up until the mid-1990s. One is that the computer industry was previously only a small part of the economy. In 1990, computer hardware and software represented 0.9 percent of real GDP; by 1999, this share had risen to 4.2 percent. As computers made up a larger part of the economy, technological advance in that sector had a greater overall effect.

The second reason why the productivity benefits of computers may have been delayed is that it took time for firms to figure out how best to use the technology. Whenever firms change their production systems and train workers to use a technology, they disrupt the existing means of production. Measured productivity can fall for a while before the economy reaps the benefits. Indeed, some economists even suggest that the spread of computers can help explain the productivity slowdown that began in the 1970s.

Economic history provides some support for the idea that new technologies influence growth with a long lag. The electric light bulb was invented in 1879. But it took several decades before electricity had a big economic impact. For businesses to reap large productivity gains, they had to do more than simply re-

[4] For various views on the growth slowdown, see "Symposium: The Slowdown in Productivity Growth," *The Journal of Economic Perspectives* 2 (Fall 1988): 3–98.

place steam engines with electric motors; they had to rethink the entire organization of factories. Similarly, replacing the typewriters on desks with computers and word processing programs, as was common in the 1980s, may have had small productivity effects. Only later, when the Internet and other advanced applications were invented, did the computers yield large economic gains.

Eventually, advances in technology should show up in economic growth, as was the case in the second half of the 1990s. This extra growth occurs through three channels. First, because the computer industry is part of the economy, productivity growth in that industry directly affects overall productivity growth. Second, because computers are a type of capital good, falling computer prices allow firms to accumulate more computing capital for every dollar of investment spending; the resulting increase in capital accumulation raises growth in all sectors that use computers as a factor of production. Third, the innovations in the computer industry may induce other industries to reconsider their own production methods, which in turn leads to productivity growth in those industries.

The big, open question is whether the computer industry will remain an engine of growth. Will Moore's law describe the future as well as it has described the past? Will the technological advances of the next decade be as profound as the Internet was during the 1990s? Stay tuned.[5]

8-3 From Growth Theory to Growth Empirics

So far in this chapter we have introduced exogenous technological progress into the Solow model to explain sustained growth in standards of living. We then used the theoretical framework as a lens through which to view some key issues facing policymakers. Let's now discuss what happens when the theory is asked to confront the facts.

Balanced Growth

According to the Solow model, technological progress causes the values of many variables to rise together in the steady state. This property, called *balanced growth*, does a good job of describing the long-run data for the U.S. economy.

Consider first output per worker Y/L and the capital stock per worker K/L. According to the Solow model, in the steady state, both of these variables grow at the rate of technological progress. United States data for the half century show that output per worker and the capital stock per worker have in fact grown at approximately the same rate—about 2 percent per year. To put it another way, the capital–output ratio has remained approximately constant over time.

[5] For more on this topic, see the symposium on "Computers and Productivity" in the Fall 2000 issue of *The Journal of Economic Perspectives*. On the parallel between electricity and computers, see Paul A. David, "The Dynamo and the Computer: A Historical Perspective on the Modern Productivity Paradox," *American Economic Review* 80, no. 2 (May 1990): 355–361.

Technological progress also affects factor prices. Problem 3(d) at the end of the chapter asks you to show that, in the steady state, the real wage grows at the rate of technological progress. The real rental price of capital, however, is constant over time. Again, these predictions hold true for the United States. Over the past 50 years, the real wage has increased about 2 percent per year; it has increased about the same amount as real GDP per worker. Yet the real rental price of capital (measured as real capital income divided by the capital stock) has remained about the same.

The Solow model's prediction about factor prices—and the success of this prediction—is especially noteworthy when contrasted with Karl Marx's theory of the development of capitalist economies. Marx predicted that the return to capital would decline over time and that this would lead to economic and political crises. Economic history has not supported Marx's prediction, which partly explains why we now study Solow's theory of growth rather than Marx's.

Convergence

If you travel around the world, you will see tremendous variations in living standards. The world's poor countries have average levels of income per person that are less than one-tenth the average levels in the world's rich countries. These differences in income are reflected in almost every measure of the quality of life—from the number of televisions and telephones per household to the infant mortality rate and life expectancy.

Much research has been devoted to the question of whether economies converge over time to one another. In particular, do economies that start off poor subsequently grow faster than economies that start off rich? If they do, then the world's poor economies will tend to catch up with the world's rich economies. This property of catch-up is called *convergence*.

To understand the study of convergence, consider an analogy. Imagine that you were to collect data on college students. At the end of their first year, some students have A averages, whereas others have C averages. Would you expect the A and the C students to converge over the remaining three years of college? The answer depends on why their first-year grades differed. If the differences arose because some students came from better high schools than others, then you might expect those who were initially disadvantaged to start catching up to their better-prepared peers. But if the differences arose because some students study more than others, you might expect the differences in grades to persist.

The Solow model predicts that much the same is true with nations: whether economies converge depends on why they differed in the first place. On the one hand, if two economies with the same steady state happened by historical accident to start off with different capital stocks, then we should expect them to converge. The economy with the smaller capital stock will naturally grow more quickly. (In a case study in Chapter 7, we applied this logic to explain rapid growth in Germany and Japan after World War II.) On the other hand, if two economies have different steady states, perhaps because the economies have different rates of saving, then we should not expect convergence. Instead, each economy will approach its own steady state.

Experience is consistent with this analysis. In samples of economies with similar cultures and policies, studies find that economies converge to one another at a rate of about 2 percent per year. That is, the gap between rich and poor economies closes by about 2 percent each year. An example is the economies of individual American states. For historical reasons, such as the Civil War of the 1860s, income levels varied greatly among states a century ago. Yet these differences have slowly disappeared over time.

In international data, a more complex picture emerges. When researchers examine only data on income per person, they find little evidence of convergence: countries that start off poor do not grow faster on average than countries that start off rich. This finding suggests that different countries have different steady states. If statistical techniques are used to control for some of the determinants of the steady state, such as saving rates, population growth rates, and educational attainment, then once again the data show convergence at a rate of about 2 percent per year. In other words, the economies of the world exhibit *conditional convergence*: they appear to be converging to their own steady states, which in turn are determined by saving, population growth, and education.[6]

Factor Accumulation Versus Production Efficiency

As a matter of accounting, international differences in income per person can be attributed to either (1) differences in the factors of production, such as the quantities of physical and human capital, or (2) differences in the efficiency with which economies use their factors of production. That is, a worker in a poor country may be poor because he lacks tools and skills or because the tools and skills he has are not being put to their best use. To describe this issue in terms of the Solow model, the question is whether the large gap between rich and poor is explained by differences in capital accumulation (including human capital) or differences in the production function.

Much research has attempted to estimate the relative importance of these two sources of income disparities. The exact answer varies from study to study, but both factor accumulation and production efficiency appear important. Moreover, a common finding is that they are positively correlated: nations with high levels of physical and human capital also tend to use those factors efficiently.[7]

There are several ways to interpret this positive correlation. One hypothesis is that an efficient economy may encourage capital accumulation. For example, a person in a well-functioning economy may have greater resources and incentive

[6] Robert Barro and Xavier Sala-i-Martin, "Convergence Across States and Regions," *Brookings Papers on Economic Activity*, no. 1 (1991): 107–182; and N. Gregory Mankiw, David Romer, and David N. Weil, "A Contribution to the Empirics of Economic Growth," *Quarterly Journal of Economics* (May 1992): 407–437.

[7] Robert E. Hall and Charles I. Jones, "Why Do Some Countries Produce So Much More Output per Worker Than Others?" *Quarterly Journal of Economics* 114 (February 1999): 83–116; and Peter J. Klenow and Andres Rodriguez-Clare, "The Neoclassical Revival in Growth Economics: Has It Gone Too Far?" *NBER Macroeconomics Annual* (1997): 73–103.

to stay in school and accumulate human capital. Another hypothesis is that capital accumulation may induce greater efficiency. If there are positive externalities to physical and human capital, a possibility mentioned earlier in the chapter, then countries that save and invest more will appear to have better production functions (unless the research study accounts for these externalities, which is hard to do). Thus, greater production efficiency may cause greater factor accumulation, or the other way around.

A final hypothesis is that both factor accumulation and production efficiency are driven by a common third variable. Perhaps the common third variable is the quality of the nation's institutions, including the government's policymaking process. As one economist put it, when governments screw up, they screw up big time. Bad policies, such as high inflation, excessive budget deficits, widespread market interference, and rampant corruption, often go hand in hand. We should not be surprised that such economies both accumulate less capital and fail to use the capital they have as efficiently as they might.

8-4 Beyond the Solow Model: Endogenous Growth Theory

> A chemist, a physicist, and an economist are all trapped on a desert island, trying to figure out how to open a can of food.
>
> "Let's heat the can over the fire until it explodes," says the chemist.
>
> "No, no," says the physicist, "Let's drop the can onto the rocks from the top of a high tree."
>
> "I have an idea," says the economist. "First, we assume a can opener . . . ."

This old joke takes aim at how economists use assumptions to simplify—and sometimes oversimplify—the problems they face. It is particularly apt when evaluating the theory of economic growth. One goal of growth theory is to explain the persistent rise in living standards that we observe in most parts of the world. The Solow growth model shows that such persistent growth must come from technological progress. But where does technological progress come from? In the Solow model, it is simply assumed!

To understand fully the process of economic growth, we need to go beyond the Solow model and develop models that explain technological progress. Models that do this often go by the label **endogenous growth theory**, because they reject the Solow model's assumption of exogenous technological change. Although the field of endogenous growth theory is large and sometimes complex, here we get a quick sampling of this modern research.[8]

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[8] This section provides a brief introduction to the large and fascinating literature on endogenous growth theory. Early and important contributions to this literature include Paul M. Romer, "Increasing Returns and Long-Run Growth," *Journal of Political Economy* 94 (October 1986): 1002–1037; and Robert E. Lucas, Jr., "On the Mechanics of Economic Development," *Journal of Monetary Economics* 22 (1988): 3–42. The reader can learn more about this topic in the undergraduate textbook by Charles I. Jones, *Introduction to Economic Growth* (New York: Norton, 1998).

The Basic Model

To illustrate the idea behind endogenous growth theory, let's start with a particularly simple production function:

$$Y = AK,$$

where Y is output, K is the capital stock, and A is a constant measuring the amount of output produced for each unit of capital. Notice that this production function does not exhibit the property of diminishing returns to capital. One extra unit of capital produces A extra units of output, regardless of how much capital there is. This absence of diminishing returns to capital is the key difference between this endogenous growth model and the Solow model.

Now let's see how this production function relates to economic growth. As before, we assume a fraction s of income is saved and invested. We therefore describe capital accumulation with an equation similar to those we used previously:

$$\Delta K = sY - \delta K.$$

This equation states that the change in the capital stock (ΔK) equals investment (sY) minus depreciation (δK). Combining this equation with the $Y = AK$ production function, we obtain, after a bit of manipulation,

$$\Delta Y/Y = \Delta K/K = sA - \delta.$$

This equation shows what determines the growth rate of output $\Delta Y/Y$. Notice that, as long as $sA > \delta$, the economy's income grows forever, even without the assumption of exogenous technological progress.

Thus, a simple change in the production function can alter dramatically the predictions about economic growth. In the Solow model, saving leads to growth temporarily, but diminishing returns to capital eventually force the economy to approach a steady state in which growth depends only on exogenous technological progress. By contrast, in this endogenous growth model, saving and investment can lead to persistent growth.

But is it reasonable to abandon the assumption of diminishing returns to capital? The answer depends on how we interpret the variable K in the production function $Y = AK$. If we take the traditional view that K includes only the economy's stock of plants and equipment, then it is natural to assume diminishing returns. Giving 10 computers to each worker does not make the worker 10 times as productive as he or she is with one computer.

Advocates of endogenous growth theory, however, argue that the assumption of constant (rather than diminishing) returns to capital is more palatable if K is interpreted more broadly. Perhaps the best case for the endogenous growth model is to view knowledge as a type of capital. Clearly, knowledge is an important input into the economy's production—both its production of goods and services and its production of new knowledge. Compared to other forms of capital, however, it is less natural to assume that knowledge exhibits the property of diminishing returns. (Indeed, the increasing pace of scientific and technological innovation over the past few centuries has led some economists to argue that there are increasing returns to knowledge.) If we accept the view that knowledge is a type of capital, then this endogenous growth model with its assumption of constant returns to capital becomes a more plausible description of long-run economic growth.

A Two-Sector Model

Although the $Y = AK$ model is the simplest example of endogenous growth, the theory has gone well beyond this. One line of research has tried to develop models with more than one sector of production in order to offer a better description of the forces that govern technological progress. To see what we might learn from such models, let's sketch out an example.

The economy has two sectors, which we can call manufacturing firms and research universities. Firms produce goods and services, which are used for consumption and investment in physical capital. Universities produce a factor of production called "knowledge," which is then freely used in both sectors. The economy is described by the production function for firms, the production function for universities, and the capital-accumulation equation:

$$Y = F[K,(1 - u)EL] \quad \text{(production function in manufacturing firms),}$$
$$\Delta E = g(u)E \quad \text{(production function in research universities),}$$
$$\Delta K = sY - \delta K \quad \text{(capital accumulation),}$$

where u is the fraction of the labor force in universities (and $1 - u$ is the fraction in manufacturing), E is the stock of knowledge (which in turn determines the efficiency of labor), and g is a function that shows how the growth in knowledge depends on the fraction of the labor force in universities. The rest of the notation is standard. As usual, the production function for the manufacturing firms is assumed to have constant returns to scale: if we double both the amount of physical capital (K) and the number of effective workers in manufacturing $[(1 - u)EL]$, we double the output of goods and services (Y).

This model is a cousin of the $Y = AK$ model. Most important, this economy exhibits constant (rather than diminishing) returns to capital, as long as capital is broadly defined to include knowledge. In particular, if we double both physical capital K and knowledge E, then we double the output of both sectors in the economy. As a result, like the $Y = AK$ model, this model can generate persistent growth without the assumption of exogenous shifts in the production function. Here persistent growth arises endogenously because the creation of knowledge in universities never slows down.

At the same time, however, this model is also a cousin of the Solow growth model. If u, the fraction of the labor force in universities, is held constant, then the efficiency of labor E grows at the constant rate $g(u)$. This result of constant growth in the efficiency of labor at rate g is precisely the assumption made in the Solow model with technological progress. Moreover, the rest of the model—the manufacturing production function and the capital-accumulation equation—also resembles the rest of the Solow model. As a result, for any given value of u, this endogenous growth model works just like the Solow model.

There are two key decision variables in this model. As in the Solow model, the fraction of output used for saving and investment, s, determines the steady-state stock of physical capital. In addition, the fraction of labor in universities, u, determines the growth in the stock of knowledge. Both s and u affect the level of income, although only u affects the steady-state growth rate of income. Thus, this model of endogenous growth takes a small step in the direction of showing which societal decisions determine the rate of technological change.

The Microeconomics of Research and Development

The two-sector endogenous growth model just presented takes us closer to understanding technological progress, but it still tells only a rudimentary story about the creation of knowledge. If one thinks about the process of research and development for even a moment, three facts become apparent. First, although knowledge is largely a public good (that is, a good freely available to everyone), much research is done in firms that are driven by the profit motive. Second, research is profitable because innovations give firms temporary monopolies, either because of the patent system or because there is an advantage to being the first firm on the market with a new product. Third, when one firm innovates, other firms build on that innovation to produce the next generation of innovations. These (essentially microeconomic) facts are not easily connected with the (essentially macroeconomic) growth models we have discussed so far.

Some endogenous growth models try to incorporate these facts about research and development. Doing this requires modeling the decisions that firms face as they engage in research and modeling the interactions among firms that have some degree of monopoly power over their innovations. Going into more detail about these models is beyond the scope of this book. But it should be clear already that one virtue of these endogenous growth models is that they offer a more complete description of the process of technological innovation.

One question these models are designed to address is whether, from the standpoint of society as a whole, private profit-maximizing firms tend to engage in too little or too much research. In other words, is the social return to research (which is what society cares about) greater or smaller than the private return (which is what motivates individual firms)? It turns out that, as a theoretical matter, there are effects in both directions. On the one hand, when a firm creates a new technology, it makes other firms better off by giving them a base of knowledge on which to build future research. As Isaac Newton famously remarked, "If I have seen farther than others, it is because I was standing on the shoulders of giants." On the other hand, when one firm invests in research, it can also make other firms worse off by merely being first to discover a technology that another firm would have invented. This duplication of research effort has been called the "stepping on toes" effect. Whether firms left to their own devices do too little or too much research depends on whether the positive "standing on shoulders" externality or the negative "stepping on toes" externality is more prevalent.

Although theory alone is ambiguous about the optimality of research effort, the empirical work in this area is usually less so. Many studies have suggested the "standing on shoulders" externality is important and, as a result, the social return to research is large—often in excess of 40 percent per year. This is an impressive rate of return, especially when compared to the return to physical capital, which we earlier estimated to be about 8 percent per year. In the judgment of some economists, this finding justifies substantial government subsidies to research.[9]

8-5 Conclusion

Long-run economic growth is the single most important determinant of the economic well-being of a nation's citizens. Everything else that macroeconomists study—unemployment, inflation, trade deficits, and so on—pales in comparison.

Fortunately, economists know quite a lot about the forces that govern economic growth. The Solow growth model and the more recent endogenous growth models show how saving, population growth, and technological progress interact in determining the level and growth of a nation's standard of living. Although these theories offer no magic pill to ensure an economy achieves rapid growth, they do offer much insight, and they provide the intellectual framework for much of the debate over public policy.

Summary

1. In the steady state of the Solow growth model, the growth rate of income per person is determined solely by the exogenous rate of technological progress.
2. In the Solow model with population growth and technological progress, the Golden Rule (consumption-maximizing) steady state is characterized by equality between the net marginal product of capital ($MPK - \delta$) and the steady-state growth rate ($n + g$). By contrast, in the U.S. economy, the net marginal product of capital is well in excess of the growth rate, indicating that the U.S. economy has much less capital than in the Golden Rule steady state.
3. Policymakers in the United States and other countries often claim that their nations should devote a larger percentage of their output to saving and investment. Increased public saving and tax incentives for private saving are two ways to encourage capital accumulation.
4. In the early 1970s, the rate of growth fell substantially in most industrialized countries. The cause of this slowdown is not well understood. In the mid-1990s, the rate of growth increased, most likely because of advances in information technology.

[9] For an overview of the empirical literature on the effects of research, see Zvi Griliches, "The Search for R&D Spillovers," *Scandinavian Journal of Economics* 94 (1991): 29–47.

5. Many empirical studies have examined to what extent the Solow model can help explain long-run economic growth. The model can explain much of what we see in the data, such as balanced growth and conditional convergence. Recent studies have also found that international variation in standards of living is attributable to a combination of capital accumulation and the efficiency with which capital is used.

6. Modern theories of endogenous growth attempt to explain the rate of technological progress, which the Solow model takes as exogenous. These models try to explain the decisions that determine the creation of knowledge through research and development.

KEY CONCEPTS

Efficiency of labor

Labor-augmenting technological progress

Endogenous growth theory

QUESTIONS FOR REVIEW

1. In the Solow model, what determines the steady-state rate of growth of income per worker?

2. What data would you need to determine whether an economy has more or less capital than in the Golden Rule steady state?

3. How can policymakers influence a nation's saving rate?

4. What has happened to the rate of productivity growth over the past 40 years? How might you explain this phenomenon?

5. In the steady state of the Solow model, at what rate does output per person grow? At what rate does capital per person grow? How does this compare with U.S. experience?

6. How does endogenous growth theory explain persistent growth without the assumption of exogenous technological progress? How does this differ from the Solow model?

PROBLEMS AND APPLICATIONS

1. An economy described by the Solow growth model has the following production function:

$$y = \sqrt{k}.$$

   a. Solve for the steady-state value of y as a function of s, n, g, and δ.

   b. A developed country has a saving rate of 28 percent and a population growth rate of 1 percent per year. A less-developed country has a saving rate of 10 percent and a population growth rate of 4 percent per year. In both countries, $g = 0.02$ and $\delta = 0.04$. Find the steady-state value of y for each country.

   c. What policies might the less-developed country pursue to raise its level of income?

2. In the United States, the capital share of GDP is about 30 percent; the average growth in output is about 3 percent per year; the depreciation rate is about 4 percent per year; and the capital–output ratio is about 2.5. Suppose that the production function is Cobb–Douglas, so that the capital

share in output is constant, and that the United States has been in a steady state. (For a discussion of the Cobb–Douglas production function, see the appendix to Chapter 3.)

a. What must the saving rate be in the initial steady state? [*Hint:* Use the steady-state relationship, $sy = (\delta + n + g)k$.]

b. What is the marginal product of capital in the initial steady state?

c. Suppose that public policy raises the saving rate so that the economy reaches the Golden Rule level of capital. What will the marginal product of capital be at the Golden Rule steady state? Compare the marginal product at the Golden Rule steady state to the marginal product in the initial steady state. Explain.

d. What will the capital–output ratio be at the Golden Rule steady state? (*Hint:* For the Cobb–Douglas production function, the capital–output ratio is related to the marginal product of capital.)

e. What must the saving rate be to reach the Golden Rule steady state?

3. Prove each of the following statements about the steady state with population growth and technological progress.

a. The capital–output ratio is constant.

b. Capital and labor each earn a constant share of an economy's income. [*Hint:* Recall the definition $MPK = f(k + 1) - f(k)$.]

c. Total capital income and total labor income both grow at the rate of population growth plus the rate of technological progress, $n + g$.

d. The real rental price of capital is constant, and the real wage grows at the rate of technological progress g. (*Hint:* The real rental price of capital equals total capital income divided by the capital stock, and the real wage equals total labor income divided by the labor force.)

4. The amount of education the typical person receives varies substantially among countries. Suppose you were to compare a country with a highly educated labor force and a country with a less educated labor force. Assume that education affects only the level of the efficiency of labor. Also assume that the countries are otherwise the same: they have the same saving rate, the same depreciation rate, the same population growth rate, and the same rate of technological progress. Both countries are described by the Solow model and are in their steady states. What would you predict for the following variables?

a. The rate of growth of total income.

b. The level of income per worker.

c. The real rental price of capital.

d. The real wage.

5. This question asks you to analyze in more detail the two-sector endogenous growth model presented in the text.

a. Rewrite the production function for manufactured goods in terms of output per effective worker and capital per effective worker.

b. In this economy, what is break-even investment (the amount of investment needed to keep capital per effective worker constant)?

c. Write down the equation of motion for k, which shows Δk as saving minus break-even investment. Use this equation to draw a graph showing the determination of steady-state k. (*Hint:* This graph will look much like those we used to analyze the Solow model.)

d. In this economy, what is the steady-state growth rate of output per worker Y/L? How do the saving rate s and the fraction of the labor force in universities u affect this steady-state growth rate?

e. Using your graph, show the impact of an increase in u. (*Hint:* This change affects both curves.) Describe both the immediate and the steady-state effects.

f. Based on your analysis, is an increase in u an unambiguously good thing for the economy? Explain.

APPENDIX

Accounting for the Sources of Economic Growth

Real GDP in the United States has grown an average of 3 percent per year over the past 40 years. What explains this growth? In Chapter 3 we linked the output of the economy to the factors of production—capital and labor—and to the production technology. Here we develop a technique called *growth accounting* that divides the growth in output into three different sources: increases in capital, increases in labor, and advances in technology. This breakdown provides us with a measure of the rate of technological change.

Increases in the Factors of Production

We first examine how increases in the factors of production contribute to increases in output. To do this, we start by assuming there is no technological change, so the production function relating output Y to capital K and labor L is constant over time:

$$Y = F(K, L).$$

In this case, the amount of output changes only because the amount of capital or labor changes.

Increases in Capital First, consider changes in capital. If the amount of capital increases by ΔK units, by how much does the amount of output increase? To answer this question, we need to recall the definition of the marginal product of capital MPK:

$$MPK = F(K + 1, L) - F(K, L).$$

The marginal product of capital tells us how much output increases when capital increases by 1 unit. Therefore, when capital increases by ΔK units, output increases by approximately $MPK \times \Delta K$.[10]

For example, suppose that the marginal product of capital is 1/5; that is, an additional unit of capital increases the amount of output produced by one-fifth of a

[10] Note the word "approximately" here. This answer is only an approximation because the marginal product of capital varies: it falls as the amount of capital increases. An exact answer would take into account the fact that each unit of capital has a different marginal product. If the change in K is not too large, however, the approximation of a constant marginal product is very accurate.

unit. If we increase the amount of capital by 10 units, we can compute the amount of additional output as follows:

$$\begin{aligned}\Delta Y &= \quad MPK \quad \times \quad \Delta K \\ &= 1/5 \frac{\text{Units of Output}}{\text{Unit of Capital}} \times 10 \text{ Units of Capital} \\ &= 2 \text{ Units of Output.}\end{aligned}$$

By increasing capital 10 units, we obtain 2 more units of output. Thus, we use the marginal product of capital to convert changes in capital into changes in output.

Increases in Labor Next, consider changes in labor. If the amount of labor increases by ΔL units, by how much does output increase? We answer this question the same way we answered the question about capital. The marginal product of labor MPL tells us how much output changes when labor increases by 1 unit—that is,

$$MPL = F(K, L + 1) - F(K, L).$$

Therefore, when the amount of labor increases by ΔL units, output increases by approximately $MPL \times \Delta L$.

For example, suppose that the marginal product of labor is 2; that is, an additional unit of labor increases the amount of output produced by 2 units. If we increase the amount of labor by 10 units, we can compute the amount of additional output as follows:

$$\begin{aligned}\Delta Y &= \quad MPL \quad \times \quad \Delta L \\ &= 2 \frac{\text{Units of Ouput}}{\text{Unit of Labor}} \times 10 \text{ Units of Labor} \\ &= 20 \text{ Units of Output.}\end{aligned}$$

By increasing labor 10 units, we obtain 20 more units of output. Thus, we use the marginal product of labor to convert changes in labor into changes in output.

Increases in Capital and Labor Finally, let's consider the more realistic case in which both factors of production change. Suppose that the amount of capital increases by ΔK and the amount of labor increases by ΔL. The increase in output then comes from two sources: more capital and more labor. We can divide this increase into the two sources using the marginal products of the two inputs:

$$\Delta Y = (MPK \times \Delta K) + (MPL \times \Delta L).$$

The first term in parentheses is the increase in output resulting from the increase in capital, and the second term in parentheses is the increase in output resulting from the increase in labor. This equation shows us how to attribute growth to each factor of production.

We now want to convert this last equation into a form that is easier to interpret and apply to the available data. First, with some algebraic rearrangement, the equation becomes[11]

$$\frac{\Delta Y}{Y} = \left(\frac{MPK \times K}{Y}\right)\frac{\Delta K}{K} + \left(\frac{MPL \times L}{Y}\right)\frac{\Delta L}{L}.$$

This form of the equation relates the growth rate of output, $\Delta Y/Y$, to the growth rate of capital, $\Delta K/K$, and the growth rate of labor, $\Delta L/L$.

Next, we need to find some way to measure the terms in parentheses in the last equation. In Chapter 3 we showed that the marginal product of capital equals its real rental price. Therefore, $MPK \times K$ is the total return to capital, and $(MPK \times K)/Y$ is capital's share of output. Similarly, the marginal product of labor equals the real wage. Therefore, $MPL \times L$ is the total compensation that labor receives, and $(MPL \times L)/Y$ is labor's share of output. Under the assumption that the production function has constant returns to scale, Euler's theorem (which we discussed in Chapter 3) tells us that these two shares sum to 1. In this case, we can write

$$\frac{\Delta Y}{Y} = \alpha\frac{\Delta K}{K} + (1-\alpha)\frac{\Delta L}{L}.$$

where α is capital's share and $(1 - \alpha)$ is labor's share.

This last equation gives us a simple formula for showing how changes in inputs lead to changes in output. In particular, we must weight the growth rates of the inputs by the factor shares. As we discussed in the appendix to Chapter 3, capital's share in the United States is about 30 percent, that is, $\alpha = 0.30$. Therefore, a 10-percent increase in the amount of capital ($\Delta K/K = 0.10$) leads to a 3-percent increase in the amount of output ($\Delta Y/Y = 0.03$). Similarly, a 10-percent increase in the amount of labor ($\Delta L/L = 0.10$) leads to a 7-percent increase in the amount of output ($\Delta Y/Y = 0.07$).

Technological Progress

So far in our analysis of the sources of growth, we have been assuming that the production function does not change over time. In practice, of course, technological progress improves the production function. For any given amount of inputs, we get more output today than we did in the past. We now extend the analysis to allow for technological progress.

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[11] *Mathematical note*: To see that this is equivalent to the previous equation, note that we can multiply both sides of this equation by Y and thereby cancel Y from three places in which it appears. We can cancel the K in the top and bottom of the first term on the right-hand side and the L in the top and bottom of the second term on the right-hand side. These algebraic manipulations turn this equation into the previous one.

We include the effects of the changing technology by writing the production function as

$$Y = AF(K, L),$$

where A is a measure of the current level of technology called *total factor productivity*. Output now increases not only because of increases in capital and labor but also because of increases in total factor productivity. If total factor productivity increases by 1 percent and if the inputs are unchanged, then output increases by 1 percent.

Allowing for a changing technology adds another term to our equation accounting for economic growth:

$$\begin{array}{ccccccc} \dfrac{\Delta Y}{Y} & = & \alpha\dfrac{\Delta K}{K} & + & (1-\alpha)\dfrac{\Delta L}{L} & + & \dfrac{\Delta A}{A} \\ \text{Growth in Output} & = & \text{Contribution of Capital} & + & \text{Contribution of Labor} & + & \text{Growth in Total Factor Productivity}. \end{array}$$

This is the key equation of growth accounting. It identifies and allows us to measure the three sources of growth: changes in the amount of capital, changes in the amount of labor, and changes in total factor productivity.

Because total factor productivity is not observable directly, it is measured indirectly. We have data on the growth in output, capital, and labor; we also have data on capital's share of output. From these data and the growth-accounting equation, we can compute the growth in total factor productivity to make sure that everything adds up:

$$\frac{\Delta A}{A} = \frac{\Delta Y}{Y} - \alpha\frac{\Delta K}{K} - (1-\alpha)\frac{\Delta L}{L}.$$

$\Delta A/A$ is the change in output that cannot be explained by changes in inputs. Thus, the growth in total factor productivity is computed as a residual—that is, as the amount of output growth that remains after we have accounted for the determinants of growth that we can measure. Indeed, $\Delta A/A$ is sometimes called the *Solow residual,* after Robert Solow, who first showed how to compute it.[12]

Total factor productivity can change for many reasons. Changes most often arise because of increased knowledge about production methods, and the Solow residual is often used as a measure of technological progress. Yet other

[12] Robert M. Solow, "Technical Change and the Aggregate Production Function," *Review of Economics and Statistics* 39 (1957): 312–320. It is natural to ask how growth in labor efficiency E relates to growth in total factor productivity. One can show that $\Delta A/A = (1-\alpha)\Delta E/E$, where α is capital's share. Thus, technological change as measured by growth in the efficiency of labor is proportional to technological change as measured by the Solow residual.

factors, such as education and government regulation, can affect total factor productivity as well. For example, if higher public spending raises the quality of education, then workers may become more productive and output may rise, which implies higher total factor productivity. As another example, if government regulations require firms to purchase capital to reduce pollution or increase worker safety, then the capital stock may rise without any increase in measured output, which implies lower total factor productivity. *Total factor productivity captures anything that changes the relation between measured inputs and measured output.*

The Sources of Growth in the United States

Having learned how to measure the sources of economic growth, we now look at the data. Table 8-3 uses U.S. data to measure the contributions of the three sources of growth between 1950 and 1999.

This table shows that real GDP has grown an average of 3.6 percent per year since 1950. Of this 3.6 percent, 1.2 percent is attributable to increases in the capital stock, 1.3 percent to increases in the labor input, and 1.1 percent to increases in total factor productivity. These data show that increases in capital, labor, and productivity have contributed almost equally to economic growth in the United States.

Table 8-3 also shows that the growth in total factor productivity slowed substantially around 1970. In a previous case study in this chapter, we discussed some hypotheses to explain this productivity slowdown.

table 8-3

Accounting for Economic Growth in the United States

			SOURCE OF GROWTH				
Years	**Output Growth** $\Delta Y/Y$	=	**Capital** $\alpha\Delta K/K$	+	**Labor** $(1-\alpha)\Delta K/K$	+	**Total Factor Productivity** $\Delta A/A$
			(average percentage increase per year)				
1950–1999	3.6		1.2		1.3		1.1
1950–1960	3.3		1.0		1.0		1.3
1960–1970	4.4		1.4		1.2		1.8
1970–1980	3.6		1.4		1.2		1.0
1980–1990	3.4		1.2		1.6		0.6
1990–1999	3.7		1.2		1.6		0.9

Source: U.S. Department of Commerce, U.S. Department of Labor, and the author's calculations.The parameter α is set to equal 0.3.

CASE STUDY

Growth in the East Asian Tigers

Perhaps the most spectacular growth experiences in recent history have been those of the "Tigers" of East Asia: Hong Kong, Singapore, South Korea, and Taiwan. From 1966 to 1990, while real income per person was growing about 2 percent per year in the United States, it grew more than 7 percent per year in each of these countries. In the course of a single generation, real income per person increased fivefold, moving the Tigers from among the world's poorest countries to among the richest. (In the late 1990s, a period of pronounced financial turmoil tarnished the reputation of some of these economies. But this short-run problem, which we examine in a case study in Chapter 12, doesn't come close to reversing the spectacular long-run growth performance that the Asian Tigers have experienced.)

What accounts for these growth miracles? Some commentators have argued that the success of these four countries is hard to reconcile with basic growth theory, such as the Solow growth model, which has technology growing at a constant, exogenous rate. They have suggested that these countries' rapid growth is explained by their ability to imitate foreign technologies. By adopting technology developed abroad, the argument goes, these countries managed to improve their production functions substantially in a relatively short period of time. If this argument is correct, these countries should have experienced unusually rapid growth in total factor productivity.

One recent study shed light on this issue by examining in detail the data from these four countries. The study found that their exceptional growth can be traced to large increases in measured factor inputs: increases in labor-force participation, increases in the capital stock, and increases in educational attainment. In South Korea, for example, the investment–GDP ratio rose from about 5 percent in the 1950s to about 30 percent in the 1980s; the percentage of the working population with at least a high-school education went from 26 percent in 1966 to 75 percent in 1991.

Once we account for growth in labor, capital, and human capital, little of the growth in output is left to explain. None of these four countries experienced unusually rapid growth in total factor productivity. Indeed, the average growth in total factor productivity in the East Asian Tigers was almost exactly the same as in the United States. Thus, although these countries' rapid growth has been truly impressive, it is easy to explain using the tools of basic growth theory.[13]

[13] Alwyn Young, "The Tyranny of Numbers: Confronting the Statistical Realities of the East Asian Growth Experience," *Quarterly Journal of Economics* 101 (August 1995): 641–680.

MORE PROBLEMS AND APPLICATIONS

1. In the economy of Solovia, the owners of capital get two-thirds of national income, and the workers receive one-third.

a. The men of Solovia stay at home performing household chores, while the women work in factories. If some of the men started working outside the home so that the labor force increased by 5 percent, what would happen to the measured output of the economy? Does labor productivity—defined as output per worker—increase, decrease, or stay the same? Does total factor productivity increase, decrease, or stay the same?

b. In year 1, the capital stock was 6, the labor input was 3, and output was 12. In year 2, the capital stock was 7, the labor input was 4, and output was 14. What happened to total factor productivity between the two years?

2. Labor productivity is defined as Y/L, the amount of output divided by the amount of labor input. Start with the growth-accounting equation and show that the growth in labor productivity depends on growth in total factor productivity and growth in the capital–labor ratio. In particular, show that

$$\frac{\Delta(Y/L)}{Y/L} = \frac{\Delta A}{A} + \alpha\frac{\Delta(K/L)}{K/L}.$$

(*Hint:* You may find the following mathematical trick helpful. If $z = wx$, then the growth rate of z is approximately the growth rate of w plus the growth rate of x. That is,

$$\Delta z/z \approx \Delta w/w + \Delta x/x.)$$

3. Suppose an economy described by the Solow model is in a steady state with population growth n of 1.0 percent per year and technological progress g of 2.0 percent per year. Total output and total capital grow at 3.0 percent per year. Suppose further that the capital share of output is 0.3. If you used the growth-accounting equation to divide output growth into three sources—capital, labor, and total factor productivity—how much would you attribute to each source? Compare your results to the figures we found for the United States in Table 8-3.

part IV

Business Cycle Theory: The Economy in the Short Run

CHAPTER NINE

Introduction to Economic Fluctuations

> *The modern world regards business cycles much as the ancient Egyptians regarded the overflowing of the Nile. The phenomenon recurs at intervals, it is of great importance to everyone, and natural causes of it are not in sight.*
>
> *— John Bates Clark, 1898*

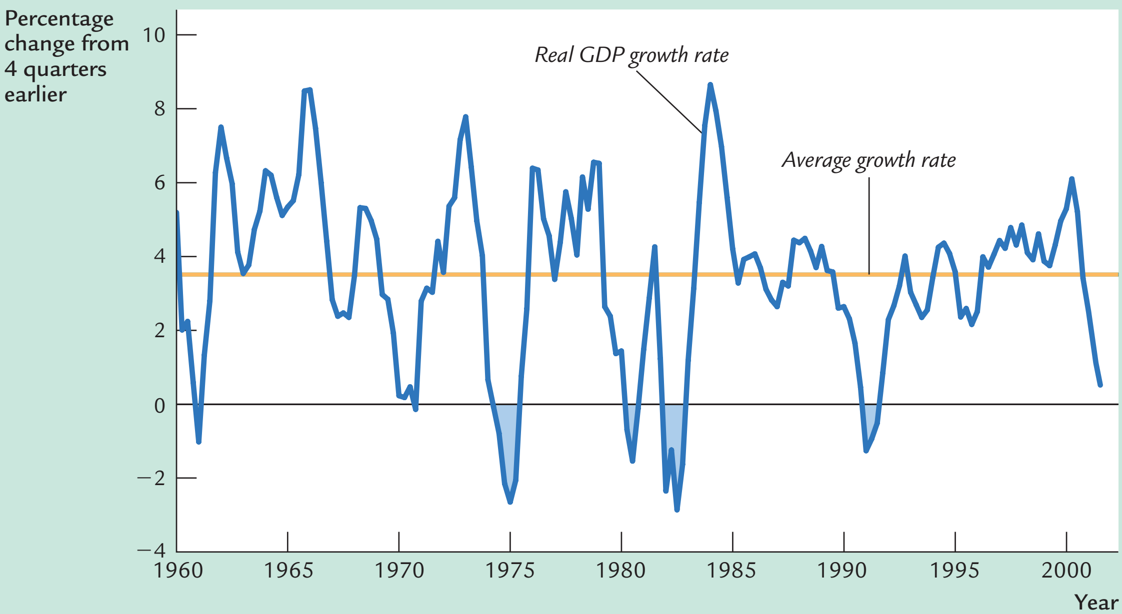
Economic fluctuations present a recurring problem for economists and policymakers. This problem is illustrated in Figure 9-1, which shows growth in real GDP for the U.S. economy. As you can see, although the economy experiences long-run growth that averages about 3.5 percent per year, this growth is not at all steady. Recessions—periods of falling incomes and rising unemployment—are frequent. In the recession of 1990, for instance, real GDP fell 2.2 percent from its peak to its trough, and the unemployment rate rose to 7.7 percent. During recessions, not only are more people unemployed, but those who are employed have shorter workweeks, as more workers have to accept part-time jobs and fewer workers have the opportunity to work overtime. When recessions end and the economy enters a boom, these effects work in reverse: incomes rise, unemployment falls, and workweeks expand.

Economists call these short-run fluctuations in output and employment the *business cycle*. Although this term suggests that economic fluctuations are regular and predictable, they are not. Recessions are as irregular as they are common. Sometimes they are close together, such as the recessions of 1980 and 1982. Sometimes they are far apart, such as the recessions of 1982 and 1990.

In Parts II and III of this book, we developed theories to explain how the economy behaves in the long run. Those theories were based on the classical dichotomy—the premise that real variables, such as output and employment, are not affected by what happens to nominal variables, such as the money supply and the price level. Although classical theories are useful for explaining long-run trends, including the economic growth we observe from decade to decade, most economists believe that the classical dichotomy does not hold in the short run and, therefore, that classical theories cannot explain year-to-year fluctuations in output and employment.

Here, in Part IV, we see how economists explain these short-run fluctuations. This chapter begins our analysis by discussing the key differences between the long run and the short run and by introducing the model of aggregate supply

figure 9-1



Real GDP Growth in the United States Growth in real GDP averages about 3.5 percent per year, as indicated by the orange line, but there are substantial fluctuations around this average. Recessions are periods when the production of goods and services is declining, represented here by negative growth in real GDP.

Source: U.S. Department of Commerce.

and aggregate demand. With this model we can show how shocks to the economy lead to short-run fluctuations in output and employment.

Just as Egypt now controls the flooding of the Nile Valley with the Aswan Dam, modern society tries to control the business cycle with appropriate economic policies. The model we develop over the next several chapters shows how monetary and fiscal policies influence the business cycle. We will see that these policies can potentially stabilize the economy or, if poorly conducted, make the problem of economic instability even worse.

9-1 Time Horizons in Macroeconomics

Before we start building a model of short-run economic fluctuations, let's step back and ask a fundamental question: Why do economists need different models for different time horizons? Why can't we stop the course here and be content with the classical models developed in Chapters 3 through 8? The answer, as this book has consistently reminded its reader, is that classical macroeconomic theory applies to the long run but not to the short run. But why is this so?

How the Short Run and Long Run Differ

Most macroeconomists believe that the key difference between the short run and the long run is the behavior of prices. *In the long run, prices are flexible and can respond to changes in supply or demand. In the short run, many prices are "sticky" at some predetermined level.* Because prices behave differently in the short run than in the long run, economic policies have different effects over different time horizons.

To see how the short run and the long run differ, consider the effects of a change in monetary policy. Suppose that the Federal Reserve suddenly reduced the money supply by 5 percent. According to the classical model, which almost all economists agree describes the economy in the long run, the money supply affects nominal variables—variables measured in terms of money—but not real variables. In the long run, a 5-percent reduction in the money supply lowers all prices (including nominal wages) by 5 percent whereas all real variables remain the same. Thus, in the long run, changes in the money supply do not cause fluctuations in output or employment.

In the short run, however, many prices do not respond to changes in monetary policy. A reduction in the money supply does not immediately cause all firms to cut the wages they pay, all stores to change the price tags on their goods, all mail-order firms to issue new catalogs, and all restaurants to print new menus. Instead, there is little immediate change in many prices; that is, many prices are sticky. This short-run price stickiness implies that the short-run impact of a change in the money supply is not the same as the long-run impact.

A model of economic fluctuations must take into account this short-run price stickiness. We will see that the failure of prices to adjust quickly and completely means that, in the short run, output and employment must do some of the adjusting instead. In other words, during the time horizon over which prices are sticky, the classical dichotomy no longer holds: nominal variables can influence real variables, and the economy can deviate from the equilibrium predicted by the classical model.

CASE STUDY

The Puzzle of Sticky Magazine Prices

How sticky are prices? The answer to this question depends on what price we consider. Some commodities, such as wheat, soybeans, and pork bellies, are traded on organized exchanges, and their prices change every minute. No one would call these prices sticky. Yet the prices of most goods and services change much less frequently. One survey found that 39 percent of firms change their prices once a year, and another 10 percent change their prices less than once a year.[1]

The reasons for price stickiness are not always apparent. Consider, for example, the market for magazines. A study has documented that magazines change their newsstand prices very infrequently. The typical magazine allows inflation to erode

---

[1] Alan S. Blinder, "On Sticky Prices: Academic Theories Meet the Real World," in N. G. Mankiw, ed., *Monetary Policy* (Chicago: University of Chicago Press, 1994): 117–154. A case study in Chapter 19 discusses this survey in more detail.

its real price by about 25 percent before it raises its nominal price. When inflation is 4 percent per year, the typical magazine changes its price about every six years.[2]

Why do magazines keep their prices the same for so long? Economists do not have a definitive answer. The question is puzzling because it would seem that for magazines, the cost of a price change is small. To change prices, a mail-order firm must issue a new catalog and a restaurant must print a new menu, but a magazine publisher can simply print a new price on the cover of the next issue. Perhaps the cost to the publisher of charging the wrong price is also small. Or maybe customers would find it inconvenient if the price of their favorite magazine changed every month.

As the magazine example shows, explaining at the microeconomic level why prices are sticky is sometimes hard. The cause of price stickiness is, therefore, an active area of research, which we discuss more fully in Chapter 19. In this chapter, however, we simply assume that prices are sticky so we can start developing the link between sticky prices and the business cycle. Although not yet fully explained, short-run price stickiness is widely believed to be crucial for understanding short-run economic fluctuations.

The Model of Aggregate Supply and Aggregate Demand

How does introducing sticky prices change our view of how the economy works? We can answer this question by considering economists' two favorite words—supply and demand.

In classical macroeconomic theory, the amount of output depends on the economy's ability to *supply* goods and services, which in turn depends on the supplies of capital and labor and on the available production technology. This is the essence of the basic classical model in Chapter 3, as well as of the Solow growth model in Chapters 7 and 8. Flexible prices are a crucial assumption of classical theory. The theory posits, sometimes implicitly, that prices adjust to ensure that the quantity of output demanded equals the quantity supplied.

The economy works quite differently when prices are sticky. In this case, as we will see, output also depends on the *demand* for goods and services. Demand, in turn, is influenced by monetary policy, fiscal policy, and various other factors. Because monetary and fiscal policy can influence the economy's output over the time horizon when prices are sticky, price stickiness provides a rationale for why these policies may be useful in stabilizing the economy in the short run.

In the rest of this chapter, we develop a model that makes these ideas more precise. The model of supply and demand, which we used in Chapter 1 to discuss the market for pizza, offers some of the most fundamental insights in economics. This model shows how the supply and demand for any good jointly determine the

[2] Stephen G. Cecchetti, "The Frequency of Price Adjustment: A Study of the Newsstand Prices of Magazines," *Journal of Econometrics* 31 (1986): 255–274.

good's price and the quantity sold, and how shifts in supply and demand affect the price and quantity. In the rest of this chapter, we introduce the "economy-size" version of this model—*the model of aggregate supply and aggregate demand*. This macroeconomic model allows us to study how the aggregate price level and the quantity of aggregate output are determined. It also provides a way to contrast how the economy behaves in the long run and how it behaves in the short run.

Although the model of aggregate supply and aggregate demand resembles the model of supply and demand for a single good, the analogy is not exact. The model of supply and demand for a single good considers only one good within a large economy. By contrast, as we will see in the coming chapters, the model of aggregate supply and aggregate demand is a sophisticated model that incorporates the interactions among many markets.

9-2 Aggregate Demand

Aggregate demand (AD) is the relationship between the quantity of output demanded and the aggregate price level. In other words, the aggregate demand curve tells us the quantity of goods and services people want to buy at any given level of prices. We examine the theory of aggregate demand in detail in Chapters 10 through 12. Here we use the quantity theory of money to provide a simple, although incomplete, derivation of the aggregate demand curve.

The Quantity Equation as Aggregate Demand

Recall from Chapter 4 that the quantity theory says that

$$MV = PY,$$

where M is the money supply, V is the velocity of money, P is the price level, and Y is the amount of output. If the velocity of money is constant, then this equation states that the money supply determines the nominal value of output, which in turn is the product of the price level and the amount of output.

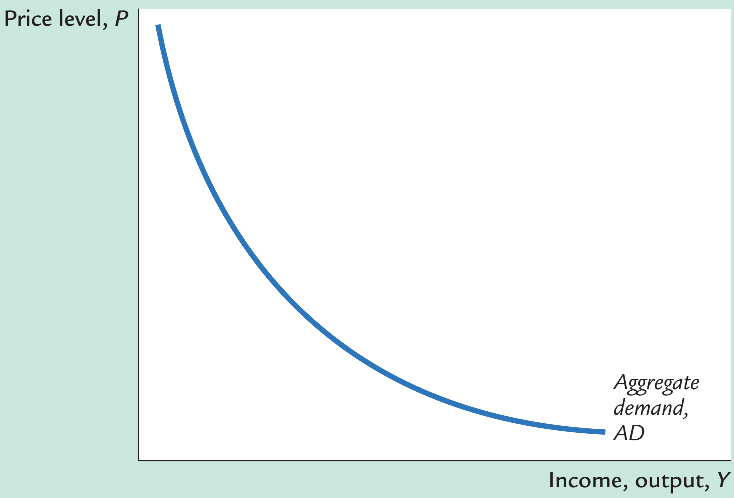
You might recall that the quantity equation can be rewritten in terms of the supply and demand for real money balances:

$$M/P = (M/P)^{\mathrm{d}} = kY,$$

where $k = 1/V$ is a parameter determining how much money people want to hold for every dollar of income. In this form, the quantity equation states that the supply of real money balances M/P equals the demand $(M/P)^{\mathrm{d}}$ and that the demand is proportional to output Y. The velocity of money V is the "flip side" of the money demand parameter k.

For any fixed money supply and velocity, the quantity equation yields a negative relationship between the price level P and output Y. Figure 9-2 graphs the combinations of P and Y that satisfy the quantity equation holding M and V constant. This downward-sloping curve is called the aggregate demand curve.

figure 9-2



The Aggregate Demand Curve The aggregate demand curve *AD* shows the relationship between the price level *P* and the quantity of goods and services demanded *Y*. It is drawn for a given value of the money supply *M*. The aggregate demand curve slopes downward: the higher the price level *P*, the lower the level of real balances *M*/*P*, and therefore the lower the quantity of goods and services demanded *Y*.

Why the Aggregate Demand Curve Slopes Downward

As a strictly mathematical matter, the quantity equation explains the downward slope of the aggregate demand curve very simply. The money supply *M* and the velocity of money *V* determine the nominal value of output *PY*. Once *PY* is fixed, if *P* goes up, *Y* must go down.

What is the economics that lies behind this mathematical relationship? For a complete answer, we have to wait for a couple of chapters. For now, however, consider the following logic: Because we have assumed the velocity of money is fixed, the money supply determines the dollar value of all transactions in the economy. (This conclusion should be familiar from Chapter 4.) If the price level rises, each transaction requires more dollars, so the number of transactions and thus the quantity of goods and services purchased must fall.

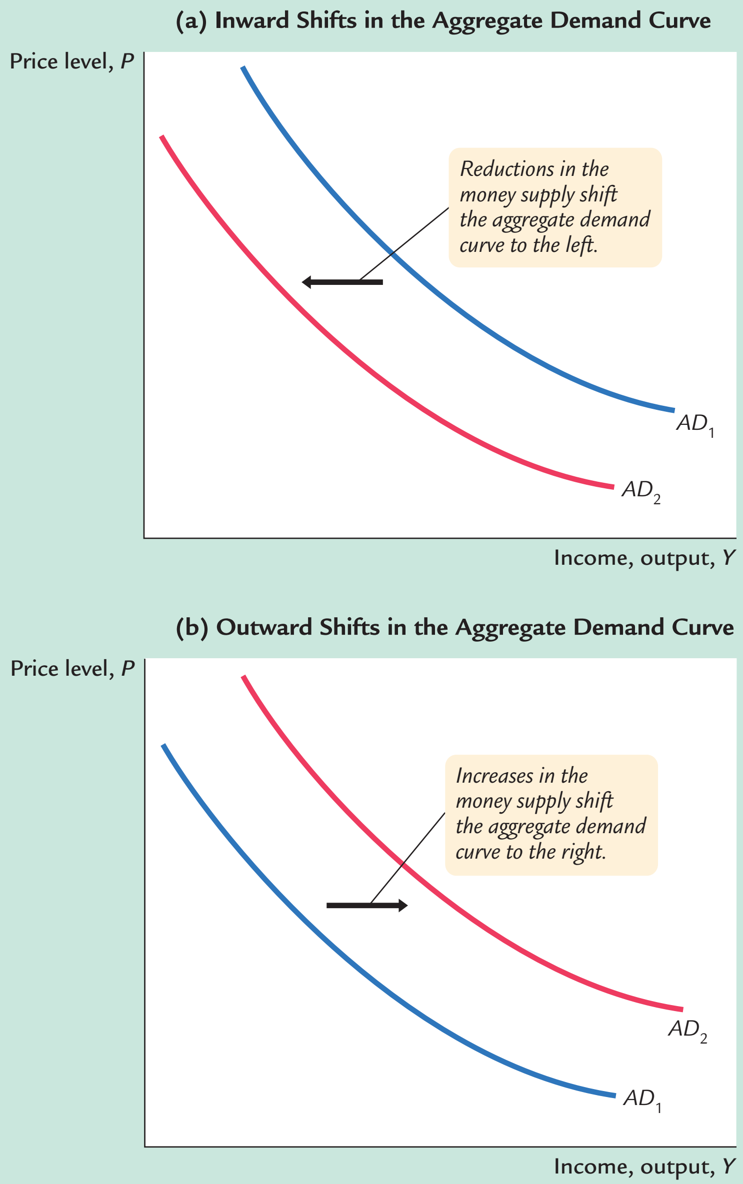
We can also explain the downward slope of the aggregate demand curve by thinking about the supply and demand for real money balances. If output is higher, people engage in more transactions and need higher real balances *M*/*P*. For a fixed money supply *M*, higher real balances imply a lower price level. Conversely, if the price level is lower, real money balances are higher; the higher level of real balances allows a greater volume of transactions, which means a greater quantity of output is demanded.

Shifts in the Aggregate Demand Curve

The aggregate demand curve is drawn for a fixed value of the money supply. In other words, it tells us the possible combinations of *P* and *Y* for a given value of *M*. If the Fed changes the money supply, then the possible combinations of *P* and *Y* change, which means the aggregate demand curve shifts.

For example, consider what happens if the Fed reduces the money supply. The quantity equation, $MV = PY$, tells us that the reduction in the money supply leads to a proportionate reduction in the nominal value of output PY. For any given price level, the amount of output is lower, and for any given amount of output, the price level is lower. As in Figure 9-3(a), the aggregate demand curve relating P and Y shifts inward.

figure 9-3



Shifts in the Aggregate Demand Curve Changes in the money supply shift the aggregate demand curve. In panel (a), a decrease in the money supply M reduces the nominal value of output PY. For any given price level P, output Y is lower. Thus, a decrease in the money supply shifts the aggregate demand curve inward from AD_1 to AD_2. In panel (b), an increase in the money supply M raises the nominal value of output PY. For any given price level P, output Y is higher. Thus, an increase in the money supply shifts the aggregate demand curve outward from AD_1 to AD_2.

The opposite occurs if the Fed increases the money supply. The quantity equation tells us that an increase in M leads to an increase in PY. For any given price level, the amount of output is higher, and for any given amount of output, the price level is higher. As shown in Figure 9-3(b), the aggregate demand curve shifts outward.

Fluctuations in the money supply are not the only source of fluctuations in aggregate demand. Even if the money supply is held constant, the aggregate demand curve shifts if some event causes a change in the velocity of money. Over the next three chapters, we consider many possible reasons for shifts in the aggregate demand curve.

9-3 Aggregate Supply

By itself, the aggregate demand curve does not tell us the price level or the amount of output; it merely gives a relationship between these two variables. To accompany the aggregate demand curve, we need another relationship between P and Y that crosses the aggregate demand curve—an aggregate supply curve. The aggregate demand and aggregate supply curves together pin down the economy's price level and quantity of output.

Aggregate supply (AS) is the relationship between the quantity of goods and services supplied and the price level. Because the firms that supply goods and services have flexible prices in the long run but sticky prices in the short run, the aggregate supply relationship depends on the time horizon. We need to discuss two different aggregate supply curves: the long-run aggregate supply curve $LRAS$ and the short-run aggregate supply curve $SRAS$. We also need to discuss how the economy makes the transition from the short run to the long run.

The Long Run: The Vertical Aggregate Supply Curve

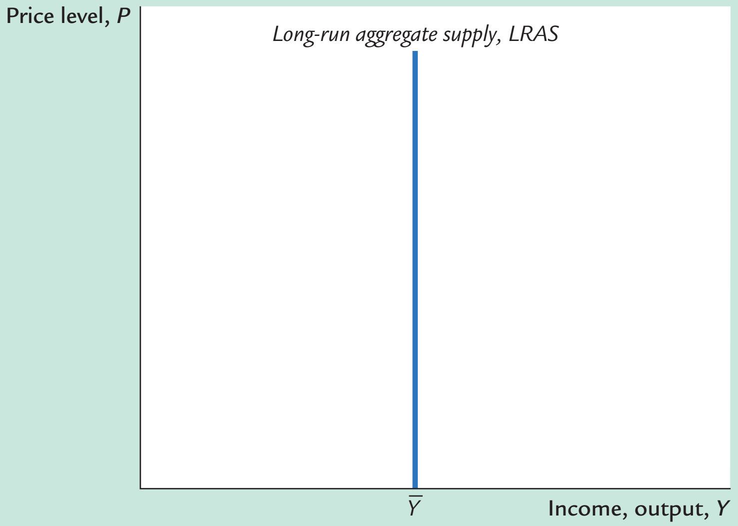
Because the classical model describes how the economy behaves in the long run, we derive the long-run aggregate supply curve from the classical model. Recall from Chapter 3 that the amount of output produced depends on the fixed amounts of capital and labor and on the available technology. To show this, we write

$$\begin{aligned} Y &= F(\bar{K}, \bar{L}) \\ &= \bar{Y}. \end{aligned}$$

According to the classical model, output does not depend on the price level. To show that output is the same for all price levels, we draw a vertical aggregate supply curve, as in Figure 9-4. The intersection of the aggregate demand curve with this vertical aggregate supply curve determines the price level.

If the aggregate supply curve is vertical, then changes in aggregate demand affect prices but not output. For example, if the money supply falls, the aggregate

figure 9-4

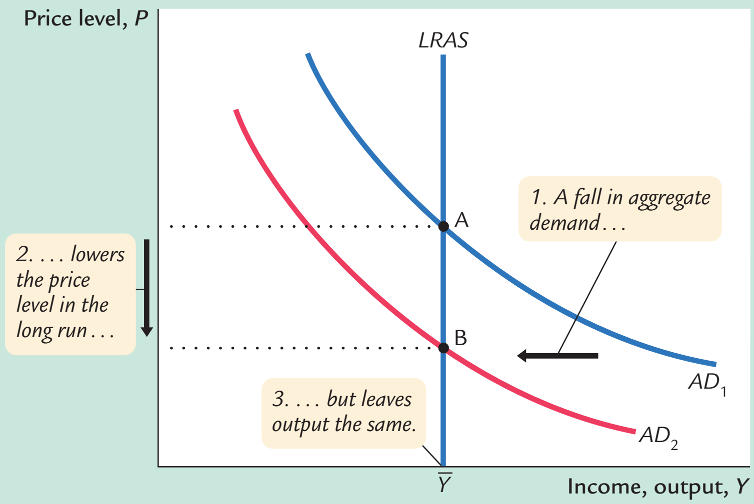


The Long-Run Aggregate Supply Curve In the long run, the level of output is determined by the amounts of capital and labor and by the available technology; it does not depend on the price level. The long-run aggregate supply curve, *LRAS*, is vertical.

demand curve shifts downward, as in Figure 9-5. The economy moves from the old intersection of aggregate supply and aggregate demand, point A, to the new intersection, point B. The shift in aggregate demand affects only prices.

The vertical aggregate supply curve satisfies the classical dichotomy, because it implies that the level of output is independent of the money supply. This long-run level of output, $\overline{Y}$, is called the *full-employment* or *natural* level of output. It is the level of output at which the economy's resources are fully employed or, more realistically, at which unemployment is at its natural rate.

figure 9-5



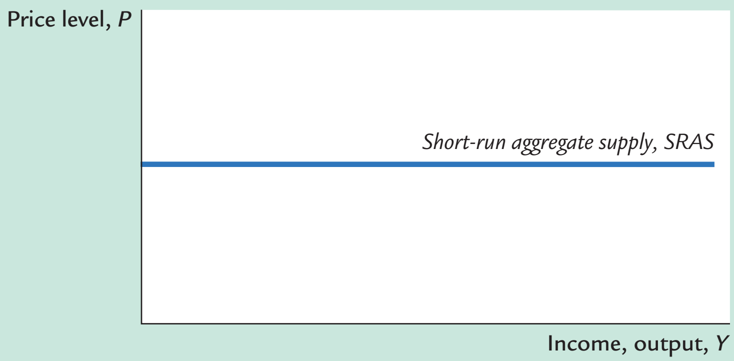
Shifts in Aggregate Demand in the Long Run A reduction in the money supply shifts the aggregate demand curve downward from AD_1 to AD_2. The equilibrium for the economy moves from point A to point B. Since the aggregate supply curve is vertical in the long run, the reduction in aggregate demand affects the price level but not the level of output.

The Short Run: The Horizontal Aggregate Supply Curve

The classical model and the vertical aggregate supply curve apply only in the long run. In the short run, some prices are sticky and, therefore, do not adjust to changes in demand. Because of this price stickiness, the short-run aggregate supply curve is not vertical.

As an extreme example, suppose that all firms have issued price catalogs and that it is costly for them to issue new ones. Thus, all prices are stuck at predetermined levels. At these prices, firms are willing to sell as much as their customers are willing to buy, and they hire just enough labor to produce the amount demanded. Because the price level is fixed, we represent this situation in Figure 9-6 with a horizontal aggregate supply curve.

figure 9-6



The Short-Run Aggregate Supply Curve In this extreme example, all prices are fixed in the short run. Therefore, the short-run aggregate supply curve, *SRAS*, is horizontal.

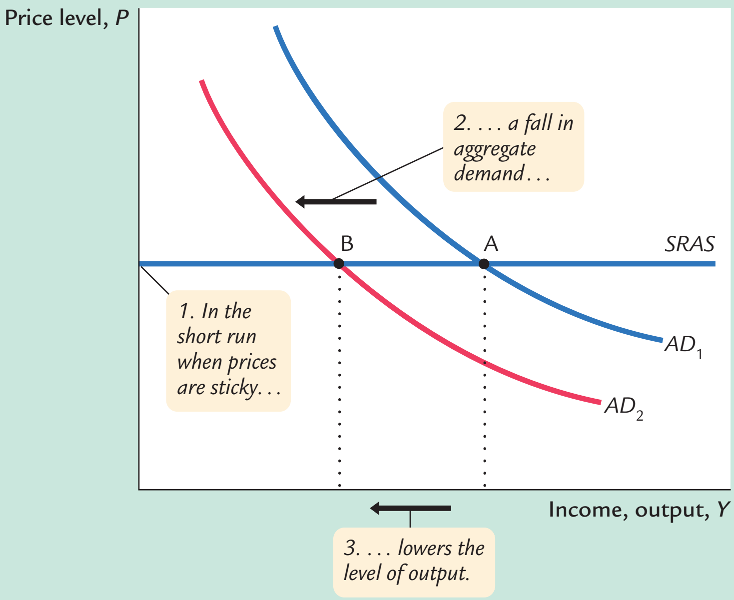
The short-run equilibrium of the economy is the intersection of the aggregate demand curve and this horizontal short-run aggregate supply curve. In this case, changes in aggregate demand do affect the level of output. For example, if the Fed suddenly reduces the money supply, the aggregate demand curve shifts inward, as in Figure 9-7. The economy moves from the old intersection of aggregate demand and aggregate supply, point A, to the new intersection, point B. The movement from point A to point B represents a decline in output at a fixed price level.

Thus, a fall in aggregate demand reduces output in the short run because prices do not adjust instantly. After the sudden fall in aggregate demand, firms are stuck with prices that are too high. With demand low and prices high, firms sell less of their product, so they reduce production and lay off workers. The economy experiences a recession.

From the Short Run to the Long Run

We can summarize our analysis so far as follows: *Over long periods of time, prices are flexible, the aggregate supply curve is vertical, and changes in aggregate demand affect the price level but not output. Over short periods of time, prices are sticky, the aggregate supply curve is flat, and changes in aggregate demand do affect the economy's output of goods and services.*

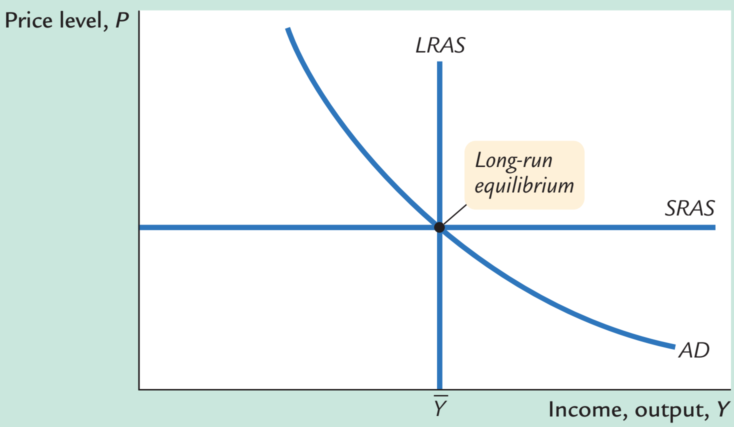
figure 9-7



Shifts in Aggregate Demand in the Short Run A reduction in the money supply shifts the aggregate demand curve downward from AD_1 to AD_2. The equilibrium for the economy moves from point A to point B. Since the aggregate supply curve is horizontal in the short run, the reduction in aggregate demand reduces the level of output.

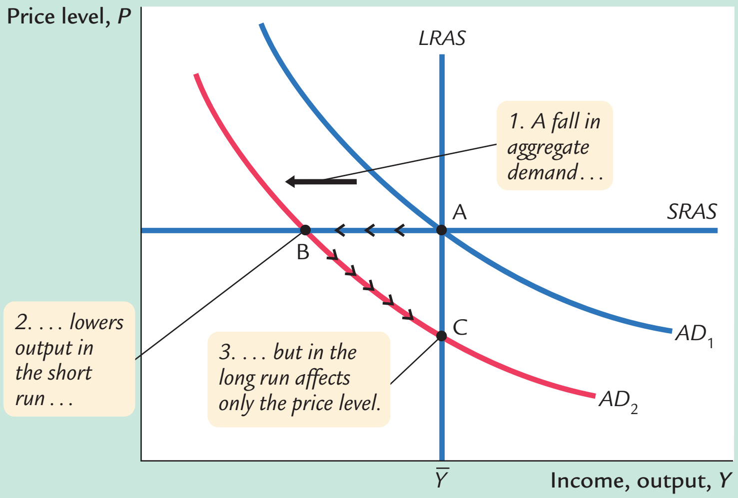
How does the economy make the transition from the short run to the long run? Let's trace the effects over time of a fall in aggregate demand. Suppose that the economy is initially in long-run equilibrium, as shown in Figure 9-8. In this figure, there are three curves: the aggregate demand curve, the long-run aggregate supply curve, and the short-run aggregate supply curve. The long-run equilibrium is the point at which aggregate demand crosses the long-run aggregate supply curve. Prices have adjusted to reach this equilibrium. Therefore, when the

figure 9-8



Long-Run Equilibrium In the long run, the economy finds itself at the intersection of the long-run aggregate supply curve and the aggregate demand curve. Because prices have adjusted to this level, the short-run aggregate supply curve crosses this point as well.

figure 9-9



A Reduction in Aggregate Demand The economy begins in long-run equilibrium at point A. A reduction in aggregate demand, perhaps caused by a decrease in the money supply, moves the economy from point A to point B, where output is below its natural level. As prices fall, the economy gradually recovers from the recession, moving from point B to point C.

economy is in its long-run equilibrium, the short-run aggregate supply curve must cross this point as well.

Now suppose that the Fed reduces the money supply and the aggregate demand curve shifts downward, as in Figure 9-9. In the short run, prices are sticky, so the economy moves from point A to point B. Output and employment fall below their natural levels, which means the economy is in a recession. Over time, in response to the low demand, wages and prices fall. The gradual reduction in the price level moves the economy downward along the aggregate demand curve to point C, which is the new long-run equilibrium. In the new long-run equilibrium (point C), output and employment are back to their natural levels, but prices are lower than in the old long-run equilibrium (point A). Thus, a shift in aggregate demand affects output in the short run, but this effect dissipates over time as firms adjust their prices.

CASE STUDY

Gold, Greenbacks, and the Contraction of the 1870s

The aftermath of the Civil War in the United States provides a vivid example of how contractionary monetary policy affects the economy. Before the war, the United States was on a gold standard. Paper dollars were readily convertible into gold. Under this policy, the quantity of gold determined the money supply and the price level.

In 1862, after the Civil War broke out, the Treasury announced that it would no longer redeem dollars for gold. In essence, this act replaced the gold standard with a system of fiat money. Over the next few years, the government printed large quantities of paper currency—called *greenbacks* for their color—and used the seigniorage to finance wartime expenditure. Because of this increase in the money supply, the price level approximately doubled during the war.

When the war was over, much political debate centered on the question of whether to return to the gold standard. The Greenback party was formed with the primary goal of maintaining the system of fiat money. Eventually, however, the Greenback party lost the debate. Policymakers decided to retire the greenbacks over time in order to reinstate the gold standard at the rate of exchange between dollars and gold that had prevailed before the war. Their goal was to return the value of the dollar to its former level.

Returning to the gold standard in this way required reversing the wartime rise in prices, which meant aggregate demand had to fall. (To be more precise, the growth in aggregate demand needed to fall short of the growth in the natural rate of output.) As the price level fell, the economy experienced a recession from 1873 to 1879, the longest on record. By 1879, the price level was back to its level before the war, and the gold standard was reinstated.

9-4 Stabilization Policy

Fluctuations in the economy as a whole come from changes in aggregate supply or aggregate demand. Economists call exogenous changes in these curves **shocks** to the economy. A shock that shifts the aggregate demand curve is called a **demand shock**, and a shock that shifts the aggregate supply curve is called a **supply shock**. These shocks disrupt economic well-being by pushing output and employment away from their natural rates. One goal of the model of aggregate supply and aggregate demand is to show how shocks cause economic fluctuations.

Another goal of the model is to evaluate how macroeconomic policy can respond to these shocks. Economists use the term **stabilization policy** to refer to policy actions aimed at reducing the severity of short-run economic fluctuations. Because output and employment fluctuate around their long-run natural rates, stabilization policy dampens the business cycle by keeping output and employment as close to their natural rates as possible.

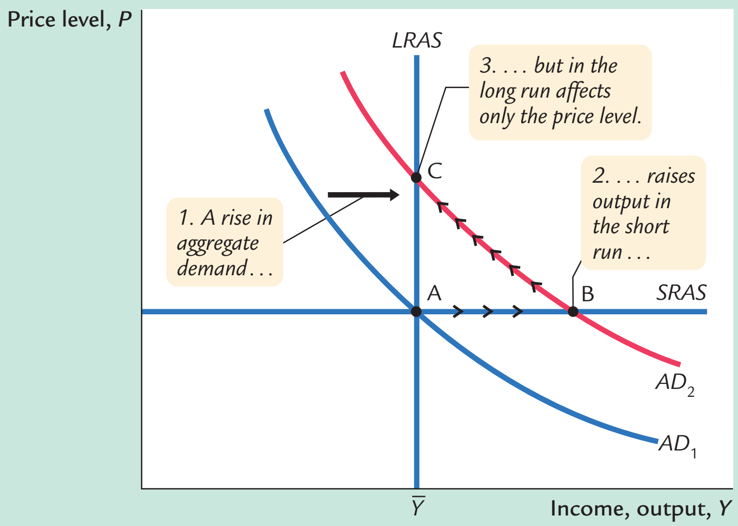
In the coming chapters, we examine in detail how stabilization policy works and what practical problems arise in its use. Here we begin our analysis of stabilization policy by examining how monetary policy might respond to shocks. Monetary policy is an important component of stabilization policy because, as we have seen, the money supply has a powerful impact on aggregate demand.

Shocks to Aggregate Demand

Consider an example of a demand shock: the introduction and expanded availability of credit cards. Because credit cards are often a more convenient way to make purchases than using cash, they reduce the quantity of money that people choose to hold. This reduction in money demand is equivalent to an increase in the velocity of money. When each person holds less money, the money demand parameter k falls. This means that each dollar of money moves from hand to hand more quickly, so velocity V (= $1/k$) rises.

If the money supply is held constant, the increase in velocity causes nominal spending to rise and the aggregate demand curve to shift outward, as in Figure 9-10. In the short run, the increase in demand raises the output of the economy—it causes an economic boom. At the old prices, firms now sell more output. Therefore, they hire more workers, ask their existing workers to work longer hours, and make greater use of their factories and equipment.

figure 9-10



An Increase in Aggregate Demand The economy begins in long-run equilibrium at point A. An increase in aggregate demand, due to an increase in the velocity of money, moves the economy from point A to point B, where output is above its natural level. As prices rise, output gradually returns to its natural rate, and the economy moves from point B to point C.

Over time, the high level of aggregate demand pulls up wages and prices. As the price level rises, the quantity of output demanded declines, and the economy gradually approaches the natural rate of production. But during the transition to the higher price level, the economy's output is higher than the natural rate.

What can the Fed do to dampen this boom and keep output closer to the natural rate? The Fed might reduce the money supply to offset the increase in velocity. Offsetting the change in velocity would stabilize aggregate demand. Thus, the Fed can reduce or even eliminate the impact of demand shocks on output and employment if it can skillfully control the money supply. Whether the Fed in fact has the necessary skill is a more difficult question, which we take up in Chapter 14.

Shocks to Aggregate Supply

Shocks to aggregate supply, as well as shocks to aggregate demand, can cause economic fluctuations. A supply shock is a shock to the economy that alters the cost of producing goods and services and, as a result, the prices that firms charge.

Because supply shocks have a direct impact on the price level, they are sometimes called *price shocks*. Here are some examples:

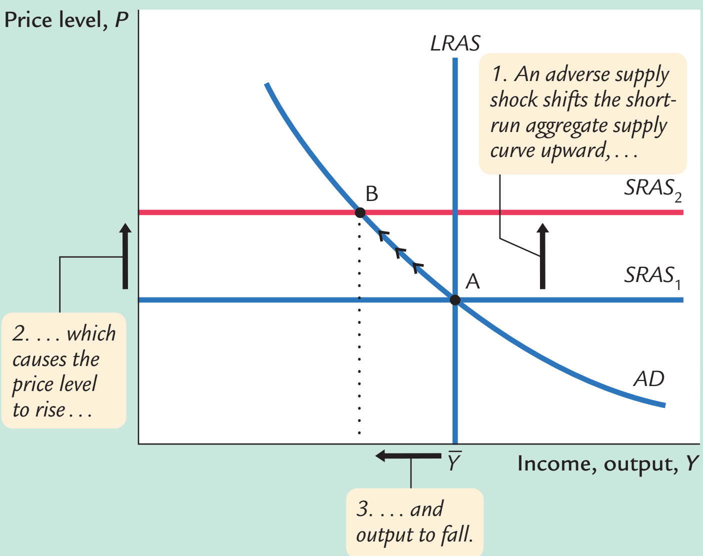
- A drought that destroys crops. The reduction in food supply pushes up food prices.
- A new environmental protection law that requires firms to reduce their emissions of pollutants. Firms pass on the added costs to customers in the form of higher prices.
- An increase in union aggressiveness. This pushes up wages and the prices of the goods produced by union workers.
- The organization of an international oil cartel. By curtailing competition, the major oil producers can raise the world price of oil.

All these events are *adverse* supply shocks, which means they push costs and prices upward. A *favorable* supply shock, such as the breakup of an international oil cartel, reduces costs and prices.

Figure 9-11 shows how an adverse supply shock affects the economy. The short-run aggregate supply curve shifts upward. (The supply shock may also lower the natural level of output and thus shift the long-run aggregate supply curve to the left, but we ignore that effect here.) If aggregate demand is held constant, the economy moves from point A to point B: the price level rises and the amount of output falls below the natural rate. An experience like this is called *stagflation*, because it combines stagnation (falling output) with inflation (rising prices).

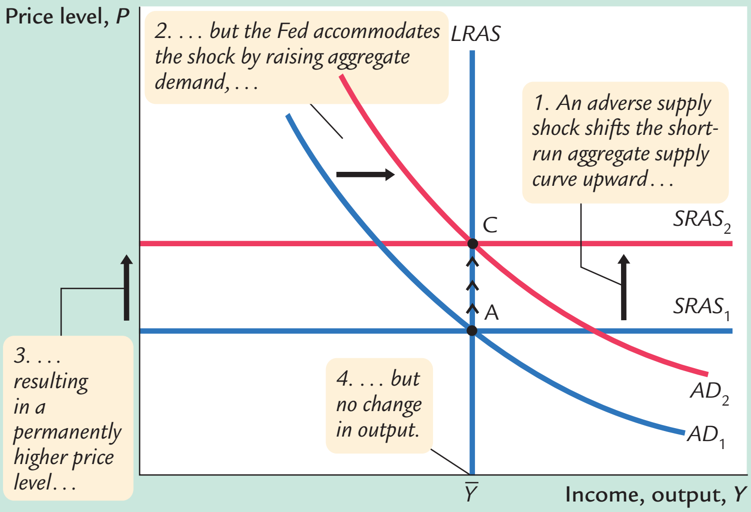
Faced with an adverse supply shock, a policymaker controlling aggregate demand, such as the Fed, has a difficult choice between two options. The first option, implicit in Figure 9-11, is to hold aggregate demand constant. In this case, output and employment are lower than the natural rate. Eventually, prices

figure 9-11



An Adverse Supply Shock An adverse supply shock pushes up costs and thus prices. If aggregate demand is held constant, the economy moves from point A to point B, leading to stagflation—a combination of increasing prices and falling output. Eventually, as prices fall, the economy returns to the natural rate, point A.

figure 9-12



Accommodating an Adverse Supply Shock In response to an adverse supply shock, the Fed can increase aggregate demand to prevent a reduction in output. The economy moves from point A to point C. The cost of this policy is a permanently higher level of prices.

will fall to restore full employment at the old price level (point A). But the cost of this adjustment process is a painful recession.

The second option, illustrated in Figure 9-12, is to expand aggregate demand to bring the economy toward the natural rate more quickly. If the increase in aggregate demand coincides with the shock to aggregate supply, the economy goes immediately from point A to point C. In this case, the Fed is said to *accommodate* the supply shock. The drawback of this option, of course, is that the price level is permanently higher. There is no way to adjust aggregate demand to maintain full employment and keep the price level stable.

CASE STUDY

How OPEC Helped Cause Stagflation in the 1970s and Euphoria in the 1980s

The most disruptive supply shocks in recent history were caused by OPEC, the Organization of Petroleum Exporting Countries. In the early 1970s, OPEC's coordinated reduction in the supply of oil nearly doubled the world price. This increase in oil prices caused stagflation in most industrial countries. These statistics show what happened in the United States:

Year	Change in Oil Prices	Inflation Rate (CPI)	Unemployment Rate
1973	11.0%	6.2%	4.9%
1974	68.0	11.0	5.6
1975	16.0	9.1	8.5
1976	3.3	5.8	7.7
1977	8.1	6.5	7.1

The 68-percent increase in the price of oil in 1974 was an adverse supply shock of major proportions. As one would have expected, it led to both higher inflation and higher unemployment.

A few years later, when the world economy had nearly recovered from the first OPEC recession, almost the same thing happened again. OPEC raised oil prices, causing further stagflation. Here are the statistics for the United States:

Year	Change in Oil Prices	Inflation Rate (CPI)	Unemployment Rate
1978	9.4%	7.7%	6.1%
1979	25.4	11.3	5.8
1980	47.8	13.5	7.0
1981	44.4	10.3	7.5
1982	−8.7	6.1	9.5

The increases in oil prices in 1979, 1980, and 1981 again led to double-digit inflation and higher unemployment.

In the mid-1980s, political turmoil among the Arab countries weakened OPEC's ability to restrain supplies of oil. Oil prices fell, reversing the stagflation of the 1970s and the early 1980s. Here's what happened:

Year	Change in Oil Prices	Inflation Rate (CPI)	Unemployment Rate
1983	−7.1%	3.2%	9.5%
1984	−1.7	4.3	7.4
1985	−7.5	3.6	7.1
1986	−44.5	1.9	6.9
1987	18.3	3.6	6.1

In 1986 oil prices fell by nearly half. This favorable supply shock led to one of the lowest inflation rates experienced in recent U.S. history and to falling unemployment.

More recently, OPEC has not been a major cause of economic fluctuations. This is in part because OPEC has been less successful at raising the price of oil. Although world oil prices have fluctuated, the changes have not been as large as those experienced during the 1970s, and the real price of oil has never returned to the peaks reached in the early 1980s. Moreover, conservation efforts and technological changes have made the economy less susceptible to oil shocks. The amount of oil consumed per unit of real GDP has fallen about 40 percent over the past three decades.

But we should not be too sanguine. The experiences of the 1970s and 1980s could always be repeated. Events in the Middle East are a potential source of shocks to economies around the world.[3]

[3] Some economists have suggested that changes in oil prices played a major role in economic fluctuations even before the 1970s. See James D. Hamilton, "Oil and the Macroeconomy Since World War II," *Journal of Political Economy* 91 (April 1983): 228–248.

9-5 Conclusion

This chapter introduced a framework to study economic fluctuations: the model of aggregate supply and aggregate demand. The model is built on the assumption that prices are sticky in the short run and flexible in the long run. It shows how shocks to the economy cause output to deviate temporarily from the level implied by the classical model.

The model also highlights the role of monetary policy. Poor monetary policy can be a source of shocks to the economy. A well-run monetary policy can respond to shocks and stabilize the economy.

In the chapters that follow, we refine our understanding of this model and our analysis of stabilization policy. Chapters 10 through 12 go beyond the quantity equation to refine our theory of aggregate demand. This refinement shows that aggregate demand depends on fiscal policy as well as monetary policy. Chapter 13 examines aggregate supply in more detail. Chapter 14 examines the debate over the virtues and limits of stabilization policy.

Summary

1. The crucial difference between the long run and the short run is that prices are flexible in the long run but sticky in the short run. The model of aggregate supply and aggregate demand provides a framework to analyze economic fluctuations and see how the impact of policies varies over different time horizons.
2. The aggregate demand curve slopes downward. It tells us that the lower the price level, the greater the aggregate quantity of goods and services demanded.
3. In the long run, the aggregate supply curve is vertical because output is determined by the amounts of capital and labor and by the available technology, but not by the level of prices. Therefore, shifts in aggregate demand affect the price level but not output or employment.
4. In the short run, the aggregate supply curve is horizontal, because wages and prices are sticky at predetermined levels. Therefore, shifts in aggregate demand affect output and employment.
5. Shocks to aggregate demand and aggregate supply cause economic fluctuations. Because the Fed can shift the aggregate demand curve, it can attempt to offset these shocks to maintain output and employment at their natural rates.

KEY CONCEPTS

Aggregate demand	Shocks	Supply shocks
Aggregate supply	Demand shocks	Stabilization policy

QUESTIONS FOR REVIEW

1. Give an example of a price that is sticky in the short run and flexible in the long run.
2. Why does the aggregate demand curve slope downward?
3. Explain the impact of an increase in the money supply in the short run and in the long run.
4. Why is it easier for the Fed to deal with demand shocks than with supply shocks?

PROBLEMS AND APPLICATIONS

1. Suppose that a change in government regulations allows banks to start paying interest on checking accounts. Recall that the money stock is the sum of currency and demand deposits, including checking accounts, so this regulatory change makes holding money more attractive.
   a. How does this change affect the demand for money?
   b. What happens to the velocity of money?
   c. If the Fed keeps the money supply constant, what will happen to output and prices in the short run and in the long run?
   d. Should the Fed keep the money supply constant in response to this regulatory change? Why or why not?
2. Suppose the Fed reduces the money supply by 5 percent.
   a. What happens to the aggregate demand curve?
   b. What happens to the level of output and the price level in the short run and in the long run?
   c. According to Okun's law, what happens to unemployment in the short run and in the long run? (*Hint:* Okun's law is the relationship between output and unemployment discussed in Chapter 2.)
   d. What happens to the real interest rate in the short run and in the long run? (*Hint:* Use the model of the real interest rate in Chapter 3 to see what happens when output changes.)
3. Let's examine how the goals of the Fed influence its response to shocks. Suppose Fed A cares only about keeping the price level stable, and Fed B cares only about keeping output and employment at their natural rates. Explain how each Fed would respond to
   a. An exogenous decrease in the velocity of money.
   b. An exogenous increase in the price of oil.
4. The official arbiter of when recessions begin and end is the National Bureau of Economic Research, a nonprofit economics research group. Go to the NBER's Web site (www.nber.org) and find the latest turning point in the business cycle. When did it occur? Was this a switch from expansion to contraction or the other way around? List all the recessions (contractions) that have occurred during your lifetime and the dates when they began and ended.

CHAPTER TEN

Aggregate Demand I

I shall argue that the postulates of the classical theory are applicable to a special case only and not to the general case. . . . Moreover, the characteristics of the special case assumed by the classical theory happen not to be those of the economic society in which we actually live, with the result that its teaching is misleading and disastrous if we attempt to apply it to the facts of experience.

— *John Maynard Keynes,* The General Theory

Of all the economic fluctuations in world history, the one that stands out as particularly large, painful, and intellectually significant is the Great Depression of the 1930s. During this time, the United States and many other countries experienced massive unemployment and greatly reduced incomes. In the worst year, 1933, one-fourth of the U.S. labor force was unemployed, and real GDP was 30 percent below its 1929 level.

This devastating episode caused many economists to question the validity of classical economic theory—the theory we examined in Chapters 3 through 6. Classical theory seemed incapable of explaining the Depression. According to that theory, national income depends on factor supplies and the available technology, neither of which changed substantially from 1929 to 1933. After the onset of the Depression, many economists believed that a new model was needed to explain such a large and sudden economic downturn and to suggest government policies that might reduce the economic hardship so many people faced.

In 1936 the British economist John Maynard Keynes revolutionized economics with his book *The General Theory of Employment, Interest, and Money*. Keynes proposed a new way to analyze the economy, which he presented as an alternative to classical theory. His vision of how the economy works quickly became a center of controversy. Yet, as economists debated *The General Theory*, a new understanding of economic fluctuations gradually developed.

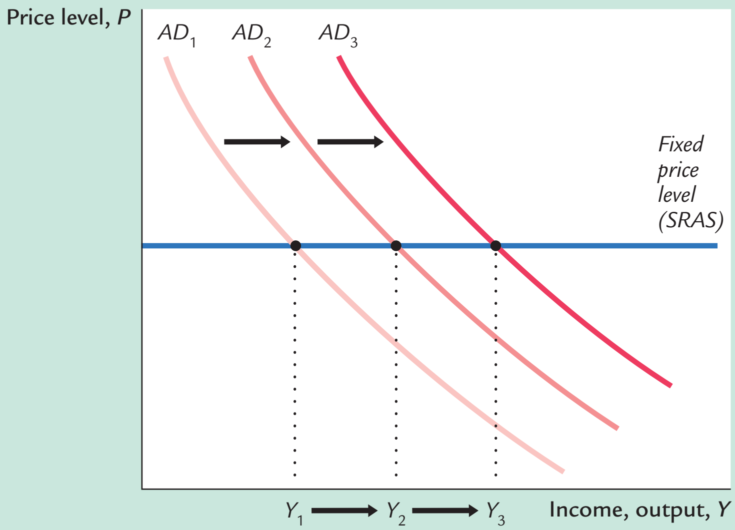
Keynes proposed that low aggregate demand is responsible for the low income and high unemployment that characterize economic downturns. He criticized classical theory for assuming that aggregate supply alone—capital, labor, and technology—determines national income. Economists today reconcile these two views with the model of aggregate demand and aggregate supply introduced in Chapter 9. In the long run, prices are flexible, and aggregate supply determines income. But in the short run, prices are sticky, so changes in aggregate demand influence income.

In this chapter and the next, we continue our study of economic fluctuations by looking more closely at aggregate demand. Our goal is to identify the variables that shift the aggregate demand curve, causing fluctuations in national income. We also examine more fully the tools policymakers can use to influence aggregate demand. In Chapter 9 we derived the aggregate demand curve from the quantity theory of money, and we showed that monetary policy can shift the aggregate demand curve. In this chapter we see that the government can influence aggregate demand with both monetary and fiscal policy.

The model of aggregate demand developed in this chapter, called the ***IS–LM* model**, is the leading interpretation of Keynes's theory. The goal of the model is to show what determines national income for any given price level. There are two ways to view this exercise. We can view the *IS–LM* model as showing what causes income to change in the short run when the price level is fixed. Or we can view the model as showing what causes the aggregate demand curve to shift. These two views of the model are equivalent: as Figure 10-1 shows, in the short run when the price level is fixed, shifts in the aggregate demand curve lead to changes in national income.

The two parts of the *IS–LM* model are, not surprisingly, the ***IS* curve** and the ***LM* curve**. *IS* stands for "investment" and "saving," and the *IS* curve represents what's going on in the market for goods and services (which we first discussed in Chapter 3). *LM* stands for "liquidity" and "money," and the *LM* curve represents what's happening to the supply and demand for money (which we first discussed in Chapter 4). Because the interest rate influences both investment and money

figure 10-1



Shifts in Aggregate Demand For a given price level, national income fluctuates because of shifts in the aggregate demand curve. The *IS–LM* model takes the price level as given and shows what causes income to change. The model therefore shows what causes aggregate demand to shift.

demand, it is the variable that links the two halves of the *IS–LM* model. The model shows how interactions between these markets determine the position and slope of the aggregate demand curve and, therefore, the level of national income in the short run.[1]

10-1 The Goods Market and the *IS* Curve

The *IS* curve plots the relationship between the interest rate and the level of income that arises in the market for goods and services. To develop this relationship, we start with a basic model called the **Keynesian cross**. This model is the simplest interpretation of Keynes's theory of national income and is a building block for the more complex and realistic *IS–LM* model.

The Keynesian Cross

In *The General Theory,* Keynes proposed that an economy's total income was, in the short run, determined largely by the desire to spend by households, firms, and the government. The more people want to spend, the more goods and services firms can sell. The more firms can sell, the more output they will choose to produce and the more workers they will choose to hire. Thus, the problem during recessions and depressions, according to Keynes, was inadequate spending. The Keynesian cross is an attempt to model this insight.

Planned Expenditure We begin our derivation of the Keynesian cross by drawing a distinction between actual and planned expenditure. *Actual expenditure* is the amount households, firms, and the government spend on goods and services, and as we first saw in Chapter 2, it equals the economy's gross domestic product (GDP). *Planned expenditure* is the amount households, firms, and the government would like to spend on goods and services.

Why would actual expenditure ever differ from planned expenditure? The answer is that firms might engage in unplanned inventory investment because their sales do not meet their expectations. When firms sell less of their product than they planned, their stock of inventories automatically rises; conversely, when firms sell more than planned, their stock of inventories falls. Because these unplanned changes in inventory are counted as investment spending by firms, actual expenditure can be either above or below planned expenditure.

Now consider the determinants of planned expenditure. Assuming that the economy is closed, so that net exports are zero, we write planned expenditure E as the sum of consumption C, planned investment I, and government purchases G:

$$E = C + I + G.$$

[1] The *IS–LM* model was introduced in a classic article by the Nobel-Prize-winning economist John R. Hicks, "Mr. Keynes and the Classics: A Suggested Interpretation," *Econometrica* 5 (1937): 147–159.

To this equation, we add the consumption function

$$C = C(Y - T).$$

This equation states that consumption depends on disposable income $(Y - T)$, which is total income Y minus taxes T. To keep things simple, for now we take planned investment as exogenously fixed:

$$I = \bar{I}.$$

And as in Chapter 3, we assume that fiscal policy—the levels of government purchases and taxes—is fixed:

$$G = \overline{G},$$
$$T = \overline{T}.$$

Combining these five equations, we obtain

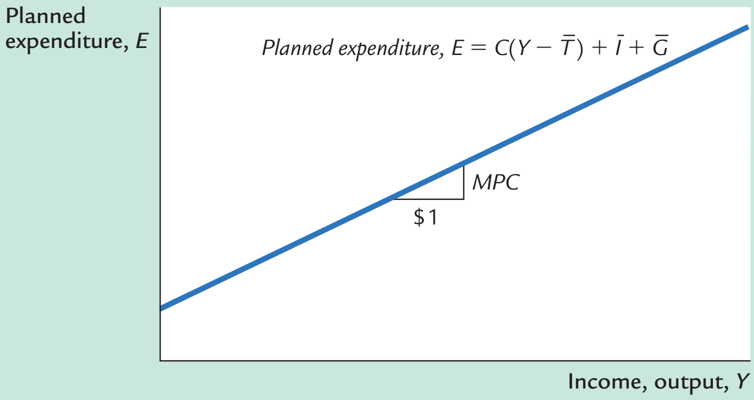
$$E = C(Y - \overline{T}) + \bar{I} + \overline{G}.$$

This equation shows that planned expenditure is a function of income Y, the level of planned investment $\bar{I}$, and the fiscal policy variables $\overline{G}$ and $\overline{T}$.

Figure 10-2 graphs planned expenditure as a function of the level of income. This line slopes upward because higher income leads to higher consumption and thus higher planned expenditure. The slope of this line is the marginal propensity to consume, the *MPC:* it shows how much planned expenditure increases when income rises by \$1. This planned-expenditure function is the first piece of the model called the Keynesian cross.

The Economy in Equilibrium The next piece of the Keynesian cross is the assumption that the economy is in equilibrium when actual expenditure equals planned expenditure. This assumption is based on the idea that when people's plans have been realized, they have no reason to change what they are doing.

figure 10-2



Planned Expenditure as a Function of Income Planned expenditure depends on income because higher income leads to higher consumption, which is part of planned expenditure. The slope of this planned-expenditure function is the marginal propensity to consume, *MPC*.

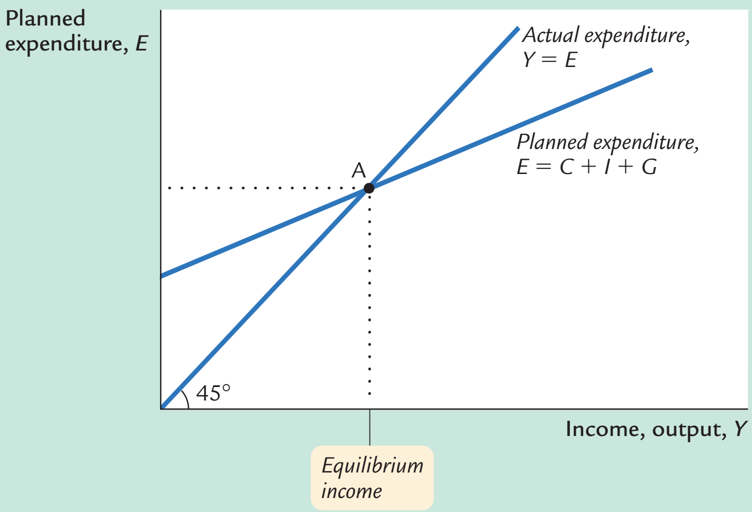
Recalling that Y as GDP equals not only total income but also total actual expenditure on goods and services, we can write this equilibrium condition as

$$\text{Actual Expenditure} = \text{Planned Expenditure}$$
$$Y = E.$$

The 45-degree line in Figure 10-3 plots the points where this condition holds. With the addition of the planned-expenditure function, this diagram becomes the Keynesian cross. The equilibrium of this economy is at point A, where the planned-expenditure function crosses the 45-degree line.

How does the economy get to the equilibrium? In this model, inventories play an important role in the adjustment process. Whenever the economy is not in equilibrium, firms experience unplanned changes in inventories, and this induces them to change production levels. Changes in production in turn influence total income and expenditure, moving the economy toward equilibrium.

figure 10-3

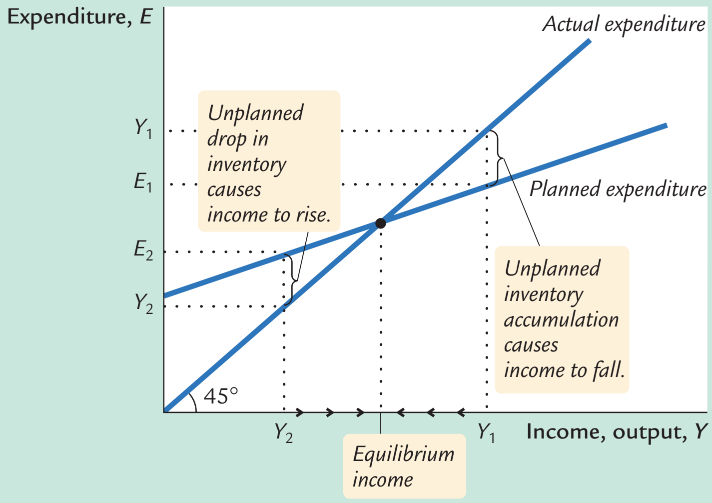


The Keynesian Cross The equilibrium in the Keynesian cross is at point A, where income (actual expenditure) equals planned expenditure.

For example, suppose the economy were ever to find itself with GDP at a level greater than the equilibrium level, such as the level Y_1 in Figure 10-4. In this case, planned expenditure E_1 is less than production Y_1, so firms are selling less than they are producing. Firms add the unsold goods to their stock of inventories. This unplanned rise in inventories induces firms to lay off workers and reduce production, and these actions in turn reduce GDP. This process of unintended inventory accumulation and falling income continues until income Y falls to the equilibrium level.

Similarly, suppose GDP were at a level lower than the equilibrium level, such as the level Y_2 in Figure 10-4. In this case, planned expenditure E_2 is greater than production Y_2. Firms meet the high level of sales by drawing down their inventories.

figure 10-4



The Adjustment to Equilibrium in the Keynesian Cross If firms were producing at level Y_1, then planned expenditure E_1 would fall short of production, and firms would accumulate inventories. This inventory accumulation would induce firms to reduce production. Similarly, if firms were producing at level Y_2, then planned expenditure E_2 would exceed production, and firms would run down their inventories. This fall in inventories would induce firms to raise production. In both cases, the firms' decisions drive the economy toward equilibrium.

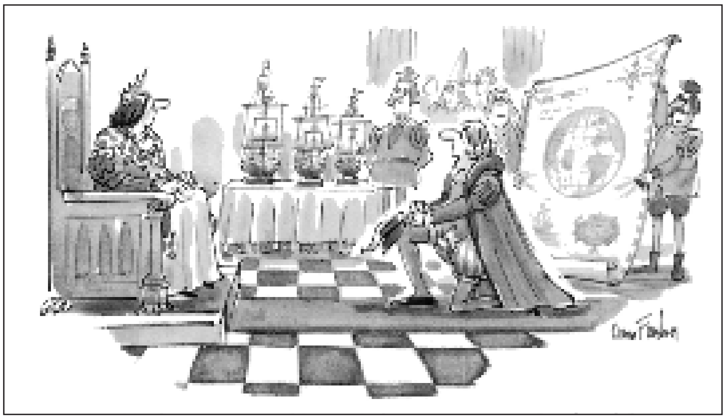
But when firms see their stock of inventories dwindle, they hire more workers and increase production. GDP rises, and the economy approaches the equilibrium.

In summary, the Keynesian cross shows how income Y is determined for given levels of planned investment I and fiscal policy G and T. We can use this model to show how income changes when one of these exogenous variables changes.

Fiscal Policy and the Multiplier: Government Purchases Consider how changes in government purchases affect the economy. Because government purchases are one component of expenditure, higher government purchases result in higher planned expenditure for any given level of income. If government purchases rise by ΔG, then the planned-expenditure schedule shifts upward by ΔG, as in Figure 10-5. The equilibrium of the economy moves from point A to point B.

This graph shows that an increase in government purchases leads to an even greater increase in income. That is, ΔY is larger than ΔG. The ratio $\Delta Y/\Delta G$ is called the **government-purchases multiplier**; it tells us how much income rises in response to a \$1 increase in government purchases. An implication of the Keynesian cross is that the government-purchases multiplier is larger than 1.

Why does fiscal policy have a multiplied effect on income?



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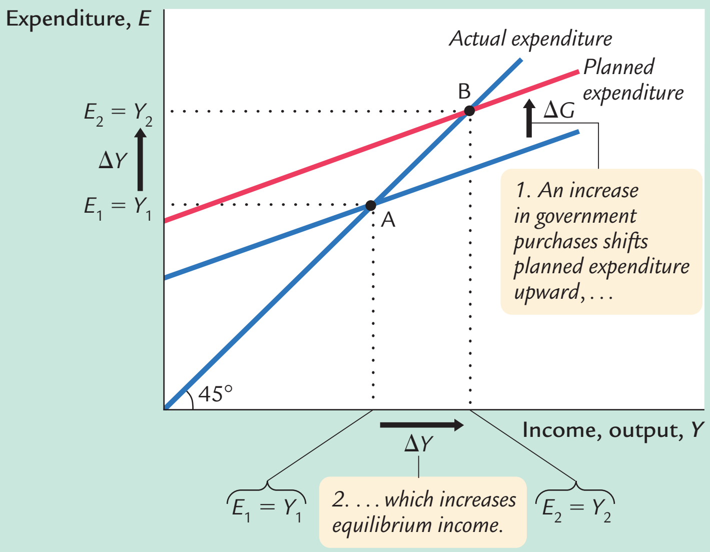
"Your Majesty, my voyage will not only forge a new route to the spices of the East but also create over three thousand new jobs."

figure 10-5



An Increase in Government Purchases in the Keynesian Cross An increase in government purchases of ΔG raises planned expenditure by that amount for any given level of income. The equilibrium moves from point A to point B, and income rises from Y_1 to Y_2. Note that the increase in income ΔY exceeds the increase in government purchases ΔG. Thus, fiscal policy has a multiplied effect on income.

The reason is that, according to the consumption function $C = C(Y - T)$, higher income causes higher consumption. When an increase in government purchases raises income, it also raises consumption, which further raises income, which further raises consumption, and so on. Therefore, in this model, an increase in government purchases causes a greater increase in income.

How big is the multiplier? To answer this question, we trace through each step of the change in income. The process begins when expenditure rises by ΔG, which implies that income rises by ΔG as well. This increase in income in turn raises consumption by $MPC \times \Delta G$, where MPC is the marginal propensity to consume. This increase in consumption raises expenditure and income once again. This second increase in income of $MPC \times \Delta G$ again raises consumption, this time by $MPC \times (MPC \times \Delta G)$, which again raises expenditure and income, and so on. This feedback from consumption to income to consumption continues indefinitely. The total effect on income is

$$\begin{array}{lr}
\text{Initial Change in Government Purchases} = & \Delta G \\
\text{First Change in Consumption} & = MPC \times \Delta G \\
\text{Second Change in Consumption} & = MPC^2 \times \Delta G \\
\text{Third Change in Consumption} & = MPC^3 \times \Delta G \\
\vdots & \vdots \\
\hline
\multicolumn{2}{c}{\Delta Y = (1 + MPC + MPC^2 + MPC^3 + \cdots)\Delta G.}
\end{array}$$

The government-purchases multiplier is

$$\Delta Y/\Delta G = 1 + MPC + MPC^2 + MPC^3 + \cdots$$

This expression for the multiplier is an example of an *infinite geometric series*. A result from algebra allows us to write the multiplier as[2]

$$\Delta Y/\Delta G = 1/(1 - MPC).$$

For example, if the marginal propensity to consume is 0.6, the multiplier is

$$\begin{aligned}\Delta Y/\Delta G &= 1 + 0.6 + 0.6^2 + 0.6^3 + \cdots \\ &= 1/(1 - 0.6) \\ &= 2.5.\end{aligned}$$

In this case, a \$1.00 increase in government purchases raises equilibrium income by \$2.50.[3]

Fiscal Policy and the Multiplier: Taxes Consider now how changes in taxes affect equilibrium income. A decrease in taxes of ΔT immediately raises disposable income $Y - T$ by ΔT and, therefore, increases consumption by $MPC \times \Delta T$. For any given level of income Y, planned expenditure is now higher. As Figure 10-6 shows, the planned-expenditure schedule shifts upward by $MPC \times \Delta T$. The equilibrium of the economy moves from point A to point B.

---

[2] *Mathematical note:* We prove this algebraic result as follows. Let

$$z = 1 + x + x^2 + \cdots.$$

Multiply both sides of this equation by x:

$$xz = x + x^2 + x^3 + \cdots.$$

Subtract the second equation from the first:

$$z - xz = 1.$$

Rearrange this last equation to obtain

$$z(1 - x) = 1,$$

which implies

$$z = 1/(1 - x).$$

This completes the proof.

[3] *Mathematical note:* The government-purchases multiplier is most easily derived using a little calculus. Begin with the equation

$$Y = C(Y - T) + I + G.$$

Holding T and I fixed, differentiate to obtain

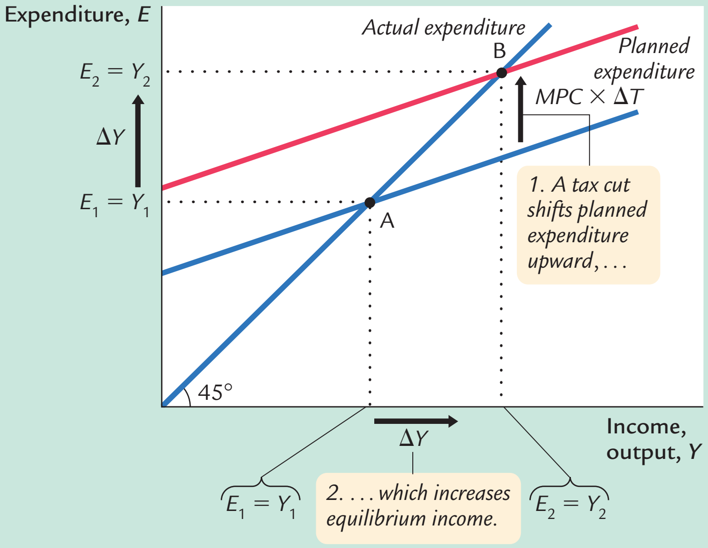
$$dY = C'dY + dG,$$

and then rearrange to find

$$dY/dG = 1/(1 - C').$$

This is the same as the equation in the text.

figure 10-6



A Decrease in Taxes in the Keynesian Cross A decrease in taxes of ΔT raises planned expenditure by $MPC \times \Delta T$ for any given level of income. The equilibrium moves from point A to point B, and income rises from Y_1 to Y_2. Again, fiscal policy has a multiplied effect on income.

Just as an increase in government purchases has a multiplied effect on income, so does a decrease in taxes. As before, the initial change in expenditure, now $MPC \times \Delta T$, is multiplied by $1/(1 - MPC)$. The overall effect on income of the change in taxes is

$$\Delta Y/\Delta T = -MPC/(1 - MPC).$$

This expression is the **tax multiplier**, the amount income changes in response to a \$1 change in taxes. For example, if the marginal propensity to consume is 0.6, then the tax multiplier is

$$\Delta Y/\Delta T = -0.6/(1 - 0.6) = -1.5.$$

In this example, a \$1.00 cut in taxes raises equilibrium income by \$1.50.[4]

---

[4] *Mathematical note:* As before, the multiplier is most easily derived using a little calculus. Begin with the equation

$$Y = C(Y - T) + I + G.$$

Holding I and G fixed, differentiate to obtain

$$dY = C'(dY - dT),$$

and then rearrange to find

$$dY/dT = -C'/(1 - C').$$

This is the same as the equation in the text.

CASE STUDY

Cutting Taxes to Stimulate the Economy

When John F. Kennedy became president of the United States in 1961, he brought to Washington some of the brightest young economists of the day to work on his Council of Economic Advisers. These economists, who had been schooled in the economics of Keynes, brought Keynesian ideas to discussions of economic policy at the highest level.

One of the council's first proposals was to expand national income by reducing taxes. This eventually led to a substantial cut in personal and corporate income taxes in 1964. The tax cut was intended to stimulate expenditure on consumption and investment and thus lead to higher levels of income and employment. When a reporter asked Kennedy why he advocated a tax cut, Kennedy replied, "To stimulate the economy. Don't you remember your Economics 101?"

As Kennedy's economic advisers predicted, the passage of the tax cut was followed by an economic boom. Growth in real GDP was 5.3 percent in 1964 and 6.0 percent in 1965. The unemployment rate fell from 5.7 percent in 1963 to 5.2 percent in 1964 and then to 4.5 percent in 1965.[5]

Economists continue to debate the source of this rapid growth in the early 1960s. A group called *supply-siders* argues that the economic boom resulted from the incentive effects of the cut in income tax rates. According to supply-siders, when workers are allowed to keep a higher fraction of their earnings, they supply substantially more labor and expand the aggregate supply of goods and services. Keynesians, however, emphasize the impact of tax cuts on aggregate demand. Most likely, both views have some truth: *Tax cuts stimuate aggregate supply by improving workers' incentives and expand aggregate demand by raising households' disposable income.*

When George W. Bush was elected president in 2001, a major element of his platform was a cut in income taxes. Bush and his advisers used both supply-side and Keynesian rhetoric to make the case for their policy. During the campaign, when the economy was doing fine, they argued that lower marginal tax rates would improve work incentives. But then the economy started to slow: unemployment rose from 3.9 percent in October 2000 to 4.5 percent in April 2001. The argument shifted to emphasize that the tax cut would stimulate spending and reduce the risk of recession.

Congress passed the tax cut in May 2001. Compared to the original Bush proposal, the bill cut tax rates less in the long run. But it added an immediate tax rebate of $600 per family ($300 for single taxpayers) that was mailed out in the summer of 2001. Consistent with Keynesian theory, the goal of the rebate was to provide an immediate stimulus to aggregate demand.

[5] For an analysis of the 1964 tax cut by one of Kennedy's economists, see Arthur Okun, "Measuring the Impact of the 1964 Tax Reduction," in W. W. Heller, ed., *Perspectives on Economic Growth* (New York: Random House, 1968); reprinted in Arthur M. Okun, *Economics for Policymaking* (Cambridge, MA: MIT Press, 1983), 405–423.

The Interest Rate, Investment, and the *IS* Curve

The Keynesian cross is only a steppingstone on our path to the *IS–LM* model. The Keynesian cross is useful because it shows how the spending plans of households, firms, and the government determine the economy's income. Yet it makes the simplifying assumption that the level of planned investment *I* is fixed. As we discussed in Chapter 3, an important macroeconomic relationship is that planned investment depends on the interest rate *r*.

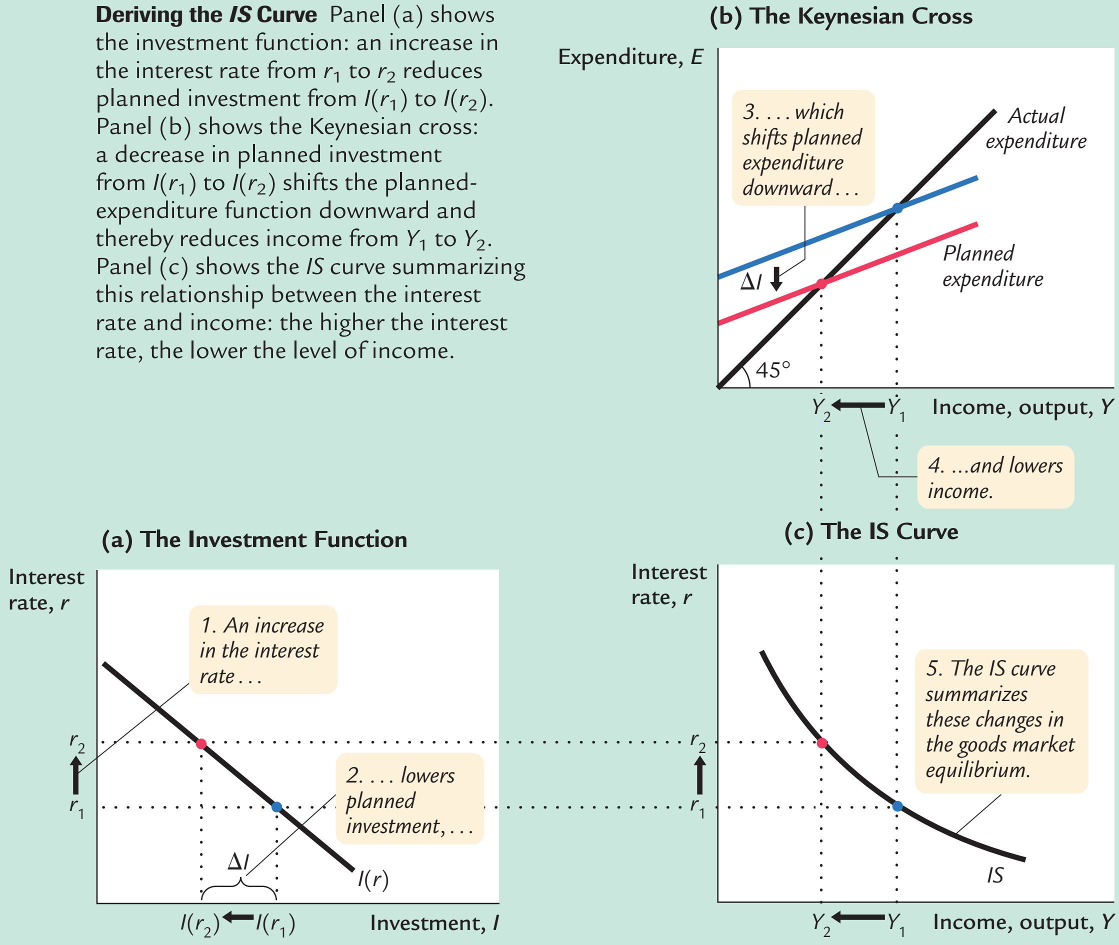
To add this relationship between the interest rate and investment to our model, we write the level of planned investment as

$$I = I(r).$$

This investment function is graphed in panel (a) of Figure 10-7. Because the interest rate is the cost of borrowing to finance investment projects, an increase in

figure 10-7

Deriving the *IS* Curve Panel (a) shows the investment function: an increase in the interest rate from r_1 to r_2 reduces planned investment from $I(r_1)$ to $I(r_2)$. Panel (b) shows the Keynesian cross: a decrease in planned investment from $I(r_1)$ to $I(r_2)$ shifts the planned-expenditure function downward and thereby reduces income from Y_1 to Y_2. Panel (c) shows the *IS* curve summarizing this relationship between the interest rate and income: the higher the interest rate, the lower the level of income.



the interest rate reduces planned investment. As a result, the investment function slopes downward.

To determine how income changes when the interest rate changes, we can combine the investment function with the Keynesian-cross diagram. Because investment is inversely related to the interest rate, an increase in the interest rate from r_1 to r_2 reduces the quantity of investment from $I(r_1)$ to $I(r_2)$. The reduction in planned investment, in turn, shifts the planned-expenditure function downward, as in panel (b) of Figure 10-7. The shift in the planned-expenditure function causes the level of income to fall from Y_1 to Y_2. Hence, an increase in the interest rate lowers income.

The *IS* curve, shown in panel (c) of Figure 10-7, summarizes this relationship between the interest rate and the level of income. In essence, the *IS* curve combines the interaction between r and I expressed by the investment function and the interaction between I and Y demonstrated by the Keynesian cross. Because an increase in the interest rate causes planned investment to fall, which in turn causes income to fall, the *IS* curve slopes downward.

How Fiscal Policy Shifts the *IS* Curve

The *IS* curve shows us, for any given interest rate, the level of income that brings the goods market into equilibrium. As we learned from the Keynesian cross, the level of income also depends on fiscal policy. The *IS* curve is drawn for a given fiscal policy; that is, when we construct the *IS* curve, we hold G and T fixed. When fiscal policy changes, the *IS* curve shifts.

Figure 10-8 uses the Keynesian cross to show how an increase in government purchases by ΔG shifts the *IS* curve. This figure is drawn for a given interest rate $\bar{r}$ and thus for a given level of planned investment. The Keynesian cross shows that this change in fiscal policy raises planned expenditure and thereby increases equilibrium income from Y_1 to Y_2. Therefore, an increase in government purchases shifts the *IS* curve outward.

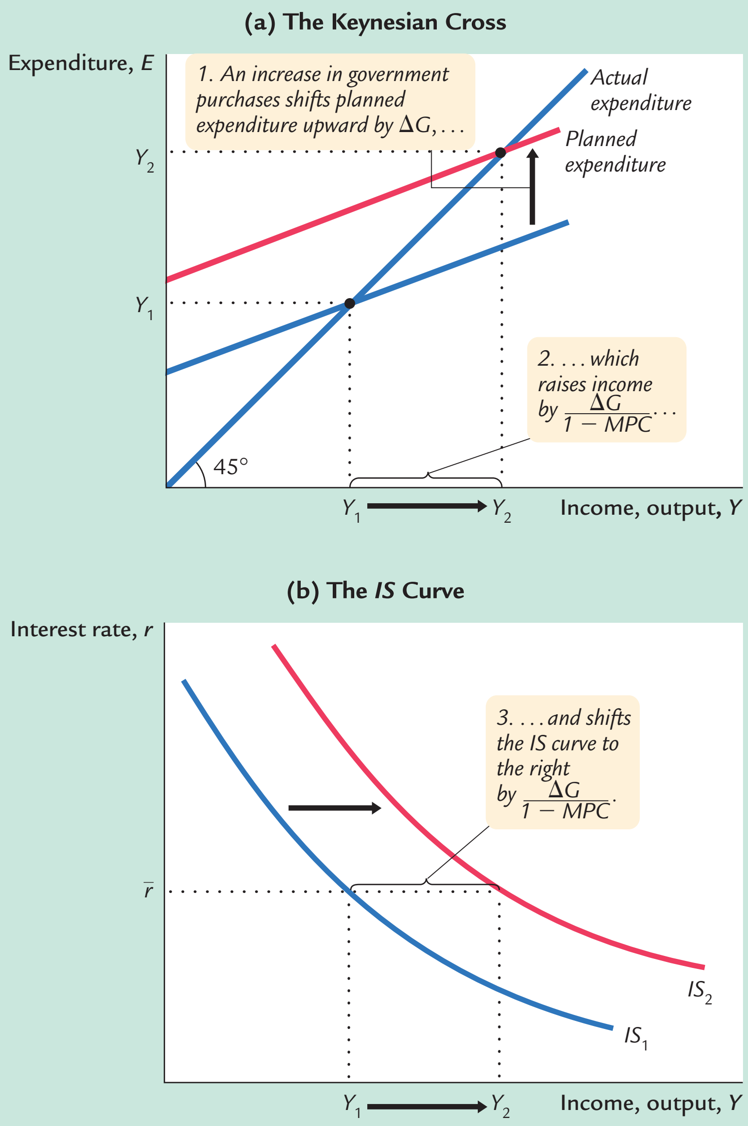
We can use the Keynesian cross to see how other changes in fiscal policy shift the *IS* curve. Because a decrease in taxes also expands expenditure and income, it too shifts the *IS* curve outward. A decrease in government purchases or an increase in taxes reduces income; therefore, such a change in fiscal policy shifts the *IS* curve inward.

In summary, the IS curve shows the combinations of the interest rate and the level of income that are consistent with equilibrium in the market for goods and services. The IS curve is drawn for a given fiscal policy. Changes in fiscal policy that raise the demand for goods and services shift the IS curve to the right. Changes in fiscal policy that reduce the demand for goods and services shift the IS curve to the left.

A Loanable-Funds Interpretation of the *IS* Curve

When we first studied the market for goods and services in Chapter 3, we noted an equivalence between the supply and demand for goods and services and the supply and demand for loanable funds. This equivalence provides another way to interpret the *IS* curve.

figure 10-8



An Increase in Government Purchases Shifts the *IS* Curve Outward Panel (a) shows that an increase in government purchases raises planned expenditure. For any given interest rate, the upward shift in planned expenditure of ΔG leads to an increase in income Y of $\Delta G/(1 - MPC)$. Therefore, in panel (b), the *IS* curve shifts to the right by this amount.

Recall that the national income accounts identity can be written as

$$Y - C - G = I$$
$$S = I.$$

The left-hand side of this equation is national saving S, and the right-hand side is investment I. National saving represents the supply of loanable funds, and investment represents the demand for these funds.

To see how the market for loanable funds produces the *IS* curve, substitute the consumption function for C and the investment function for I:

$$Y - C(Y - T) - G = I(r).$$

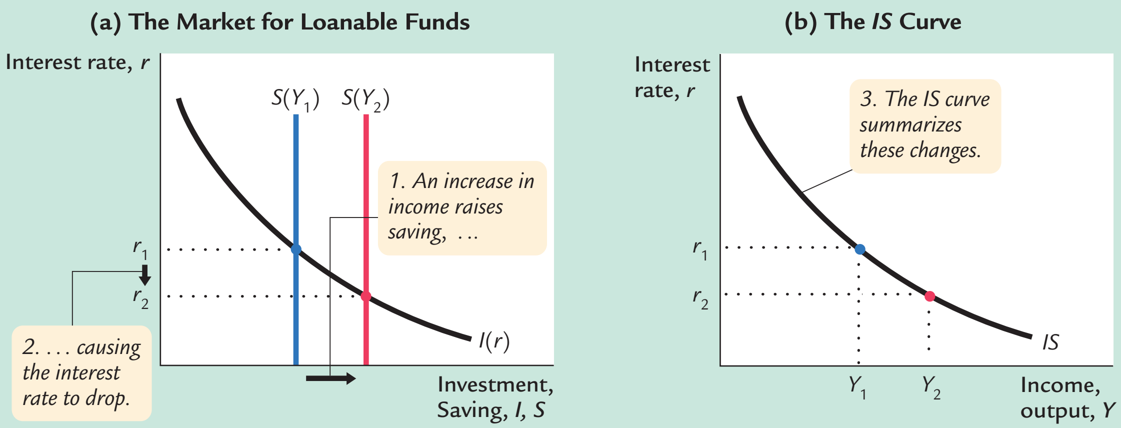
The left-hand side of this equation shows that the supply of loanable funds depends on income and fiscal policy. The right-hand side shows that the demand for loanable funds depends on the interest rate. The interest rate adjusts to equilibrate the supply and demand for loans.

As Figure 10-9 illustrates, we can interpret the *IS* curve as showing the interest rate that equilibrates the market for loanable funds for any given level of income. When income rises from Y_1 to Y_2, national saving, which equals $Y - C - G$, increases. (Consumption rises by less than income, because the marginal propensity to consume is less than 1.) As panel (a) shows, the increased supply of loanable funds drives down the interest rate from r_1 to r_2. The *IS* curve in panel (b) summarizes this relationship: higher income implies higher saving, which in turn implies a lower equilibrium interest rate. For this reason, the *IS* curve slopes downward.

This alternative interpretation of the *IS* curve also explains why a change in fiscal policy shifts the *IS* curve. An increase in government purchases or a decrease in taxes reduces national saving for any given level of income. The reduced supply of loanable funds raises the interest rate that equilibrates the market. Because the interest rate is now higher for any given level of income, the *IS* curve shifts upward in response to the expansionary change in fiscal policy.

Finally, note that the *IS* curve does not determine either income Y or the interest rate r. Instead, the *IS* curve is a relationship between Y and r arising in the

figure 10-9



A Loanable-Funds Interpretation of the *IS* Curve Panel (a) shows that an increase in income from Y_1 to Y_2 raises saving and thus lowers the interest rate that equilibrates the supply and demand for loanable funds. The *IS* curve in panel (b) expresses this negative relationship between income and the interest rate.

market for goods and services or, equivalently, the market for loanable funds. To determine the equilibrium of the economy, we need another relationship between these two variables, to which we now turn.

10-2 The Money Market and the *LM* Curve

The *LM* curve plots the relationship between the interest rate and the level of income that arises in the market for money balances. To understand this relationship, we begin by looking at a theory of the interest rate, called the **theory of liquidity preference.**

The Theory of Liquidity Preference

In his classic work *The General Theory*, Keynes offered his view of how the interest rate is determined in the short run. That explanation is called the theory of liquidity preference, because it posits that the interest rate adjusts to balance the supply and demand for the economy's most liquid asset—money. Just as the Keynesian cross is a building block for the *IS* curve, the theory of liquidity preference is a building block for the *LM* curve.

To develop this theory, we begin with the supply of real money balances. If M stands for the supply of money and P stands for the price level, then M/P is the supply of real money balances. The theory of liquidity preference assumes there is a fixed supply of real money balances. That is,

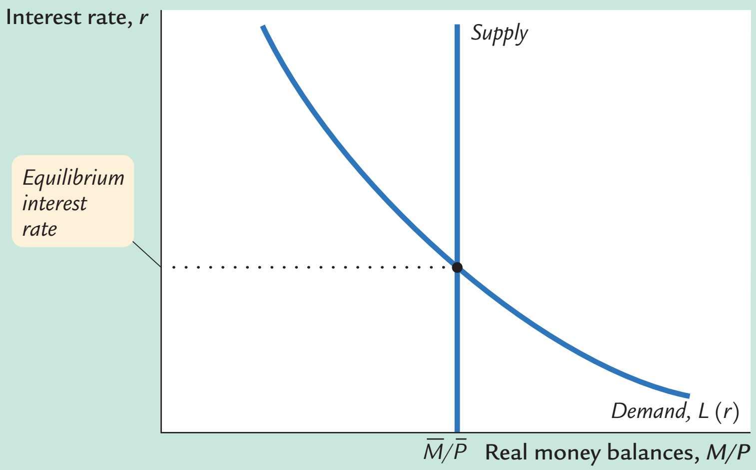
$$(M/P)^{s} = \overline{M}/\overline{P}.$$

The money supply M is an exogenous policy variable chosen by a central bank, such as the Federal Reserve. The price level P is also an exogenous variable in this model. (We take the price level as given because the *IS–LM* model—our ultimate goal in this chapter—explains the short run when the price level is fixed.) These assumptions imply that the supply of real money balances is fixed and, in particular, does not depend on the interest rate. Thus, when we plot the supply of real money balances against the interest rate in Figure 10-10, we obtain a vertical supply curve.

Next, consider the demand for real money balances. The theory of liquidity preference posits that the interest rate is one determinant of how much money people choose to hold. The reason is that the interest rate is the opportunity cost of holding money: it is what you forgo by holding some of your assets as money, which does not bear interest, instead of as interest-bearing bank deposits or bonds. When the interest rate rises, people want to hold less of their wealth in the form of money. We can write the demand for real money balances as

$$(M/P)^{d} = L(r),$$

figure 10-10



The Theory of Liquidity Preference The supply and demand for real money balances determine the interest rate. The supply curve for real money balances is vertical because the supply does not depend on the interest rate. The demand curve is downward sloping because a higher interest rate raises the cost of holding money and thus lowers the quantity demanded. At the equilibrium interest rate, the quantity of real money balances demanded equals the quantity supplied.

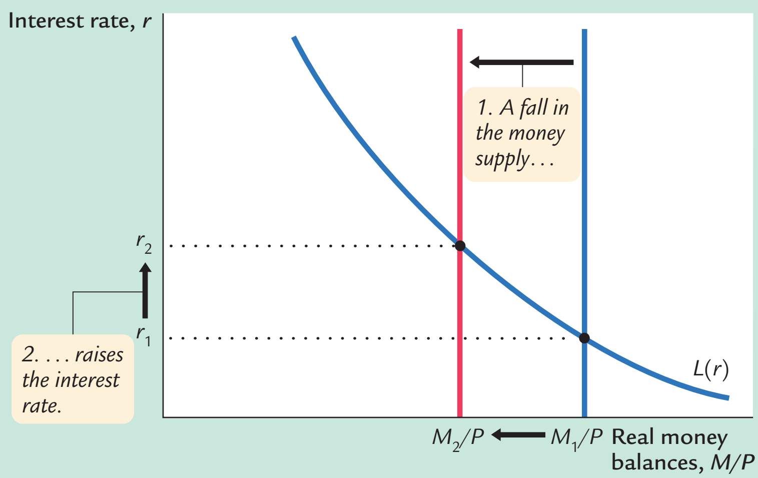
where the function $L(\ )$ shows that the quantity of money demanded depends on the interest rate. Thus, the demand curve in Figure 10-10 slopes downward because higher interest rates reduce the quantity of real money balances demanded.[6]

According to the theory of liquidity preference, the supply and demand for real money balances determine what interest rate prevails in the economy. That is, the interest rate adjusts to equilibrate the money market. As the figure shows, at the equilibrium interest rate, the quantity of real money balances demanded equals the quantity supplied.

How does the interest rate get to this equilibrium of money supply and money demand? The adjustment occurs because whenever the money market is not in equilibrium, people try to adjust their portfolios of assets and, in the process, alter the interest rate. For instance, if the interest rate is above the equilibrium level, the quantity of real money balances supplied exceeds the quantity demanded. Individuals holding the excess supply of money try to convert some of their non-interest-bearing money into interest-bearing bank deposits or bonds. Banks and bond issuers, who prefer to pay lower interest rates, respond to this excess supply of money by lowering the interest rates they offer. Conversely, if the interest rate is below the equilibrium level, so that the quantity of money demanded exceeds the quantity supplied, individuals try to obtain money by selling bonds or making bank withdrawals. To attract now-scarcer funds, banks and bond issuers respond by increasing the interest rates they offer. Eventually, the

[6] Note that r is being used to denote the interest rate here, as it was in our discussion of the *IS* curve. More accurately, it is the nominal interest rate that determines money demand and the real interest rate that determines investment. To keep things simple, we are ignoring expected inflation, which creates the difference between the real and nominal interest rates. The role of expected inflation in the *IS–LM* model is explored in Chapter 11.

figure 10-11



A Reduction in the Money Supply in the Theory of Liquidity Preference If the price level is fixed, a reduction in the money supply from M_1 to M_2 reduces the supply of real money balances. The equilibrium interest rate therefore rises from r_1 to r_2.

interest rate reaches the equilibrium level, at which people are content with their portfolios of monetary and nonmonetary assets.

Now that we have seen how the interest rate is determined, we can use the theory of liquidity preference to show how the interest rate responds to changes in the supply of money. Suppose, for instance, that the Fed suddenly decreases the money supply. A fall in M reduces M/P, because P is fixed in the model. The supply of real money balances shifts to the left, as in Figure 10-11. The equilibrium interest rate rises from r_1 to r_2, and the higher interest rate makes people satisfied to hold the smaller quantity of real money balances. The opposite would occur if the Fed had suddenly increased the money supply. Thus, according to the theory of liquidity preference, a decrease in the money supply raises the interest rate, and an increase in the money supply lowers the interest rate.

CASE STUDY

Did Paul Volcker's Monetary Tightening Raise or Lower Interest Rates?

The early 1980s saw the largest and quickest reduction in inflation in recent U.S. history. By the late 1970s inflation had reached the double-digit range; in 1979, consumer prices were rising at a rate of 11.3 percent per year. In October 1979, only two months after becoming the chairman of the Federal Reserve, Paul Volcker announced that monetary policy would aim to reduce the rate of inflation. This announcement began a period of tight money that, by 1983, brought the inflation rate down to about 3 percent.

How does such a monetary tightening influence interest rates? According to the theories we have been developing, the answer depends on the time horizon. Our analysis of the Fisher effect in Chapter 4 suggests that in the long run

Volcker's change in monetary policy would lower inflation, and this in turn would lead to lower nominal interest rates. Yet the theory of liquidity preference predicts that, in the short run when prices are sticky, anti-inflationary monetary policy would lead to falling real money balances and higher nominal interest rates.

Both conclusions are consistent with experience. Nominal interest rates did fall in the 1980s as inflation fell. But comparing the year before the October 1979 announcement and the year after, we find that real money balances (*M*1 divided by the CPI) fell 8.3 percent and the nominal interest rate (on short-term commercial loans) rose from 10.1 percent to 11.9 percent. Hence, although a monetary tightening leads to lower nominal interest rates in the long run, it leads to higher nominal interest rates in the short run.

Income, Money Demand, and the *LM* Curve

Having developed the theory of liquidity preference as an explanation for what determines the interest rate, we can now use the theory to derive the *LM* curve. We begin by considering the following question: How does a change in the economy's level of income Y affect the market for real money balances? The answer (which should be familiar from Chapter 4) is that the level of income affects the demand for money. When income is high, expenditure is high, so people engage in more transactions that require the use of money. Thus, greater income implies greater money demand. We can express these ideas by writing the money demand function as

$$(M/P)^{d} = L(r, Y).$$

The quantity of real money balances demanded is negatively related to the interest rate and positively related to income.

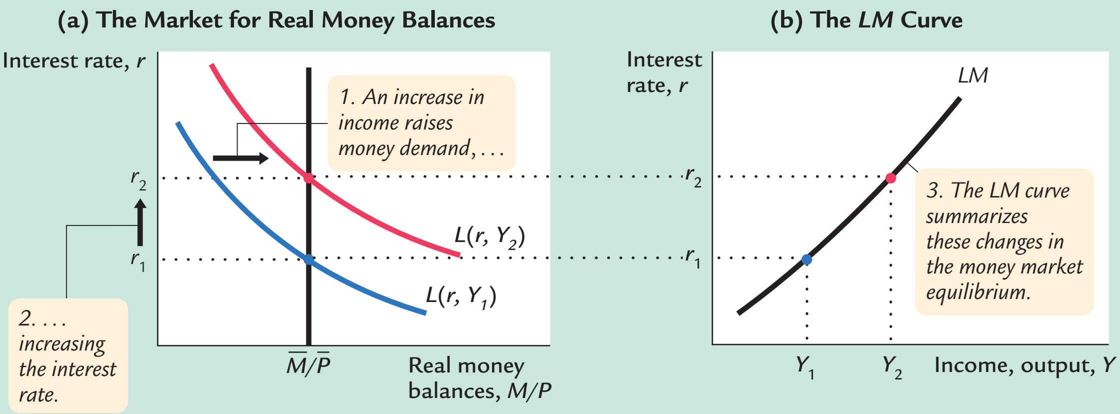
Using the theory of liquidity preference, we can figure out what happens to the equilibrium interest rate when the level of income changes. For example, consider what happens in Figure 10-12 when income increases from Y_1 to Y_2. As panel (a) illustrates, this increase in income shifts the money demand curve to the right. With the supply of real money balances unchanged, the interest rate must rise from r_1 to r_2 to equilibrate the money market. Therefore, according to the theory of liquidity preference, higher income leads to a higher interest rate.

The *LM* curve plots this relationship between the level of income and the interest rate. The higher the level of income, the higher the demand for real money balances, and the higher the equilibrium interest rate. For this reason, the *LM* curve slopes upward, as in panel (b) of Figure 10-12.

How Monetary Policy Shifts the *LM* Curve

The *LM* curve tells us the interest rate that equilibrates the money market at any level of income. Yet, as we saw earlier, the equilibrium interest rate also depends on the supply of real money balances, M/P. This means that the *LM* curve is

figure 10-12



Deriving the *LM* Curve Panel (a) shows the market for real money balances: an increase in income from Y_1 to Y_2 raises the demand for money and thus raises the interest rate from r_1 to r_2. Panel (b) shows the *LM* curve summarizing this relationship between the interest rate and income: the higher the level of income, the higher the interest rate.

drawn for a *given* supply of real money balances. If real money balances change—for example, if the Fed alters the money supply—the *LM* curve shifts.

We can use the theory of liquidity preference to understand how monetary policy shifts the *LM* curve. Suppose that the Fed decreases the money supply from M_1 to M_2, which causes the supply of real money balances to fall from M_1/P to M_2/P. Figure 10-13 shows what happens. Holding constant the amount of income and thus the demand curve for real money balances, we see that a reduction in the supply of real money balances raises the interest rate that equilibrates the money market. Hence, a decrease in the money supply shifts the *LM* curve upward.

In summary, the LM curve shows the combinations of the interest rate and the level of income that are consistent with equilibrium in the market for real money balances. The LM curve is drawn for a given supply of real money balances. Decreases in the supply of real money balances shift the LM curve upward. Increases in the supply of real money balances shift the LM curve downward.

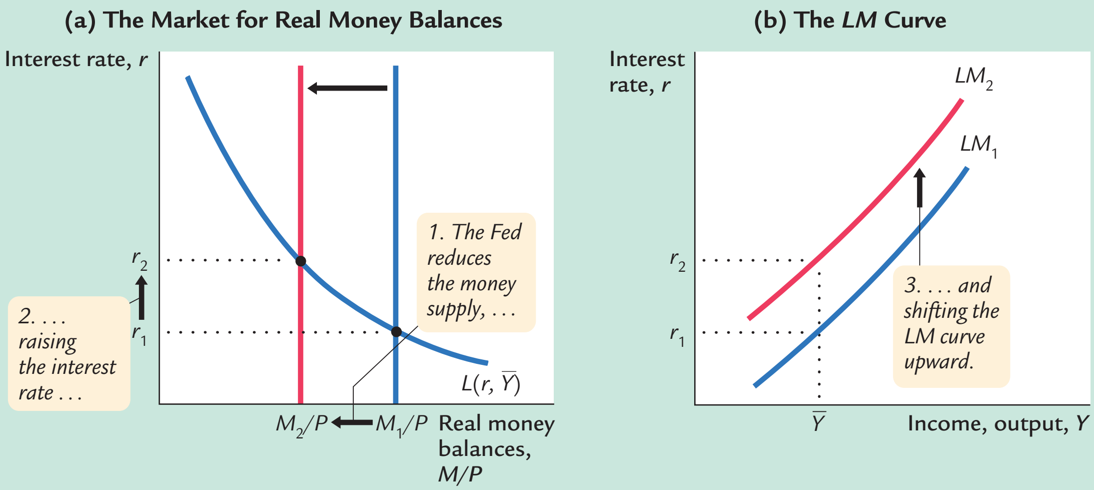
A Quantity-Equation Interpretation of the *LM* Curve

When we first discussed aggregate demand and the short-run determination of income in Chapter 9, we derived the aggregate demand curve from the quantity theory of money. We described the money market with the quantity equation,

$$MV = PY,$$

and assumed that velocity V is constant. This assumption implies that, for any given price level P, the supply of money M by itself determines the level of

figure 10-13



A Reduction in the Money Supply Shifts the *LM* Curve Upward Panel (a) shows that for any given level of income $\bar{Y}$, a reduction in the money supply raises the interest rate that equilibrates the money market. Therefore, the *LM* curve in panel (b) shifts upward.

income *Y*. Because the level of income does not depend on the interest rate, the quantity theory is equivalent to a vertical *LM* curve.

We can derive the more realistic upward-sloping *LM* curve from the quantity equation by relaxing the assumption that velocity is constant. The assumption of constant velocity is based on the assumption that the demand for real money balances depends only on the level of income. Yet, as we have noted in our discussion of the liquidity-preference model, the demand for real money balances also depends on the interest rate: a higher interest rate raises the cost of holding money and reduces money demand. When people respond to a higher interest rate by holding less money, each dollar they do hold must be used more often to support a given volume of transactions—that is, the velocity of money must increase. We can write this as

$$MV(r) = PY.$$

The velocity function $V(r)$ indicates that velocity is positively related to the interest rate.

This form of the quantity equation yields an *LM* curve that slopes upward. Because an increase in the interest rate raises the velocity of money, it raises the level of income for any given money supply and price level. The *LM* curve expresses this positive relationship between the interest rate and income.

This equation also shows why changes in the money supply shift the *LM* curve. For any given interest rate and price level, the money supply and the level of income must move together. Thus, increases in the money supply shift the *LM* curve to the right, and decreases in the money supply shift the *LM* curve to the left.

Keep in mind that the quantity equation is merely another way to express the theory behind the *LM* curve. This quantity-theory interpretation of the *LM* curve is substantively the same as that provided by the theory of liquidity preference. In both cases, the *LM* curve represents a positive relationship between income and the interest rate that arises from the money market.

Finally, remember that the *LM* curve by itself does not determine either income *Y* or the interest rate *r* that will prevail in the economy. Like the *IS* curve, the *LM* curve is only a relationship between these two endogenous variables. The *IS* and *LM* curves together determine the economy's equilibrium.

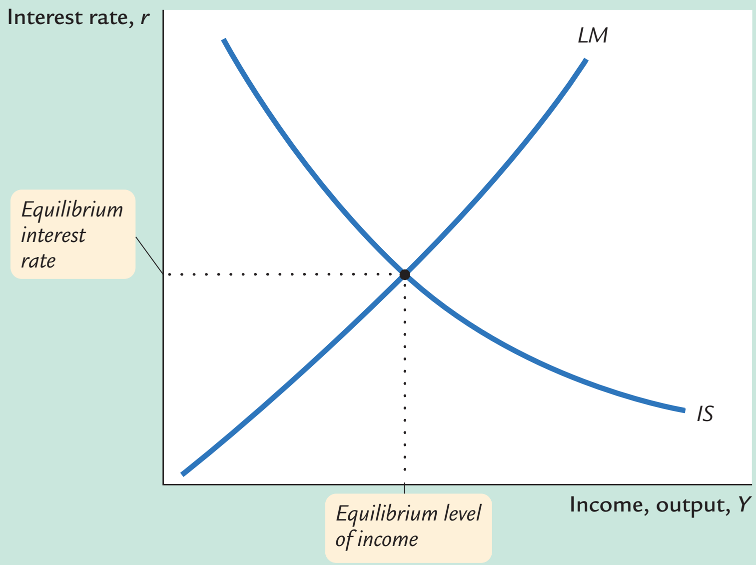
10-3 Conclusion: The Short-Run Equilibrium

We now have all the pieces of the *IS–LM* model. The two equations of this model are

$$Y = C(Y - T) + I(r) + G \qquad IS,$$
$$M/P = L(r, Y) \qquad LM.$$

The model takes fiscal policy, *G* and *T*, monetary policy *M*, and the price level *P* as exogenous. Given these exogenous variables, the *IS* curve provides the combinations of *r* and *Y* that satisfy the equation representing the goods market, and the *LM* curve provides the combinations of *r* and *Y* that satisfy the equation representing the money market. These two curves are shown together in Figure 10-14.

figure 10-14

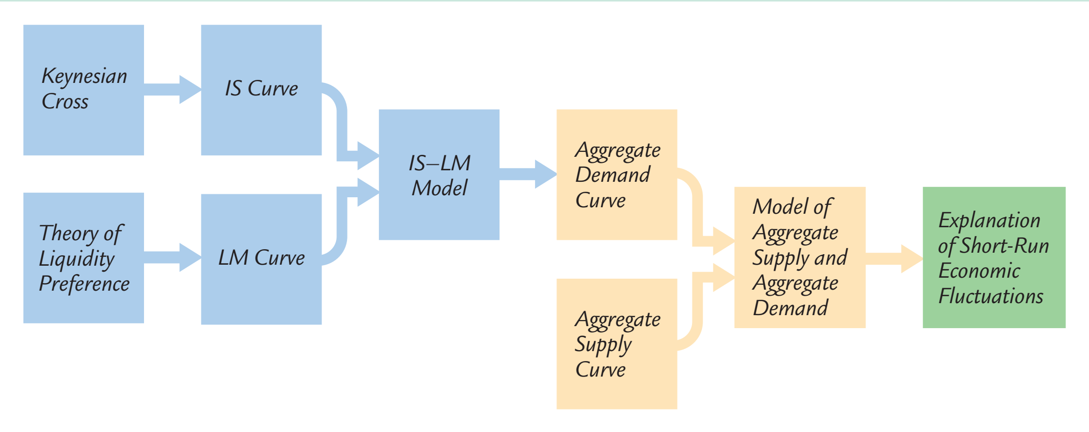


Equilibrium in the *IS–LM* Model The intersection of the *IS* and *LM* curves represents simultaneous equilibrium in the market for goods and services and in the market for real money balances for given values of government spending, taxes, the money supply, and the price level.

The equilibrium of the economy is the point at which the *IS* curve and the *LM* curve cross. This point gives the interest rate *r* and the level of income *Y* that satisfy conditions for equilibrium in both the goods market and the money market. In other words, at this intersection, actual expenditure equals planned expenditure, and the demand for real money balances equals the supply.

As we conclude this chapter, let's recall that our ultimate goal in developing the *IS–LM* model is to analyze short-run fluctuations in economic activity. Figure 10-15 illustrates how the different pieces of our theory fit together. In this chapter we developed the Keynesian cross and the theory of liquidity preference as building blocks for the *IS–LM* model. As we see more fully in the next chapter, the *IS–LM* model helps explain the position and slope of the aggregate demand curve. The aggregate demand curve, in turn, is a piece of the model of aggregate supply and aggregate demand, which economists use to explain the short-run effects of policy changes and other events on national income.

figure 10-15



The Theory of Short-Run Fluctuations This schematic diagram shows how the different pieces of the theory of short-run fluctuations fit together. The Keynesian cross explains the *IS* curve, and the theory of liquidity preference explains the *LM* curve. The *IS* and *LM* curves together yield the *IS–LM* model, which explains the aggregate demand curve. The aggregate demand curve is part of the model of aggregate supply and aggregate demand, which economists use to explain short-run fluctuations in economic activity.

Summary

1. The Keynesian cross is a basic model of income determination. It takes fiscal policy and planned investment as exogenous and then shows that there is one level of national income at which actual expenditure equals planned expenditure. It shows that changes in fiscal policy have a multiplied impact on income.

2. Once we allow planned investment to depend on the interest rate, the Keynesian cross yields a relationship between the interest rate and national income. A higher interest rate lowers planned investment, and this in turn lowers national income. The downward-sloping *IS* curve summarizes this negative relationship between the interest rate and income.

3. The theory of liquidity preference is a basic model of the determination of the interest rate. It takes the money supply and the price level as exogenous and assumes that the interest rate adjusts to equilibrate the supply and demand for real money balances. The theory implies that increases in the money supply lower the interest rate.

4. Once we allow the demand for real money balances to depend on national income, the theory of liquidity preference yields a relationship between income and the interest rate. A higher level of income raises the demand for real money balances, and this in turn raises the interest rate. The upward-sloping *LM* curve summarizes this positive relationship between income and the interest rate.

5. The *IS–LM* model combines the elements of the Keynesian cross and the elements of the theory of liquidity preference. The *IS* curve shows the points that satisfy equilibrium in the goods market, and the *LM* curve shows the points that satisfy equilibrium in the money market. The intersection of the *IS* and *LM* curves shows the interest rate and income that satisfy equilibrium in both markets.

KEY CONCEPTS

IS–LM model
IS curve
LM curve
Keynesian cross
Government-purchases multiplier
Tax multiplier
Theory of liquidity preference

QUESTIONS FOR REVIEW

1. Use the Keynesian cross to explain why fiscal policy has a multiplied effect on national income.

2. Use the theory of liquidity preference to explain why an increase in the money supply lowers the interest rate. What does this explanation assume about the price level?

3. Why does the *IS* curve slope downward?

4. Why does the *LM* curve slope upward?

PROBLEMS AND APPLICATIONS

1. Use the Keynesian cross to predict the impact of
   a. An increase in government purchases.
   b. An increase in taxes.
   c. An equal increase in government purchases and taxes.

2. In the Keynesian cross, assume that the consumption function is given by

$$C = 200 + 0.75\,(Y - T).$$

Planned investment is 100; government purchases and taxes are both 100.

a. Graph planned expenditure as a function of income.

b. What is the equilibrium level of income?

c. If government purchases increase to 125, what is the new equilibrium income?

d. What level of government purchases is needed to achieve an income of 1,600?

3. Although our development of the Keynesian cross in this chapter assumes that taxes are a fixed amount, in many countries (including the United States) taxes depend on income. Let's represent the tax system by writing tax revenue as

$$T = \overline{T} + tY,$$

where $\overline{T}$ and t are parameters of the tax code. The parameter t is the marginal tax rate: if income rises by \$1, taxes rise by $t \times$ \$1.

a. How does this tax system change the way consumption responds to changes in GDP?

b. In the Keynesian cross, how does this tax system alter the government-purchases multiplier?

c. In the *IS–LM* model, how does this tax system alter the slope of the *IS* curve?

4. Consider the impact of an increase in thriftiness in the Keynesian cross. Suppose the consumption function is

$$C = \overline{C} + c(Y - T),$$

where $\overline{C}$ is a parameter called *autonomous consumption* and c is the marginal propensity to consume.

a. What happens to equilibrium income when the society becomes more thrifty, as represented by a decline in $\overline{C}$

b. What happens to equilibrium saving?

c. Why do you suppose this result is called the *paradox of thrift*?

d. Does this paradox arise in the classical model of Chapter 3? Why or why not?

5. Suppose that the money demand function is

$$(M/P)^{d} = 1{,}000 - 100r,$$

where r is the interest rate in percent. The money supply M is 1,000 and the price level P is 2.

a. Graph the supply and demand for real money balances.

b. What is the equilibrium interest rate?

c. Assume that the price level is fixed. What happens to the equilibrium interest rate if the supply of money is raised from 1,000 to 1,200?

d. If the Fed wishes to raise the interest rate to 7 percent, what money supply should it set?

CHAPTER ELEVEN

Aggregate Demand II

> *Science is a parasite: the greater the patient population the better the advance in physiology and pathology; and out of pathology arises therapy. The year 1932 was the trough of the great depression, and from its rotten soil was belatedly begot a new subject that today we call macroeconomics.*
>
> — *Paul Samuelson*

In Chapter 10 we assembled the pieces of the *IS–LM* model. We saw that the *IS* curve represents the equilibrium in the market for goods and services, that the *LM* curve represents the equilibrium in the market for real money balances, and that the *IS* and *LM* curves together determine the interest rate and national income in the short run when the price level is fixed. Now we turn our attention to applying the *IS–LM* model to analyze three issues.

First, we examine the potential causes of fluctuations in national income. We use the *IS–LM* model to see how changes in the exogenous variables (government purchases, taxes, and the money supply) influence the endogenous variables (the interest rate and national income). We also examine how various shocks to the goods markets (the *IS* curve) and the money market (the *LM* curve) affect the interest rate and national income in the short run.

Second, we discuss how the *IS–LM* model fits into the model of aggregate supply and aggregate demand we introduced in Chapter 9. In particular, we examine how the *IS–LM* model provides a theory of the slope and position of the aggregate demand curve. Here we relax the assumption that the price level is fixed, and we show that the *IS–LM* model implies a negative relationship between the price level and national income. The model can also tell us what events shift the aggregate demand curve and in what direction.

Third, we examine the Great Depression of the 1930s. As this chapter's opening quotation indicates, this episode gave birth to short-run macroeconomic theory, for it led Keynes and his many followers to think that aggregate demand was the key to understanding fluctuations in national income. With the benefit of hindsight, we can use the *IS–LM* model to discuss the various explanations of this traumatic economic downturn.

11-1 Explaining Fluctuations With the *IS–LM* Model

The intersection of the *IS* curve and the *LM* curve determines the level of national income. When one of these curves shifts, the short-run equilibrium of the economy changes, and national income fluctuates. In this section we examine how changes in policy and shocks to the economy can cause these curves to shift.

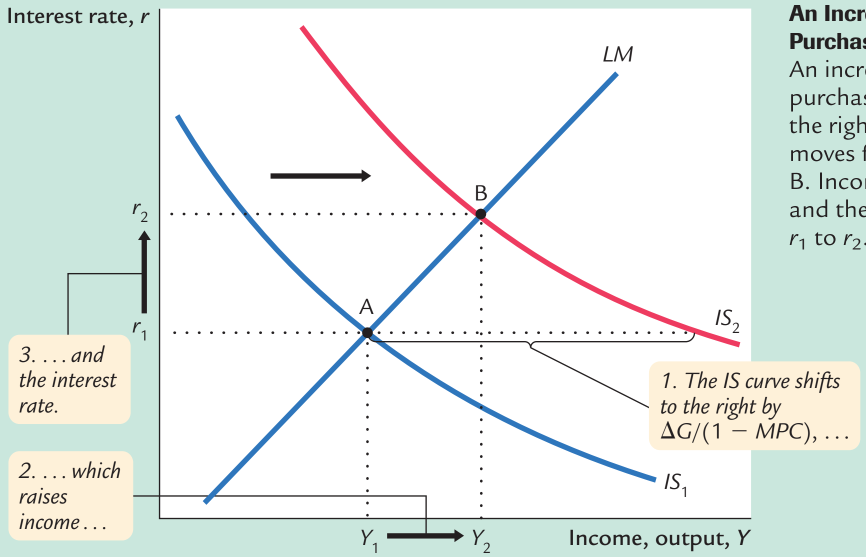
How Fiscal Policy Shifts the *IS* Curve and Changes the Short-Run Equilibrium

We begin by examining how changes in fiscal policy (government purchases and taxes) alter the economy's short-run equilibrium. Recall that changes in fiscal policy influence planned expenditure and thereby shift the *IS* curve. The *IS–LM* model shows how these shifts in the *IS* curve affect income and the interest rate.

Changes in Government Purchases Consider an increase in government purchases of ΔG. The government-purchases multiplier in the Keynesian cross tells us that, at any given interest rate, this change in fiscal policy raises the level of income by $\Delta G/(1 - MPC)$. Therefore, as Figure 11-1 shows, the *IS* curve shifts to the right by this amount. The equilibrium of the economy moves from point A to point B. The increase in government purchases raises both income and the interest rate.

To understand fully what's happening in Figure 11-1, it helps to keep in mind the building blocks for the *IS–LM* model from the preceding chapter—the Keynesian cross and the theory of liquidity preference. Here is the story. When the government

figure 11-1



An Increase in Government Purchases in the *IS–LM* Model An increase in government purchases shifts the *IS* curve to the right. The equilibrium moves from point A to point B. Income rises from Y_1 to Y_2, and the interest rate rises from r_1 to r_2.

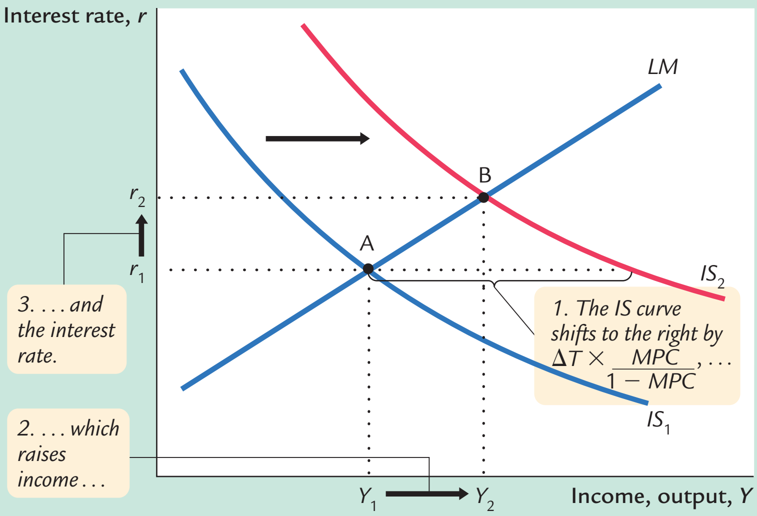
increases its purchases of goods and services, the economy's planned expenditure rises. The increase in planned expenditure stimulates the production of goods and services, which causes total income Y to rise. These effects should be familiar from the Keynesian cross.

Now consider the money market, as described by the theory of liquidity preference. Because the economy's demand for money depends on income, the rise in total income increases the quantity of money demanded at every interest rate. The supply of money has not changed, however, so higher money demand causes the equilibrium interest rate r to rise.

The higher interest rate arising in the money market, in turn, has ramifications back in the goods market. When the interest rate rises, firms cut back on their investment plans. This fall in investment partially offsets the expansionary effect of the increase in government purchases. Thus, the increase in income in response to a fiscal expansion is smaller in the *IS–LM* model than it is in the Keynesian cross (where investment is assumed to be fixed). You can see this in Figure 11-1. The horizontal shift in the *IS* curve equals the rise in equilibrium income in the Keynesian cross. This amount is larger than the increase in equilibrium income here in the *IS–LM* model. The difference is explained by the crowding out of investment caused by a higher interest rate.

Changes in Taxes In the *IS–LM* model, changes in taxes affect the economy much the same as changes in government purchases do, except that taxes affect expenditure through consumption. Consider, for instance, a decrease in taxes of ΔT. The tax cut encourages consumers to spend more and, therefore, increases planned expenditure. The tax multiplier in the Keynesian cross tells us that, at any given interest rate, this change in policy raises the level of income by $\Delta T \times MPC/(1 - MPC)$. Therefore, as Figure 11-2 illustrates, the *IS* curve shifts to the

figure 11-2



A Decrease in Taxes in the *IS–LM* Model A decrease in taxes shifts the *IS* curve to the right. The equilibrium moves from point A to point B. Income rises from Y_1 to Y_2, and the interest rate rises from r_1 to r_2.

right by this amount. The equilibrium of the economy moves from point A to point B. The tax cut raises both income and the interest rate. Once again, because the higher interest rate depresses investment, the increase in income is smaller in the *IS–LM* model than it is in the Keynesian cross.

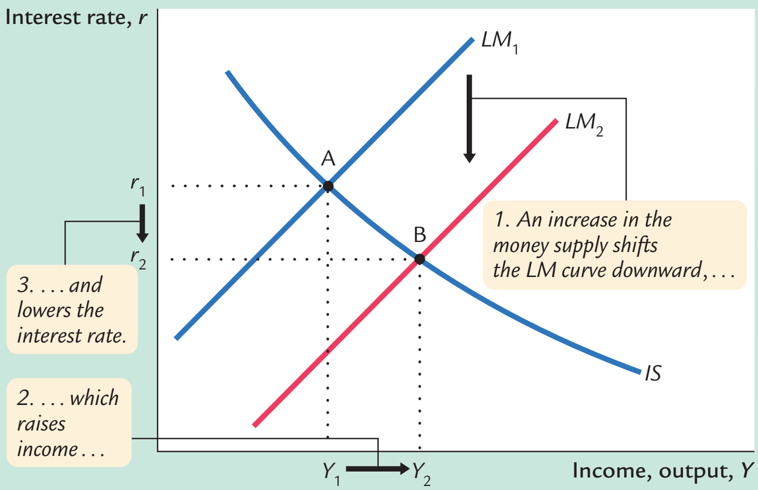
How Monetary Policy Shifts the *LM* Curve and Changes the Short-Run Equilibrium

We now examine the effects of monetary policy. Recall that a change in the money supply alters the interest rate that equilibrates the money market for any given level of income and, thereby, shifts the *LM* curve. The *IS–LM* model shows how a shift in the *LM* curve affects income and the interest rate.

Consider an increase in the money supply. An increase in M leads to an increase in real money balances M/P, because the price level P is fixed in the short run. The theory of liquidity preference shows that for any given level of income, an increase in real money balances leads to a lower interest rate. Therefore, the *LM* curve shifts downward, as in Figure 11-3. The equilibrium moves from point A to point B. The increase in the money supply lowers the interest rate and raises the level of income.

Once again, to tell the story that explains the economy's adjustment from point A to point B, we rely on the building blocks of the *IS–LM* model—the Keynesian cross and the theory of liquidity preference. This time, we begin with the money market, where the monetary-policy action occurs. When the Federal Reserve increases the supply of money, people have more money than they want to hold at the prevailing interest rate. As a result, they start depositing this extra money in banks or use it to buy bonds. The interest rate r then falls until people are willing to hold all the extra money that the Fed has created; this brings the money market to a new equilibrium. The lower interest rate, in turn,

figure 11-3



An Increase in the Money Supply in the *IS–LM* Model An increase in the money supply shifts the *LM* curve downward. The equilibrium moves from point A to point B. Income rises from Y_1 to Y_2, and the interest rate falls from r_1 to r_2.

has ramifications for the goods market. A lower interest rate stimulates planned investment, which increases planned expenditure, production, and income *Y*.

Thus, the *IS–LM* model shows that monetary policy influences income by changing the interest rate. This conclusion sheds light on our analysis of monetary policy in Chapter 9. In that chapter we showed that in the short run, when prices are sticky, an expansion in the money supply raises income. But we did not discuss *how* a monetary expansion induces greater spending on goods and services—a process called the **monetary transmission mechanism**. The *IS–LM* model shows that an increase in the money supply lowers the interest rate, which stimulates investment and thereby expands the demand for goods and services.

The Interaction Between Monetary and Fiscal Policy

When analyzing any change in monetary or fiscal policy, it is important to keep in mind that the policymakers who control these policy tools are aware of what the other policymakers are doing. A change in one policy, therefore, may influence the other, and this interdependence may alter the impact of a policy change.

For example, suppose Congress were to raise taxes. What effect should this policy have on the economy? According to the *IS–LM* model, the answer depends on how the Fed responds to the tax increase.

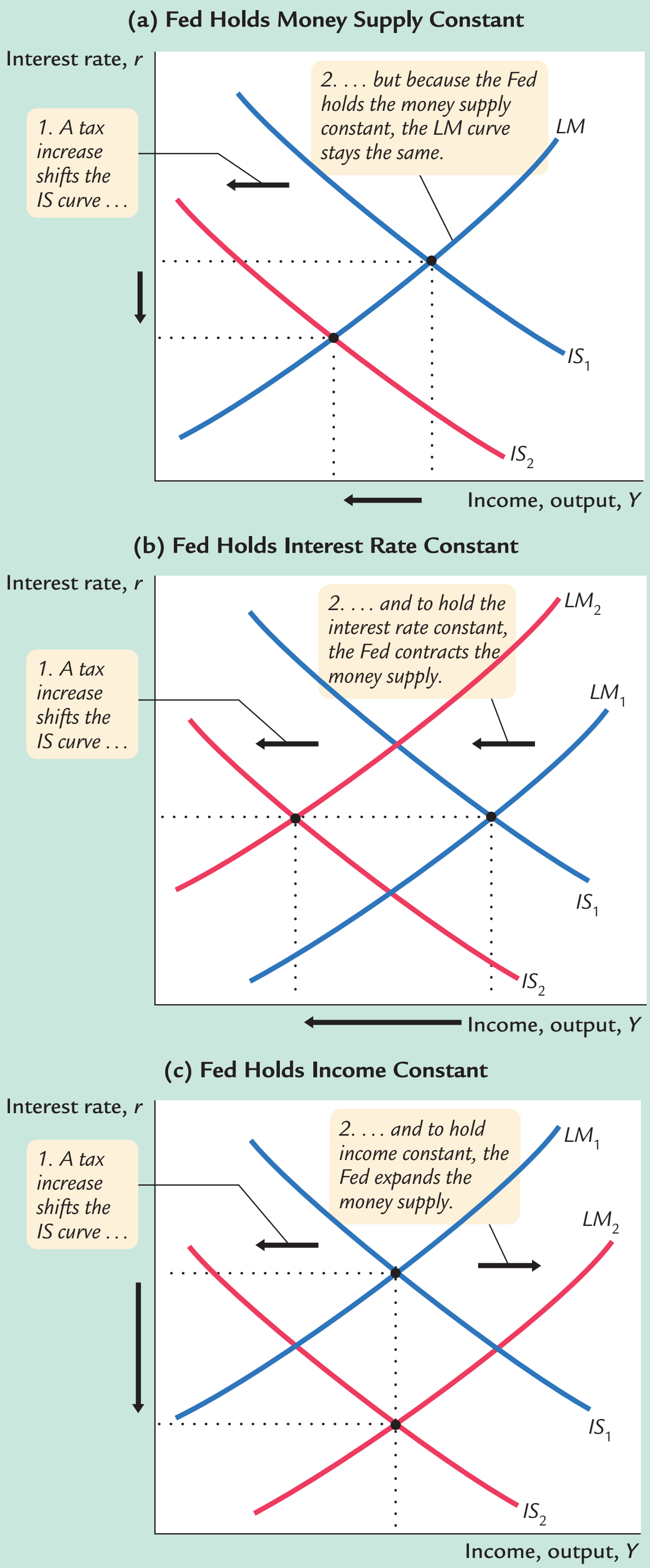
Figure 11-4 shows three of the many possible outcomes. In panel (a), the Fed holds the money supply constant. The tax increase shifts the *IS* curve to the left. Income falls (because higher taxes reduce consumer spending), and the interest rate falls (because lower income reduces the demand for money). The fall in income indicates that the tax hike causes a recession.

In panel (b), the Fed wants to hold the interest rate constant. In this case, when the tax increase shifts the *IS* curve to the left, the Fed must decrease the money supply to keep the interest rate at its original level. This fall in the money supply shifts the *LM* curve upward. The interest rate does not fall, but income falls by a larger amount than if the Fed had held the money supply constant. Whereas in panel (a) the lower interest rate stimulated investment and partially offset the contractionary effect of the tax hike, in panel (b) the Fed deepens the recession by keeping the interest rate high.

In panel (c), the Fed wants to prevent the tax increase from lowering income. It must, therefore, raise the money supply and shift the *LM* curve downward enough to offset the shift in the *IS* curve. In this case, the tax increase does not cause a recession, but it does cause a large fall in the interest rate. Although the level of income is not changed, the combination of a tax increase and a monetary expansion does change the allocation of the economy's resources. The higher taxes depress consumption, while the lower interest rate stimulates investment. Income is not affected because these two effects exactly balance.

From this example we can see that the impact of a change in fiscal policy depends on the policy the Fed pursues—that is, on whether it holds the money supply, the interest rate, or the level of income constant. More generally, whenever analyzing a change in one policy, we must make an assumption about its effect on the other policy. The most appropriate assumption depends on the case at hand and the many political considerations that lie behind economic policymaking.

figure 11-4



The Response of the Economy to a Tax Increase How the economy responds to a tax increase depends on how the monetary authority responds. In panel (a) the Fed holds the money supply constant. In panel (b) the Fed holds the interest rate constant by reducing the money supply. In panel (c) the Fed holds the level of income constant by raising the money supply.

CASE STUDY

Policy Analysis With Macroeconometric Models

The *IS–LM* model shows how monetary and fiscal policy influence the equilibrium level of income. The predictions of the model, however, are qualitative, not quantitative. The *IS–LM* model shows that increases in government purchases raise GDP and that increases in taxes lower GDP. But when economists analyze specific policy proposals, they need to know not only the direction of the effect but also the size. For example, if Congress increases taxes by $100 billion and if monetary policy is not altered, how much will GDP fall? To answer this question, economists need to go beyond the graphical representation of the *IS–LM* model.

Macroeconometric models of the economy provide one way to evaluate policy proposals. A *macroeconometric model* is a model that describes the economy quantitatively, rather than only qualitatively. Many of these models are essentially more complicated and more realistic versions of our *IS–LM* model. The economists who build macroeconometric models use historical data to estimate parameters such as the marginal propensity to consume, the sensitivity of investment to the interest rate, and the sensitivity of money demand to the interest rate. Once a model is built, economists can simulate the effects of alternative policies with the help of a computer.

Table 11-1 shows the fiscal-policy multipliers implied by one widely used macroeconometric model, the Data Resources Incorporated (DRI) model, named for the economic forecasting firm that developed it. The multipliers are given for two assumptions about how the Fed might respond to changes in fiscal policy.

One assumption about monetary policy is that the Fed keeps the nominal interest rate constant. That is, when fiscal policy shifts the *IS* curve to the right or to the left, the Fed adjusts the money supply to shift the *LM* curve in the same direction. Because there is no crowding out of investment due to a changing interest rate, the fiscal-policy multipliers are similar to those from the Keynesian cross. The DRI model indicates that, in this case, the government-purchases multiplier is 1.93, and the tax multiplier is −1.19. That is, a $100 billion increase in government purchases raises GDP by $193 billion, and a $100 billion increase in taxes lowers GDP by $119 billion.

table 11-1

The Fiscal-Policy Multipliers in the DRI Model

Assumption About Monetary Policy	VALUE OF MULTIPLIERS $\Delta Y/\Delta G$	$\Delta Y/\Delta T$
Nominal interest rate held constant	1.93	−1.19
Money supply held constant	0.60	−0.26

Note: This table gives the fiscal-policy multipliers for a sustained change in government purchases or in personal income taxes. These multipliers are for the fourth quarter after the policy change is made.

Source: Otto Eckstein, *The DRI Model of the U.S. Economy* (New York: McGraw-Hill, 1983), 169.

The second assumption about monetary policy is that the Fed keeps the money supply constant so that the *LM* curve does not shift. In this case, the interest rate rises, and investment is crowded out, so the multipliers are much smaller. The government-purchases multiplier is only 0.60, and the tax multiplier is only –0.26. That is, a $100 billion increase in government purchases raises GDP by $60 billion, and a $100 billion increase in taxes lowers GDP by $26 billion.

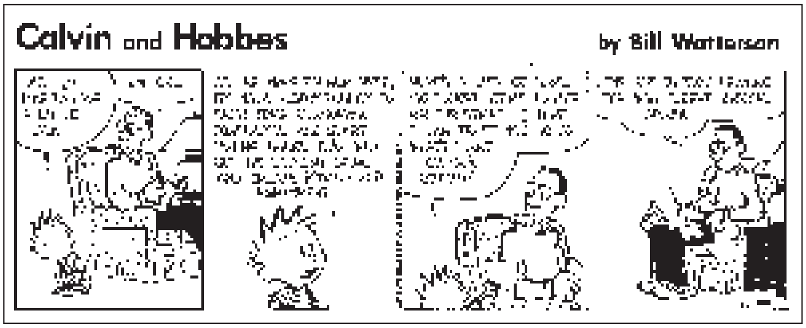
Table 11-1 shows that the fiscal-policy multipliers are very different under the two assumptions about monetary policy. The impact of any change in fiscal policy depends crucially on how the Fed responds to that change.

Shocks in the *IS–LM* Model

Because the *IS–LM* model shows how national income is determined in the short run, we can use the model to examine how various economic disturbances affect income. So far we have seen how changes in fiscal policy shift the *IS* curve and how changes in monetary policy shift the *LM* curve. Similarly, we can group other disturbances into two categories: shocks to the *IS* curve and shocks to the *LM* curve.

Shocks to the *IS* curve are exogenous changes in the demand for goods and services. Some economists, including Keynes, have emphasized that such changes in demand can arise from investors' *animal spirits*—exogenous and perhaps self-fulfilling waves of optimism and pessimism. For example, suppose that firms become pessimistic about the future of the economy and that this pessimism causes them to build fewer new factories. This reduction in the demand for investment goods causes a contractionary shift in the investment function: at every interest rate, firms want to invest less. The fall in investment reduces planned expenditure and shifts the *IS* curve to the left, reducing income and employment. This fall in equilibrium income in part validates the firms' initial pessimism.

Shocks to the *IS* curve may also arise from changes in the demand for consumer goods. Suppose, for instance, that the election of a popular president increases consumer confidence in the economy. This induces consumers to save less for the future and consume more today. We can interpret this change as an upward shift in the consumption function. This shift in the consumption function increases planned expenditure and shifts the *IS* curve to the right, and this raises income.



Calvin and Hobbes © 1992 Watterson. Dist. by Universal Press Syndicate.

Shocks to the *LM* curve arise from exogenous changes in the demand for money. For example, suppose that new restrictions on credit-card availability increase the amount of money people choose to hold. According to the theory of liquidity preference, when money demand rises, the interest rate necessary to equilibrate the money market is higher (for any given level of income and money supply). Hence, an increase in money demand shifts the *LM* curve upward, which tends to raise the interest rate and depress income.

In summary, several kinds of events can cause economic fluctuations by shifting the *IS* curve or the *LM* curve. Remember, however, that such fluctuations are not inevitable. Policymakers can try to use the tools of monetary and fiscal policy to offset exogenous shocks. If policymakers are sufficiently quick and skillful (admittedly, a big if), shocks to the *IS* or *LM* curves need not lead to fluctuations in income or employment.

CASE STUDY

The U.S. Slowdown of 2001

In 2001, the U.S. economy experienced a pronounced slowdown in economic activity. The unemployment rate rose from 3.9 percent in October 2000 to 4.9 percent in August 2001, and then to 5.8 percent in December 2001. In many ways, the slowdown looked like a typical recession driven by a fall in aggregate demand.

Two notable shocks can help explain this event. The first was a decline in the stock market. During the 1990s, the stock market experienced a boom of historic proportions, as investors became optimistic about the prospects of the new information technology. Some economists viewed the optimism as excessive at the time, and in hindsight this proved to be the case. When the optimism faded, average stock prices fell by about 25 percent from August 2000 to August 2001. The fall in the market reduced household wealth and thus consumer spending. In addition, the declining perceptions of the profitability of the new technologies led to a fall in investment spending. In the language of the *IS–LM* model, the *IS* curve shifted to the left.

The second shock was the terrorist attacks on New York and Washington on September 11, 2001. In the week after the attacks, the stock market fell another 12 percent, its biggest weekly loss since the Great Depression of the 1930s. Moreover, the attacks increased uncertainty about what the future would hold. Uncertainty can reduce spending because households and firms postpone some of their plans until the uncertainty is resolved. Thus, the terrorist attacks shifted the *IS* curve further to the left.

Fiscal and monetary policymakers were quick to respond to these events. Congress passed a tax cut in 2001, including an immediate tax rebate. One goal of the tax cut was to stimulate consumer spending. After the terrorist attacks, Congress increased government spending by appropriating funds to rebuild New York and to bail out the ailing airline industry. Both of these fiscal measures shifted the *IS* curve to the right.

At the same time, the Fed pursued expansionary monetary policy, shifting the *LM* curve to the right. Money growth accelerated, and interest rates fell. The interest rate on three-month Treasury bills fell from 6.4 percent in November of 2000 to 3.3 percent in August 2001, and then to 2.1 percent in September 2001 in the immediate aftermath of the terrorist attacks.

The magnitude of the slowdown of 2001 was not yet determined as this book was going to press. The big question was whether the policy measures undertaken were sufficient to offset the shocks that the economy had suffered. By the time you are reading this, you may know the answer.

What Is the Fed's Policy Instrument—The Money Supply or the Interest Rate?

Our analysis of monetary policy has been based on the assumption that the Fed influences the economy by controlling the money supply. By contrast, when the media report on changes in Fed policy, they often simply say that the Fed has raised or lowered interest rates. Which is right? Even though these two views may seem different, both are correct, and it is important to understand why.

In recent years, the Fed has used the *federal funds rate*—the interest rate that banks charge one another for overnight loans—as its short-term policy instrument. When the Federal Open Market Committee meets every six weeks to set monetary policy, it votes on a target for this interest rate that will apply until the next meeting. After the meeting is over, the Fed's bond traders in New York are told to conduct the open-market operations necessary to hit that target. These open-market operations change the money supply and shift the *LM* curve so that the equilibrium interest rate (determined by the intersection of the *IS* and *LM* curves) equals the target interest rate that the Federal Open Market Committee has chosen.

As a result of this operating procedure, Fed policy is often discussed in terms of changing interest rates. Keep in mind, however, that behind these changes in interest rates are the necessary changes in the money supply. A newspaper might report, for instance, that "the Fed has lowered interest rates." To be more precise, we can translate this statement as meaning "the Federal Open Market Committee has instructed the Fed bond traders to buy bonds in open-market operations so as to increase the money supply, shift the *LM* curve, and reduce the equilibrium interest rate to hit a new lower target."

Why has the Fed chosen to use an interest rate, rather than the money supply, as its short-term policy instrument? One possible answer is that shocks to the *LM* curve are more prevalent than shocks to the *IS* curve. When the Fed targets interest rates, it automatically offsets *LM* shocks by altering the money supply, but the policy exacerbates *IS* shocks. If *LM* shocks are the more prevalent type, then a policy of targeting the interest rate leads to greater economic stability than a policy of targeting the money supply. (Problem 7 at the end of this chapter asks you to analyze this issue more fully.)

Another possible reason for using the interest rate as the short-term policy instrument is that interest rates are easier to measure than the money supply. As we saw in Chapter 4, the Fed has several different measures of money—*M*1, *M*2, and so on—which sometimes move in different directions. Rather than deciding which measure is best, the Fed avoids the question by using the federal funds rate as its policy instrument.

11-2 *IS–LM* as a Theory of Aggregate Demand

We have been using the *IS–LM* model to explain national income in the short run when the price level is fixed. To see how the *IS–LM* model fits into the model of aggregate supply and aggregate demand introduced in Chapter 9, we now examine what happens in the *IS–LM* model if the price level is allowed to change. As was promised when we began our study of this model, the *IS–LM* model provides a theory to explain the position and slope of the aggregate demand curve.

From the *IS–LM* Model to the Aggregate Demand Curve

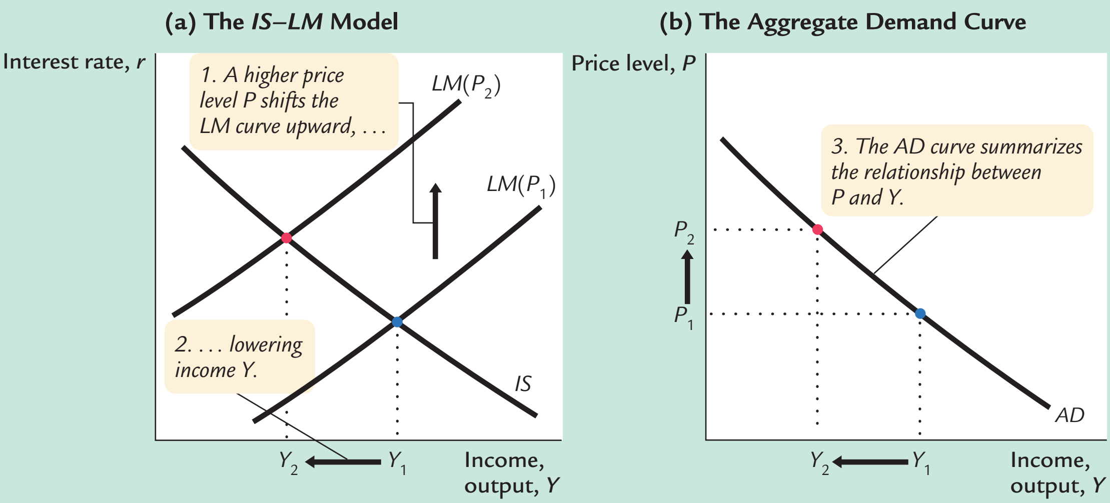
Recall from Chapter 9 that the aggregate demand curve describes a relationship between the price level and the level of national income. In Chapter 9 this relationship was derived from the quantity theory of money. The analysis showed that for a given money supply, a higher price level implies a lower level of income. Increases in the money supply shift the aggregate demand curve to the right, and decreases in the money supply shift the aggregate demand curve to the left.

To understand the determinants of aggregate demand more fully, we now use the *IS–LM* model, rather than the quantity theory, to derive the aggregate demand curve. First, we use the *IS–LM* model to show why national income falls as the price level rises—that is, why the aggregate demand curve is downward sloping. Second, we examine what causes the aggregate demand curve to shift.

To explain why the aggregate demand curve slopes downward, we examine what happens in the *IS–LM* model when the price level changes. This is done in Figure 11-5. For any given money supply M, a higher price level P reduces the supply of real money balances M/P. A lower supply of real money balances shifts the *LM* curve upward, which raises the equilibrium interest rate and lowers the equilibrium level of income, as shown in panel (a). Here the price level rises from P_1 to P_2, and income falls from Y_1 to Y_2. The aggregate demand curve in panel (b) plots this negative relationship between national income and the price level. In other words, the aggregate demand curve shows the set of equilibrium points that arise in the *IS–LM* model as we vary the price level and see what happens to income.

What causes the aggregate demand curve to shift? Because the aggregate demand curve is merely a summary of results from the *IS–LM* model, events that shift the *IS* curve or the *LM* curve (for a given price level) cause the aggregate demand curve to shift. For instance, an increase in the money supply raises income in the *IS–LM* model for any given price level; it thus shifts the

figure 11-5



Deriving the Aggregate Demand Curve With the *IS–LM* Model Panel (a) shows the *IS–LM* model: an increase in the price level from P_1 to P_2 lowers real money balances and thus shifts the *LM* curve upward. The shift in the *LM* curve lowers income from Y_1 to Y_2. Panel (b) shows the aggregate demand curve summarizing this relationship between the price level and income: the higher the price level, the lower the level of income.

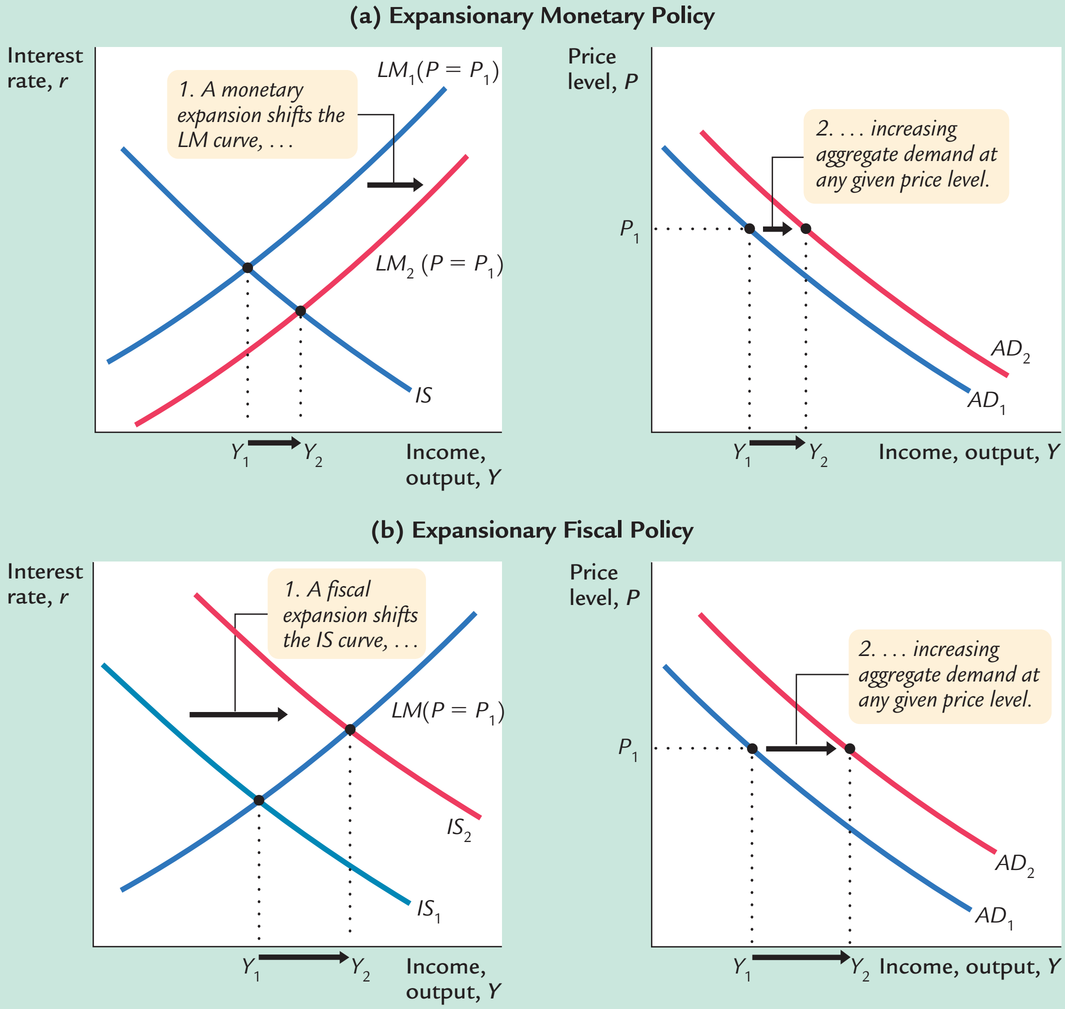
aggregate demand curve to the right, as shown in panel (a) of Figure 11-6. Similarly, an increase in government purchases or a decrease in taxes raises income in the *IS–LM* model for a given price level; it also shifts the aggregate demand curve to the right, as shown in panel (b) of Figure 11-6. Conversely, a decrease in the money supply, a decrease in government purchases, or an increase in taxes lowers income in the *IS–LM* model and shifts the aggregate demand curve to the left.

We can summarize these results as follows: *A change in income in the IS–LM model resulting from a change in the price level represents a movement along the aggregate demand curve. A change in income in the IS–LM model for a fixed price level represents a shift in the aggregate demand curve.*

The *IS–LM* Model in the Short Run and Long Run

The *IS–LM* model is designed to explain the economy in the short run when the price level is fixed. Yet, now that we have seen how a change in the price level influences the equilibrium in the *IS–LM* model, we can also use the model to describe the economy in the long run when the price level adjusts to ensure that the economy produces at its natural rate. By using the *IS–LM* model to describe the long run, we can show clearly how the Keynesian model of income determination differs from the classical model of Chapter 3.

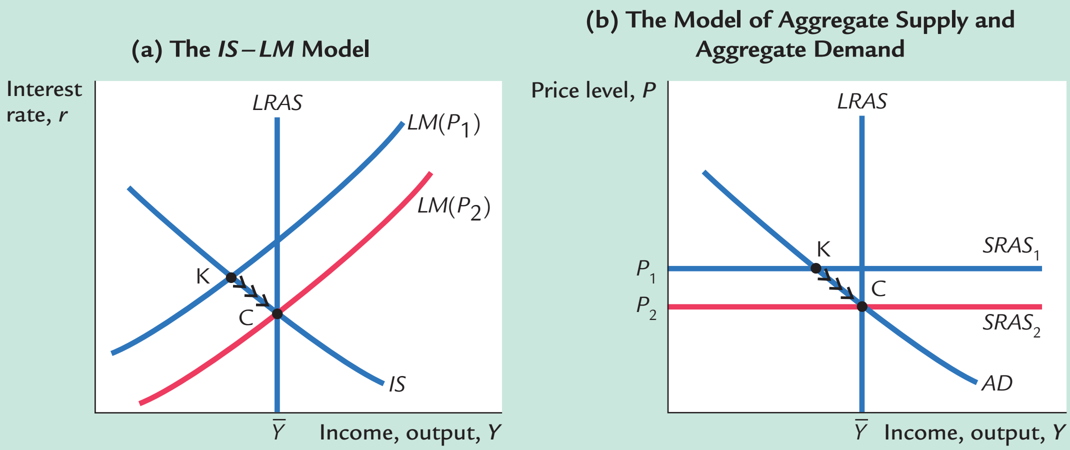
figure 11-6



How Monetary and Fiscal Policies Shift the Aggregate Demand Curve Panel (a) shows a monetary expansion. For any given price level, an increase in the money supply raises real money balances, shifts the *LM* curve downward, and raises income. Hence, an increase in the money supply shifts the aggregate demand curve to the right. Panel (b) shows a fiscal expansion, such as an increase in government purchases or a decrease in taxes. The fiscal expansion shifts the *IS* curve to the right and, for any given price level, raises income. Hence, a fiscal expansion shifts the aggregate demand curve to the right.

Panel (a) of Figure 11-7 shows the three curves that are necessary for understanding the short-run and long-run equilibria: the *IS* curve, the *LM* curve, and the vertical line representing the natural rate of output $\bar{Y}$. The *LM* curve is, as always, drawn for a fixed price level, P_1. The short-run equilibrium of the economy is point K, where the *IS* curve crosses the *LM* curve. Notice that in this short-run equilibrium, the economy's income is less than its natural rate.

figure 11-7



The Short-Run and Long-Run Equilibria We can compare the short-run and long-run equilibria using either the *IS–LM* diagram in panel (a) or the aggregate supply–aggregate demand diagram in panel (b). In the short run, the price level is stuck at P_1. The short-run equilibrium of the economy is therefore point K. In the long run, the price level adjusts so that the economy is at the natural rate. The long-run equilibrium is therefore point C.

Panel (b) of Figure 11-7 shows the same situation in the diagram of aggregate supply and aggregate demand. At the price level P_1, the quantity of output demanded is below the natural rate. In other words, at the existing price level, there is insufficient demand for goods and services to keep the economy producing at its potential.

In these two diagrams we can examine the short-run equilibrium at which the economy finds itself and the long-run equilibrium toward which the economy gravitates. Point K describes the short-run equilibrium, because it assumes that the price level is stuck at P_1. Eventually, the low demand for goods and services causes prices to fall, and the economy moves back toward its natural rate. When the price level reaches P_2, the economy is at point C, the long-run equilibrium. The diagram of aggregate supply and aggregate demand shows that at point C, the quantity of goods and services demanded equals the natural rate of output. This long-run equilibrium is achieved in the *IS–LM* diagram by a shift in the *LM* curve: the fall in the price level raises real money balances and therefore shifts the *LM* curve to the right.

We can now see the key difference between Keynesian and classical approaches to the determination of national income. The Keynesian assumption (represented by point K) is that the price level is stuck. Depending on monetary policy, fiscal policy, and the other determinants of aggregate demand, output may deviate from the natural rate. The classical assumption (represented by point C) is that the price level is fully flexible. The price level adjusts to ensure that national income is always at the natural rate.

To make the same point somewhat differently, we can think of the economy as being described by three equations. The first two are the *IS* and *LM* equations:

$$Y = C(Y - T) + I(r) + G \qquad IS,$$
$$M/P = L(r, Y) \qquad LM.$$

The *IS* equation describes the goods market, and the *LM* equation describes the money market. These two equations contain three endogenous variables: Y, P, and r. The Keynesian approach is to complete the model with the assumption of fixed prices, so the Keynesian third equation is

$$P = P_1.$$

This assumption implies that r and Y must adjust to satisfy the *IS* and *LM* equations. The classical approach is to complete the model with the assumption that output reaches the natural rate, so the classical third equation is

$$Y = \bar{Y}.$$

This assumption implies that r and P must adjust to satisfy the *IS* and *LM* equations.

Which assumption is most appropriate? The answer depends on the time horizon. The classical assumption best describes the long run. Hence, our long-run analysis of national income in Chapter 3 and prices in Chapter 4 assumes that output equals the natural rate. The Keynesian assumption best describes the short run. Therefore, our analysis of economic fluctuations relies on the assumption of a fixed price level.

11-3 The Great Depression

Now that we have developed the model of aggregate demand, let's use it to address the question that originally motivated Keynes: What caused the Great Depression? Even today, more than half a century after the event, economists continue to debate the cause of this major economic downturn. The Great Depression provides an extended case study to show how economists use the *IS–LM* model to analyze economic fluctuations.[1]

Before turning to the explanations economists have proposed, look at Table 11-2, which presents some statistics regarding the Depression. These statistics are the battlefield on which debate about the Depression takes place. What do you think happened? An *IS* shift? An *LM* shift? Or something else?

[1] For a flavor of the debate, see Milton Friedman and Anna J. Schwartz, *A Monetary History of the United States, 1867–1960* (Princeton, NJ: Princeton University Press, 1963); Peter Temin, *Did Monetary Forces Cause the Great Depression?* (New York: W. W. Norton, 1976); the essays in Karl Brunner, ed., *The Great Depression Revisited* (Boston: Martinus Nijhoff, 1981); and the symposium on the Great Depression in the Spring 1993 issue of the *Journal of Economic Perspectives*.

table 11-2

What Happened During the Great Depression?

Year	Unemployment Rate (1)	Real GNP (2)	Consumption (2)	Investment (2)	Government Purchases (2)
1929	3.2	203.6	139.6	40.4	22.0
1930	8.9	183.5	130.4	27.4	24.3
1931	16.3	169.5	126.1	16.8	25.4
1932	24.1	144.2	114.8	4.7	24.2
1933	25.2	141.5	112.8	5.3	23.3
1934	22.0	154.3	118.1	9.4	26.6
1935	20.3	169.5	125.5	18.0	27.0
1936	17.0	193.2	138.4	24.0	31.8
1937	14.3	203.2	143.1	29.9	30.8
1938	19.1	192.9	140.2	17.0	33.9
1939	17.2	209.4	148.2	24.7	35.2
1940	14.6	227.2	155.7	33.0	36.4

Source: Historical Statistics of the United States, Colonial Times to 1970, Parts I and II (Washington, DC: U.S. Department of Commerce, Bureau of Census, 1975).
Note: (1) The unemployment rate is series D9. (2) Real GNP, consumption, investment, and government purchases are series F3, F48, F52, and F66, and are measured in billions of 1958 dollars. (3) The interest rate is the prime Commercial

The Spending Hypothesis: Shocks to the *IS* Curve

Table 11-2 shows that the decline in income in the early 1930s coincided with falling interest rates. This fact has led some economists to suggest that the cause of the decline may have been a contractionary shift in the *IS* curve. This view is sometimes called the *spending hypothesis,* because it places primary blame for the Depression on an exogenous fall in spending on goods and services.

Economists have attempted to explain this decline in spending in several ways. Some argue that a downward shift in the consumption function caused the contractionary shift in the *IS* curve. The stock market crash of 1929 may have been partly responsible for this shift: by reducing wealth and increasing uncertainty about the future prospects of the U.S. economy, the crash may have induced consumers to save more of their income rather than spending it.

Others explain the decline in spending by pointing to the large drop in investment in housing. Some economists believe that the residential investment boom of the 1920s was excessive and that once this "overbuilding" became apparent, the demand for residential investment declined drastically. Another possible explanation for the fall in residential investment is the reduction in immigration in the 1930s: a more slowly growing population demands less new housing.

Once the Depression began, several events occurred that could have reduced spending further. First, many banks failed in the early 1930s, in part because of inadequate bank regulation, and these bank failures may have exacerbated the fall in investment spending. Banks play the crucial role of getting the funds available

Year	Nominal Interest Rate (3)	Money Supply (4)	Price Level (5)	Inflation (6)	Real Money Balances (7)
1929	5.9	26.6	50.6	–	52.6
1930	3.6	25.8	49.3	−2.6	52.3
1931	2.6	24.1	44.8	−10.1	54.5
1932	2.7	21.1	40.2	−9.3	52.5
1933	1.7	19.9	39.3	−2.2	50.7
1934	1.0	21.9	42.2	7.4	51.8
1935	0.8	25.9	42.6	0.9	60.8
1936	0.8	29.6	42.7	0.2	62.9
1937	0.9	30.9	44.5	4.2	69.5
1938	0.8	30.5	43.9	−1.3	69.5
1939	0.6	34.2	43.2	−1.6	79.1
1940	0.6	39.7	43.9	1.6	90.3

Paper rate, 4–6 months, series ×445. (4) The money supply is series ×414, currency plus demand deposits, measured in billions of dollars. (5) The price level is the GNP deflator (1958 = 100), series E1. (6) The inflation rate is the percentage change in the price level series. (7) Real money balances, calculated by dividing the money supply by the price level and multiplying by 100, are in billions of 1958 dollars.

for investment to those households and firms that can best use them. The closing of many banks in the early 1930s may have prevented some businesses from getting the funds they needed for capital investment and, therefore, may have led to a further contractionary shift in the investment function.[2]

In addition, the fiscal policy of the 1930s caused a contractionary shift in the *IS* curve. Politicians at that time were more concerned with balancing the budget than with using fiscal policy to keep production and employment at their natural rates. The Revenue Act of 1932 increased various taxes, especially those falling on lower- and middle-income consumers.[3] The Democratic platform of that year expressed concern about the budget deficit and advocated an "immediate and drastic reduction of governmental expenditures." In the midst of historically high unemployment, policymakers searched for ways to raise taxes and reduce government spending.

There are, therefore, several ways to explain a contractionary shift in the *IS* curve. Keep in mind that these different views may all be true. There may be no single explanation for the decline in spending. It is possible that all of these changes coincided and that together they led to a massive reduction in spending.

[2] Ben Bernanke, "Non-Monetary Effects of the Financial Crisis in the Propagation of the Great Depression," *American Economic Review* 73 (June 1983): 257–276.

[3] E. Cary Brown, "Fiscal Policy in the 'Thirties: A Reappraisal," *American Economic Review* 46 (December 1956): 857–879.

The Money Hypothesis: A Shock to the *LM* Curve

Table 11-2 shows that the money supply fell 25 percent from 1929 to 1933, during which time the unemployment rate rose from 3.2 percent to 25.2 percent. This fact provides the motivation and support for what is called the *money hypothesis*, which places primary blame for the Depression on the Federal Reserve for allowing the money supply to fall by such a large amount.[4] The best-known advocates of this interpretation are Milton Friedman and Anna Schwartz, who defend it in their treatise on U.S. monetary history. Friedman and Schwartz argue that contractions in the money supply have caused most economic downturns and that the Great Depression is a particularly vivid example.

Using the *IS–LM* model, we might interpret the money hypothesis as explaining the Depression by a contractionary shift in the *LM* curve. Seen in this way, however, the money hypothesis runs into two problems.

The first problem is the behavior of *real* money balances. Monetary policy leads to a contractionary shift in the *LM* curve only if real money balances fall. Yet from 1929 to 1931 real money balances rose slightly, because the fall in the money supply was accompanied by an even greater fall in the price level. Although the monetary contraction may be responsible for the rise in unemployment from 1931 to 1933, when real money balances did fall, it cannot easily explain the initial downturn from 1929 to 1931.

The second problem for the money hypothesis is the behavior of interest rates. If a contractionary shift in the *LM* curve triggered the Depression, we should have observed higher interest rates. Yet nominal interest rates fell continuously from 1929 to 1933.

These two reasons appear sufficient to reject the view that the Depression was instigated by a contractionary shift in the *LM* curve. But was the fall in the money stock irrelevant? Next, we turn to another mechanism through which monetary policy might have been responsible for the severity of the Depression—the deflation of the 1930s.

The Money Hypothesis Again: The Effects of Falling Prices

From 1929 to 1933 the price level fell 25 percent. Many economists blame this deflation for the severity of the Great Depression. They argue that the deflation may have turned what in 1931 was a typical economic downturn into an unprecedented period of high unemployment and depressed income. If it is correct, this argument gives new life to the money hypothesis. Because the falling money supply was, plausibly, responsible for the falling price level, it could have been responsible for the severity of the Depression. To evaluate this argument, we must discuss how changes in the price level affect income in the *IS–LM* model.

[4] We discuss the reasons for this large decrease in the money supply in Chapter 18, where we examine the money supply process in more detail. In particular, see the case study "Bank Failures and the Money Supply in the 1930s."

The Stabilizing Effects of Deflation In the *IS–LM* model we have developed so far, falling prices raise income. For any given supply of money M, a lower price level implies higher real money balances M/P. An increase in real money balances causes an expansionary shift in the *LM* curve, which leads to higher income.

Another channel through which falling prices expand income is called the **Pigou effect**. Arthur Pigou, a prominent classical economist in the 1930s, pointed out that real money balances are part of households' wealth. As prices fall and real money balances rise, consumers should feel wealthier and spend more. This increase in consumer spending should cause an expansionary shift in the *IS* curve, also leading to higher income.

These two reasons led some economists in the 1930s to believe that falling prices would help stabilize the economy. That is, they thought that a decline in the price level would automatically push the economy back toward full employment. Yet other economists were less confident in the economy's ability to correct itself. They pointed to other effects of falling prices, to which we now turn.

The Destabilizing Effects of Deflation Economists have proposed two theories to explain how falling prices could depress income rather than raise it. The first, called the **debt-deflation theory**, describes the effects of unexpected falls in the price level. The second explains the effects of expected deflation.

The debt-deflation theory begins with an observation from Chapter 4: unanticipated changes in the price level redistribute wealth between debtors and creditors. If a debtor owes a creditor \$1,000, then the real amount of this debt is \$1,000/P, where P is the price level. A fall in the price level raises the real amount of this debt—the amount of purchasing power the debtor must repay the creditor. Therefore, an unexpected deflation enriches creditors and impoverishes debtors.

The debt-deflation theory then posits that this redistribution of wealth affects spending on goods and services. In response to the redistribution from debtors to creditors, debtors spend less and creditors spend more. If these two groups have equal spending propensities, there is no aggregate impact. But it seems reasonable to assume that debtors have higher propensities to spend than creditors—perhaps that is why the debtors are in debt in the first place. In this case, debtors reduce their spending by more than creditors raise theirs. The net effect is a reduction in spending, a contractionary shift in the *IS* curve, and lower national income.

To understand how *expected* changes in prices can affect income, we need to add a new variable to the *IS–LM* model. Our discussion of the model so far has not distinguished between the nominal and real interest rates. Yet we know from previous chapters that investment depends on the real interest rate and that money demand depends on the nominal interest rate. If i is the nominal interest rate and π^e is expected inflation, then the *ex ante* real interest rate is $i - \pi^e$. We can now write the *IS–LM* model as

$$\begin{aligned} Y &= C(Y - T) + I(i - \pi^e) + G \qquad && IS, \\ M/P &= L(i, Y) && LM. \end{aligned}$$

Expected inflation enters as a variable in the *IS* curve. Thus, changes in expected inflation shift the *IS* curve.

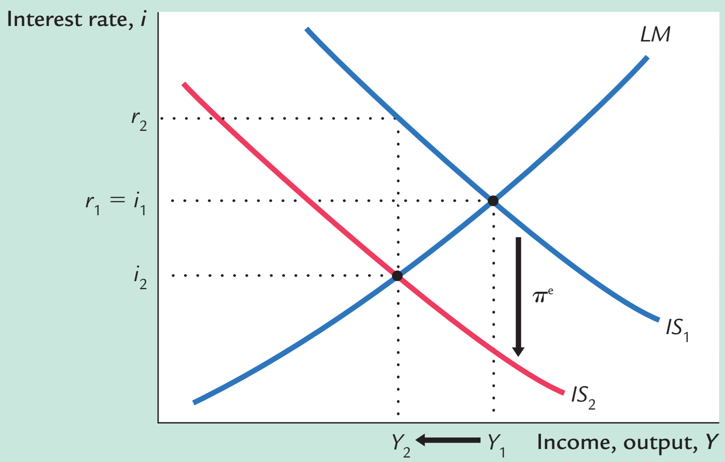
Let's use this extended *IS–LM* model to examine how changes in expected inflation influence the level of income. We begin by assuming that everyone expects the price level to remain the same. In this case, there is no expected inflation ($\pi^e = 0$), and these two equations produce the familiar *IS–LM* model. Figure 11-8 depicts this initial situation with the *LM* curve and the *IS* curve labeled IS_1. The intersection of these two curves determines the nominal and real interest rates, which for now are the same.

Now suppose that everyone suddenly expects that the price level will fall in the future, so that π^e becomes negative. The real interest rate is now higher at any given nominal interest rate. This increase in the real interest rate depresses planned investment spending, shifting the *IS* curve from IS_1 to IS_2. Thus, an expected deflation leads to a reduction in national income from Y_1 to Y_2. The nominal interest rate falls from i_1 to i_2, whereas the real interest rate rises from r_1 to r_2.

Here is the story behind this figure. When firms come to expect deflation, they become reluctant to borrow to buy investment goods because they believe they will have to repay these loans later in more valuable dollars. The fall in investment depresses planned expenditure, which in turn depresses income. The fall in income reduces the demand for money, and this reduces the nominal interest rate that equilibrates the money market. The nominal interest rate falls by less than the expected deflation, so the real interest rate rises.

Note that there is a common thread in these two stories of destabilizing deflation. In both, falling prices depress national income by causing a contractionary shift in the *IS* curve. Because a deflation of the size observed from 1929 to 1933 is unlikely except in the presence of a major contraction in the money supply, these two explanations give some of the responsibility for the Depression—especially its severity—to the Fed. In other words, if falling prices are destabilizing, then a contraction in the money supply can lead to a fall in income, even without a decrease in real money balances or a rise in nominal interest rates.

figure 11-8



Expected Deflation in the *IS–LM* Model An expected deflation (a negative value of π^e) raises the real interest rate for any given nominal interest rate, and this depresses investment spending. The reduction in investment shifts the *IS* curve downward. The level of income falls from Y_1 to Y_2. The nominal interest rate falls from i_1 to i_2, and the real interest rate rises from r_1 to r_2.

Could the Depression Happen Again?

Economists study the Depression both because of its intrinsic interest as a major economic event and to provide guidance to policymakers so that it will not happen again. To state with confidence whether this event could recur, we would need to know why it happened. Because there is not yet agreement on the causes of the Great Depression, it is impossible to rule out with certainty another depression of this magnitude.

Yet most economists believe that the mistakes that led to the Great Depression are unlikely to be repeated. The Fed seems unlikely to allow the money supply to fall by one-fourth. Many economists believe that the deflation of the early 1930s was responsible for the depth and length of the Depression. And it seems likely that such a prolonged deflation was possible only in the presence of a falling money supply.

The fiscal-policy mistakes of the Depression are also unlikely to be repeated. Fiscal policy in the 1930s not only failed to help but actually further depressed aggregate demand. Few economists today would advocate such a rigid adherence to a balanced budget in the face of massive unemployment.

In addition, there are many institutions today that would help prevent the events of the 1930s from recurring. The system of Federal Deposit Insurance makes widespread bank failures less likely. The income tax causes an automatic reduction in taxes when income falls, which stabilizes the economy. Finally, economists know more today than they did in the 1930s. Our knowledge of how the economy works, limited as it still is, should help policymakers formulate better policies to combat such widespread unemployment.

CASE STUDY

The Japanese Slump

During the 1990s, after many years of rapid growth and enviable prosperity, the Japanese economy experienced a prolonged downturn. Real GDP grew at an average rate of only 1.3 percent over the decade, compared with 4.3 percent over the previous twenty years. The unemployment rate, which had historically been very low in Japan, rose from 2.1 percent in 1990 to 4.7 percent in 1999. In August 2001, unemployment hit 5.0 percent, the highest rate since the government began compiling the statistic in 1953.

Although the Japanese slump of the 1990s is not even close in magnitude to the Great Depression of the 1930s, the episodes are similar in several ways. First, both episodes are traced in part to a large decline in stock prices. In Japan, stock prices at the end of the 1990s were less than half the peak level they had reached about a decade earlier. Like the stock market, Japanese land prices had also skyrocketed in the 1980s before crashing in the 1990s. (At the peak of Japan's land bubble, it was said that the land under the Imperial Palace was worth more than the entire state of California.) When stock and land prices collapsed, Japanese citizens saw their wealth plummet. This decline in wealth, like that during the Great Depression, depressed consumer spending.

Second, during both episodes, banks ran into trouble and exacerbated the slump in economic activity. Japanese banks in the 1980s had made many loans that were backed by stock or land. When the value of this collateral fell, borrowers started defaulting on their loans. These defaults on the old loans reduced the banks' ability to make new loans. The resulting "credit crunch" made it harder for firms to finance investment projects and, thus, depressed investment spending.

Third, both episodes saw a fall in economic activity coincide with very low interest rates. In Japan in the 1990s, as in the United States in the 1930s, short-term nominal interest rates were less than 1 percent. This fact suggests that the cause of the slump was primarily a contractionary shift in the *IS* curve, because such a shift reduces both income and the interest rate. The obvious suspects to explain the *IS* shift are the crashes in stock and land prices and the problems in the banking system.

Finally, the policy debate in Japan mirrored the debate over the Great Depression. Some economists recommended that the Japanese government pass large tax cuts to encourage more consumer spending. Although this advice was followed to some extent, Japanese policymakers were reluctant to enact very large tax cuts because, like the U.S. policymakers in the 1930s, they wanted to avoid budget deficits. In Japan, this reluctance to increase government debt arose in part because the government was facing a large unfunded pension liability and a rapidly aging population.

Other economists recommended that the Bank of Japan expand the money supply more rapidly. Even if nominal interest rates could not go much lower, then perhaps more rapid money growth could raise expected inflation, lower real interest rates, and stimulate investment spending. Thus, although economists differed about whether fiscal or monetary policy was more likely to be effective, there was wide agreement that the solution to Japan's slump, like the solution to the Great Depression, rested in more aggressive expansion of aggregate demand.[5]

11-4 Conclusion

The purpose of this chapter and the previous one has been to deepen our understanding of aggregate demand. We now have the tools to analyze the effects of monetary and fiscal policy in the long run and in the short run. In the long run, prices are flexible, and we use the classical analysis of Parts II and III of this book. In the short run, prices are sticky, and we use the *IS–LM* model to examine how changes in policy influence the economy.

[5] To learn more about this episode, see Adam S. Posen, *Restoring Japan's Economic Growth* (Washington, DC: Institute for International Economics, 1998).

FYI The Liquidity Trap

In Japan in the 1990s and the United States in the 1930s, interest rates reached very low levels. As Table 11-2 shows, U.S. interest rates were well under 1 percent throughout the second half of the 1930s. The same was true in Japan during the second half of the 1990s. In 1999, Japanese short-term interest rates fell to about one-tenth of 1 percent.

Some economists describe this situation as a *liquidity trap*. According to the *IS–LM* model, expansionary monetary policy works by reducing interest rates and stimulating investment spending. But if interest rates have already fallen almost to zero, then perhaps monetary policy is no longer effective. Nominal interest rates cannot fall below zero: rather than making a loan at a negative nominal interest rate, a person would simply hold cash. In this environment, expansionary monetary policy raises the supply of money, making the public more liquid, but because interest rates can't fall any further, the extra liquidity might not have any effect. Aggregate demand, production, and employment may be "trapped" at low levels.

Other economists are skeptical about this argument. One response is that expansionary monetary policy might raise inflation expectations. Even if nominal interest rates cannot fall any further, higher expected inflation can lower real interest rates by making them negative, which would stimulate investment spending. A second response is that monetary expansion would cause the currency to lose value in the market for foreign-currency exchange. This depreciation would make the nation's goods cheaper abroad, stimulating export demand. This second argument goes beyond the closed-economy *IS–LM* model we have used in this chapter, but it has merit in the open-economy version of the model developed in the next chapter.

Is the liquidity trap something about which monetary policymakers need to worry? Might the tools of monetary policy at times lose their power to influence the economy? There is no consensus about the answers. Skeptics say we shouldn't worry about the liquidity trap. But others say the possibility of a liquidity trap argues for a target rate of inflation greater than zero. Under zero inflation, the real interest rate, like the nominal interest, can never fall below zero. But if the normal rate of inflation is, say, 3 percent, then the central bank can easily push the real interest rate to negative 3 percent by lowering the nominal interest rate toward zero. Thus, moderate inflation gives monetary policymakers more room to stimulate the economy when needed, reducing the risk of falling into a liquidity trap.[6]

Although the model presented in this chapter provides the basic framework for analyzing aggregate demand, it is not the whole story. In later chapters, we examine in more detail the elements of this model and thereby refine our understanding of aggregate demand. In Chapter 16, for example, we study theories of consumption. Because the consumption function is a crucial piece of the *IS–LM* model, a deeper analysis of consumption may modify our view of the impact of monetary and fiscal policy on the economy. The simple *IS–LM* model presented in Chapters 10 and 11 provides the starting point for this further analysis.

[6] To read more about the liquidity trap, see Paul R. Krugman, "It's Baaack: Japan's Slump and the Return of the Liquidity Trap," *Brookings Panel on Economic Activity* (1998): 137–205.

Summary

1. The *IS–LM* model is a general theory of the aggregate demand for goods and services. The exogenous variables in the model are fiscal policy, monetary policy, and the price level. The model explains two endogenous variables: the interest rate and the level of national income.
2. The *IS* curve represents the negative relationship between the interest rate and the level of income that arises from equilibrium in the market for goods and services. The *LM* curve represents a positive relationship between the interest rate and the level of income that arises from equilibrium in the market for real money balances. Equilibrium in the *IS–LM* model—the intersection of the *IS* and *LM* curves—represents simultaneous equilibrium in the market for goods and services and in the market for real money balances.
3. The aggregate demand curve summarizes the results from the *IS–LM* model by showing equilibrium income at any given price level. The aggregate demand curve slopes downward because a lower price level increases real money balances, lowers the interest rate, stimulates investment spending, and thereby raises equilibrium income.
4. Expansionary fiscal policy—an increase in government purchases or a decrease in taxes—shifts the *IS* curve to the right. This shift in the *IS* curve increases the interest rate and income. The increase in income represents a rightward shift in the aggregate demand curve. Similarly, contractionary fiscal policy shifts the *IS* curve to the left, lowers the interest rate and income, and shifts the aggregate demand curve to the left.
5. Expansionary monetary policy shifts the *LM* curve downward. This shift in the *LM* curve lowers the interest rate and raises income. The increase in income represents a rightward shift of the aggregate demand curve. Similarly, contractionary monetary policy shifts the *LM* curve upward, raises the interest rate, lowers income, and shifts the aggregate demand curve to the left.

KEY CONCEPTS

Monetary transmission mechanism

Pigou effect

Debt-deflation theory

QUESTIONS FOR REVIEW

1. Explain why the aggregate demand curve slopes downward.
2. What is the impact of an increase in taxes on the interest rate, income, consumption, and investment?
3. What is the impact of a decrease in the money supply on the interest rate, income, consumption, and investment?
4. Describe the possible effects of falling prices on equilibrium income.

PROBLEMS AND APPLICATIONS

1. According to the *IS–LM* model, what happens to the interest rate, income, consumption, and investment under the following circumstances?
   a. The central bank increases the money supply.
   b. The government increases government purchases.
   c. The government increases taxes.
   d. The government increases government purchases and taxes by equal amounts.

2. Use the *IS–LM* model to predict the effects of each of the following shocks on income, the interest rate, consumption, and investment. In each case, explain what the Fed should do to keep income at its initial level.
   a. After the invention of a new high-speed computer chip, many firms decide to upgrade their computer systems.
   b. A wave of credit-card fraud increases the frequency with which people make transactions in cash.
   c. A best-seller titled *Retire Rich* convinces the public to increase the percentage of their income devoted to saving.

3. Consider the economy of Hicksonia.
   a. The consumption function is given by
   $$C = 200 + 0.75(Y - T).$$
   The investment function is
   $$I = 200 - 25r.$$
   Government purchases and taxes are both 100. For this economy, graph the *IS* curve for r ranging from 0 to 8.
   b. The money demand function in Hicksonia is
   $$(M/P)^{d} = Y - 100r.$$
   The money supply M is 1,000 and the price level P is 2. For this economy, graph the *LM* curve for r ranging from 0 to 8.
   c. Find the equilibrium interest rate r and the equilibrium level of income Y.
   d. Suppose that government purchases are raised from 100 to 150. How much does the *IS* curve shift? What are the new equilibrium interest rate and level of income?
   e. Suppose instead that the money supply is raised from 1,000 to 1,200. How much does the *LM* curve shift? What are the new equilibrium interest rate and level of income?
   f. With the initial values for monetary and fiscal policy, suppose that the price level rises from 2 to 4. What happens? What are the new equilibrium interest rate and level of income?
   g. Derive and graph an equation for the aggregate demand curve. What happens to this aggregate demand curve if fiscal or monetary policy changes, as in parts (d) and (e)?

4. Explain why each of the following statements is true. Discuss the impact of monetary and fiscal policy in each of these special cases.
   a. If investment does not depend on the interest rate, the *IS* curve is vertical.
   b. If money demand does not depend on the interest rate, the *LM* curve is vertical.
   c. If money demand does not depend on income, the *LM* curve is horizontal.
   d. If money demand is extremely sensitive to the interest rate, the *LM* curve is horizontal.

5. Suppose that the government wants to raise investment but keep output constant. In the *IS–LM* model, what mix of monetary and fiscal policy will achieve this goal? In the early 1980s, the U.S. government cut taxes and ran a budget deficit while the Fed pursued a tight monetary policy. What effect should this policy mix have?

6. Use the *IS–LM* diagram to describe the short-run and long-run effects of the following changes on national income, the interest rate, the price level, consumption, investment, and real money balances.
   a. An increase in the money supply.
   b. An increase in government purchases.
   c. An increase in taxes.

7. The Fed is considering two alternative monetary policies:

- holding the money supply constant and letting the interest rate adjust, or
- adjusting the money supply to hold the interest rate constant.

In the *IS–LM* model, which policy will better stabilize output under the following conditions?

a. All shocks to the economy arise from exogenous changes in the demand for goods and services.

b. All shocks to the economy arise from exogenous changes in the demand for money.

8. Suppose that the demand for real money balances depends on disposable income. That is, the money demand function is

$$M/P = L(r, Y - T).$$

Using the *IS–LM* model, discuss whether this change in the money demand function alters the following:

a. The analysis of changes in government purchases.

b. The analysis of changes in taxes.

APPENDIX

The Simple Algebra of the *IS–LM* Model and the Aggregate Demand Curve

The chapter analyzes the *IS–LM* model with graphs of the *IS* and *LM* curves. Here we analyze the model algebraically rather than graphically. This alternative presentation offers additional insight into how monetary and fiscal policy influence aggregate demand.

The *IS* Curve

One way to think about the *IS* curve is that it describes the combinations of income Y and the interest rate r that satisfy an equation we first saw in Chapter 3:

$$Y = C(Y - T) + I(r) + G.$$

This equation combines the national income accounts identity, the consumption function, and the investment function. It states that the quantity of goods produced, Y, must equal the quantity of goods demanded, $C + I + G$.

We can learn more about the *IS* curve by considering the special case in which the consumption function and investment function are linear. We begin with the national income accounts identity

$$Y = C + I + G.$$

Now suppose that the consumption function is

$$C = a + b(Y - T),$$

where a and b are numbers greater than zero, and the investment function is

$$I = c - dr,$$

where c and d also are numbers greater than zero. The parameter b is the marginal propensity to consume, so we expect b to be between zero and one. The parameter d determines how much investment responds to the interest rate; because investment rises when the interest rate falls, there is a minus sign in front of d.

From these three equations, we can derive an algebraic expression for the *IS* curve and see what influences the *IS* curve's position and slope. If we substitute the consumption and investment functions into the national income accounts identity, we obtain

$$Y = [a + b(Y - T)] + (c - dr) + G.$$

Note that Y shows up on both sides of this equation. We can simplify this equation by bringing all the Y terms to the left-hand side and rearranging the terms on the right-hand side:

$$Y - bY = (a + c) + (G - bT) - dr.$$

We solve for Y to get

$$Y = \frac{a + c}{1 - b} + \frac{1}{1 - b}G + \frac{-b}{1 - b}T + \frac{-d}{1 - b}r.$$

This equation expresses the *IS* curve algebraically. It tells us the level of income Y for any given interest rate r and fiscal policy G and T. Holding fiscal policy fixed, the equation gives us a relationship between the interest rate and the level of income: the higher the interest rate, the lower the level of income. The *IS* curve graphs this equation for different values of Y and r given fixed values of G and T.

Using this last equation, we can verify our previous conclusions about the *IS* curve. First, because the coefficient of the interest rate is negative, the *IS* curve slopes downward: higher interest rates reduce income. Second, because the coefficient of government purchases is positive, an increase in government purchases shifts the *IS* curve to the right. Third, because the coefficient of taxes is negative, an increase in taxes shifts the *IS* curve to the left.

The coefficient of the interest rate, $-d/(1 - b)$, tells us what determines whether the *IS* curve is steep or flat. If investment is highly sensitive to the interest rate, then d is large, and income is highly sensitive to the interest rate as well. In this case, small changes in the interest rate lead to large changes in income: the *IS* curve is relatively flat. Conversely, if investment is not very sensitive to the interest rate, then d is small, and income is also not very sensitive to the interest rate. In this case, large changes in interest rates lead to small changes in income: the *IS* curve is relatively steep.

Similarly, the slope of the *IS* curve depends on the marginal propensity to consume b. The larger the marginal propensity to consume, the larger the change in income resulting from a given change in the interest rate. The reason is that a large marginal propensity to consume leads to a large multiplier for changes in investment. The larger the multiplier, the larger the impact of a change in investment on income, and the flatter the *IS* curve.

The marginal propensity to consume b also determines how much changes in fiscal policy shift the *IS* curve. The coefficient of G, $1/(1 - b)$, is the government-purchases multiplier in the Keynesian cross. Similarly, the coefficient of T, $-b/(1 - b)$, is the tax multiplier in the Keynesian cross. The larger the marginal propensity to consume, the greater the multiplier, and thus the greater the shift in the *IS* curve that arises from a change in fiscal policy.

The *LM* Curve

The *LM* curve describes the combinations of income Y and the interest rate r that satisfy the money market equilibrium condition

$$M/P = L(r, Y).$$

This equation simply equates money supply and money demand.

We can learn more about the *LM* curve by considering the case in which the money demand function is linear—that is,

$$L(r, Y) = eY - fr,$$

where e and f are numbers greater than zero. The value of e determines how much the demand for money rises when income rises. The value of f determines how much the demand for money falls when the interest rate rises. There is a minus sign in front of the interest rate term because money demand is inversely related to the interest rate.

The equilibrium in the money market is now described by

$$M/P = eY - fr.$$

To see what this equation implies, rearrange the terms so that r is on the left-hand side. We obtain

$$r = (e/f)Y - (1/f)M/P.$$

This equation gives us the interest rate that equilibrates the money market for any values of income and real money balances. The *LM* curve graphs this equation for different values of Y and r given a fixed value of M/P.

From this last equation, we can verify some of our conclusions about the *LM* curve. First, because the coefficient of income is positive, the *LM* curve slopes upward: higher income requires a higher interest rate to equilibrate the money market. Second, because the coefficient of real money balances is negative, decreases in real balances shift the *LM* curve upward, and increases in real balances shift the *LM* curve downward.

From the coefficient of income, e/f, we can see what determines whether the *LM* curve is steep or flat. If money demand is not very sensitive to the level of income, then e is small. In this case, only a small change in the interest rate is necessary to offset the small increase in money demand caused by a change in income: the *LM* curve is relatively flat. Similarly, if the quantity of money demanded is not very sensitive to the interest rate, then f is small. In this case, a shift in money demand caused by a change in income leads to a large change in the equilibrium interest rate: the *LM* curve is relatively steep.

The Aggregate Demand Curve

To find the aggregate demand equation, we must find the level of income that satisfies both the *IS* equation and the *LM* equation. To do this, substitute the *LM* equation for the interest rate r into the *IS* equation to obtain

$$Y = \frac{a + c}{1 - b} + \frac{1}{1 - b}G + \frac{-b}{1 - b}T + \frac{-d}{1 - b}\left(\frac{e}{f}Y - \frac{1}{f}\,\frac{M}{P}\right).$$

With some algebraic manipulation, we can solve for Y. The final equation for Y is

$$Y = \frac{z(a + c)}{1 - b} + \frac{z}{1 - b}G + \frac{-zb}{1 - b}T + \frac{d}{(1 - b)[f + de/(1 - b)]}\frac{M}{P},$$

where $z = f/[f + de/(1 - b)]$ is a composite of some of the parameters and is between zero and one.

This last equation expresses the aggregate demand curve algebraically. It says that income depends on fiscal policy G and T, monetary policy M, and the price level P. The aggregate demand curve graphs this equation for different values of Y and P given fixed values of G, T, and M.

We can explain the slope and position of the aggregate demand curve with this equation. First, the aggregate demand curve slopes downward, because an increase in P lowers M/P and thus lowers Y. Second, increases in the money supply raise income and shift the aggregate demand curve to the right. Third, increases in government purchases or decreases in taxes also raise income and shift the aggregate demand curve to the right. Note that, because z is less than one, the multipliers for fiscal policy are smaller in the *IS–LM* model than in the Keynesian cross. Hence, the parameter z reflects the crowding out of investment discussed earlier.

Finally, this equation shows the relationship between the aggregate demand curve derived in this chapter from the *IS–LM* model and the aggregate demand curve derived in Chapter 9 from the quantity theory of money. The quantity theory assumes that the interest rate does not influence the quantity of real money balances demanded. Put differently, the quantity theory assumes that the parameter f equals zero. If f equals zero, then the composite parameter z also equals zero, so fiscal policy does not influence aggregate demand. Thus, the aggregate demand curve derived in Chapter 9 is a special case of the aggregate demand curve derived here.

CASE STUDY

The Effectiveness of Monetary and Fiscal Policy

Economists have long debated whether monetary or fiscal policy exerts a more powerful influence on aggregate demand. According to the *IS–LM* model, the answer to this question depends on the parameters of the *IS* and *LM* curves. Therefore, economists have spent much energy arguing about the size of these parameters. The most hotly contested parameters are those that describe the influence of the interest rate on economic decisions.

Those economists who believe that fiscal policy is more potent than monetary policy argue that the responsiveness of investment to the interest rate—measured by the parameter d—is small. If you look at the algebraic equation for aggregate demand, you will see that a small value of d implies a small effect of the money supply on income. The reason is that when d is small, the *IS* curve is nearly vertical, and shifts in the *LM* curve do not cause much of a change in income. In addition, a small value of d implies a large value of z, which in turn implies that fiscal policy has a large effect on income. The reason for this large effect is that when investment is not very responsive to the interest rate, there is little crowding out.

Those economists who believe that monetary policy is more potent than fiscal policy argue that the responsiveness of money demand to the interest rate—measured by the parameter f—is small. When f is small, z is small, and fiscal policy has a small effect on income; in this case, the *LM* curve is nearly vertical. In addition, when f is small, changes in the money supply have a large effect on income.

Few economists today endorse either of these extreme views. The evidence indicates that the interest rate affects both investment and money demand. This finding implies that both monetary and fiscal policy are important determinants of aggregate demand.

MORE PROBLEMS AND APPLICATIONS

1. Give an algebraic answer to each of the following questions. Then explain in words the economics that underlies your answer.

a. How does the sensitivity of investment to the interest rate affect the slope of the aggregate demand curve?

b. How does the sensitivity of money demand to the interest rate affect the slope of the aggregate demand curve?

c. How does the marginal propensity to consume affect the response of aggregate demand to changes in government purchases?

CHAPTER 12 TWELVE

Aggregate Demand in the Open Economy

When conducting monetary and fiscal policy, policymakers often look beyond their own country's borders. Even if domestic prosperity is their sole objective, it is necessary for them to consider the rest of the world. The international flow of goods and services and the international flow of capital can affect an economy in profound ways. Policymakers ignore these effects at their peril.

In this chapter we extend our analysis of aggregate demand to include international trade and finance. The model developed in this chapter, called the **Mundell–Fleming model**, is an open-economy version of the *IS–LM* model. Both models stress the interaction between the goods market and the money market. Both models assume that the price level is fixed and then show what causes short-run fluctuations in aggregate income (or, equivalently, shifts in the aggregate demand curve). The key difference is that the *IS–LM* model assumes a closed economy, whereas the Mundell–Fleming model assumes an open economy. The Mundell–Fleming model extends the short-run model of national income from Chapters 10 and 11 by including the effects of international trade and finance from Chapter 5.

The Mundell–Fleming model makes one important and extreme assumption: it assumes that the economy being studied is a small open economy with perfect capital mobility. That is, the economy can borrow or lend as much as it wants in world financial markets and, as a result, the economy's interest rate is determined by the world interest rate. One virtue of this assumption is that it simplifies the analysis: once the interest rate is determined, we can concentrate our attention on the role of the exchange rate. In addition, for some economies, such as Belgium or the Netherlands, the assumption of a small open economy with perfect capital mobility is a good one. Yet this assumption—and thus the Mundell–Fleming model—does not apply exactly to a large open economy such as the United States. In the conclusion to this chapter (and more fully in the appendix), we consider what happens in the more complex case in which international capital mobility is less than perfect or a nation is so large it can influence world financial markets.

One lesson from the Mundell–Fleming model is that the behavior of an economy depends on the exchange-rate system it has adopted. We begin by assuming that the economy operates with a floating exchange rate. That is, we assume that the central bank allows the exchange rate to adjust to changing economic conditions. We then examine how the economy operates under a fixed exchange rate, and we discuss whether a floating or fixed exchange rate is better. This question has been important in recent years, as many nations around the world have debated what exchange-rate system to adopt.

12-1 The Mundell–Fleming Model

In this section we build the Mundell–Fleming model, and in the following sections we use the model to examine the impact of various policies. As you will see, the Mundell–Fleming model is built from components we have used in previous chapters. But these pieces are put together in a new way to address a new set of questions.[1]

The Key Assumption: Small Open Economy With Perfect Capital Mobility

Let's begin with the assumption of a small open economy with perfect capital mobility. As we saw in Chapter 5, this assumption means that the interest rate in this economy r is determined by the world interest rate r^*. Mathematically, we can write this assumption as

$$r = r^*.$$

This world interest rate is assumed to be exogenously fixed because the economy is sufficiently small relative to the world economy that it can borrow or lend as much as it wants in world financial markets without affecting the world interest rate.

Although the idea of perfect capital mobility is expressed with a simple equation, it is important not to lose sight of the sophisticated process that this equation represents. Imagine that some event were to occur that would normally raise the interest rate (such as a decline in domestic saving). In a small open economy, the domestic interest rate might rise by a little bit for a short time, but as soon as it did, foreigners would see the higher interest rate and start lending to this country (by, for instance, buying this country's bonds). The capital inflow would drive the domestic interest rate back toward r^*. Similarly, if any event were ever to start driving the domestic interest rate downward, capital would flow out of the country to earn a higher return abroad, and this capital outflow would drive the domestic interest rate back upward toward r^*. Hence, the $r = r^*$ equation represents the assumption that the international flow of capital is rapid enough to keep the domestic interest rate equal to the world interest rate.

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[1] The Mundell–Fleming model was developed in the early 1960s. Mundell's contributions are collected in Robert A. Mundell, *International Economics* (New York: Macmillan, 1968). For Fleming's contribution, see J. Marcus Fleming, "Domestic Financial Policies Under Fixed and Under Floating Exchange Rates," *IMF Staff Papers* 9 (November 1962): 369–379. In 1999, Robert Mundell was awarded the Nobel Prize for his work in open-economy macroeconomics.

The Goods Market and the *IS** Curve

The Mundell–Fleming model describes the market for goods and services much as the *IS–LM* model does, but it adds a new term for net exports. In particular, the goods market is represented with the following equation:

$$Y = C(Y - T) + I(r^*) + G + NX(e).$$

This equation states that aggregate income Y is the sum of consumption C, investment I, government purchases G, and net exports NX. Consumption depends positively on disposable income $Y - T$. Investment depends negatively on the interest rate, which equals the world interest rate r^*. Net exports depend negatively on the exchange rate e. As before, we define the exchange rate e as the amount of foreign currency per unit of domestic currency—for example, e might be 100 yen per dollar.

You may recall that in Chapter 5 we related net exports to the real exchange rate (the relative price of goods at home and abroad) rather than the nominal exchange rate (the relative price of domestic and foreign currencies). If e is the nominal exchange rate, then the real exchange rate ϵ equals eP/P^*, where P is the domestic price level and P^* is the foreign price level. The Mundell–Fleming model, however, assumes that the price levels at home and abroad are fixed, so the real exchange rate is proportional to the nominal exchange rate. That is, when the nominal exchange rate appreciates (say, from 100 to 120 yen per dollar), foreign goods become cheaper compared to domestic goods, and this causes exports to fall and imports to rise.

We can illustrate this equation for goods market equilibrium on a graph in which income is on the horizontal axis and the exchange rate is on the vertical axis. This curve is shown in panel (c) of Figure 12-1 and is called the IS^* curve. The new label reminds us that the curve is drawn holding the interest rate constant at the world interest rate r^*.

The IS^* curve slopes downward because a higher exchange rate reduces net exports, which in turn lowers aggregate income. To show how this works, the other panels of Figure 12-1 combine the net-exports schedule and the Keynesian cross to derive the IS^* curve. In panel (a), an increase in the exchange rate from e_1 to e_2 lowers net exports from $NX(e_1)$ to $NX(e_2)$. In panel (b), the reduction in net exports shifts the planned-expenditure schedule downward and thus lowers income from Y_1 to Y_2. The IS^* curves summarizes this relationship between the exchange rate e and income Y.

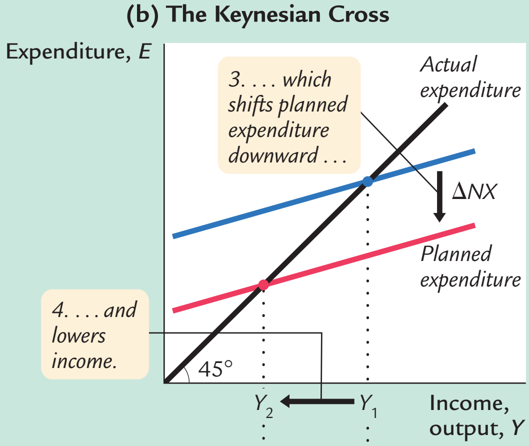
The Money Market and the *LM** Curve

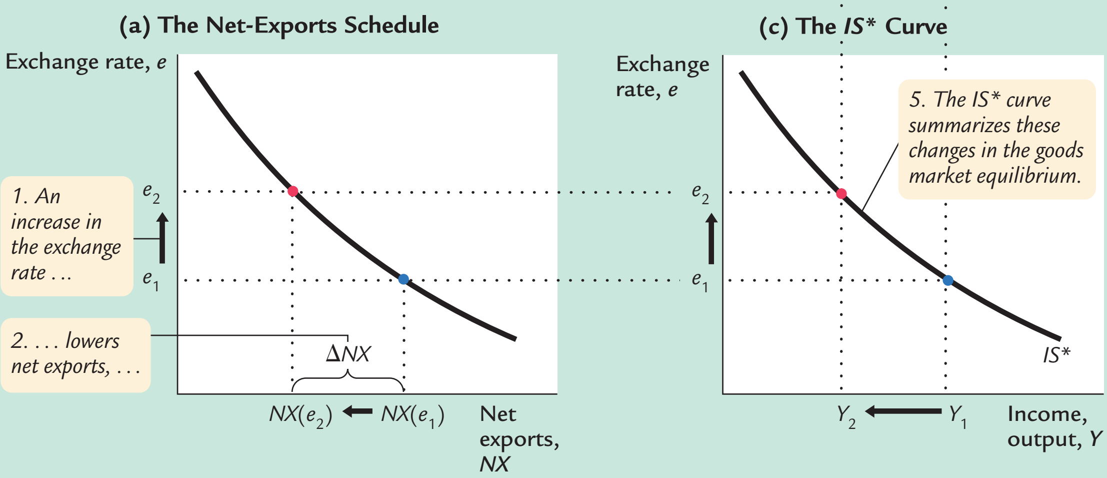
The Mundell–Fleming model represents the money market with an equation that should be familiar from the *IS–LM* model, with the additional assumption that the domestic interest rate equals the world interest rate:

$$M/P = L(r^*, Y).$$

figure 12-1

The *IS Curve** The IS^* curve is derived from the net-exports schedule and the Keynesian cross. Panel (a) shows the net-exports schedule: an increase in the exchange rate from e_1 to e_2 lowers net exports from $NX(e_1)$ to $NX(e_2)$. Panel (b) shows the Keynesian cross: a decrease in net exports from $NX(e_1)$ to $NX(e_2)$ shifts the planned-expenditure schedule downward and reduces income from Y_1 to Y_2. Panel (c) shows the IS^* curve summarizing this relationship between the exchange rate and income: the higher the exchange rate, the lower the level of income.

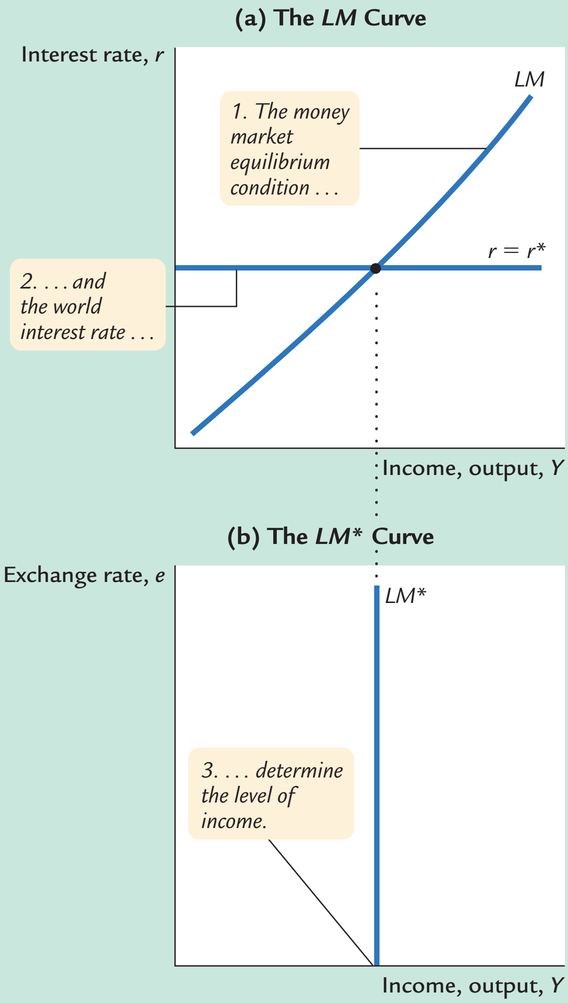




This equation states that the supply of real money balances, M/P, equals the demand, $L(r, Y)$. The demand for real balances depends negatively on the interest rate, which is now set equal to the world interest rate r^*, and positively on income Y. The money supply M is an exogenous variable controlled by the central bank, and because the Mundell–Fleming model is designed to analyze short-run fluctuations, the price level P is also assumed to be exogenously fixed.

We can represent this equation graphically with a vertical LM^* curve, as in panel (b) of Figure 12-2. The LM^* curve is vertical because the exchange rate does not enter into the LM^* equation. Given the world interest rate, the LM^* equation determines aggregate income, regardless of the exchange rate. Figure 12-2 shows how the LM^* curve arises from the world interest rate and the LM curve, which relates the interest rate and income.

figure 12-2



The *LM Curve** Panel (a) shows the standard *LM* curve [which graphs the equation $M/P = L(r, Y)$] together with a horizontal line representing the world interest rate r^*. The intersection of these two curves determines the level of income, regardless of the exchange rate. Therefore, as panel (b) shows, the *LM** curve is vertical.

Putting the Pieces Together

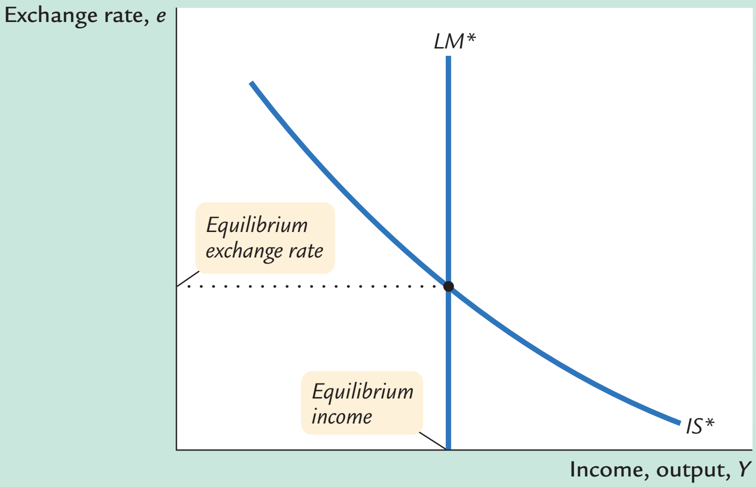
According to the Mundell–Fleming model, a small open economy with perfect capital mobility can be described by two equations:

$$Y = C(Y - T) + I(r^*) + G + NX(e) \qquad IS^*,$$
$$M/P = L(r^*, Y) \qquad LM^*.$$

The first equation describes equilibrium in the goods market, and the second equation describes equilibrium in the money market. The exogenous variables are fiscal policy G and T, monetary policy M, the price level P, and the world interest rate r^*. The endogenous variables are income Y and the exchange rate e.

Figure 12-3 illustrates these two relationships. The equilibrium for the economy is found where the IS^* curve and the LM^* curve intersect. This intersection

figure 12-3



The Mundell–Fleming Model This graph of the Mundell–Fleming model plots the goods market equilibrium condition *IS** and the money market equilibrium condition *LM**. Both curves are drawn holding the interest rate constant at the world interest rate. The intersection of these two curves shows the level of income and the exchange rate that satisfy equilibrium both in the goods market and in the money market.

shows the exchange rate and the level of income at which both the goods market and the money market are in equilibrium. With this diagram, we can use the Mundell–Fleming model to show how aggregate income Y and the exchange rate e respond to changes in policy.

12-2 The Small Open Economy Under Floating Exchange Rates

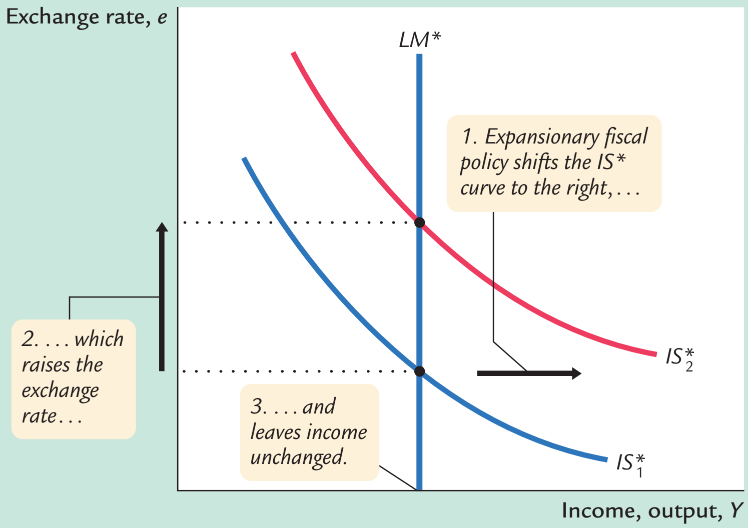
Before analyzing the impact of policies in an open economy, we must specify the international monetary system in which the country has chosen to operate. We start with the system relevant for most major economies today: **floating exchange rates**. Under floating exchange rates, the exchange rate is allowed to fluctuate in response to changing economic conditions.

Fiscal Policy

Suppose that the government stimulates domestic spending by increasing government purchases or by cutting taxes. Because such expansionary fiscal policy increases planned expenditure, it shifts the *IS** curve to the right, as in Figure 12-4. As a result, the exchange rate appreciates, whereas the level of income remains the same.

Notice that fiscal policy has very different effects in a small open economy than it does in a closed economy. In the closed-economy *IS–LM* model, a fiscal expansion raises income, whereas in a small open economy with a floating exchange rate, a fiscal expansion leaves income at the same level. Why the

figure 12-4



A Fiscal Expansion Under Floating Exchange Rates An increase in government purchases or a decrease in taxes shifts the *IS** curve to the right. This raises the exchange rate but has no effect on income.

difference? When income rises in a closed economy, the interest rate rises, because higher income increases the demand for money. That is not possible in a small open economy: as soon as the interest rate tries to rise above the world interest rate r^*, capital flows in from abroad. This capital inflow increases the demand for the domestic currency in the market for foreign-currency exchange and, thus, bids up the value of the domestic currency. The appreciation of the exchange rate makes domestic goods expensive relative to foreign goods, and this reduces net exports. The fall in net exports offsets the effects of the expansionary fiscal policy on income.

Why is the fall in net exports so great that it renders fiscal policy powerless to influence income? To answer this question, consider the equation that describes the money market:

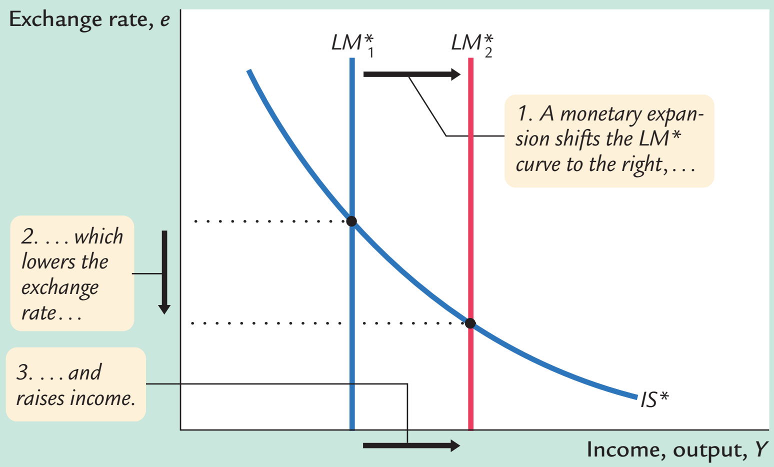
$$M/P = L(r, Y).$$

In both closed and open economies, the quantity of real money balances supplied M/P is fixed, and the quantity demanded (determined by r and Y) must equal this fixed supply. In a closed economy, a fiscal expansion causes the equilibrium interest rate to rise. This increase in the interest rate (which reduces the quantity of money demanded) allows equilibrium income to rise (which increases the quantity of money demanded). By contrast, in a small open economy, r is fixed at r^*, so there is only one level of income that can satisfy this equation, and this level of income does not change when fiscal policy changes. Thus, when the government increases spending or cuts taxes, the appreciation of the exchange rate and the fall in net exports must be large enough to offset fully the normal expansionary effect of the policy on income.

Monetary Policy

Suppose now that the central bank increases the money supply. Because the price level is assumed to be fixed, the increase in the money supply means an increase in real balances. The increase in real balances shifts the *LM** curve to the right, as in Figure 12-5. Hence, an increase in the money supply raises income and lowers the exchange rate.

figure 12-5



A Monetary Expansion Under Floating Exchange Rates An increase in the money supply shifts the *LM** curve to the right, lowering the exchange rate and raising income.

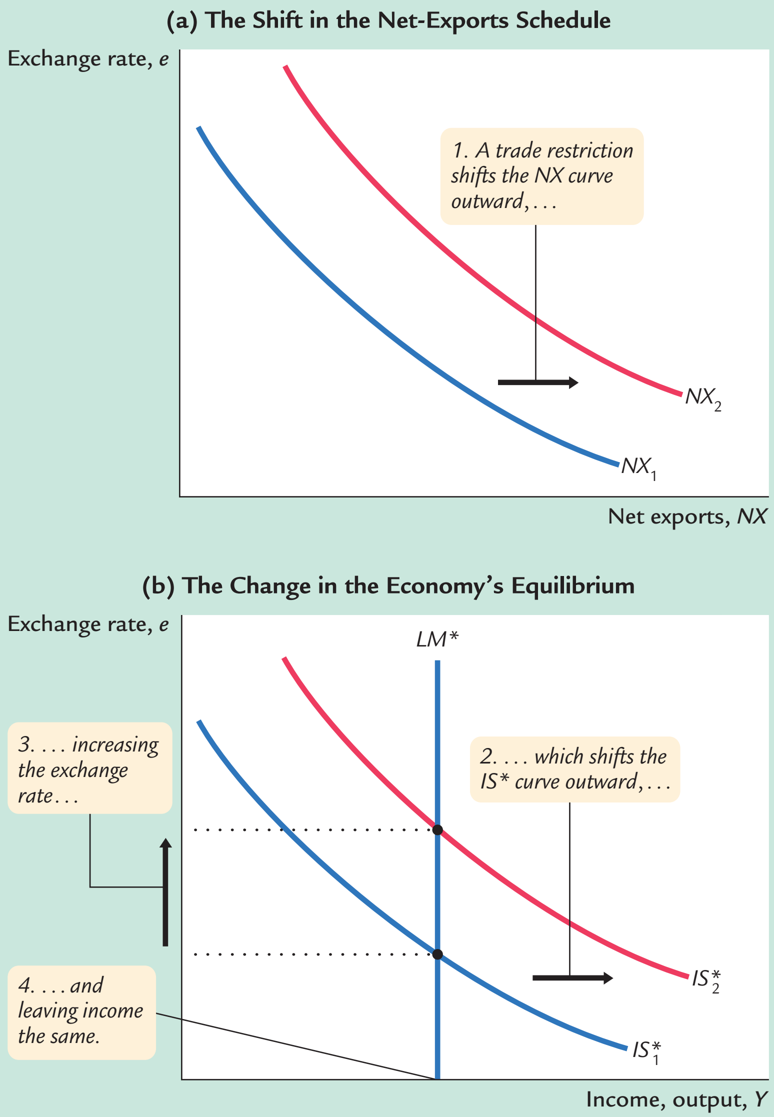
Although monetary policy influences income in an open economy, as it does in a closed economy, the monetary transmission mechanism is different. Recall that in a closed economy an increase in the money supply increases spending because it lowers the interest rate and stimulates investment. In a small open economy, the interest rate is fixed by the world interest rate. As soon as an increase in the money supply puts downward pressure on the domestic interest rate, capital flows out of the economy as investors seek a higher return elsewhere. This capital outflow prevents the domestic interest rate from falling. In addition, because the capital outflow increases the supply of the domestic currency in the market for foreign-currency exchange, the exchange rate depreciates. The fall in the exchange rate makes domestic goods inexpensive relative to foreign goods and, thereby, stimulates net exports. Hence, in a small open economy, monetary policy influences income by altering the exchange rate rather than the interest rate.

Trade Policy

Suppose that the government reduces the demand for imported goods by imposing an import quota or a tariff. What happens to aggregate income and the exchange rate?

Because net exports equal exports minus imports, a reduction in imports means an increase in net exports. That is, the net-exports schedule shifts to the

figure 12-6



A Trade Restriction Under Floating Exchange Rates A tariff or an import quota shifts the net-exports schedule in panel (a) to the right. As a result, the *IS** curve in panel (b) shifts to the right, raising the exchange rate and leaving income unchanged.

right, as in Figure 12-6. This shift in the net-exports schedule increases planned expenditure and thus moves the *IS** curve to the right. Because the *LM** curve is vertical, the trade restriction raises the exchange rate but does not affect income.

Often a stated goal of policies to restrict trade is to alter the trade balance *NX*. Yet, as we first saw in Chapter 5, such policies do not necessarily have that effect. The same conclusion holds in the Mundell–Fleming model under floating exchange rates. Recall that

$$NX(e) = Y - C(Y - T) - I(r^*) - G.$$

Because a trade restriction does not affect income, consumption, investment, or government purchases, it does not affect the trade balance. Although the shift in the net-exports schedule tends to raise *NX*, the increase in the exchange rate reduces *NX* by the same amount.

12-3 The Small Open Economy Under Fixed Exchange Rates

We now turn to the second type of exchange-rate system: **fixed exchange rates**. In the 1950s and 1960s, most of the world's major economies, including the United States, operated within the Bretton Woods system—an international monetary system under which most governments agreed to fix exchange rates. The world abandoned this system in the early 1970s, and exchange rates were allowed to float. Some European countries later reinstated a system of fixed exchange rates among themselves, and some economists have advocated a return to a worldwide system of fixed exchange rates. In this section we discuss how such a system works, and we examine the impact of economic policies on an economy with a fixed exchange rate.

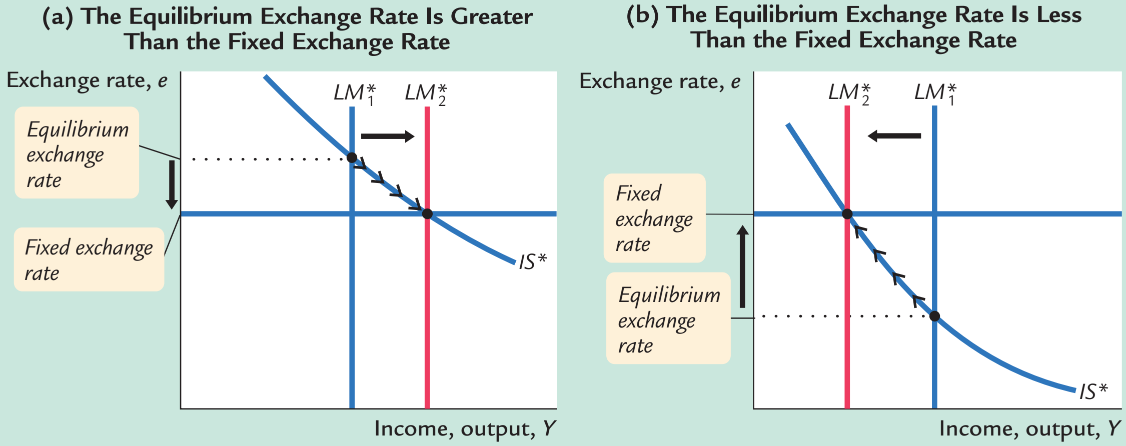
How a Fixed-Exchange-Rate System Works

Under a system of fixed exchange rates, a central bank stands ready to buy or sell the domestic currency for foreign currencies at a predetermined price. For example, suppose that the Fed announced that it was going to fix the exchange rate at 100 yen per dollar. It would then stand ready to give $1 in exchange for 100 yen or to give 100 yen in exchange for $1. To carry out this policy, the Fed would need a reserve of dollars (which it can print) and a reserve of yen (which it must have purchased previously).

A fixed exchange rate dedicates a country's monetary policy to the single goal of keeping the exchange rate at the announced level. In other words, the essence of a fixed-exchange-rate system is the commitment of the central bank to allow the money supply to adjust to whatever level will ensure that the equilibrium exchange rate equals the announced exchange rate. Moreover, as long as the central bank stands ready to buy or sell foreign currency at the fixed exchange rate, the money supply adjusts automatically to the necessary level.

To see how fixing the exchange rate determines the money supply, consider the following example. Suppose that the Fed announces that it will fix the exchange rate at 100 yen per dollar, but, in the current equilibrium with the current money supply, the exchange rate is 150 yen per dollar. This situation is illustrated in panel (a) of Figure 12-7. Notice that there is a profit opportunity: an arbitrageur could buy 300 yen in the marketplace for $2, and then sell the yen to the Fed for $3, making a $1 profit. When the Fed buys these yen from the arbitrageur, the dollars it pays for them automatically increase the money supply. The

figure 12-7



How a Fixed Exchange Rate Governs the Money Supply In panel (a), the equilibrium exchange rate initially exceeds the fixed level. Arbitrageurs will buy foreign currency in foreign-exchange markets and sell it to the Fed for a profit. This process automatically increases the money supply, shifting the *LM** curve to the right and lowering the exchange rate. In panel (b), the equilibrium exchange rate is initially below the fixed level. Arbitrageurs will buy dollars in foreign-exchange markets and use them to buy foreign currency from the Fed. This process automatically reduces the money supply, shifting the *LM** curve to the left and raising the exchange rate.

rise in the money supply shifts the *LM** curve to the right, lowering the equilibrium exchange rate. In this way, the money supply continues to rise until the equilibrium exchange rate falls to the announced level.

Conversely, suppose that when the Fed announces that it will fix the exchange rate at 100 yen per dollar, the equilibrium is 50 yen per dollar. Panel (b) of Figure 12-7 shows this situation. In this case, an arbitrageur could make a profit by buying 100 yen from the Fed for $1 and then selling the yen in the marketplace for $2. When the Fed sells these yen, the $1 it receives automatically reduces the money supply. The fall in the money supply shifts the *LM** curve to the left, raising the equilibrium exchange rate. The money supply continues to fall until the equilibrium exchange rate rises to the announced level.

It is important to understand that this exchange-rate system fixes the nominal exchange rate. Whether it also fixes the real exchange rate depends on the time horizon under consideration. If prices are flexible, as they are in the long run, then the real exchange rate can change even while the nominal exchange rate is fixed. Therefore, in the long run described in Chapter 5, a policy to fix the nominal exchange rate would not influence any real variable, including the real exchange rate. A fixed nominal exchange rate would influence only the money supply and the price level. Yet in the short run described by the Mundell–Fleming model, prices are fixed, so a fixed nominal exchange rate implies a fixed real exchange rate as well.

CASE STUDY

The International Gold Standard

During the late nineteenth and early twentieth centuries, most of the world's major economies operated under a gold standard. Each country maintained a reserve of gold and agreed to exchange one unit of its currency for a specified amount of gold. Through the gold standard, the world's economies maintained a system of fixed exchange rates.

To see how an international gold standard fixes exchange rates, suppose that the U.S. Treasury stands ready to buy or sell 1 ounce of gold for $100, and the Bank of England stands ready to buy or sell 1 ounce of gold for 100 pounds. Together, these policies fix the rate of exchange between dollars and pounds: $1 must trade for 1 pound. Otherwise, the law of one price would be violated, and it would be profitable to buy gold in one country and sell it in the other.

For example, suppose that the exchange rate were 2 pounds per dollar. In this case, an arbitrageur could buy 200 pounds for $100, use the pounds to buy 2 ounces of gold from the Bank of England, bring the gold to the United States, and sell it to the Treasury for $200—making a $100 profit. Moreover, by bringing the gold to the United States from England, the arbitrageur would increase the money supply in the United States and decrease the money supply in England.

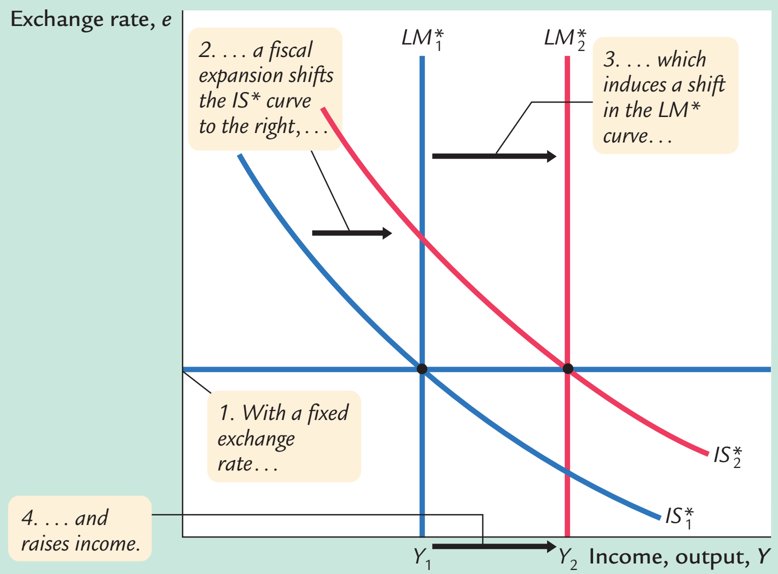
Thus, during the era of the gold standard, the international transport of gold by arbitrageurs was an automatic mechanism adjusting the money supply and stabilizing exchange rates. This system did not completely fix exchange rates, because shipping gold across the Atlantic was costly. Yet the international gold standard did keep the exchange rate within a range dictated by transportation costs. It thereby prevented large and persistent movements in exchange rates.[2]

Fiscal Policy

Let's now examine how economic policies affect a small open economy with a fixed exchange rate. Suppose that the government stimulates domestic spending by increasing government purchases or by cutting taxes. This policy shifts the *IS** curve to the right, as in Figure 12-8, putting upward pressure on the exchange rate. But because the central bank stands ready to trade foreign and domestic currency at the fixed exchange rate, arbitrageurs quickly respond to the rising exchange rate by selling foreign currency to the central bank, leading to an automatic monetary expansion. The rise in the money supply shifts the *LM** curve to the right. Thus, under a fixed exchange rate, a fiscal expansion raises aggregate income.

[2] For more on how the gold standard worked, see the essays in Barry Eichengreen, ed., *The Gold Standard in Theory and History* (New York: Methuen, 1985).

figure 12-8

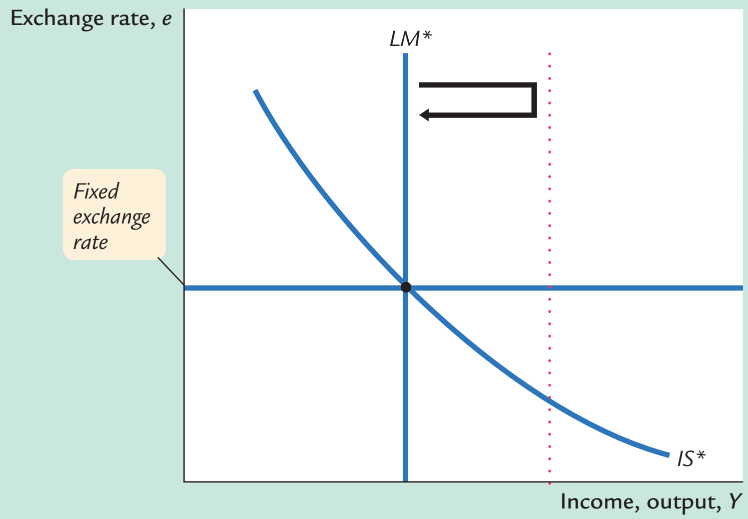


A Fiscal Expansion Under Fixed Exchange Rates A fiscal expansion shifts the *IS** curve to the right. To maintain the fixed exchange rate, the Fed must increase the money supply, thereby shifting the *LM** curve to the right. Hence, in contrast to the case of floating exchange rates, under fixed exchange rates a fiscal expansion raises income.

Monetary Policy

Imagine that a central bank operating with a fixed exchange rate were to try to increase the money supply—for example, by buying bonds from the public. What would happen? The initial impact of this policy is to shift the *LM** curve to the right, lowering the exchange rate, as in Figure 12-9. But, because the central bank is committed to trading foreign and domestic currency at a fixed exchange

figure 12-9



A Monetary Expansion Under Fixed Exchange Rates If the Fed tries to increase the money supply—for example, by buying bonds from the public—it will put downward pressure on the exchange rate. To maintain the fixed exchange rate, the money supply and the *LM** curve must return to their initial positions. Hence, under fixed exchange rates, normal monetary policy is ineffectual.

rate, arbitrageurs quickly respond to the falling exchange rate by selling the domestic currency to the central bank, causing the money supply and the *LM** curve to return to their initial positions. Hence, monetary policy as usually conducted is ineffectual under a fixed exchange rate. By agreeing to fix the exchange rate, the central bank gives up its control over the money supply.

A country with a fixed exchange rate can, however, conduct a type of monetary policy: it can decide to change the level at which the exchange rate is fixed. A reduction in the value of the currency is called a **devaluation**, and an increase in its value is called a **revaluation**. In the Mundell–Fleming model, a devaluation shifts the *LM** curve to the right; it acts like an increase in the money supply under a floating exchange rate. A devaluation thus expands net exports and raises aggregate income. Conversely, a revaluation shifts the *LM** curve to the left, reduces net exports, and lowers aggregate income.

CASE STUDY

Devaluation and the Recovery From the Great Depression

The Great Depression of the 1930s was a global problem. Although events in the United States may have precipitated the downturn, all of the world's major economies experienced huge declines in production and employment. Yet not all governments responded to this calamity in the same way.

One key difference among governments was how committed they were to the fixed exchange rate set by the international gold standard. Some countries, such as France, Germany, Italy, and the Netherlands, maintained the old rate of exchange between gold and currency. Other countries, such as Denmark, Finland, Norway, Sweden, and the United Kingdom, reduced the amount of gold they would pay for each unit of currency by about 50 percent. By reducing the gold content of their currencies, these governments devalued their currencies relative to those of other countries.

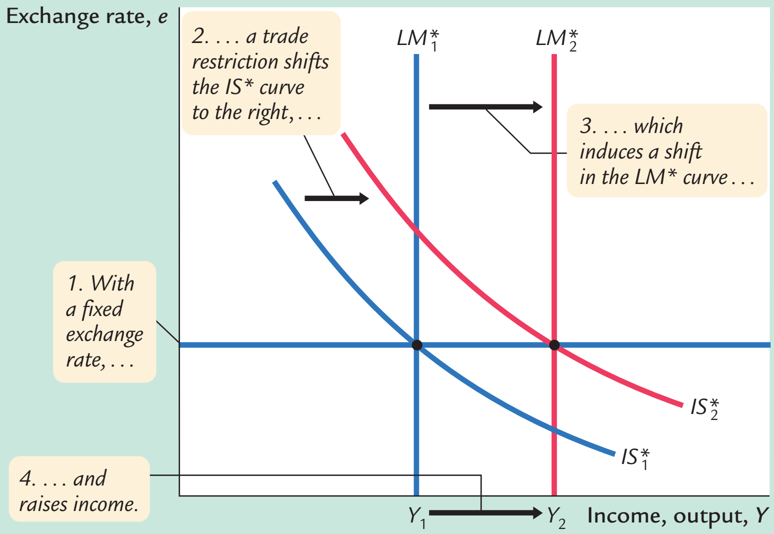
The subsequent experience of these two groups of countries conforms to the prediction of the Mundell–Fleming model. Those countries that pursued a policy of devaluation recovered quickly from the Depression. The lower value of the currency raised the money supply, stimulated exports, and expanded production. By contrast, those countries that maintained the old exchange rate suffered longer with a depressed level of economic activity.[3]

Trade Policy

Suppose that the government reduces imports by imposing an import quota or a tariff. This policy shifts the net-exports schedule to the right and thus shifts the *IS** curve to the right, as in Figure 12-10. The shift in the *IS** curve tends to

[3] Barry Eichengreen and Jeffrey Sachs, "Exchange Rates and Economic Recovery in the 1930s," *Journal of Economic History* 45 (December 1985): 925–946.

figure 12-10



A Trade Restriction Under Fixed Exchange Rates A tariff or an import quota shifts the *IS** curve to the right. This induces an increase in the money supply to maintain the fixed exchange rate. Hence, aggregate income increases.

raise the exchange rate. To keep the exchange rate at the fixed level, the money supply must rise, shifting the *LM** curve to the right.

The result of a trade restriction under a fixed exchange rate is very different from that under a floating exchange rate. In both cases, a trade restriction shifts the net-exports schedule to the right, but only under a fixed exchange rate does a trade restriction increase net exports *NX*. The reason is that a trade restriction under a fixed exchange rate induces monetary expansion rather than an appreciation of the exchange rate. The monetary expansion, in turn, raises aggregate income. Recall the accounting identity

$$NX = S - I.$$

When income rises, saving also rises, and this implies an increase in net exports.

Policy in the Mundell–Fleming Model: A Summary

The Mundell–Fleming model shows that the effect of almost any economic policy on a small open economy depends on whether the exchange rate is floating or fixed. Table 12-1 summarizes our analysis of the short-run effects of fiscal, monetary, and trade policies on income, the exchange rate, and the trade balance. What is most striking is that all of the results are different under floating and fixed exchange rates.

To be more specific, the Mundell–Fleming model shows that the power of monetary and fiscal policy to influence aggregate income depends on the exchange-rate regime. Under floating exchange rates, only monetary policy can affect income. The usual expansionary impact of fiscal policy is offset by a rise in

table 12-1

The Mundell–Fleming Model: Summary of Policy Effects

	EXCHANGE-RATE REGIME					
	FLOATING			FIXED		
	IMPACT ON:					
Policy	*Y*	*e*	*NX*	*Y*	*e*	*NX*
Fiscal expansion	0	↑	↓	↑	0	0
Monetary expansion	↑	↓	↑	0	0	0
Import restriction	0	↑	0	↑	0	↑

Note: This table shows the direction of impact of various economic policies on income Y, the exchange rate e, and the trade balance NX. A "↑" indicates that the variable increases; a "↓" indicates that it decreases; a "0" indicates no effect. Remember that the exchange rate is defined as the amount of foreign currency per unit of domestic currency (for example, 100 yen per dollar).

the value of the currency. Under fixed exchange rates, only fiscal policy can affect income. The normal potency of monetary policy is lost because the money supply is dedicated to maintaining the exchange rate at the announced level.

12-4 Interest-Rate Differentials

So far, our analysis has assumed that the interest rate in a small open economy is equal to the world interest rate: $r = r^*$. To some extent, however, interest rates differ around the world. We now extend our analysis by considering the causes and effects of international interest-rate differentials.

Country Risk and Exchange-Rate Expectations

When we assumed earlier that the interest rate in our small open economy is determined by the world interest rate, we were applying the law of one price. We reasoned that if the domestic interest rate were above the world interest rate, people from abroad would lend to that country, driving the domestic interest rate down. And if the domestic interest rate were below the world interest rate, domestic residents would lend abroad to earn a higher return, driving the domestic interest rate up. In the end, the domestic interest rate would equal the world interest rate.

Why doesn't this logic always apply? There are two reasons.

One reason is country risk. When investors buy U.S. government bonds or make loans to U.S. corporations, they are fairly confident that they will be repaid with interest. By contrast, in some less developed countries, it is plausible to fear that a revolution or other political upheaval might lead to a default on loan repayments. Borrowers in such countries often have to pay higher interest rates to compensate lenders for this risk.

Another reason interest rates differ across countries is expected changes in the exchange rate. For example, suppose that people expect the French franc to fall in value relative to the U.S. dollar. Then loans made in francs will be repaid in a less valuable currency than loans made in dollars. To compensate for this expected fall in the French currency, the interest rate in France will be higher than the interest rate in the United States.

Thus, because of both country risk and expectations of future exchange-rate changes, the interest rate of a small open economy can differ from interest rates in other economies around the world. Let's now see how this fact affects our analysis.

Differentials in the Mundell–Fleming Model

To incorporate interest-rate differentials into the Mundell–Fleming model, we assume that the interest rate in our small open economy is determined by the world interest rate plus a risk premium θ:

$$r = r^* + \theta.$$

The risk premium is determined by the perceived political risk of making loans in a country and the expected change in the real exchange rate. For our purposes here, we can take the risk premium as exogenous in order to examine how changes in the risk premium affect the economy.

The model is largely the same as before. The two equations are

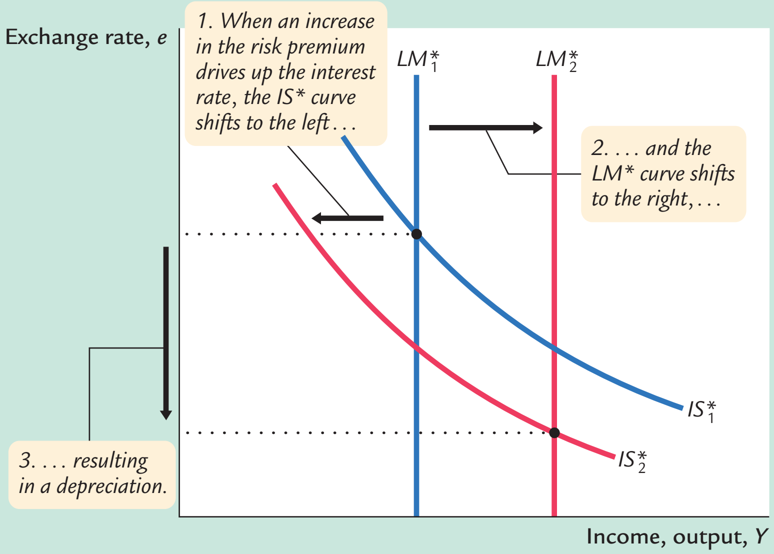
$$\begin{aligned} Y &= C(Y - T) + I(r^* + \theta) + G + NX(e) \qquad && IS^*, \\ M/P &= L(r^* + \theta, Y) && LM^*. \end{aligned}$$

For any given fiscal policy, monetary policy, price level, and risk premium, these two equations determine the level of income and exchange rate that equilibrate the goods market and the money market. Holding constant the risk premium, the tools of monetary, fiscal, and trade policy work as we have already seen.

Now suppose that political turmoil causes the country's risk premium θ to rise. The most direct effect is that the domestic interest rate r rises. The higher interest rate, in turn, has two effects. First, the IS^* curve shifts to the left, because the higher interest rate reduces investment. Second, the LM^* curve shifts to the right, because the higher interest rate reduces the demand for money, and this allows a higher level of income for any given money supply. [Recall that Y must satisfy the equation $M/P = L(r^* + \theta, Y)$.] As Figure 12-11 shows, these two shifts cause income to rise and the currency to depreciate.

This analysis has an important implication: expectations of the exchange rate are partially self-fulfilling. For example, suppose that people come to believe that the French franc will not be valuable in the future. Investors will place a larger risk premium on French assets: θ will rise in France. This expectation will drive

figure 12-11



An Increase in the Risk Premium An increase in the risk premium associated with a country drives up its interest rate. Because the higher interest rate reduces investment, the *IS** curve shifts to the left. Because it also reduces money demand, the *LM** curve shifts to the right. Income rises, and the exchange rate depreciates.

up French interest rates and, as we have just seen, will drive down the value of the French currency. *Thus, the expectation that a currency will lose value in the future causes it to lose value today.*

One surprising—and perhaps inaccurate—prediction of this analysis is that an increase in country risk as measured by θ will cause the economy's income to increase. This occurs in Figure 12-11 because of the rightward shift in the *LM** curve. Although higher interest rates depress investment, the depreciation of the currency stimulates net exports by an even greater amount. As a result, aggregate income rises.

There are three reasons why, in practice, such a boom in income does not occur. First, the central bank might want to avoid the large depreciation of the domestic currency and, therefore, may respond by decreasing the money supply M. Second, the depreciation of the domestic currency may suddenly increase the price of imported goods, causing an increase in the price level P. Third, when some event increases the country risk premium θ, residents of the country might respond to the same event by increasing their demand for money (for any given income and interest rate), because money is often the safest asset available. All three of these changes would tend to shift the *LM** curve toward the left, which mitigates the fall in the exchange rate but also tends to depress income.

Thus, increases in country risk are not desirable. In the short run, they typically lead to a depreciating currency and, through the three channels just described, falling aggregate income. In addition, because a higher interest rate reduces investment, the long-run implication is reduced capital accumulation and lower economic growth.

CASE STUDY

International Financial Crisis: Mexico 1994–1995

In August 1994, a Mexican peso was worth 30 cents. A year later, it was worth only 16 cents. What explains this massive fall in the value of the Mexican currency? Country risk is a large part of the story.

At the beginning of 1994, Mexico was a country on the rise. The recent passage of the North American Free Trade Agreement (NAFTA), which reduced trade barriers among the United States, Canada, and Mexico, made many confident about the future of the Mexican economy. Investors around the world were eager to make loans to the Mexican government and to Mexican corporations.

Political developments soon changed that perception. A violent uprising in the Chiapas region of Mexico made the political situation in Mexico seem precarious. Then Luis Donaldo Colosio, the leading presidential candidate, was assassinated. The political future looked less certain, and many investors started placing a larger risk premium on Mexican assets.

At first, the rising risk premium did not affect the value of the peso, because Mexico was operating with a fixed exchange rate. As we have seen, under a fixed exchange rate, the central bank agrees to trade the domestic currency (pesos) for a foreign currency (dollars) at a predetermined rate. Thus, when an increase in the country risk premium put downward pressure on the value of the peso, the Mexican central bank had to accept pesos and pay out dollars. This automatic exchange-market intervention contracted the Mexican money supply (shifting the LM^* curve to the left) when the currency might otherwise have depreciated.

Yet Mexico's reserves of foreign currency were too small to maintain its fixed exchange rate. When Mexico ran out of dollars at the end of 1994, the Mexican government announced a devaluation of the peso. This decision had repercussions, however, because the government had repeatedly promised that it would not devalue. Investors became even more distrustful of Mexican policymakers and feared further Mexican devaluations.

Investors around the world (including those in Mexico) avoided buying Mexican assets. The country risk premium rose once again, adding to the upward pressure on interest rates and the downward pressure on the peso. The Mexican stock market plummeted. When the Mexican government needed to roll over some of its debt that was coming due, investors were unwilling to buy the new debt. Default appeared to be the government's only option. In just a few months, Mexico had gone from being a promising emerging economy to being a risky economy with a government on the verge of bankruptcy.

Then the United States stepped in. The U.S. government had three motives: to help its neighbor to the south, to prevent the massive illegal immigration that might follow government default and economic collapse, and to prevent the investor pessimism regarding Mexico from spreading to other developing countries. The U.S. government, together with the International Monetary Fund (IMF), led an international effort to bail out the Mexican government. In particular, the United States provided loan guarantees for Mexican government debt, which allowed the Mexican government to refinance the debt that was coming due. These loan guarantees helped restore confidence in the Mexican economy, thereby reducing to some extent the country risk premium.

Although the U.S. loan guarantees may well have stopped a bad situation from getting worse, they did not prevent the Mexican meltdown of 1994–1995 from being a painful experience for the Mexican people. Not only did the Mexican currency lose much of its value, but Mexico also went through a deep recession. Fortunately, by the late 1990s, aggregate income was growing again, and the worst appeared to be over. But the lesson from this experience is clear and could well apply again in the future: changes in perceived country risk, often attributable to political instability, are an important determinant of interest rates and exchange rates in small open economies.

CASE STUDY

International Financial Crisis: Asia 1997–1998

In 1997, as the Mexican economy was recovering from its financial crisis, a similar story started to unfold in several Asian economies, including Thailand, South Korea, and especially Indonesia. The symptoms were familiar: high interest rates, falling asset values, and a depreciating currency. In Indonesia, for instance, short-term nominal interest rates rose above 50 percent, the stock market lost about 90 percent of its value (measured in U.S. dollars), and the rupiah fell against the dollar by more than 80 percent. The crisis led to rising inflation in these countries (because the depreciating currency made imports more expensive) and to falling GDP (because high interest rates and reduced confidence depressed spending). Real GDP in Indonesia fell about 13 percent in 1998, making the downturn larger than any U.S. recession since the Great Depression of the 1930s.

What sparked this firestorm? The problem began in the Asian banking systems. For many years, the governments in the Asian nations had been more involved in managing the allocation of resources—in particular, financial resources—than is true in the United States and other developed countries. Some commentators had applauded this "partnership" between government and private enterprise and had even suggested that the United States should follow the example. Over time, however, it became clear that many Asian banks had been extending loans to those with the most political clout rather than to those with the most profitable investment projects. Once rising default rates started to expose this "crony capitalism," as it was then called, international investors started to lose confidence in the future of these economies. The risk premiums for Asian assets rose, causing interest rates to skyrocket and currencies to collapse.

International crises of confidence often involve a vicious circle that can amplify the problem. Here is one story about what happened in Asia:

1. Problems in the banking system eroded international confidence in these economies.
2. Loss of confidence raised risk premiums and interest rates.

3. Rising interest rates, together with the loss of confidence, depressed the prices of stock and other assets.
4. Falling asset prices reduced the value of collateral being used for bank loans.
5. Reduced collateral increased default rates on bank loans.
6. Greater defaults exacerbated problems in the banking system. Now return to step 1 to complete and continue the circle.

Some economists have used this vicious-circle argument to suggest that the Asian crisis was a self-fulfilling prophecy: bad things happened merely because people expected bad things to happen. Most economists, however, thought the political corruption of the banking system was a real problem, which was then compounded by this vicious circle of reduced confidence.

As the Asian crisis developed, the IMF and the United States tried to restore confidence, much as they had with Mexico a few years earlier. In particular, the IMF made loans to the Asian countries to help them over the crisis; in exchange for these loans, it exacted promises that the governments would reform their banking systems and eliminate crony capitalism. The IMF's hope was that the short-term loans and longer-term reforms would restore confidence, lower the risk premium, and turn the vicious circle into a virtuous circle. This policy seems to have worked: the Asian economies recovered quickly from their crisis.

12-5 Should Exchange Rates Be Floating or Fixed?

Having analyzed how an economy works under floating and fixed exchange rates, let's consider which exchange-rate regime is better.

Pros and Cons of Different Exchange-Rate Systems

The primary argument for a floating exchange rate is that it allows monetary policy to be used for other purposes. Under fixed rates, monetary policy is committed to the single goal of maintaining the exchange rate at its announced level. Yet the exchange rate is only one of many macroeconomic variables that monetary policy can influence. A system of floating exchange rates leaves monetary policymakers free to pursue other goals, such as stabilizing employment or prices.

Advocates of fixed exchange rates argue that exchange-rate uncertainty makes international trade more difficult. After the world abandoned the Bretton Woods system of fixed exchange rates in the early 1970s, both real and nominal exchange rates became (and remained) much more volatile than anyone had expected. Some economists attribute this volatility to irrational and destabilizing speculation by international investors. Business executives often claim that this volatility is harmful because it increases the uncertainty that accompanies international business transactions. Yet, despite this exchange-rate volatility, the amount of world trade has continued to rise under floating exchange rates.

Advocates of fixed exchange rates sometimes argue that a commitment to a fixed exchange rate is one way to discipline a nation's monetary authority and prevent excessive growth in the money supply. Yet there are many other policy rules to which the central bank could be committed. In Chapter 14, for instance, we discuss policy rules such as targets for nominal GDP or the inflation rate. Fixing the exchange rate has the advantage of being simpler to implement than these other policy rules, because the money supply adjusts automatically, but this policy may lead to greater volatility in income and employment.

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"Then it's agreed. Until the dollar firms up, we let the clamshell float."

In the end, the choice between floating and fixed rates is not as stark as it may seem at first. During periods of fixed exchange rates, countries can change the value of their currency if maintaining the exchange rate conflicts too severely with other goals. During periods of floating exchange rates, countries often use formal or informal targets for the exchange rate when deciding whether to expand or contract the money supply. We rarely observe exchange rates that are completely fixed or completely floating. Instead, under both systems, stability of the exchange rate is usually one among many of the central bank's objectives.

CASE STUDY

Monetary Union in the United States and Europe

If you have ever driven the 3,000 miles from New York City to San Francisco, you may recall that you never needed to change your money from one form of currency to another. In all fifty U.S. states, local residents are happy to accept the U.S. dollar for the items you buy. Such a *monetary union* is the most extreme form of a fixed exchange rate. The exchange rate between New York dollars and San Francisco dollars is so irrevocably fixed that you may not even know that there is a difference between the two. (What's the difference? Each dollar bill is issued by one of the dozen local Federal Reserve Banks. Although the bank of origin can be identified from the bill's markings, you don't care which type of dollar you hold because everyone else, including the Federal Reserve system, is ready to trade them one for one.)

If you have ever made a similar 3,000-mile trip across Europe, however, your experience was probably very different. You didn't have to travel far before needing to exchange your French francs for German marks, Dutch guilders, Spanish pesetas, or Italian lira. The large number of currencies in Europe made traveling less convenient and more expensive. Every time you crossed a border, you had to wait in line at a bank to get the local money, and you had to pay the bank a fee for the service.

Recently, however, this has started to change. Many countries in Europe have decided to form their own monetary union and use a common currency called the *euro*, which was introduced in January 1999. The adoption of the euro is an extension of the *European Monetary System* (*EMS*), which during the previous two decades had attempted to limit exchange-rate fluctuations among participating countries. When the euro is fully adopted, this goal will be achieved: the exchange rate between France and Germany will be as fixed as the exchange rate between New York City and San Francisco.

The introduction of a common currency has its costs. The most important is that the nations of Europe will no longer be able to conduct their own monetary policies. Instead, a European central bank, with participation of all member countries, will set a single monetary policy for all of Europe. The central banks of the individual countries will play a role similar to that of regional Federal Reserve Banks: they will monitor local conditions but they will have no control over the money supply or interest rates. Critics of the move toward a common currency argue that the cost of losing national monetary policy is large. If a recession hits one country but not others in Europe, that country may wish it had the tool of monetary policy to combat the downturn.

Why, according to these economists, is monetary union a bad idea for Europe if it works so well in the United States? These economists argue that the United States is different from Europe in two important ways. First, labor is more mobile among U.S. states than among European countries. This is in part because the United States has a common language and in part because most Americans are descended from immigrants, who have shown a willingness to move. Therefore, when a regional recession occurs, U.S. workers are more likely to move from high-unemployment states to low-unemployment states. Second, the United States has a strong central government that can use fiscal policy—such as the federal income tax—to redistribute resources among regions. Because Europe does not have these two advantages, it will suffer more when it restricts itself to a single monetary policy.

Advocates of a common currency believe that the loss of national monetary policy is more than offset by other gains. With a single currency in all of Europe, travelers and businesses will no longer need to worry about exchange rates, and this should encourage more international trade. In addition, a common currency may have the political advantage of making Europeans feel more connected to one another. The twentieth century was marked by two world wars, both of which were sparked by European discord. If a common currency makes the nations of Europe more harmonious, it will benefit the entire world.

Speculative Attacks, Currency Boards, and Dollarization

Imagine that you are a central banker of a small country. You and your fellow policymakers decide to fix your currency—let's call it the peso—against the U.S. dollar. From now on, one peso will sell for one dollar.

As we discussed earlier, you now have to stand ready to buy and sell pesos for a dollar each. The money supply will adjust automatically to make the equilibrium exchange rate equal your target. There is, however, one potential problem with this plan: you might run out of dollars. If people come to the central bank to sell large quantities of pesos, the central bank's dollar reserves might dwindle to zero. In this case, the central bank has no choice but to abandon the fixed exchange rate and let the peso depreciate.

This fact raises the possibility of a *speculative attack*—a change in investors' perceptions that makes the fixed exchange rate untenable. Suppose that, for no good reason, a rumor spreads that the central bank is going to abandon the exchange-rate peg. People would respond by rushing to the central bank to convert pesos into dollars before the pesos lose value. This rush would drain the central bank's reserves and could force the central bank to abandon the peg. In this case, the rumor would prove self-fulfilling.

To avoid this possibility, some economists argue that a fixed exchange rate should be supported by a *currency board*, such as that used by Argentina in the 1990s. A currency board is an arrangement by which the central bank holds enough foreign currency to back each unit of the domestic currency. In our example, the central bank would hold one U.S. dollar (or one dollar invested in a U.S. government bond) for every peso. No matter how many pesos turned up at the central bank to be exchanged, the central bank would never run out of dollars.

Once a central bank has adopted a currency board, it might consider the natural next step: it can abandon the peso altogether and let its country use the U.S. dollar. Such a plan is called *dollarization*. It happens on its own in high-inflation economies, where foreign currencies offer a more reliable store of value than the domestic currency. But it can also occur as a matter of public policy: Panama is an example. If a country really wants its currency to be irrevocably fixed to the dollar, the most reliable method is to make its currency the dollar. The only loss from dollarization is the small seigniorage revenue, which accrues to the U.S. government.[4]

12-6 The Mundell–Fleming Model With a Changing Price Level

So far we have been using the Mundell–Fleming model to study the small open economy in the short run when the price level is fixed. To see how this model relates to models we have examined previously, let's consider what happens when the price level changes.

To examine price adjustment in an open economy, we must distinguish between the nominal exchange rate e and the real exchange rate ϵ, which equals eP/P^*. We can write the Mundell–Fleming model as

$$Y = C(Y - T) + I(r^*) + G + NX(\epsilon) \qquad IS^*,$$
$$M/P = L(r^*, Y) \qquad LM^*.$$

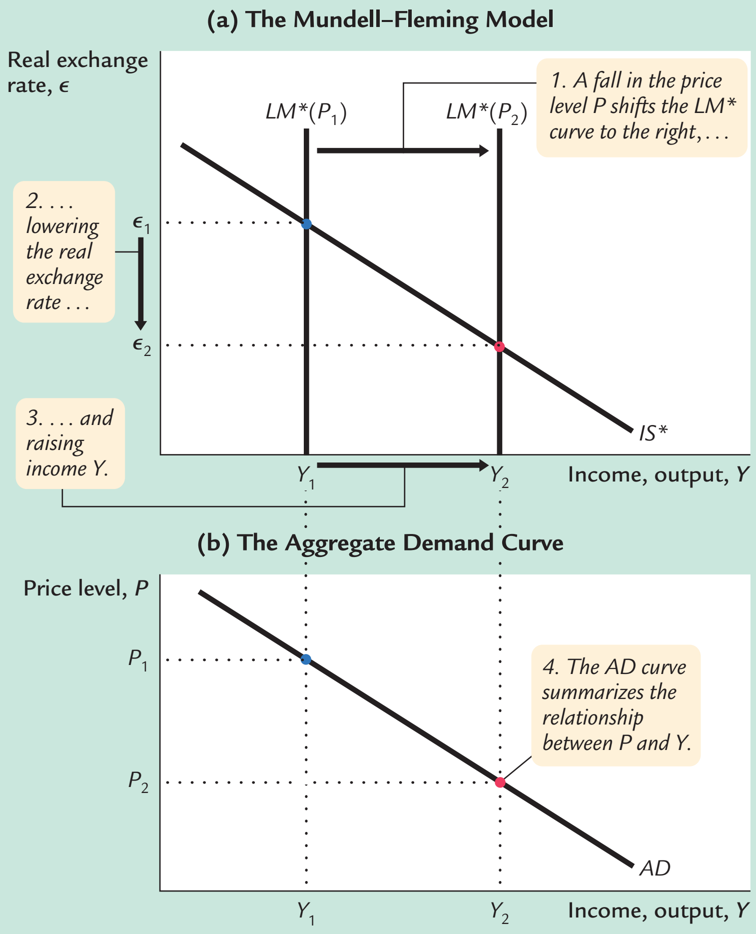
[4] Dollarization may also lead to a loss in national pride from seeing American portraits on the currency. If it wanted, the U.S. government could fix this problem by leaving blank the center space that now has George Washington's portrait. Each nation using the U.S. dollar could insert the face of its own local hero.

These equations should be familiar by now. The first equation describes the *IS** curve, and the second equation describes the *LM** curve. Note that net exports depend on the real exchange rate.

Figure 12-12 shows what happens when the price level falls. Because a lower price level raises the level of real money balances, the *LM** curve shifts to the right, as in panel (a) of Figure 12-12. The real exchange rate depreciates, and the equilibrium level of income rises. The aggregate demand curve summarizes this negative relationship between the price level and the level of income, as shown in panel (b) of Figure 12-12.

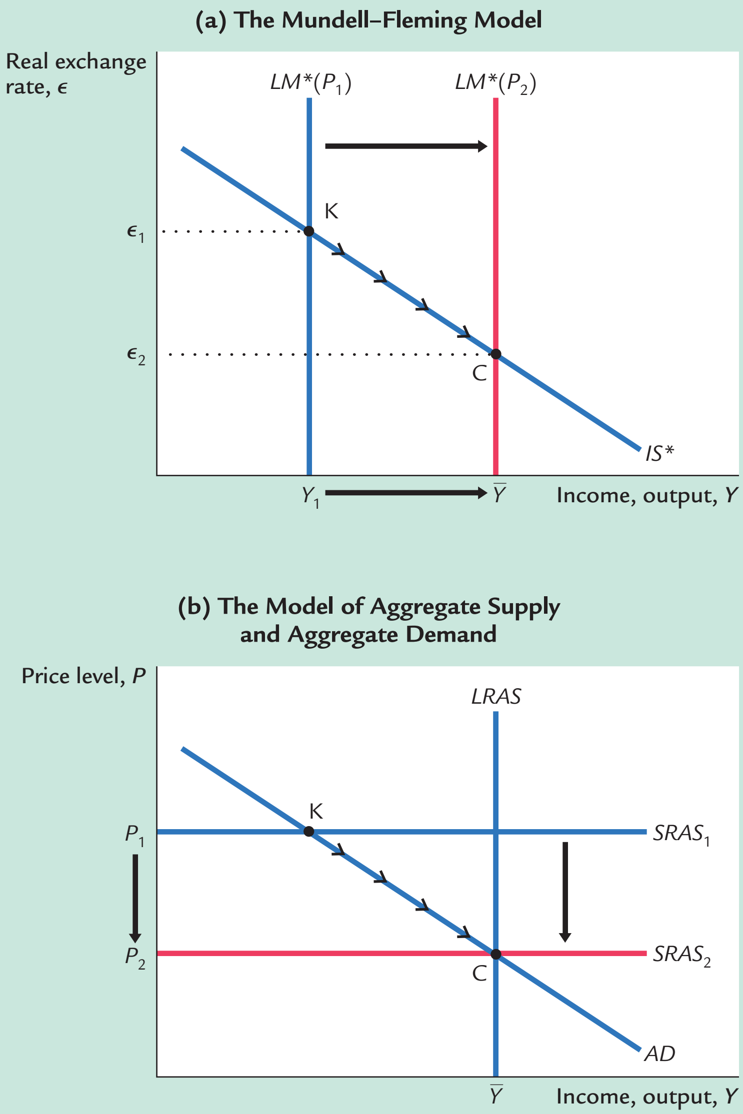
Thus, just as the *IS–LM* model explains the aggregate demand curve in a closed economy, the Mundell–Fleming model explains the aggregate demand curve for a small open economy. In both cases, the aggregate demand curve shows the set of equilibria that arise as the price level varies. And in both cases, anything that changes the equilibrium for a given price level shifts the aggregate demand curve. Policies that raise income shift the aggregate demand curve to the right; policies that lower income shift the aggregate demand curve to the left.

figure 12-12



Mundell–Fleming as a Theory of Aggregate Demand Panel (a) shows that when the price level falls, the *LM** curve shifts to the right. The equilibrium level of income rises. Panel (b) shows that this negative relationship between *P* and *Y* is summarized by the aggregate demand curve.

figure 12-13



The Short-Run and Long-Run Equilibria in a Small Open Economy Point K in both panels shows the equilibrium under the Keynesian assumption that the price level is fixed at P_1. Point C in both panels shows the equilibrium under the classical assumption that the price level adjusts to maintain income at its natural rate $\bar{Y}$.

We can use this diagram to show how the short-run model in this chapter is related to the long-run model in Chapter 5. Figure 12-13 shows the short-run and long-run equilibria. In both panels of the figure, point K describes the short-run equilibrium, because it assumes a fixed price level. At this equilibrium, the demand for goods and services is too low to keep the economy producing at its natural rate. Over time, low demand causes the price level to fall. The fall in the price level raises real money balances, shifting the *LM** curve to the right. The real exchange rate depreciates, so net exports rise. Eventually, the economy reaches point C, the long-run equilibrium. The speed of transition between the short-run and long-run equilibria depends on how quickly the price level adjusts to restore the economy to the natural rate.

The levels of income at point K and point C are both of interest. Our central concern in this chapter has been how policy influences point K, the short-run equilibrium. In Chapter 5 we examined the determinants of point C, the long-run equilibrium. Whenever policymakers consider any change in policy, they need to consider both the short-run and long-run effects of their decision.

12-7 A Concluding Reminder

In this chapter we have examined how a small open economy works in the short run when prices are sticky. We have seen how monetary and fiscal policy influence income and the exchange rate, and how the behavior of the economy depends on whether the exchange rate is floating or fixed. In closing, it is worth repeating a lesson from Chapter 5. Many countries, including the United States, are neither closed economies nor small open economies: they lie somewhere in between.

A large open economy, such as the United States, combines the behavior of a closed economy and the behavior of a small open economy. When analyzing policies in a large open economy, we need to consider both the closed-economy logic of Chapter 11 and the open-economy logic developed in this chapter. The appendix to this chapter presents a model for a large open economy. The results of that model are, as one would guess, a mixture of the two polar cases we have already examined.

To see how we can draw on the logic of both the closed and small open economies and apply these insights to the United States, consider how a monetary contraction affects the economy in the short run. In a closed economy, a monetary contraction raises the interest rate, lowers investment, and thus lowers aggregate income. In a small open economy with a floating exchange rate, a monetary contraction raises the exchange rate, lowers net exports, and thus lowers aggregate income. The interest rate is unaffected, however, because it is determined by world financial markets.

The U.S. economy contains elements of both cases. Because the United States is large enough to affect the world interest rate and because capital is not perfectly mobile across countries, a monetary contraction does raise the interest rate and depress investment. At the same time, a monetary contraction also raises the value of the dollar, thereby depressing net exports. Hence, although the Mundell–Fleming model does not precisely describe an economy like that of the United States, it does predict correctly what happens to international variables such as the exchange rate, and it shows how international interactions alter the effects of monetary and fiscal policies.

Summary

1. The Mundell–Fleming model is the *IS–LM* model for a small open economy. It takes the price level as given and then shows what causes fluctuations in income and the exchange rate.
2. The Mundell–Fleming model shows that fiscal policy does not influence aggregate income under floating exchange rates. A fiscal expansion causes the

currency to appreciate, reducing net exports and offsetting the usual expansionary impact on aggregate income. Fiscal policy does influence aggregate income under fixed exchange rates.

3. The Mundell–Fleming model shows that monetary policy does not influence aggregate income under fixed exchange rates. Any attempt to expand the money supply is futile, because the money supply must adjust to ensure that the exchange rate stays at its announced level. Monetary policy does influence aggregate income under floating exchange rates.
4. If investors are wary of holding assets in a country, the interest rate in that country may exceed the world interest rate by some risk premium. According to the Mundell–Fleming model, an increase in the risk premium causes the interest rate to rise and the currency of that country to depreciate.
5. There are advantages to both floating and fixed exchange rates. Floating exchange rates leave monetary policymakers free to pursue objectives other than exchange-rate stability. Fixed exchange rates reduce some of the uncertainty in international business transactions.

KEY CONCEPTS

Mundell–Fleming model

Floating exchange rates

Fixed exchange rates

Devaluation

Revaluation

QUESTIONS FOR REVIEW

1. In the Mundell–Fleming model with floating exchange rates, explain what happens to aggregate income, the exchange rate, and the trade balance when taxes are raised. What would happen if exchange rates were fixed rather than floating?
2. In the Mundell–Fleming model with floating exchange rates, explain what happens to aggregate income, the exchange rate, and the trade balance when the money supply is reduced. What would happen if exchange rates were fixed rather than floating?
3. In the Mundell–Fleming model with floating exchange rates, explain what happens to aggregate income, the exchange rate, and the trade balance when a quota on imported cars is removed. What would happen if exchange rates were fixed rather than floating?
4. What are the advantages of floating exchange rates and fixed exchange rates?

PROBLEMS AND APPLICATIONS

1. Use the Mundell–Fleming model to predict what would happen to aggregate income, the exchange rate, and the trade balance under both floating and fixed exchange rates in response to each of the following shocks:
   a. A fall in consumer confidence about the future induces consumers to spend less and save more.
   b. The introduction of a stylish line of Toyotas makes some consumers prefer foreign cars over domestic cars.
   c. The introduction of automatic teller machines reduces the demand for money.
2. The Mundell–Fleming model takes the world interest rate r^* as an exogenous variable. Let's

consider what happens when this variable changes.

a. What might cause the world interest rate to rise?

b. In the Mundell–Fleming model with a floating exchange rate, what happens to aggregate income, the exchange rate, and the trade balance when the world interest rate rises?

c. In the Mundell–Fleming model with a fixed exchange rate, what happens to aggregate income, the exchange rate, and the trade balance when the world interest rate rises?

3. Business executives and policymakers are often concerned about the "competitiveness" of American industry (the ability of U.S. industries to sell their goods profitably in world markets).

a. How would a change in the exchange rate affect competitiveness?

b. Suppose you wanted to make domestic industries more competitive but did not want to alter aggregate income. According to the Mundell–Fleming model, what combination of monetary and fiscal policies should you pursue?

4. Suppose that higher income implies higher imports and thus lower net exports. That is, the net-exports function is

$$NX = NX(e, Y).$$

Examine the effects in a small open economy of a fiscal expansion on income and the trade balance under

a. A floating exchange rate.

b. A fixed exchange rate.

How does your answer compare to the results in Table 12-1?

5. Suppose that money demand depends on disposable income, so that the equation for the money market becomes

$$M/P = L(r, Y - T).$$

Analyze the impact of a tax cut in a small open economy on the exchange rate and income under both floating and fixed exchange rates.

6. Suppose that the price level relevant for money demand includes the price of imported goods and that the price of imported goods depends on the exchange rate. That is, the money market is described by

$$M/P = L(r, Y),$$

where

$$P = \lambda P_d + (1 - \lambda)P_f/e.$$

The parameter λ is the share of domestic goods in the price index P. Assume that the price of domestic goods P_d and the price of foreign goods measured in foreign currency P_f are fixed.

a. Suppose we graph the LM^* curve for given values of P_d and P_f (instead of the usual P). Explain why in this model this LM^* curve is upward sloping rather than vertical.

b. What is the effect of expansionary fiscal policy under floating exchange rates in this model? Explain. Contrast with the standard Mundell–Fleming model.

c. Suppose that political instability increases the country risk premium and, thereby, the interest rate. What is the effect on the exchange rate, the price level, and aggregate income in this model? Contrast with the standard Mundell–Fleming model.

7. Use the Mundell–Fleming model to answer the following questions about the state of California (a small open economy).

a. If California suffers from a recession, should the state government use monetary or fiscal policy to stimulate employment? Explain. (*Note:* For this question, assume that the state government can print dollar bills.)

b. If California prohibited the import of wines from the state of Washington, what would happen to income, the exchange rate, and the trade balance? Consider both the short-run and the long-run impacts.

APPENDIX

A Short-Run Model of the Large Open Economy

When analyzing policies in an economy such as the United States, we need to combine the closed-economy logic of the *IS–LM* model and the small-open-economy logic of the Mundell–Fleming model. This appendix presents a model for the intermediate case of a large open economy.

As we discussed in the appendix to Chapter 5, a large open economy differs from a small open economy because its interest rate is not fixed by world financial markets. In a large open economy, we must consider the relationship between the interest rate and the flow of capital abroad. The net capital outflow is the amount that domestic investors lend abroad minus the amount that foreign investors lend here. As the domestic interest rate falls, domestic investors find foreign lending more attractive, and foreign investors find lending here less attractive. Thus, the net capital outflow is negatively related to the interest rate. Here we add this relationship to our short-run model of national income.

The three equations of the model are

$$\begin{aligned} Y &= C(Y - T) + I(r) + G + NX(e), \\ M/P &= L(r, Y), \\ NX(e) &= CF(r). \end{aligned}$$

The first two equations are the same as those used in the Mundell–Fleming model of this chapter. The third equation, taken from the appendix to Chapter 5, states that the trade balance NX equals the net capital outflow CF, which in turn depends on the domestic interest rate.

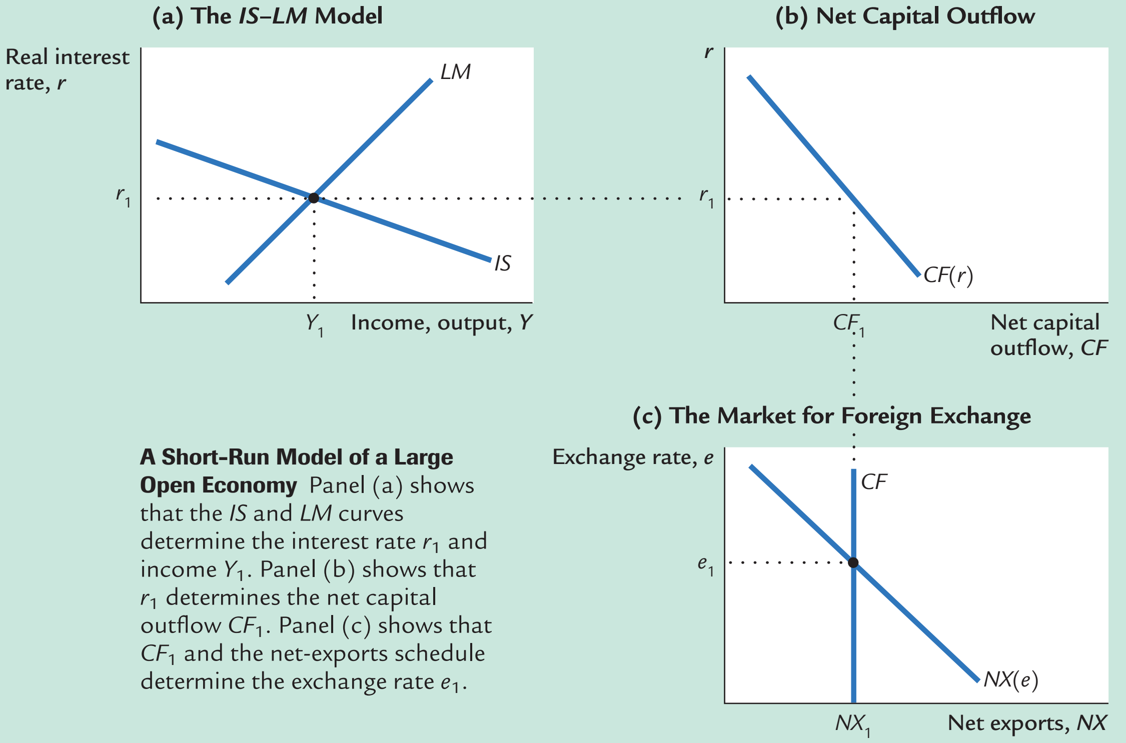
To see what this model implies, substitute the third equation into the first, so the model becomes

$$\begin{aligned} Y &= C(Y - T) + I(r) + G + CF(r) \qquad && IS, \\ M/P &= L(r, Y) && LM. \end{aligned}$$

These two equations are much like the two equations of the closed-economy *IS–LM* model. The only difference is that expenditure now depends on the interest rate for two reasons. As before, a higher interest rate reduces investment. But now, a higher interest rate also reduces the net capital outflow and thus lowers net exports.

To analyze this model, we can use the three graphs in Figure 12-14 on page 342. Panel (a) shows the *IS–LM* diagram. As in the closed-economy model in Chapters 10 and 11, the interest rate r is on the vertical axis, and income Y is on the horizontal axis. The *IS* and *LM* curves together determine the equilibrium level of income and the equilibrium interest rate.

figure 12-14



A Short-Run Model of a Large Open Economy Panel (a) shows that the *IS* and *LM* curves determine the interest rate r_1 and income Y_1. Panel (b) shows that r_1 determines the net capital outflow CF_1. Panel (c) shows that CF_1 and the net-exports schedule determine the exchange rate e_1.

The new net-capital-outflow term in the *IS* equation, $CF(r)$, makes this *IS* curve flatter than it would be in a closed economy. The more responsive international capital flows are to the interest rate, the flatter the *IS* curve is. You might recall from the Chapter 5 appendix that the small open economy represents the extreme case in which the net capital outflow is infinitely elastic at the world interest rate. In this extreme case, the *IS* curve is completely flat. Hence, a small open economy would be depicted in this figure with a horizontal *IS* curve.

Panels (b) and (c) show how the equilibrium from the *IS–LM* model determines the net capital outflow, the trade balance, and the exchange rate. In panel (b) we see that the interest rate determines the net capital outflow. This curve slopes downward because a higher interest rate discourages domestic investors from lending abroad and encourages foreign investors to lend here. In panel (c) we see that the exchange rate adjusts to ensure that net exports of goods and services equal the net capital outflow.

Now let's use this model to examine the impact of various policies. We assume that the economy has a floating exchange rate, because this assumption is correct for most large open economies such as the United States.

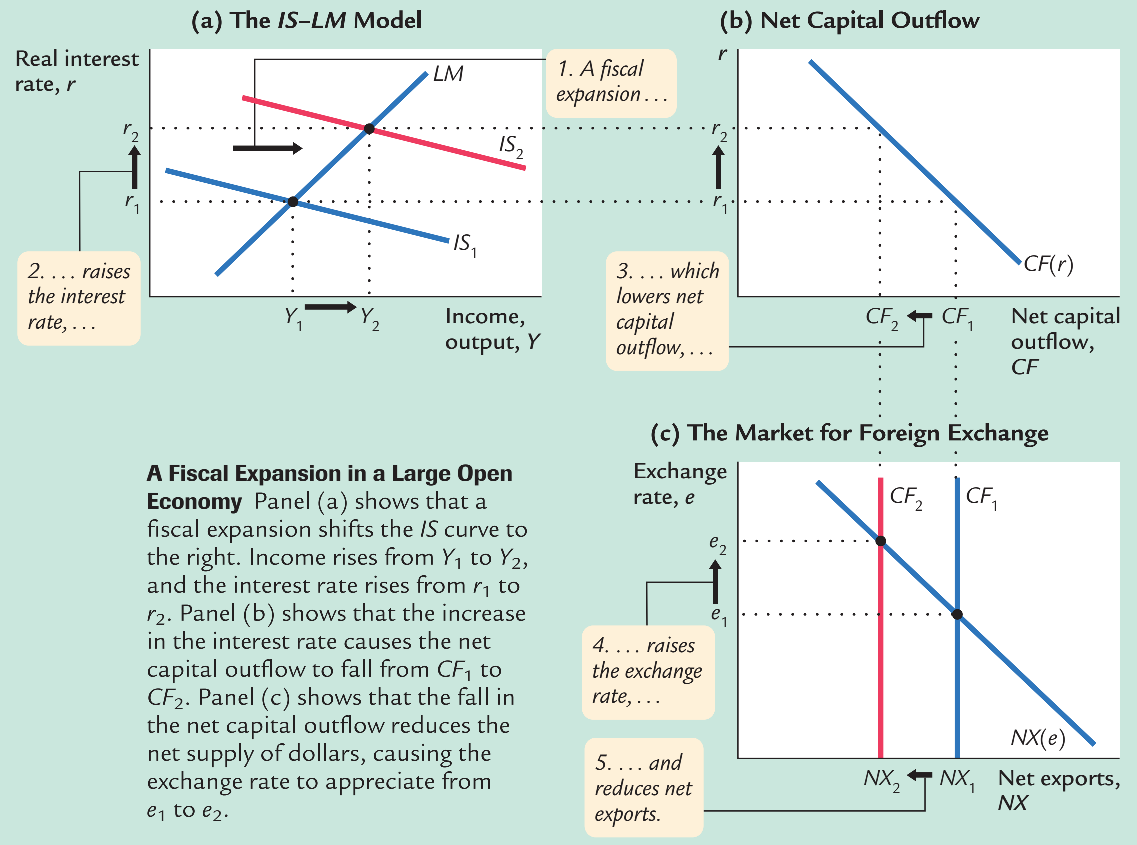
Fiscal Policy

Figure 12-15 examines the impact of a fiscal expansion. An increase in government purchases or a cut in taxes shifts the *IS* curve to the right. As panel (a) illustrates, this shift in the *IS* curve leads to an increase in the level of income and an increase in the interest rate. These two effects are similar to those in a closed economy.

Yet, in the large open economy, the higher interest rate reduces the net capital outflow, as in panel (b). The fall in the net capital outflow reduces the supply of dollars in the market for foreign exchange. The exchange rate appreciates, as in panel (c). Because domestic goods become more expensive relative to foreign goods, net exports fall.

Figure 12-15 shows that a fiscal expansion does raise income in the large open economy, unlike in a small open economy under a floating exchange rate. The impact on income, however, is smaller than in a closed economy. In a closed economy, the expansionary impact of fiscal policy is partially offset by the

figure 12-15



A Fiscal Expansion in a Large Open Economy Panel (a) shows that a fiscal expansion shifts the *IS* curve to the right. Income rises from Y_1 to Y_2, and the interest rate rises from r_1 to r_2. Panel (b) shows that the increase in the interest rate causes the net capital outflow to fall from CF_1 to CF_2. Panel (c) shows that the fall in the net capital outflow reduces the net supply of dollars, causing the exchange rate to appreciate from e_1 to e_2.

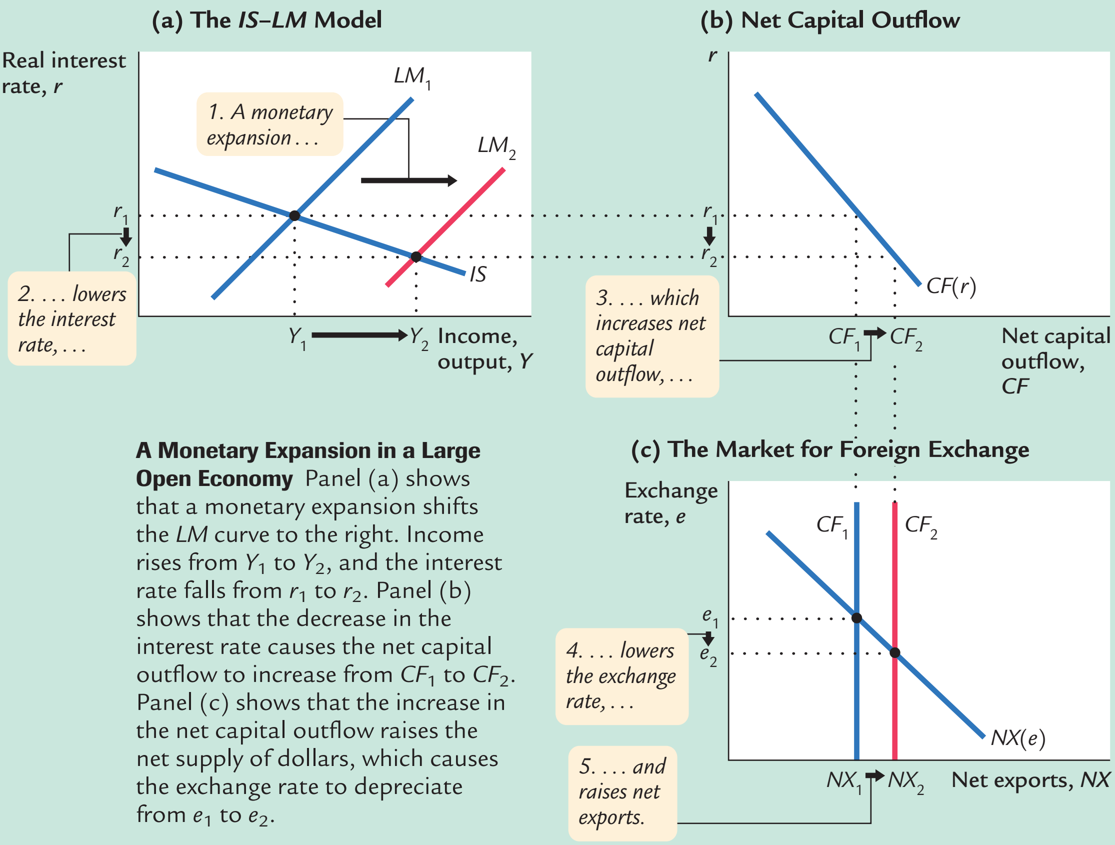
crowding out of investment: as the interest rate rises, investment falls, reducing the fiscal-policy multipliers. In a large open economy, there is yet another offsetting factor: as the interest rate rises, the net capital outflow falls, the exchange rate appreciates, and net exports fall. Together these effects are not large enough to make fiscal policy powerless, as it is in a small open economy, but they do reduce fiscal policy's impact.

Monetary Policy

Figure 12-16 examines the effect of a monetary expansion. An increase in the money supply shifts the *LM* curve to the right, as in panel (a). The level of income rises, and the interest rate falls. Once again, these effects are similar to those in a closed economy.

Yet, as panel (b) shows, the lower interest rate leads to a higher net capital outflow. The increase in *CF* raises the supply of dollars in the market for foreign exchange. The exchange rate depreciates, as in panel (c). As domestic goods become cheaper relative to foreign goods, net exports rise.

figure 12-16



A Monetary Expansion in a Large Open Economy Panel (a) shows that a monetary expansion shifts the *LM* curve to the right. Income rises from Y_1 to Y_2, and the interest rate falls from r_1 to r_2. Panel (b) shows that the decrease in the interest rate causes the net capital outflow to increase from CF_1 to CF_2. Panel (c) shows that the increase in the net capital outflow raises the net supply of dollars, which causes the exchange rate to depreciate from e_1 to e_2.

We can now see that the monetary transmission mechanism has two parts in a large open economy. As in a closed economy, a monetary expansion lowers the interest rate. As in a small open economy, a monetary expansion causes the currency to depreciate in the market for foreign exchange. The lower interest rate stimulates investment, and the lower exchange rate stimulates net exports.

A Rule of Thumb

This model of the large open economy describes well the U.S. economy today. Yet it is somewhat more complicated and cumbersome than the model of the closed economy we studied in Chapters 10 and 11 and the model of the small open economy we developed in this chapter. Fortunately, there is a useful rule of thumb to help you determine how policies influence a large open economy without remembering all the details of the model: *The large open economy is an average of the closed economy and the small open economy. To find how any policy will affect any variable, find the answer in the two extreme cases and take an average.*

For example, how does a monetary contraction affect the interest rate and investment in the short run? In a closed economy, the interest rate rises, and investment falls. In a small open economy, neither the interest rate nor investment changes. The effect in the large open economy is an average of these two cases: a monetary contraction raises the interest rate and reduces investment, but only somewhat. The fall in the net capital outflow mitigates the rise in the interest rate and the fall in investment that would occur in a closed economy. But unlike in a small open economy, the international flow of capital is not so strong as to negate fully these effects.

This rule of thumb makes the simple models all the more valuable. Although they do not describe perfectly the world in which we live, they do provide a useful guide to the effects of economic policy.

MORE PROBLEMS AND APPLICATIONS

1. Imagine that you run the central bank in a large open economy. Your goal is to stabilize income, and you adjust the money supply accordingly. Under your policy, what happens to the money supply, the interest rate, the exchange rate, and the trade balance in response to each of the following shocks?

   a. The president raises taxes to reduce the budget deficit.

   b. The president restricts the import of Japanese cars.

2. Over the past several decades, investors around the world have become more willing to take advantage of opportunities in other countries. Because of this increasing sophistication, economies are more open today than in the past. Consider how this development affects the ability of monetary policy to influence the economy.

   a. If investors become more willing to substitute foreign and domestic assets, what happens to the slope of the *CF* function?

   b. If the *CF* function changes in this way, what happens to the slope of the *IS* curve?

   c. How does this change in the *IS* curve affect the Fed's ability to control the interest rate?

   d. How does this change in the *IS* curve affect the Fed's ability to control national income?

3. Suppose that policymakers in a large open economy want to raise the level of investment without changing aggregate income or the exchange rate.
    a. Is there any combination of domestic monetary and fiscal policies that would achieve this goal?
    b. Is there any combination of domestic monetary, fiscal, and trade policies that would achieve this goal?
    c. Is there any combination of monetary and fiscal policies at home and abroad that would achieve this goal?

4. Suppose that a large open economy has a fixed exchange rate.
    a. Describe what happens in response to a fiscal contraction, such as a tax increase. Compare your answer to the case of a small open economy.
    b. Describe what happens if the central bank expands the money supply by buying bonds from the public. Compare your answer to the case of a small open economy.

CHAPTER 13 THIRTEEN

Aggregate Supply

> *There is always a temporary tradeoff between inflation and unemployment; there is no permanent tradeoff. The temporary tradeoff comes not from inflation per se, but from unanticipated inflation, which generally means, from a rising rate of inflation.*
>
> — *Milton Friedman*

Most economists analyze short-run fluctuations in aggregate income and the price level using the model of aggregate demand and aggregate supply. In the previous three chapters, we examined aggregate demand in some detail. The *IS–LM* model—together with its open-economy cousin the Mundell–Fleming model—shows how changes in monetary and fiscal policy and shocks to the money and goods markets shift the aggregate demand curve. In this chapter, we turn our attention to aggregate supply and develop theories that explain the position and slope of the aggregate supply curve.

When we introduced the aggregate supply curve in Chapter 9, we established that aggregate supply behaves differently in the short run than in the long run. In the long run, prices are flexible, and the aggregate supply curve is vertical. When the aggregate supply curve is vertical, shifts in the aggregate demand curve affect the price level, but the output of the economy remains at its natural rate. By contrast, in the short run, prices are sticky, and the aggregate supply curve is not vertical. In this case, shifts in aggregate demand do cause fluctuations in output. In Chapter 9 we took a simplified view of price stickiness by drawing the short-run aggregate supply curve as a horizontal line, representing the extreme situation in which all prices are fixed. Our task now is to refine this understanding of short-run aggregate supply.

Unfortunately, one fact makes this task more difficult: economists disagree about how best to explain aggregate supply. As a result, this chapter begins by presenting three prominent models of the short-run aggregate supply curve. Among economists, each of these models has some prominent adherents (as well as some prominent critics), and you can decide for yourself which you find most plausible. Although these models differ in some significant details, they are also related in an important way: they share a common theme about what makes the short-run and long-run aggregate supply curves differ and a common conclusion that the short-run aggregate supply curve is upward sloping.

After examining the models, we examine an implication of the short-run aggregate supply curve. We show that this curve implies a tradeoff between two measures of economic performance—inflation and unemployment. According to this tradeoff, to reduce the rate of inflation policymakers must temporarily raise unemployment, and to reduce unemployment they must accept higher inflation. As the quotation at the beginning of the chapter suggests, the tradeoff between inflation and unemployment is only temporary. One goal of this chapter is to explain why policymakers face such a tradeoff in the short run and, just as important, why they do not face it in the long run.

13-1 Three Models of Aggregate Supply

When classes in physics study balls rolling down inclined planes, they often begin by assuming away the existence of friction. This assumption makes the problem simpler and is useful in many circumstances, but no good engineer would ever take this assumption as a literal description of how the world works. Similarly, this book began with classical macroeconomic theory, but it would be a mistake to assume that this model is always true. Our job now is to look more deeply into the "frictions" of macroeconomics.

We do this by examining three prominent models of aggregate supply, roughly in the order of their development. In all the models, some market imperfection (that is, some type of friction) causes the output of the economy to deviate from the classical benchmark. As a result, the short-run aggregate supply curve is upward sloping, rather than vertical, and shifts in the aggregate demand curve cause the level of output to deviate temporarily from the natural rate. These temporary deviations represent the booms and busts of the business cycle.

Although each of the three models takes us down a different theoretical route, each route ends up in the same place. That final destination is a short-run aggregate supply equation of the form

$$Y = \overline{Y} + \alpha(P - P^e), \qquad \alpha > 0$$

where Y is output, $\overline{Y}$ is the natural rate of output, P is the price level, and P^e is the expected price level. This equation states that output deviates from its natural rate when the price level deviates from the expected price level. The parameter α indicates how much output responds to unexpected changes in the price level; $1/\alpha$ is the slope of the aggregate supply curve.

Each of the three models tells a different story about what lies behind this short-run aggregate supply equation. In other words, each highlights a particular reason why unexpected movements in the price level are associated with fluctuations in aggregate output.

The Sticky-Wage Model

To explain why the short-run aggregate supply curve is upward sloping, many economists stress the sluggish adjustment of nominal wages. In many industries, nominal wages are set by long-term contracts, so wages cannot adjust quickly when economic conditions change. Even in industries not covered by formal contracts, implicit agreements between workers and firms may limit wage changes. Wages may also depend on social norms and notions of fairness that evolve slowly. For these reasons, many economists believe that nominal wages are sticky in the short run.

The **sticky-wage model** shows what a sticky nominal wage implies for aggregate supply. To preview the model, consider what happens to the amount of output produced when the price level rises:

1. When the nominal wage is stuck, a rise in the price level lowers the real wage, making labor cheaper.
2. The lower real wage induces firms to hire more labor.
3. The additional labor hired produces more output.

This positive relationship between the price level and the amount of output means that the aggregate supply curve slopes upward during the time when the nominal wage cannot adjust.

To develop this story of aggregate supply more formally, assume that workers and firms bargain over and agree on the nominal wage before they know what the price level will be when their agreement takes effect. The bargaining parties—the workers and the firms—have in mind a target real wage. The target may be the real wage that equilibrates labor supply and demand. More likely, the target real wage is higher than the equilibrium real wage: as discussed in Chapter 6, union power and efficiency-wage considerations tend to keep real wages above the level that brings supply and demand into balance.

The workers and firms set the nominal wage W based on the target real wage ω and on their expectation of the price level P^e. The nominal wage they set is

$$\begin{array}{ccccc} W & = & \omega & \times & P^e \\ \text{Nominal Wage} & = & \text{Target Real Wage} & \times & \text{Expected Price Level.} \end{array}$$

After the nominal wage has been set and before labor has been hired, firms learn the actual price level P. The real wage turns out to be

$$\begin{array}{ccccc} W/P & = & \omega & \times & (P^e/P) \\ \text{Real Wage} & = & \text{Target Real Wage} & \times & \dfrac{\text{Expected Price Level}}{\text{Actual Price Level}}. \end{array}$$

This equation shows that the real wage deviates from its target if the actual price level differs from the expected price level. When the actual price level is greater than expected, the real wage is less than its target; when the actual price level is less than expected, the real wage is greater than its target.

The final assumption of the sticky-wage model is that employment is determined by the quantity of labor that firms demand. In other words, the bargain between the workers and the firms does not determine the level of employment in advance; instead, the workers agree to provide as much labor as the firms wish to buy at the predetermined wage. We describe the firms' hiring decisions by the labor demand function

$$L = L^{\mathrm{d}}(W/P),$$

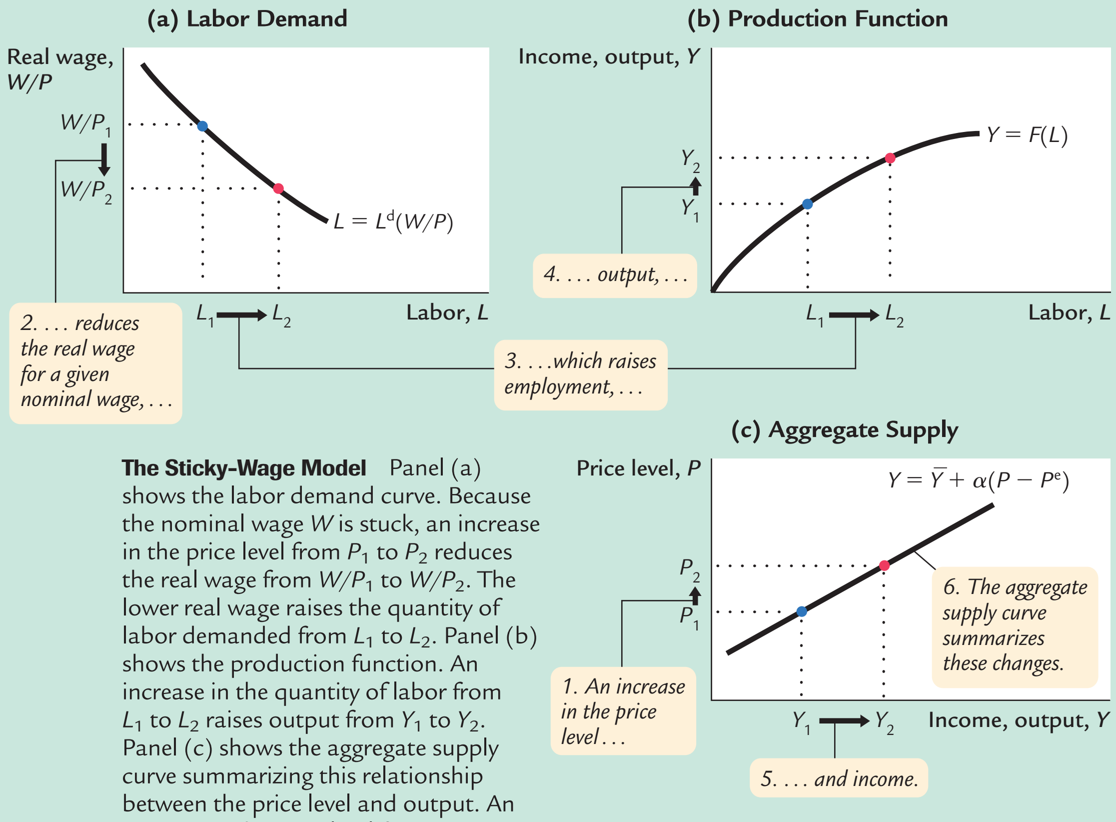
which states that the lower the real wage, the more labor firms hire. The labor demand curve is shown in panel (a) of Figure 13-1. Output is determined by the production function

$$Y = F(L),$$

which states that the more labor is hired, the more output is produced. This is shown in panel (b) of Figure 13-1.

Panel (c) of Figure 13-1 shows the resulting aggregate supply curve. Because the nominal wage is sticky, an unexpected change in the price level

figure 13-1



The Sticky-Wage Model Panel (a) shows the labor demand curve. Because the nominal wage W is stuck, an increase in the price level from P_1 to P_2 reduces the real wage from W/P_1 to W/P_2. The lower real wage raises the quantity of labor demanded from L_1 to L_2. Panel (b) shows the production function. An increase in the quantity of labor from L_1 to L_2 raises output from Y_1 to Y_2. Panel (c) shows the aggregate supply curve summarizing this relationship between the price level and output. An increase in the price level from P_1 to P_2 raises output from Y_1 to Y_2.

moves the real wage away from the target real wage, and this change in the real wage influences the amounts of labor hired and output produced. The aggregate supply curve can be written as

$$Y = \overline{Y} + \alpha(P - P^e).$$

Output deviates from its natural level when the price level deviates from the expected price level.[1]

CASE STUDY

The Cyclical Behavior of the Real Wage

In any model with an unchanging labor demand curve, such as the model we just discussed, employment rises when the real wage falls. In the sticky-wage model, an unexpected rise in the price level lowers the real wage and thereby raises the quantity of labor hired and the amount of output produced. Thus, the real wage should be *countercyclical*: it should fluctuate in the opposite direction from employment and output. Keynes himself wrote in *The General Theory* that "an increase in employment can only occur to the accompaniment of a decline in the rate of real wages."

The earliest attacks on *The General Theory* came from economists challenging Keynes's prediction. Figure 13-2 is a scatterplot of the percentage change in real compensation per hour and the percentage change in real GDP using annual data for the U.S. economy from 1960 to 2000. If Keynes's prediction were correct, the dots in this figure would show a downward-sloping pattern, indicating a negative relationship. Yet the figure shows only a weak correlation between the real wage and output, and it is the opposite of what Keynes predicted. That is, if the real wage is cyclical at all, it is slightly *procyclical*: the real wage tends to rise when output rises. Abnormally high labor costs cannot explain the low employment and output observed in recessions.

How should we interpret this evidence? Most economists conclude that the sticky-wage model cannot fully explain aggregate supply. They advocate models in which the labor demand curve shifts over the business cycle. These shifts may arise because firms have sticky prices and cannot sell all they want at those prices; we discuss this possibility later. Alternatively, the labor demand curve may shift because of shocks to technology, which alter labor productivity. The theory we discuss in Chapter 19, called the theory of real business cycles, gives a prominent role to technology shocks as a source of economic fluctuations.[2]

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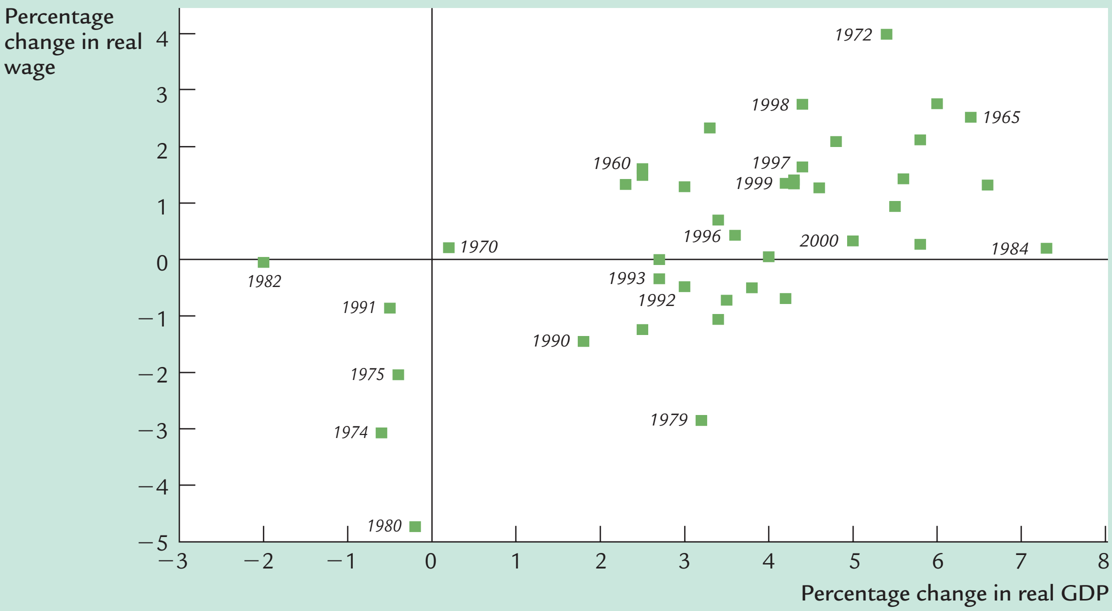
[1] For more on the sticky-wage model, see Jo Anna Gray, "Wage Indexation: A Macroeconomic Approach," *Journal of Monetary Economics* 2 (April 1976): 221–235; and Stanley Fischer, "Long-Term Contracts, Rational Expectations, and the Optimal Money Supply Rule," *Journal of Political Economy* 85 (February 1977): 191–205.

[2] For some of the recent work on the cyclical behavior of the real wage, see Scott Sumner and Stephen Silver, "Real Wages, Employment, and the Phillips Curve," *Journal of Political Economy* 97 (June 1989): 706–720; and Gary Solon, Robert Barsky, and Jonathan A. Parker, "Measuring the Cyclicality of Real Wages: How Important Is Composition Bias?" *Quarterly Journal of Economics* 109 (February 1994): 1–25.

figure 13-2



The Cyclical Behavior of the Real Wage This scatterplot shows the percentage change in real GDP and the percentage change in the real wage (measured here as real private hourly earnings). As output fluctuates, the real wage typically moves in the same direction. That is, the real wage is somewhat procyclical. This observation is inconsistent with the sticky-wage model.

Source: U.S. Department of Commerce and U.S. Department of Labor.

The Imperfect-Information Model

The second explanation for the upward slope of the short-run aggregate supply curve is called the **imperfect-information model**. Unlike the sticky-wage model, this model assumes that markets clear—that is, all wages and prices are free to adjust to balance supply and demand. In this model, the short-run and long-run aggregate supply curves differ because of temporary misperceptions about prices.

The imperfect-information model assumes that each supplier in the economy produces a single good and consumes many goods. Because the number of goods is so large, suppliers cannot observe all prices at all times. They monitor closely the prices of what they produce but less closely the prices of all the goods they consume. Because of imperfect information, they sometimes confuse changes in the overall level of prices with changes in relative prices. This confusion influences decisions about how much to supply, and it leads to a positive relationship between the price level and output in the short run.

Consider the decision facing a single supplier—a wheat farmer, for instance. Because the farmer earns income from selling wheat and uses this income to buy goods and services, the amount of wheat she chooses to produce depends on the price of wheat relative to the prices of other goods and services in the economy. If the relative price of wheat is high, the farmer is motivated to work hard and produce more wheat, because the reward is great. If the relative price of wheat is low, she prefers to enjoy more leisure and produce less wheat.

Unfortunately, when the farmer makes her production decision, she does not know the relative price of wheat. As a wheat producer, she monitors the wheat market closely and always knows the nominal price of wheat. But she does not know the prices of all the other goods in the economy. She must, therefore, estimate the relative price of wheat using the nominal price of wheat and her expectation of the overall price level.

Consider how the farmer responds if all prices in the economy, including the price of wheat, increase. One possibility is that she expected this change in prices. When she observes an increase in the price of wheat, her estimate of its relative price is unchanged. She does not work any harder.

The other possibility is that the farmer did not expect the price level to increase (or to increase by this much). When she observes the increase in the price of wheat, she is not sure whether other prices have risen (in which case wheat's relative price is unchanged) or whether only the price of wheat has risen (in which case its relative price is higher). The rational inference is that some of each has happened. In other words, the farmer infers from the increase in the nominal price of wheat that its relative price has risen somewhat. She works harder and produces more.

Our wheat farmer is not unique. When the price level rises unexpectedly, all suppliers in the economy observe increases in the prices of the goods they produce. They all infer, rationally but mistakenly, that the relative prices of the goods they produce have risen. They work harder and produce more.

To sum up, the imperfect-information model says that when actual prices exceed expected prices, suppliers raise their output. The model implies an aggregate supply curve that is now familiar:

$$Y = \overline{Y} + \alpha(P - P^e).$$

Output deviates from the natural rate when the price level deviates from the expected price level.[3]

The Sticky-Price Model

Our third explanation for the upward-sloping short-run aggregate supply curve is called the **sticky-price model**. This model emphasizes that firms do not instantly adjust the prices they charge in response to changes in demand. Sometimes prices are set by long-term contracts between firms and customers. Even

[3] Two economists who have emphasized the role of imperfect information for understanding the short-run effects of monetary policy are the Nobel Prize winners Milton Friedman and Robert Lucas. See Milton Friedman, "The Role of Monetary Policy," *American Economic Review* 58 (March 1968): 1–17; and Robert E. Lucas, Jr., "Understanding Business Cycles," *Stabilization of the Domestic and International Economy*, vol. 5 of Carnegie-Rochester Conference on Public Policy (Amsterdam: North-Holland, 1977).

without formal agreements, firms may hold prices steady in order not to annoy their regular customers with frequent price changes. Some prices are sticky because of the way markets are structured: once a firm has printed and distributed its catalog or price list, it is costly to alter prices.

To see how sticky prices can help explain an upward-sloping aggregate supply curve, we first consider the pricing decisions of individual firms and then add together the decisions of many firms to explain the behavior of the economy as a whole. Notice that this model encourages us to depart from the assumption of perfect competition, which we have used since Chapter 3. Perfectly competitive firms are price takers rather than price setters. If we want to consider how firms set prices, it is natural to assume that these firms have at least some monopoly control over the prices they charge.

Consider the pricing decision facing a typical firm. The firm's desired price p depends on two macroeconomic variables:

- The overall level of prices P. A higher price level implies that the firm's costs are higher. Hence, the higher the overall price level, the more the firm would like to charge for its product.
- The level of aggregate income Y. A higher level of income raises the demand for the firm's product. Because marginal cost increases at higher levels of production, the greater the demand, the higher the firm's desired price.

We write the firm's desired price as

$$p = P + a(Y - \overline{Y}).$$

This equation says that the desired price p depends on the overall level of prices P and on the level of aggregate output relative to the natural rate $Y - \overline{Y}$. The parameter a (which is greater than zero) measures how much the firm's desired price responds to the level of aggregate output.[4]

Now assume that there are two types of firms. Some have flexible prices: they always set their prices according to this equation. Others have sticky prices: they announce their prices in advance based on what they expect economic conditions to be. Firms with sticky prices set prices according to

$$p = P^{e} + a(Y^{e} - \overline{Y}^{e}),$$

where, as before, a superscript "e" represents the expected value of a variable. For simplicity, assume that these firms expect output to be at its natural rate, so that the last term, $a(Y^{e} - \overline{Y}^{e})$, is zero. Then these firms set the price

$$p = P^{e}.$$

That is, firms with sticky prices set their prices based on what they expect other firms to charge.

[4] *Mathematical note:* The firm cares most about its relative price, which is the ratio of its nominal price to the overall price level. If we interpret p and P as the logarithms of the firm's price and the price level, then this equation states that the desired relative price depends on the deviation of output from the natural rate.

We can use the pricing rules of the two groups of firms to derive the aggregate supply equation. To do this, we find the overall price level in the economy, which is the weighted average of the prices set by the two groups. If s is the fraction of firms with sticky prices and $1 - s$ the fraction with flexible prices, then the overall price level is

$$P = sP^e + (1 - s)[P + a(Y - \overline{Y})].$$

The first term is the price of the sticky-price firms weighted by their fraction in the economy, and the second term is the price of the flexible-price firms weighted by their fraction. Now subtract $(1 - s)P$ from both sides of this equation to obtain

$$sP = sP^e + (1 - s)[a(Y - \overline{Y})].$$

Divide both sides by s to solve for the overall price level:

$$P = P^e + [(1 - s)a/s](Y - \overline{Y})].$$

The two terms in this equation are explained as follows:

- When firms expect a high price level, they expect high costs. Those firms that fix prices in advance set their prices high. These high prices cause the other firms to set high prices also. Hence, a high expected price level P^e leads to a high actual price level P.
- When output is high, the demand for goods is high. Those firms with flexible prices set their prices high, which leads to a high price level. The effect of output on the price level depends on the proportion of firms with flexible prices.

Hence, the overall price level depends on the expected price level and on the level of output.

Algebraic rearrangement puts this aggregate pricing equation into a more familiar form:

$$Y = \overline{Y} + \alpha(P - P^e),$$

where $\alpha = s/[(1 - s)a]$. Like the other models, the sticky-price model says that the deviation of output from the natural rate is positively associated with the deviation of the price level from the expected price level.

Although the sticky-price model emphasizes the goods market, consider briefly what is happening in the labor market. If a firm's price is stuck in the short run, then a reduction in aggregate demand reduces the amount that the firm is able to sell. The firm responds to the drop in sales by reducing its production and its demand for labor. Note the contrast to the sticky-wage model: the firm here does not move along a fixed labor demand curve. Instead, fluctuations in output are associated with shifts in the labor demand curve. Because of these shifts in labor demand, employment, production, and the real wage can all move in the same direction. Thus, the real wage can be procyclical.[5]

[5] For a more advanced development of the sticky-price model, see Julio Rotemberg, "Monopolistic Price Adjustment and Aggregate Output," *Review of Economic Studies* 49 (1982): 517–531.

CASE STUDY

International Differences in the Aggregate Supply Curve

Although all countries experience economic fluctuations, these fluctuations are not exactly the same everywhere. International differences are intriguing puzzles in themselves, and they often provide a way to test alternative economic theories. Examining international differences has been especially fruitful in research on aggregate supply.

When economist Robert Lucas proposed the imperfect-information model, he derived a surprising interaction between aggregate demand and aggregate supply: according to his model, the slope of the aggregate supply curve should depend on the volatility of aggregate demand. In countries where aggregate demand fluctuates widely, the aggregate price level fluctuates widely as well. Because most movements in prices in these countries do not represent movements in relative prices, suppliers should have learned not to respond much to unexpected changes in the price level. Therefore, the aggregate supply curve should be relatively steep (that is, α will be small). Conversely, in countries where aggregate demand is relatively stable, suppliers should have learned that most price changes are relative price changes. Accordingly, in these countries, suppliers should be more responsive to unexpected price changes, making the aggregate supply curve relatively flat (that is, α will be large).

Lucas tested this prediction by examining international data on output and prices. He found that changes in aggregate demand have the biggest effect on output in those countries where aggregate demand and prices are most stable. Lucas concluded that the evidence supports the imperfect-information model.[6]

The sticky-price model also makes predictions about the slope of the short-run aggregate supply curve. In particular, it predicts that the average rate of inflation should influence the slope of the short-run aggregate supply curve. When the average rate of inflation is high, it is very costly for firms to keep prices fixed for long intervals. Thus, firms adjust prices more frequently. More frequent price adjustment in turn allows the overall price level to respond more quickly to shocks to aggregate demand. Hence, a high rate of inflation should make the short-run aggregate supply curve steeper.

International data support this prediction of the sticky-price model. In countries with low average inflation, the short-run aggregate supply curve is relatively flat: fluctuations in aggregate demand have large effects on output and are slowly reflected in prices. High-inflation countries have steep short-run aggregate supply curves. In other words, high inflation appears to erode the frictions that cause prices to be sticky.[7]

Note that the sticky-price model can also explain Lucas's finding that countries with variable aggregate demand have steep aggregate supply curves. If the price level is highly variable, few firms will commit to prices in advance (s will be small). Hence, the aggregate supply curve will be steep (α will be small).

[6] Robert E. Lucas, Jr., "Some International Evidence on Output-Inflation Tradeoffs," *American Economic Review* 63 (June 1973): 326–334.
[7] Laurence Ball, N. Gregory Mankiw, and David Romer, "The New Keynesian Economics and the Output-Inflation Tradeoff," *Brookings Papers on Economic Activity* (1988:1): 1–65.

Summary and Implications

We have seen three models of aggregate supply and the market imperfection that each uses to explain why the short-run aggregate supply curve is upward sloping. One model assumes nominal wages are sticky; the second assumes information about prices is imperfect; the third assumes prices are sticky. Keep in mind that these models are not incompatible with one another. We need not accept one model and reject the others. The world may contain all three of these market imperfections, and all may contribute to the behavior of short-run aggregate supply.

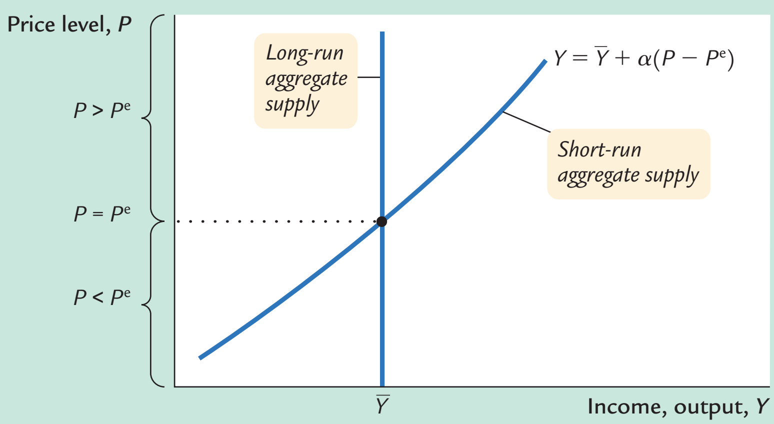
Although the three models of aggregate supply differ in their assumptions and emphases, their implications for aggregate output are similar. All can be summarized by the equation

$$Y = \overline{Y} + \alpha(P - P^e).$$

This equation states that deviations of output from the natural rate are related to deviations of the price level from the expected price level. *If the price level is higher than the expected price level, output exceeds its natural rate. If the price level is lower than the expected price level, output falls short of its natural rate.* Figure 13-3 graphs this equation. Notice that the short-run aggregate supply curve is drawn for a given expectation P^e and that a change in P^e would shift the curve.

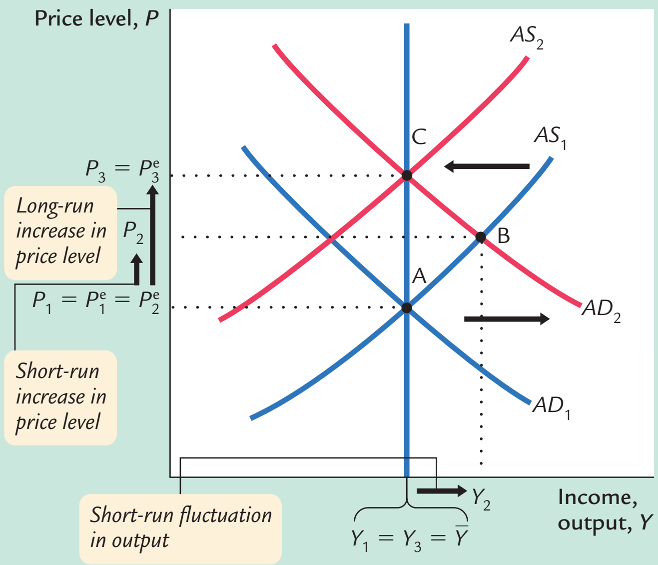
Now that we have a better understanding of aggregate supply, let's put aggregate supply and aggregate demand back together. Figure 13-4 uses our aggregate supply equation to show how the economy responds to an unexpected increase in aggregate demand attributable, say, to an unexpected monetary expansion. In the short run, the equilibrium moves from point A to point B. The increase in aggregate demand raises the actual price level from P_1 to P_2. Because people did not expect this increase in the price level, the expected price level remains at P_2^e, and output rises from Y_1 to Y_2, which is above the natural rate $\overline{Y}$. Thus, the unexpected expansion in aggregate demand causes the economy to boom.

figure 13-3



The Short-Run Aggregate Supply Curve Output deviates from the natural rate $\overline{Y}$ if the price level P deviates from the expected price level P^e.

figure 13-4



How Shifts in Aggregate Demand Lead to Short-Run Fluctuations Here the economy begins in a long-run equilibrium, point A. When aggregate demand increases unexpectedly, the price level rises from P_1 to P_2. Because the price level P_2 is above the expected price level P^e_2, output rises temporarily above the natural rate, as the economy moves along the short-run aggregate supply curve from point A to point B. In the long run, the expected price level rises to P^e_3, causing the short-run aggregate supply curve to shift upward. The economy returns to a new long-run equilbrium, point C, where output is back at its natural rate.

Yet the boom does not last forever. In the long run, the expected price level rises to catch up with reality, causing the short-run aggregate supply curve to shift upward. As the expected price level rises from P^e_2 to P^e_3, the equilibrium of the economy moves from point B to point C. The actual price level rises from P_2 to P_3, and output falls from Y_2 to Y_3. In other words, the economy returns to the natural level of output in the long run, but at a much higher price level.

This analysis shows an important principle, which holds for each of the three models of aggregate supply: long-run monetary neutrality and short-run monetary *non*neutrality are perfectly compatible. Short-run nonneutrality is represented here by the movement from point A to point B, and long-run monetary neutrality is represented by the movement from point A to point C. We reconcile the short-run and long-run effects of money by emphasizing the adjustment of expectations about the price level.

13-2 Inflation, Unemployment, and the Phillips Curve

Two goals of economic policymakers are low inflation and low unemployment, but often these goals conflict. Suppose, for instance, that policymakers were to use monetary or fiscal policy to expand aggregate demand. This policy would move the economy along the short-run aggregate supply curve to a point of higher output and a higher price level. (Figure 13-4 shows this as the change from point A to point B.) Higher output means lower unemployment, because firms need more workers when they produce more. A higher price level, given the previous year's price level, means higher inflation. Thus, when policymakers move the economy up along the short-run aggregate supply curve, they reduce the unemployment rate and raise the inflation rate. Conversely, when they contract aggregate demand and move the economy down the short-run aggregate supply curve, unemployment rises and inflation falls.

This tradeoff between inflation and unemployment, called the *Phillips curve*, is our topic in this section. As we have just seen (and will derive more formally in a moment), the Phillips curve is a reflection of the short-run aggregate supply curve: as policymakers move the economy along the short-run aggregate supply curve, unemployment and inflation move in opposite directions. The Phillips curve is a useful way to express aggregate supply because inflation and unemployment are such important measures of economic performance.

Deriving the Phillips Curve From the Aggregate Supply Curve

The **Phillips curve** in its modern form states that the inflation rate depends on three forces:

- Expected inflation;
- The deviation of unemployment from the natural rate, called *cyclical unemployment*;
- Supply shocks.

These three forces are expressed in the following equation:

$$\begin{array}{ccccccc} \pi & = & \pi^{e} & - & \beta(u - u^{n}) & + & v \\ \text{Inflation} & = & \begin{array}{c}\text{Expected}\\ \text{Inflation}\end{array} & - (\beta \times & \begin{array}{c}\text{Cyclical}\\ \text{Unemployment}\end{array}) & + & \begin{array}{c}\text{Supply}\\ \text{Shock}\end{array}, \end{array}$$

where β is a parameter measuring the response of inflation to cyclical unemployment. Notice that there is a minus sign before the cyclical unemployment term: high unemployment tends to reduce inflation. This equation summarizes the relationship between inflation and unemployment.

From where does this equation for the Phillips curve come? Although it may not seem familiar, we can derive it from our equation for aggregate supply. To see how, write the aggregate supply equation as

$$P = P^{e} + (1/\alpha)(Y - \overline{Y}).$$

With one addition, one subtraction, and one substitution, we can manipulate this equation to yield a relationship between inflation and unemployment.

Here are the three steps. First, add to the right-hand side of the equation a supply shock v to represent exogenous events (such as a change in world oil prices) that alter the price level and shift the short-run aggregate supply curve:

$$P = P^{e} + (1/\alpha)(Y - \overline{Y}) + v.$$

Next, to go from the price level to inflation rates, subtract last year's price level P_{-1} from both sides of the equation to obtain

$$(P - P_{-1}) = (P^e - P_{-1}) + (1/\alpha)(Y - \bar{Y}) + v.$$

The term on the left-hand side, $P - P_{-1}$, is the difference between the current price level and last year's price level, which is inflation π.[8] The term on the right-hand side, $P^e - P_{-1}$, is the difference between the expected price level and last year's price level, which is expected inflation π^e. Therefore, we can replace $P - P_{-1}$ with π and $P^e - P_{-1}$ with π^e:

$$\pi = \pi^e + (1/\alpha)(Y - \bar{Y}) + v.$$

Third, to go from output to unemployment, recall from Chapter 2 that Okun's law gives a relationship between these two variables. One version of Okun's law states that the deviation of output from its natural rate is inversely related to the deviation of unemployment from its natural rate; that is, when output is higher than the natural rate of output, unemployment is lower than the natural rate of unemployment. We can write this as

$$(1/\alpha)(Y - \bar{Y}) = -\beta(u - u^n).$$

Using this Okun's law relationship, we can substitute $-\beta(u - u^n)$ for $(1/\alpha)(Y - \bar{Y})$ in the previous equation to obtain

$$\pi = \pi^e - \beta(u - u^n) + v.$$

Thus, we can derive the Phillips curve equation from the aggregate supply equation.

All this algebra is meant to show one thing: the Phillips curve equation and the short-run aggregate supply equation represent essentially the same macroeconomic ideas. In particular, both equations show a link between real and nominal variables that causes the classical dichotomy (the theoretical separation of real and nominal variables) to break down in the short run. According to the short-run aggregate supply equation, output is related to unexpected movements in the price level. According to the Phillips curve equation, unemployment is related to unexpected movements in the inflation rate. The aggregate supply curve is more convenient when we are studying output and the price level, whereas the Phillips curve is more convenient when we are studying unemployment and inflation. But we should not lose sight of the fact that the Phillips curve and the aggregate supply curve are two sides of the same coin.

[8] *Mathematical note:* This statement is not precise, because inflation is really the *percentage* change in the price level. To make the statement more precise, interpret P as the logarithm of the price level. By the properties of logarithms, the change in P is roughly the inflation rate. The reason is that $dP = d(\text{log price level}) = d(\text{price level})/\text{price level}$.

FYI The History of the Modern Phillips Curve

The Phillips curve is named after New Zealand–born economist A. W. Phillips. In 1958 Phillips observed a negative relationship between the unemployment rate and the rate of wage inflation in data for the United Kingdom.[9] The Phillips curve that economists use today differs in three ways from the relationship Phillips examined.

First, the modern Phillips curve substitutes price inflation for wage inflation. This difference is not crucial, because price inflation and wage inflation are closely related. In periods when wages are rising quickly, prices are rising quickly as well.

Second, the modern Phillips curve includes expected inflation. This addition is due to the work of Milton Friedman and Edmund Phelps. In developing early versions of the imperfect information model in the 1960s, these two economists emphasized the importance of expectations for aggregate supply.

Third, the modern Phillips curve includes supply shocks. Credit for this addition goes to OPEC, the Organization of Petroleum Exporting Countries. In the 1970s OPEC caused large increases in the world price of oil, which made economists more aware of the importance of shocks to aggregate supply.

Adaptive Expectations and Inflation Inertia

To make the Phillips curve useful for analyzing the choices facing policymakers, we need to say what determines expected inflation. A simple and often plausible assumption is that people form their expectations of inflation based on recently observed inflation. This assumption is called **adaptive expectations**. For example, suppose that people expect prices to rise this year at the same rate as they did last year. Then expected inflation π^e equals last year's inflation π_{-1}:

$$\pi^e = \pi_{-1}.$$

In this case, we can write the Phillips curve as

$$\pi = \pi_{-1} - \beta(u - u^n) + v,$$

which states that inflation depends on past inflation, cyclical unemployment, and a supply shock. When the Phillips curve is written in this form, the natural rate of unemployment is sometimes called the Non-Accelerating Inflation Rate of Unemployment, or *NAIRU*.

The first term in this form of the Phillips curve, π_{-1}, implies that inflation has inertia. That is, like an object moving through space, inflation keeps going unless something acts to stop it. In particular, if unemployment is at the NAIRU and if there are no supply shocks, the continued rise in price level neither speeds up nor slows down. This inertia arises because past inflation influences expectations of future inflation and because these expectations influence the wages and prices

[9] A. W. Phillips, "The Relationship Between Unemployment and the Rate of Change of Money Wages in the United Kingdom, 1861–1957," *Economica* 25 (November 1958): 283–299.

that people set. Robert Solow captured the concept of inflation inertia well when, during the high inflation of the 1970s, he wrote, "Why is our money ever less valuable? Perhaps it is simply that we have inflation because we expect inflation, and we expect inflation because we've had it."

In the model of aggregate supply and aggregate demand, inflation inertia is interpreted as persistent upward shifts in both the aggregate supply curve and the aggregate demand curve. Consider first aggregate supply. If prices have been rising quickly, people will expect them to continue to rise quickly. Because the position of the short-run aggregate supply curve depends on the expected price level, the short-run aggregate supply curve will shift upward over time. It will continue to shift upward until some event, such as a recession or a supply shock, changes inflation and thereby changes expectations of inflation.

The aggregate demand curve must also shift upward to confirm the expectations of inflation. Most often, the continued rise in aggregate demand is caused by persistent growth in the money supply. If the Fed suddenly halted money growth, aggregate demand would stabilize, and the upward shift in aggregate supply would cause a recession. The high unemployment in the recession would reduce inflation and expected inflation, causing inflation inertia to subside.

Two Causes of Rising and Falling Inflation

The second and third terms in the Phillips curve equation show the two forces that can change the rate of inflation.

The second term, $\beta(u - u^n)$, shows that cyclical unemployment—the deviation of unemployment from its natural rate—exerts upward or downward pressure on inflation. Low unemployment pulls the inflation rate up. This is called **demand-pull inflation** because high aggregate demand is responsible for this type of inflation. High unemployment pulls the inflation rate down. The parameter β measures how responsive inflation is to cyclical unemployment.

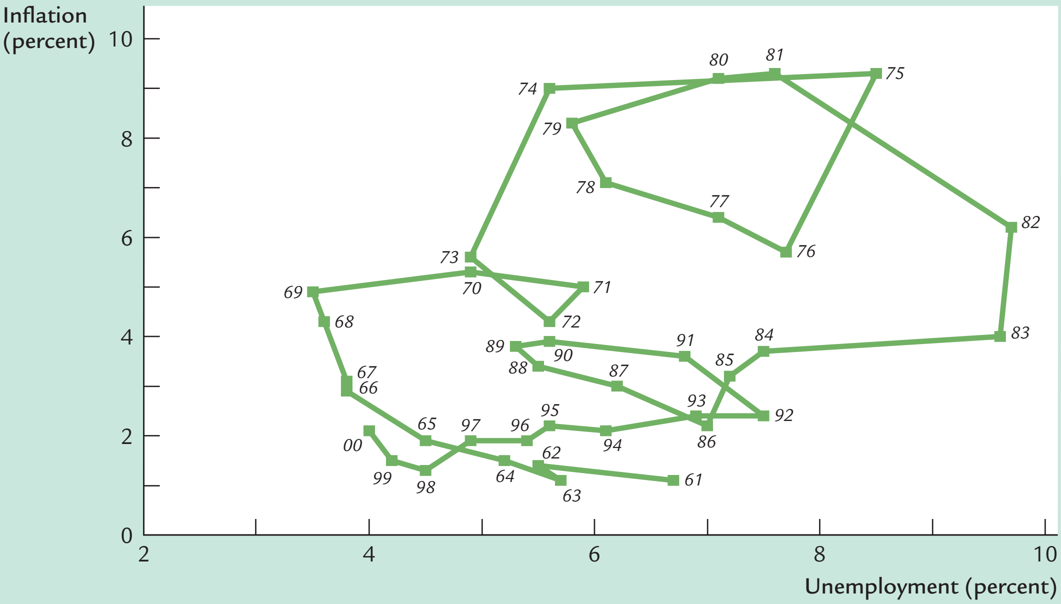
The third term, v, shows that inflation also rises and falls because of supply shocks. An adverse supply shock, such as the rise in world oil prices in the 1970s, implies a positive value of v and causes inflation to rise. This is called **cost-push inflation** because adverse supply shocks are typically events that push up the costs of production. A beneficial supply shock, such as the oil glut that led to a fall in oil prices in the 1980s, makes v negative and causes inflation to fall.

CASE STUDY

Inflation and Unemployment in the United States

Because inflation and unemployment are such important measures of economic performance, macroeconomic developments are often viewed through the lens of the Phillips curve. Figure 13-5 displays the history of inflation and unemployment in the United States since 1961. These four decades of data illustrate some of the causes of rising or falling inflation.

figure 13-5



Inflation and Unemployment in the United States Since 1961 This figure uses annual data on the unemployment rate and the inflation rate (percentage change in the GDP deflator) to illustrate macroeconomic developments over the past four decades.

Source: U.S. Department of Commerce and U.S. Department of Labor.

The 1960s showed how policymakers can, in the short run, lower unemployment at the cost of higher inflation. The tax cut of 1964, together with expansionary monetary policy, expanded aggregate demand and pushed the unemployment rate below 5 percent. This expansion of aggregate demand continued in the late 1960s largely as a by-product of government spending for the Vietnam War. Unemployment fell lower and inflation rose higher than policymakers intended.

The 1970s were a period of economic turmoil. The decade began with policymakers trying to lower the inflation inherited from the 1960s. President Nixon imposed temporary controls on wages and prices, and the Federal Reserve engineered a recession through contractionary monetary policy, but the inflation rate fell only slightly. The effects of wage and price controls ended when the controls were lifted, and the recession was too small to counteract the inflationary impact of the boom that had preceded it. By 1972 the unemployment rate was the same as a decade earlier, whereas inflation was 3 percentage points higher.

Beginning in 1973 policymakers had to cope with the large supply shocks caused by the Organization of Petroleum Exporting Countries (OPEC). OPEC first raised oil prices in the mid-1970s, pushing the inflation rate up to about 10 percent. This adverse supply shock, together with temporarily tight monetary policy, led to a recession in 1975. High unemployment during the recession reduced inflation somewhat, but further OPEC price hikes pushed inflation up again in the late 1970s.

The 1980s began with high inflation and high expectations of inflation. Under the leadership of Chairman Paul Volcker, the Federal Reserve doggedly pursued monetary policies aimed at reducing inflation. In 1982 and 1983 the unemployment rate reached its highest level in 40 years. High unemployment, aided by a fall in oil prices in 1986, pulled the inflation rate down from about 10 percent to about 3 percent. By 1987 the unemployment rate of about 6 percent was close to most estimates of the natural rate. Unemployment continued to fall through the 1980s, however, reaching a low of 5.2 percent in 1989 and beginning a new round of demand-pull inflation.

Compared to the previous 30 years, the 1990s were relatively quiet. The decade began with a recession caused by several contractionary shocks to aggregate demand: tight monetary policy, the savings-and-loan crisis, and a fall in consumer confidence coinciding with the Gulf War. The unemployment rate rose to 7.3 percent in 1992. Inflation fell, but only slightly. Unlike in the 1982 recession, unemployment in the 1990 recession was never far above the natural rate, so the effect on inflation was small.

By the late 1990s, inflation and unemployment both reached their lowest levels in many years. Some economists explain this fortunate development by claiming that the economy's natural rate of unemployment fell (for reasons discussed in Chapter 6). Others argue that various temporary factors (such as a strong U.S. dollar attributable to a financial crisis in Asia) yielded favorable supply shocks. Most likely, a combination of events helped keep inflation in check, despite low unemployment. In 2000, however, inflation did begin to creep up.

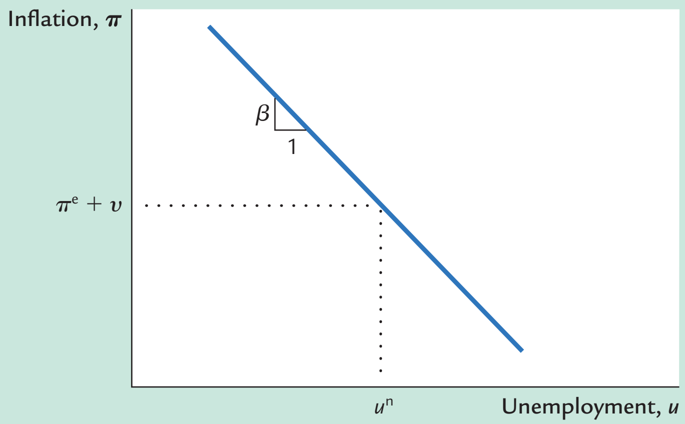
Thus, U.S. macroeconomic history exhibits the many causes of inflation. The 1960s and the 1980s show the two sides of demand-pull inflation: in the 1960s low unemployment pulled inflation up, and in the 1980s high unemployment pulled inflation down. The 1970s with their oil-price hikes show the effects of cost-push inflation.

The Short-Run Tradeoff Between Inflation and Unemployment

Consider the options the Phillips curve gives to a policymaker who can influence aggregate demand with monetary or fiscal policy. At any moment, expected inflation and supply shocks are beyond the policymaker's immediate control. Yet, by changing aggregate demand, the policymaker can alter output, unemployment, and inflation. The policymaker can expand aggregate demand to lower unemployment and raise inflation. Or the policymaker can depress aggregate demand to raise unemployment and lower inflation.

Figure 13-6 plots the Phillips curve equation and shows the short-run tradeoff between inflation and unemployment. When unemployment is at its natural rate ($u = u^n$), inflation depends on expected inflation and the supply shock ($\pi = \pi^e + \upsilon$). The parameter β determines the slope of the tradeoff between inflation and unemployment. In the short run, for a given level of expected inflation, policymakers can manipulate aggregate demand to choose a

figure 13-6



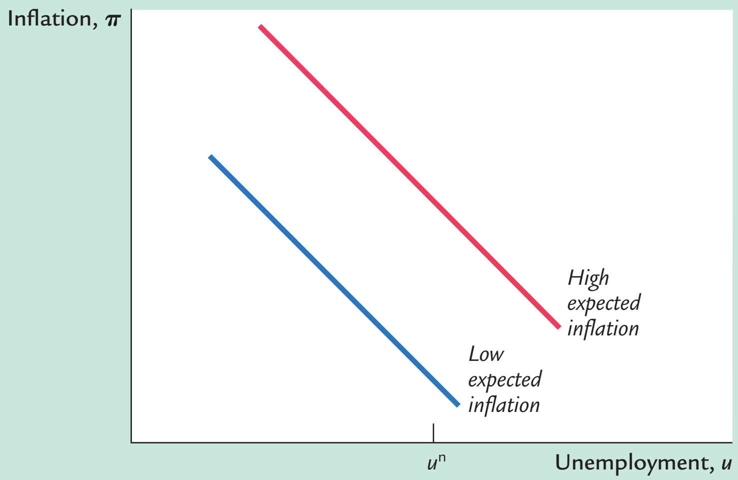
The Short-Run Tradeoff Between Inflation and Unemployment In the short run, inflation and unemployment are negatively related. At any point in time, a policymaker who controls aggregate demand can choose a combination of inflation and unemployment on this short-run Phillips curve.

combination of inflation and unemployment on this curve, called the *short-run Phillips curve*.

Notice that the position of the short-run Phillips curve depends on the expected rate of inflation. If expected inflation rises, the curve shifts upward, and the policymaker's tradeoff becomes less favorable: inflation is higher for any level of unemployment. Figure 13-7 shows how the tradeoff depends on expected inflation.

Because people adjust their expectations of inflation over time, the tradeoff between inflation and unemployment holds only in the short run. The policymaker cannot keep inflation above expected inflation (and thus unemployment below its natural rate) forever. Eventually, expectations adapt to whatever inflation rate the

figure 13-7



Shifts in the Short-Run Tradeoff The short-run tradeoff between inflation and unemployment depends on expected inflation. The curve is higher when expected inflation is higher.

FYI

How Precise Are Estimates of the Natural Rate of Unemployment?

If you ask an astronomer how far a particular star is from our sun, he'll give you a number, but it won't be accurate. Man's ability to measure astronomical distances is still limited. An astronomer might well take better measurements and conclude that a star is really twice or half as far away as he previously thought.

Estimates of the natural rate of unemployment, or NAIRU, are also far from precise. One problem is supply shocks. Shocks to oil supplies, farm harvests, or technological progress can cause inflation to rise or fall in the short run. When we observe rising inflation, therefore, we cannot be sure if it is evidence that the unemployment rate is below the natural rate or evidence that the economy is experiencing an adverse supply shock.

A second problem is that the natural rate changes over time. Demographic changes (such as the aging of the baby-boom generation), policy changes (such as minimum-wage laws), and institutional changes (such as the declining role of unions) all influence the economy's normal level of unemployment. Estimating the natural rate is like hitting a moving target.

Economists deal with these problems using statistical techniques that yield a best guess about the natural rate and allow them to gauge the uncertainty associated with their estimates. In one such study, Douglas Staiger, James Stock, and Mark Watson estimated the natural rate to be 6.2 percent in 1990, with a 95-percent confidence interval from 5.1 to 7.7 percent. A 95-percent confidence interval is a range such that the statistician is 95-percent confident that the true value falls in that range. The large confidence interval here of 2.6 percentage points shows that estimates of the natural rate are not at all precise.

This conclusion has profound implications. Policymakers may want to keep unemployment close to its natural rate, but their ability to do so is limited by the fact that we cannot be sure what that natural rate is.[10]

policymaker has chosen. In the long run, the classical dichotomy holds, unemployment returns to its natural rate, and there is no tradeoff between inflation and unemployment.

Disinflation and the Sacrifice Ratio

Imagine an economy in which unemployment is at its natural rate and inflation is running at 6 percent. What would happen to unemployment and output if the central bank pursued a policy to reduce inflation from 6 to 2 percent?

The Phillips curve shows that in the absence of a beneficial supply shock, lowering inflation requires a period of high unemployment and reduced output. But by how much and for how long would unemployment need to rise above the natural rate? Before deciding whether to reduce inflation, policymakers must know how much output would be lost during the transition to lower inflation. This cost can then be compared with the benefits of lower inflation.

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[10] Douglas Staiger, James H. Stock, and Mark W. Watson, "How Precise Are Estimates of the Natural Rate of Unemployment?" in Christina D. Romer and David H. Romer, eds., *Reducing Inflation: Motivation and Strategy* (Chicago: University of Chicago Press, 1997).

Much research has used the available data to examine the Phillips curve quantitatively. The results of these studies are often summarized in a number called the **sacrifice ratio**, the percentage of a year's real GDP that must be forgone to reduce inflation by 1 percentage point. Although estimates of the sacrifice ratio vary substantially, a typical estimate is about 5: for every percentage point that inflation is to fall, 5 percent of one year's GDP must be sacrificed.[11]

We can also express the sacrifice ratio in terms of unemployment. Okun's law says that a change of 1 percentage point in the unemployment rate translates into a change of 2 percentage points in GDP. Therefore, reducing inflation by 1 percentage point requires about 2.5 percentage points of cyclical unemployment.

We can use the sacrifice ratio to estimate by how much and for how long unemployment must rise to reduce inflation. If reducing inflation by 1 percentage point requires a sacrifice of 5 percent of a year's GDP, reducing inflation by 4 percentage points requires a sacrifice of 20 percent of a year's GDP. Equivalently, this reduction in inflation requires a sacrifice of 10 percentage points of cyclical unemployment.

This disinflation could take various forms, each totaling the same sacrifice of 20 percent of a year's GDP. For example, a rapid disinflation would lower output by 10 percent for 2 years: this is sometimes called the *cold-turkey* solution to inflation. A moderate disinflation would lower output by 5 percent for 4 years. An even more gradual disinflation would depress output by 2 percent for a decade.

Rational Expectations and the Possibility of Painless Disinflation

Because the expectation of inflation influences the short-run tradeoff between inflation and unemployment, it is crucial to understand how people form expectations. So far, we have been assuming that expected inflation depends on recently observed inflation. Although this assumption of adaptive expectations is plausible, it is probably too simple to apply in all circumstances.

An alternative approach is to assume that people have **rational expectations**. That is, we might assume that people optimally use all the available information, including information about current government policies, to forecast the future. Because monetary and fiscal policies influence inflation, expected inflation should also depend on the monetary and fiscal policies in effect. According to the theory of rational expectations, a change in monetary or fiscal policy will change expectations, and an evaluation of any policy change must incorporate this effect on expectations. If people do form their expectations rationally, then inflation may have less inertia than it first appears.

[11] Arthur M. Okun, "Efficient Disinflationary Policies," *American Economic Review* 68 (May 1978): 348–352; and Robert J. Gordon and Stephen R. King, "The Output Cost of Disinflation in Traditional and Vector Autoregressive Models," *Brookings Papers on Economic Activity* (1982:1): 205–245.

Here is how Thomas Sargent, a prominent advocate of rational expectations, describes its implications for the Phillips curve:

> An alternative "rational expectations" view denies that there is any inherent momentum to the present process of inflation. This view maintains that firms and workers have now come to expect high rates of inflation in the future and that they strike inflationary bargains in light of these expectations. However, it is held that people expect high rates of inflation in the future precisely because the government's current and prospective monetary and fiscal policies warrant those expectations. . . . Thus inflation only seems to have a momentum of its own; it is actually the long-term government policy of persistently running large deficits and creating money at high rates which imparts the momentum to the inflation rate. An implication of this view is that inflation can be stopped much more quickly than advocates of the "momentum" view have indicated and that their estimates of the length of time and the costs of stopping inflation in terms of foregone output are erroneous. . . . [Stopping inflation] would require a change in the policy regime: there must be an abrupt change in the continuing government policy, or strategy, for setting deficits now and in the future that is sufficiently binding as to be widely believed. . . . How costly such a move would be in terms of foregone output and how long it would be in taking effect would depend partly on how resolute and evident the government's commitment was.[12]

Thus, advocates of rational expectations argue that the short-run Phillips curve does not accurately represent the options that policymakers have available. They believe that if policymakers are credibly committed to reducing inflation, rational people will understand the commitment and will quickly lower their expectations of inflation. Inflation can then come down without a rise in unemployment and fall in output. According to the theory of rational expectations, traditional estimates of the sacrifice ratio are not useful for evaluating the impact of alternative policies. Under a credible policy, the costs of reducing inflation may be much lower than estimates of the sacrifice ratio suggest.

In the most extreme case, one can imagine reducing the rate of inflation without causing any recession at all. A painless disinflation has two requirements. First, the plan to reduce inflation must be announced before the workers and firms who set wages and prices have formed their expectations. Second, the workers and firms must believe the announcement; otherwise, they will not reduce their expectations of inflation. If both requirements are met, the announcement will immediately shift the short-run tradeoff between inflation and unemployment downward, permitting a lower rate of inflation without higher unemployment.

Although the rational-expectations approach remains controversial, almost all economists agree that expectations of inflation influence the short-run tradeoff between inflation and unemployment. The credibility of a policy to reduce inflation is therefore one determinant of how costly the policy will be. Unfortunately, it is often difficult to predict whether the public will view the announcement of a new policy as credible. The central role of expectations makes forecasting the results of alternative policies far more difficult.

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[12] Thomas J. Sargent, "The Ends of Four Big Inflations," in Robert E. Hall, ed., *Inflation: Causes and Effects* (Chicago: University of Chicago Press, 1982).

CASE STUDY

The Sacrifice Ratio in Practice

The Phillips curve with adaptive expectations implies that reducing inflation requires a period of high unemployment and low output. By contrast, the rational-expectations approach suggests that reducing inflation can be much less costly. What happens during actual disinflations?

Consider the U.S. disinflation in the early 1980s. This decade began with some of the highest rates of inflation in U.S. history. Yet because of the tight monetary policies the Fed pursued under Chairman Paul Volcker, the rate of inflation fell substantially in the first few years of the decade. This episode provides a natural experiment with which to estimate how much output is lost during the process of disinflation.

The first question is, how much did inflation fall? As measured by the GDP deflator, inflation reached a peak of 9.7 percent in 1981. It is natural to end the episode in 1985 because oil prices plunged in 1986—a large, beneficial supply shock unrelated to Fed policy. In 1985, inflation was 3.0 percent, so we can estimate that the Fed engineered a reduction in inflation of 6.7 percentage points over four years.

The second question is, how much output was lost during this period? Table 13-1 shows the unemployment rate from 1982 to 1985. Assuming that the natural rate of unemployment was 6 percent, we can compute the amount of cyclical unemployment in each year. In total over this period, there were 9.5 percentage points of cyclical unemployment. Okun's law says that 1 percentage point of unemployment translates into 2 percentage points of GDP. Therefore, 19.0 percentage points of annual GDP were lost during the disinflation.

table 13-1

Unemployment During the Volcker Disinflation

Year	Unemployment Rate, u	Natural Rate, u^n		Cyclical Unemployment, $u - u^n$
1982	9.5%	6.0%		3.5%
1983	9.5	6.0		3.5
1984	7.4	6.0		1.4
1985	7.1	6.0		1.1
			Total	9.5%

Now we can compute the sacrifice ratio for this episode. We know that 19.0 percentage points of GDP were lost and that inflation fell by 6.7 percentage points. Hence, 19.0/6.7, or 2.8, percentage points of GDP were lost for each percentage-point reduction in inflation. The estimate of the sacrifice ratio from the Volcker disinflation is 2.8.

This estimate of the sacrifice ratio is smaller than the estimates made before Volcker was appointed Fed chairman. In other words, Volcker reduced inflation at a smaller cost than many economists had predicted. One explanation is that Volcker's tough stand was credible enough to influence expectations of inflation directly. Yet the change in expectations was not large enough to make the disinflation painless: in 1982 unemployment reached its highest level since the Great Depression.

Although the Volcker disinflation is only one historical episode, this kind of analysis can be applied to other disinflations. A recent study documented the results of 65 disinflations in 19 countries. In almost all cases, the reduction in inflation came at the cost of temporarily lower output. Yet the size of the output loss varied from episode to episode. Rapid disinflations usually had smaller sacrifice ratios than slower ones. That is, in contrast to what the Phillips curve with adaptive expectations suggests, a cold-turkey approach appears less costly than a gradual one. Moreover, countries with more flexible wage-setting institutions, such as shorter labor contracts, had smaller sacrifice ratios. These findings indicate that reducing inflation always has some cost, but that policies and institutions can affect its magnitude.[13]

Hysteresis and the Challenge to the Natural-Rate Hypothesis

Our discussion of the cost of disinflation—and indeed our entire discussion of economic fluctuations in the past four chapters—has been based on an assumption called the **natural-rate hypothesis**. This hypothesis is summarized in the following statement:

> *Fluctuations in aggregate demand affect output and employment only in the short run. In the long run, the economy returns to the levels of output, employment, and unemployment described by the classical model.*

The natural-rate hypothesis allows macroeconomists to study separately short-run and long-run developments in the economy. It is one expression of the classical dichotomy.

Recently, some economists have challenged the natural-rate hypothesis by suggesting that aggregate demand may affect output and employment even in the long run. They have pointed out a number of mechanisms through which recessions might leave permanent scars on the economy by altering the natural rate of unemployment. **Hysteresis** is the term used to describe the long-lasting influence of history on the natural rate.

A recession can have permanent effects if it changes the people who become unemployed. For instance, workers might lose valuable job skills when unemployed, lowering their ability to find a job even after the recession ends.

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[13] Laurence Ball, "What Determines the Sacrifice Ratio?" in N. Gregory Mankiw, ed., *Monetary Policy* (Chicago: University of Chicago Press, 1994).

Alternatively, a long period of unemployment may change an individual's attitude toward work and reduce his desire to find employment. In either case, the recession permanently inhibits the process of job search and raises the amount of frictional unemployment.

Another way in which a recession can permanently affect the economy is by changing the process that determines wages. Those who become unemployed may lose their influence on the wage-setting process. Unemployed workers may lose their status as union members, for example. More generally, some of the *insiders* in the wage-setting process become *outsiders*. If the smaller group of insiders cares more about high real wages and less about high employment, then the recession may permanently push real wages further above the equilibrium level and raise the amount of structural unemployment.

Hysteresis remains a controversial theory. Some economists believe the theory helps explain persistently high unemployment in Europe, because the rise in European unemployment starting in the early 1980s coincided with disinflation but continued after inflation stabilized. Moreover, the increase in unemployment tended to be larger for those countries that experienced the greatest reductions in inflations, such as Ireland, Italy, and Spain. Yet there is still no consensus whether the hysteresis phenomenon is significant, or why it might be more pronounced in some countries than in others. (Other explanations of high European unemployment, discussed in Chapter 6, give little role to the disinflation.) If it is true, however, the theory is important, because hysteresis greatly increases the cost of recessions. Put another way, hysteresis raises the sacrifice ratio, because output is lost even after the period of disinflation is over.[14]

13-3 Conclusion

We began this chapter by discussing three models of aggregate supply, each of which focuses on a different reason why the short-run aggregate supply curve is upward sloping. The three models have similar predictions for the aggregate economy, and all of them yield a short-run tradeoff between inflation and unemployment. A convenient way to express and analyze that tradeoff is with the Phillips curve equation, according to which inflation depends on expected inflation, cyclical unemployment, and supply shocks.

Keep in mind that not all economists endorse all the ideas discussed here. There is widespread disagreement, for instance, about the practical importance of rational expectations and the relevance of hysteresis. If you find it difficult to fit all the pieces together, you are not alone. The study of aggregate supply remains one of the most unsettled—and therefore one of the most exciting—research areas in macroeconomics.

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[14] Olivier J. Blanchard and Lawrence H. Summers, "Beyond the Natural Rate Hypothesis," *American Economic Review* 78 (May 1988): 182–187; Laurence Ball, "Disinflation and the NAIRU," in Christina D. Romer and David H. Romer, eds., *Reducing Inflation: Motivation and Strategy* (Chicago: University of Chicago Press, 1997): 167–185.

Summary

1. The three theories of aggregate supply—the sticky-wage, imperfect-information, and sticky-price models—attribute deviations of output and employment from the natural rate to various market imperfections. According to all three theories, output rises above the natural rate when the price level exceeds the expected price level, and output falls below the natural rate when the price level is less than the expected price level.

2. Economists often express aggregate supply in a relationship called the Phillips curve. The Phillips curve says that inflation depends on expected inflation, the deviation of unemployment from its natural rate, and supply shocks. According to the Phillips curve, policymakers who control aggregate demand face a short-run tradeoff between inflation and unemployment.

3. If expected inflation depends on recently observed inflation, then inflation has inertia, which means that reducing inflation requires either a beneficial supply shock or a period of high unemployment and reduced output. If people have rational expectations, however, then a credible announcement of a change in policy might be able to influence expectations directly and, therefore, reduce inflation without causing a recession.

4. Most economists accept the natural-rate hypothesis, according to which fluctuations in aggregate demand have only short-run effects on output and unemployment. Yet some economists have suggested ways in which recessions can leave permanent scars on the economy by raising the natural rate of unemployment.

KEY CONCEPTS

Sticky-wage model
Imperfect-information model
Sticky-price model
Phillips curve
Adaptive expectations
Demand-pull inflation
Cost-push inflation
Sacrifice ratio
Rational expectations
Natural-rate hypothesis
Hysteresis

QUESTIONS FOR REVIEW

1. Explain the three theories of aggregate supply. On what market imperfection does each theory rely? What do the theories have in common?

2. How is the Phillips curve related to aggregate supply?

3. Why might inflation be inertial?

4. Explain the differences between demand-pull inflation and cost-push inflation.

5. Under what circumstances might it be possible to reduce inflation without causing a recession?

6. Explain two ways in which a recession might raise the natural rate of unemployment.

PROBLEMS AND APPLICATIONS

1. Consider the following changes in the sticky-wage model.

a. Suppose that labor contracts specify that the nominal wage be fully indexed for inflation. That is, the nominal wage is to be adjusted to fully compensate for changes in the consumer price index. How does full indexation alter the aggregate supply curve in this model?

b. Suppose now that indexation is only partial. That is, for every increase in the CPI, the nominal wage rises, but by a smaller percentage. How does partial indexation alter the aggregate supply curve in this model?

2. In the sticky-price model, describe the aggregate supply curve in the following special cases. How do these cases compare to the short-run aggregate supply curve we discussed in Chapter 9?

a. No firms have flexible prices ($s = 1$).

b. The desired price does not depend on aggregate output ($a = 0$).

3. Suppose that an economy has the Phillips curve

$$\pi = \pi_{-1} - 0.5(u - 0.06).$$

a. What is the natural rate of unemployment?

b. Graph the short-run and long-run relationships between inflation and unemployment.

c. How much cyclical unemployment is necessary to reduce inflation by 5 percentage points? Using Okun's law, compute the sacrifice ratio.

d. Inflation is running at 10 percent. The Fed wants to reduce it to 5 percent. Give two scenarios that will achieve that goal.

4. According to the rational-expectations approach, if everyone believes that policymakers are committed to reducing inflation, the cost of reducing inflation—the sacrifice ratio—will be lower than if the public is skeptical about the policymakers' intentions. Why might this be true? How might credibility be achieved?

5. Assume that people have rational expectations and that the economy is described by the sticky-wage or sticky-price model. Explain why each of the following propositions is true:

a. Only unanticipated changes in the money supply affect real GDP. Changes in the money supply that were anticipated when wages and prices were set do not have any real effects.

b. If the Fed chooses the money supply at the same time as people are setting wages and prices, so that everyone has the same information about the state of the economy, then monetary policy cannot be used systematically to stabilize output. Hence, a policy of keeping the money supply constant will have the same real effects as a policy of adjusting the money supply in response to the state of the economy. (This is called the *policy irrelevance proposition*.)

c. If the Fed sets the money supply well after people have set wages and prices, so the Fed has collected more information about the state of the economy, then monetary policy can be used systematically to stabilize output.

6. Suppose that an economy has the Phillips curve

$$\pi = \pi_{-1} - 0.5(u - u^{n}),$$

and that the natural rate of unemployment is given by an average of the past two years' unemployment:

$$u^{n} = 0.5(u_{-1} + u_{-2}).$$

a. Why might the natural rate of unemployment depend on recent unemployment (as is assumed in the preceding equation)?

b. Suppose that the Fed follows a policy to reduce permanently the inflation rate by 1 percentage point. What effect will that policy have on the unemployment rate over time?

c. What is the sacrifice ratio in this economy? Explain.

d. What do these equations imply about the short-run and long-run tradeoffs between inflation and unemployment?

7. Some economists believe that taxes have an important effect on labor supply. They argue that higher taxes cause people to want to work less and that lower taxes cause them to want to work more. Consider how this effect alters the macroeconomic analysis of tax changes.

a. If this view is correct, how does a tax cut affect the natural rate of output?

b. How does a tax cut affect the aggregate demand curve? The long-run aggregate supply curve? The short-run aggregate supply curve?

c. What is the short-run impact of a tax cut on output and the price level? How does your answer differ from the case without the labor-supply effect?

d. What is the long-run impact of a tax cut on output and the price level? How does your answer differ from the case without the labor-supply effect?

8. Economist Alan Blinder, whom Bill Clinton appointed to be Vice Chairman of the Federal Reserve, once wrote the following:

> The costs that attend the low and moderate inflation rates experienced in the United States and in other industrial countries appear to be quite modest—more like a bad cold than a cancer on society. . . . As rational individuals, we do not volunteer for a lobotomy to cure a head cold. Yet, as a collectivity, we routinely prescribe the economic equivalent of lobotomy (high unemployment) as a cure for the inflationary cold.[15]

What do you think Blinder meant by this? What are the policy implications of the viewpoint Blinder is advocating? Do you agree? Why or why not?

9. Go to the Web site of the Bureau of Labor Statistics (www.bls.gov). For each of the past five years, find the inflation rate as measured by the consumer price index (all items) and as measured by the CPI excluding food and energy. Compare these two measures of inflation. Why might they be different? What might the difference tell you about shifts in the aggregate supply curve and in the short-run Phillips curve?

[15] Alan Blinder, *Hard Heads, Soft Hearts: Tough-Minded Economics for a Just Society* (Reading, Mass.: Addison-Wesley, 1987), 51.

APPENDIX

A Big, Comprehensive Model

In the previous chapters, we have seen many models of how the economy works. When learning these models, it can be hard to see how they are related. Now that we have finished developing the model of aggregate demand and aggregate supply, this is a good time to look back at what we have learned. This appendix sketches a large model that incorporates much of the theory we have already seen, including the classical theory presented in Part II and the business cycle theory presented in Part IV. The notation and equations should be familiar from previous chapters.

The model has seven equations:

$Y = C(Y - T) + I(r) + G + NX(\epsilon)$	*IS*: Goods Market Equilibrium
$M/P = L(i, Y)$	*LM*: Money Market Equilibrium
$NX(\epsilon) = CF(r - r^*)$	Foreign Exchange Market Equilibrium
$i = r + \pi^e$	Relationship Between Real and Nominal Interest Rates
$\epsilon = eP/P^*$	Relationship Between Real and Nominal Exchange Rates
$Y = \bar{Y} + \alpha(P - P^e)$	Aggregate Supply
$\bar{Y} = F(\bar{K}, \bar{L})$	Natural Rate of Output

These seven equations determine the equilibrium values of seven endogenous variables: output Y, the natural rate of output $\bar{Y}$, the real interest rate r, the nominal interest rate i, the real exchange rate ϵ, the nominal exchange rate e, and the price level P.

There are many exogenous variables that influence these endogenous variables. They include the money supply M, government purchases G, taxes T, the capital stock K, the labor force L, the world price level P^*, and the world real interest rate r^*. In addition, there are two expectational variables: the expectation of future inflation π^e and the expectation of the current price level formed in the past P^e. As written, the model takes these expectational variables as exogenous, although additional equations could be added to make them endogenous.

Although mathematical techniques are available to analyze this seven-equation model, they are beyond the scope of this book. But this large model is still useful, because we can use it to see how the smaller models we have examined are related to one another. In particular, *many of the models we have been studying are special cases of this large model.* Let's consider six special cases.

Special Case 1: The Classical Closed Economy Suppose that $P^e = P$, $L(i, Y) = (1/V)Y$, and $CF(r - r^*) = 0$. In words, this means that expectations of the price level adjust so that expectations are correct, that money demand is proportional to income, and that there are no international capital flows. In this case, output is always at its natural rate, the real interest rate adjusts to equilibrate the goods market, the price level moves parallel with the money supply, and the nominal interest rate adjusts one-for-one with expected inflation. This special case corresponds to the economy analyzed in Chapters 3 and 4.

Special Case 2: The Classical Small Open Economy Suppose that $P^e = P$, $L(i, Y) = (1/V)Y$, and $CF(r - r^*)$ is infinitely elastic. Now we are examining the special case when international capital flows respond greatly to any differences between the domestic and world interest rates. This means that $r = r^*$ and that the trade balance NX equals the difference between saving and investment at the world interest rate. This special case corresponds to the economy analyzed in Chapter 5.

Special Case 3: The Basic Model of Aggregate Demand and Aggregate Supply Suppose that α is infinite and $L(i, Y) = (1/V)Y$. In this case, the short-run aggregate supply curve is horizontal, and the aggregate demand curve is determined only by the quantity equation. This special case corresponds to the economy analyzed in Chapter 9.

Special Case 4: The *IS–LM* Model Suppose that α is infinite and $CF(r - r^*) = 0$. In this case, the short-run aggregate supply curve is horizontal, and there are no international capital flows. For any given level of expected inflation π^e, the level of income and interest rate must adjust to equilibrate the goods market and the money market. This special case corresponds to the economy analyzed in Chapter 10 and 11.

Special Case 5: The Mundell–Fleming Model with a Floating Exchange Rate Suppose that α is infinite and $CF(r - r^*)$ is infinitely elastic. In this case, the short-run aggregate supply curve is horizontal, and international capital flows are so great as to ensure that $r = r^*$. The exchange rate floats freely to reach its equilibrium level. This special case corresponds to the first economy analyzed in Chapter 12.

Special Case 6: The Mundell–Fleming Model with a Fixed Exchange Rate Suppose that α is infinite, $CF(r - r^*)$ is infinitely elastic, and e is fixed. In this case, the short-run aggregate supply curve is horizontal, huge international capital flows ensure that $r = r^*$, but the exchange rate is set by the central bank. The exchange rate is now an exogenous policy variable, but the money supply M is an endogenous variable that must adjust to ensure the exchange rate hits the fixed level. This special case corresponds to the second economy analyzed in Chapter 12.

You should now see the value in this big model. Even though the model is too large to be useful in developing an intuitive understanding of how the economy works, it shows that the different models we have been studying are closely related. Each model shows a different facet of the larger and more realistic model presented here. In each chapter, we made some simplifying assumptions to make the big model smaller and easier to understand. When thinking about the real world, it is important to keep the simplifying assumptions in mind and to draw on the insights learned in each of the chapters.

MORE PROBLEMS AND APPLICATIONS

1. Let's consider some more special cases of this large model. Starting with the large model, what extra assumptions would you need to yield each of the following models:

a. The model of the classical large open economy in the appendix to Chapter 5.

b. The Keynesian cross in the first half of Chapter 10.

c. The *IS–LM* model for the large open economy in the appendix to Chapter 12.

part V

Macroeconomic Policy Debates

CHAPTER FOURTEEN

Stabilization Policy

The Federal Reserve's job is to take away the punch bowl just as the party gets going.

— *William McChesney Martin*

What we need is not a skilled monetary driver of the economic vehicle continuously turning the steering wheel to adjust to the unexpected irregularities of the route, but some means of keeping the monetary passenger who is in the back seat as ballast from occasionally leaning over and giving the steering wheel a jerk that threatens to send the car off the road.

— *Milton Friedman*

How should government policymakers respond to the business cycle? The two quotations above—the first from a former chairman of the Federal Reserve, the second from a prominent critic of the Fed—show the diversity of opinion over how this question is best answered.

Some economists, such as William McChesney Martin, view the economy as inherently unstable. They argue that the economy experiences frequent shocks to aggregate demand and aggregate supply. Unless policymakers use monetary and fiscal policy to stabilize the economy, these shocks will lead to unnecessary and inefficient fluctuations in output, unemployment, and inflation. According to the popular saying, macroeconomic policy should "lean against the wind," stimulating the economy when it is depressed and slowing the economy when it is overheated.

Other economists, such as Milton Friedman, view the economy as naturally stable. They blame bad economic policies for the large and inefficient fluctuations we have sometimes experienced. They argue that economic policy should not try to "fine-tune" the economy. Instead, economic policymakers should admit their limited abilities and be satisfied if they do no harm.

This debate has persisted for decades, with numerous protagonists advancing various arguments for their positions. The fundamental issue is how policymakers should use the theory of short-run economic fluctuations developed in the preceding chapters. In this chapter we ask two questions that arise in this debate. First, should monetary and fiscal policy take an active role in trying to stabilize the economy, or should policy remain passive? Second, should policymakers be free to use their discretion in responding to changing economic conditions, or should they be committed to following a fixed policy rule?

14-1 Should Policy Be Active or Passive?

Policymakers in the federal government view economic stabilization as one of their primary responsibilities. The analysis of macroeconomic policy is a regular duty of the Council of Economic Advisers, the Congressional Budget Office, the Federal Reserve, and other government agencies. When Congress or the president is considering a major change in fiscal policy, or when the Federal Reserve is considering a major change in monetary policy, foremost in the discussion are how the change will influence inflation and unemployment and whether aggregate demand needs to be stimulated or restrained.

Although the government has long conducted monetary and fiscal policy, the view that it should use these policy instruments to try to stabilize the economy is more recent. The Employment Act of 1946 was a key piece of legislation in which the government first held itself accountable for macroeconomic performance. The act states that "it is the continuing policy and responsibility of the Federal Government to . . . promote full employment and production." This law was written when the memory of the Great Depression was still fresh. The lawmakers who wrote it believed, as many economists do, that in the absence of an active government role in the economy, events such as the Great Depression could occur regularly.

To many economists the case for active government policy is clear and simple. Recessions are periods of high unemployment, low incomes, and increased economic hardship. The model of aggregate demand and aggregate supply shows how shocks to the economy can cause recessions. It also shows how monetary and fiscal policy can prevent recessions by responding to these shocks. These economists consider it wasteful not to use these policy instruments to stabilize the economy.

Other economists are critical of the government's attempts to stabilize the economy. These critics argue that the government should take a hands-off approach to macroeconomic policy. At first, this view might seem surprising. If our model shows how to prevent or reduce the severity of recessions, why do these critics want the government to refrain from using monetary and fiscal policy for economic stabilization? To find out, let's consider some of their arguments.

Lags in the Implementation and Effects of Policies

Economic stabilization would be easy if the effects of policy were immediate. Making policy would be like driving a car: policymakers would simply adjust their instruments to keep the economy on the desired path.

Making economic policy, however, is less like driving a car than it is like piloting a large ship. A car changes direction almost immediately after the steering wheel is turned. By contrast, a ship changes course long after the pilot adjusts the rudder, and once the ship starts to turn, it continues turning long after the rudder is set back to normal. A novice pilot is likely to oversteer and, after noticing the mistake, overreact by steering too much in the opposite direction. The ship's path could become unstable, as the novice responds to previous mistakes by making larger and larger corrections.

Like a ship's pilot, economic policymakers face the problem of long lags. Indeed, the problem for policymakers is even more difficult, because the lengths of the lags are hard to predict. These long and variable lags greatly complicate the conduct of monetary and fiscal policy.

Economists distinguish between two lags in the conduct of stabilization policy: the inside lag and the outside lag. The **inside lag** is the time between a shock to the economy and the policy action responding to that shock. This lag arises because it takes time for policymakers first to recognize that a shock has occurred and then to put appropriate policies into effect. The **outside lag** is the time between a policy action and its influence on the economy. This lag arises because policies do not immediately influence spending, income, and employment.

A long inside lag is a central problem with using fiscal policy for economic stabilization. This is especially true in the United States, where changes in spending or taxes require the approval of the president and both houses of Congress. The slow and cumbersome legislative process often leads to delays, which make fiscal policy an imprecise tool for stabilizing the economy. This inside lag is shorter in countries with parliamentary systems, such as the United Kingdom, because there the party in power can often enact policy changes more rapidly.

Monetary policy has a much shorter inside lag than fiscal policy, because a central bank can decide on and implement a policy change in less than a day, but monetary policy has a substantial outside lag. Monetary policy works by changing the money supply and thereby interest rates, which in turn influence investment. But many firms make investment plans far in advance. Therefore, a change in monetary policy is thought not to affect economic activity until about six months after it is made.

The long and variable lags associated with monetary and fiscal policy certainly make stabilizing the economy more difficult. Advocates of passive policy argue that, because of these lags, successful stabilization policy is almost impossible. Indeed, attempts to stabilize the economy can be destabilizing. Suppose that the economy's condition changes between the beginning of a policy action and its impact on the economy. In this case, active policy may end up stimulating the economy when it is overheated or depressing the economy when it is cooling off. Advocates of active policy admit that such lags do require policymakers to be cautious. But, they argue, these lags do not necessarily mean that policy should be completely passive, especially in the face of a severe and protracted economic downturn.

Some policies, called **automatic stabilizers**, are designed to reduce the lags associated with stabilization policy. Automatic stabilizers are policies that stimulate or depress the economy when necessary without any deliberate policy change. For example, the system of income taxes automatically reduces taxes when the economy goes into a recession, without any change in the tax laws, because individuals and corporations pay less tax when their incomes fall. Similarly, the unemployment-insurance and welfare systems automatically raise transfer payments when the economy moves into a recession, because more people apply for benefits. One can view these automatic stabilizers as a type of fiscal policy without any inside lag.

The Difficult Job of Economic Forecasting

Because policy influences the economy only after a long lag, successful stabilization policy requires the ability to predict accurately future economic conditions. If we cannot predict whether the economy will be in a boom or a recession in six months or a year, we cannot evaluate whether monetary and fiscal policy should now be trying to expand or contract aggregate demand. Unfortunately, economic developments are often unpredictable, at least given our current understanding of the economy.

One way forecasters try to look ahead is with **leading indicators**. A leading indicator is a data series that fluctuates in advance of the economy. A large fall in a leading indicator signals that a recession is more likely.

Another way forecasters look ahead is with macroeconometric models, which have been developed both by government agencies and by private firms for forecasting and policy analysis. As we discussed in Chapter 11,

Drawing by Dana Fradon; © 1988 The New Yorker Magazine, Inc.

"It's true, Caesar. Rome is declining, but I expect it to pick up in the next quarter."

FYI

What's in the Index of Leading Economic Indicators?

Each month the Conference Board, a private economics research group, announces the *index of leading economic indicators*. This index is made up from 10 data series that are often used to forecast changes in economic activity about six to nine months ahead. Here is a list of the series. Can you explain why each of these might help predict changes in real GDP?

1. Average workweek of production workers in manufacturing.
2. Average initial weekly claims for unemployment insurance. This series is inverted in computing the index, so that a decrease in the series raises the index.
3. New orders for consumer goods and materials, adjusted for inflation.
4. Vendor performance. This is a measure of the number of companies receiving slower deliveries from suppliers.
5. New orders, nondefense capital goods.
6. New building permits issued.
7. Index of stock prices.
8. Money supply (*M*2), adjusted for inflation.
9. Interest rate spread: the yield spread between 10-year Treasury notes and 3-month Treasury bills.
10. Index of consumer expectations.

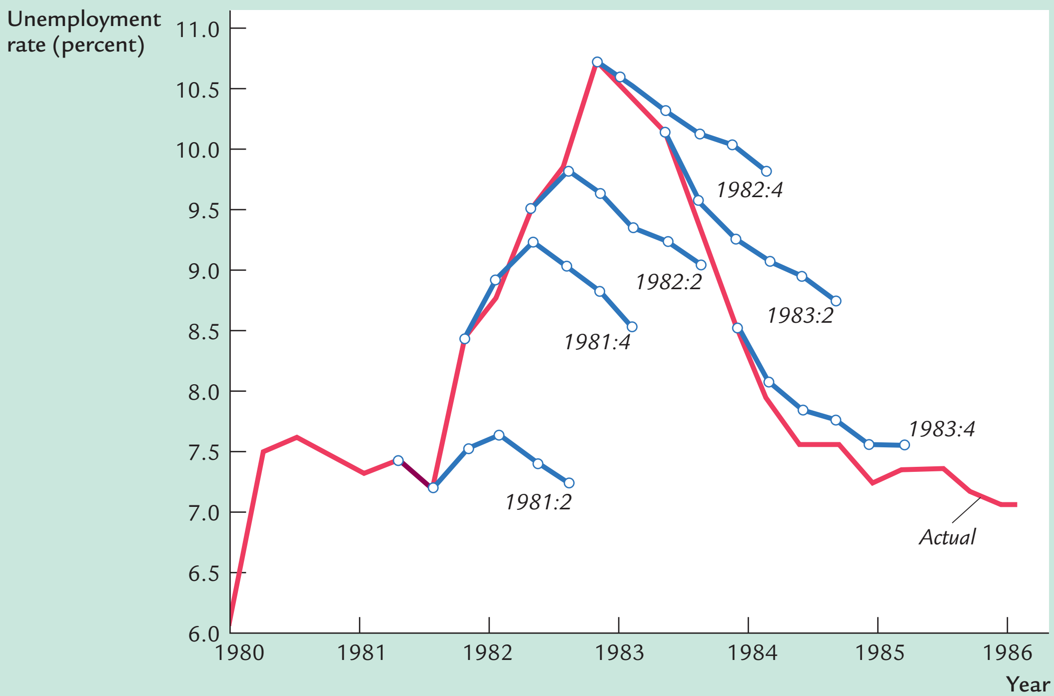
these large-scale computer models are made up of many equations, each representing a part of the economy. After making assumptions about the path of the exogenous variables, such as monetary policy, fiscal policy, and oil prices, these models yield predictions about unemployment, inflation, and other endogenous variables. Keep in mind, however, that the validity of these predictions is only as good as the model and the forecasters' assumptions about the exogenous variables.

CASE STUDY

Mistakes in Forecasting

"Light showers, bright intervals, and moderate winds." This was the forecast offered by the renowned British national weather service on October 14, 1987. The next day Britain was hit by the worst storm in more than two centuries.

figure 14-1



Forecasting the Recession of 1982 The red line shows the actual unemployment rate from the first quarter of 1980 to the first quarter of 1986. The blue lines show the unemployment rate predicted at six points in time: the second quarter of 1981, the fourth quarter of 1981, the second quarter of 1982, and so on. For each forecast, the symbols mark the current unemployment rate and the forecast for the subsequent five quarters. Notice that the forecasters failed to predict both the rapid rise in the unemployment rate and the subsequent rapid decline.

Source: The unemployment rate is from the Department of Commerce. The predicted unemployment rate is the median forecast of about 20 forecasters surveyed by the American Statistical Association and the National Bureau of Economic Research.

Like weather forecasts, economic forecasts are a crucial input to private and public decisionmaking. Business executives rely on economic forecasts when deciding how much to produce and how much to invest in plant and equipment. Government policymakers also rely on them when developing economic policies. Yet also like weather forecasts, economic forecasts are far from precise.

The most severe economic downturn in U.S. history, the Great Depression of the 1930s, caught economic forecasters completely by surprise. Even after the stock market crash of 1929, they remained confident that the economy would not suffer a substantial setback. In late 1931, when the economy was clearly in bad shape, the eminent economist Irving Fisher predicted that it would recover quickly. Subsequent events showed that these forecasts were much too optimistic.[1]

Figure 14-1 shows how economic forecasters did during the recession of 1982, the most severe economic downturn in the United States since the Great Depression. This figure shows the actual unemployment rate (in red) and six attempts to predict it for the following five quarters (in blue). You can see that the forecasters did well predicting unemployment one quarter ahead. The more distant forecasts, however, were often inaccurate. For example, in the second quarter of 1981, forecasters were predicting little change in the unemployment rate over the next five quarters; yet only two quarters later unemployment began to rise sharply. The rise in unemployment to almost 11 percent in the fourth quarter of 1982 caught the forecasters by surprise. After the depth of the recession became apparent, the forecasters failed to predict how rapid the subsequent decline in unemployment would be.

These two episodes—the Great Depression and the recession of 1982—show that many of the most dramatic economic events are unpredictable. Although private and public decisionmakers have little choice but to rely on economic forecasts, they must always keep in mind that these forecasts come with a large margin of error.

Ignorance, Expectations, and the Lucas Critique

The prominent economist Robert Lucas once wrote, "As an advice-giving profession we are in way over our heads." Even many of those who advise policymakers would agree with this assessment. Economics is a young science, and there is still much that we do not know. Economists cannot be completely confident when they assess the effects of alternative policies. This ignorance suggests that economists should be cautious when offering policy advice.

Although economists' knowledge is limited about many topics, Lucas has emphasized the issue of how people form expectations of the future. Expectations play a crucial role in the economy because they influence all sorts of economic behavior. For instance, households decide how much to consume based on expectations

[1] Kathryn M. Dominguez, Ray C. Fair, and Matthew D. Shapiro, "Forecasting the Depression: Harvard Versus Yale," *American Economic Review* 78 (September 1988): 595–612. This article shows how badly economic forecasters did during the Great Depression, and it argues that they could not have done any better with the modern forecasting techniques available today.

of future income, and firms decide how much to invest based on expectations of future profitability. These expectations depend on many things, including the economic policies being pursued by the government. Thus, when policymakers estimate the effect of any policy change, they need to know how people's expectations will respond to the policy change. Lucas has argued that traditional methods of policy evaluation—such as those that rely on standard macroeconometric models—do not adequately take into account this impact of policy on expectations. This criticism of traditional policy evaluation is known as the **Lucas critique**.[2]

An important example of the Lucas critique arises in the analysis of disinflation. As you may recall from Chapter 13, the cost of reducing inflation is often measured by the sacrifice ratio, which is the number of percentage points of GDP that must be forgone to reduce inflation by 1 percentage point. Because these estimates of the sacrifice ratio are often large, they have led some economists to argue that policymakers should learn to live with inflation, rather than incur the large cost of reducing it.

According to advocates of the rational-expectations approach, however, these estimates of the sacrifice ratio are unreliable because they are subject to the Lucas critique. Traditional estimates of the sacrifice ratio are based on adaptive expectations, that is, on the assumption that expected inflation depends on past inflation. Adaptive expectations may be a reasonable premise in some circumstances, but if the policymakers make a credible change in policy, workers and firms setting wages and prices will rationally respond by adjusting their expectations of inflation appropriately. This change in inflation expectations will quickly alter the short-run tradeoff between inflation and unemployment. As a result, reducing inflation can potentially be much less costly than is suggested by traditional estimates of the sacrifice ratio.

The Lucas critique leaves us with two lessons. The narrow lesson is that economists evaluating alternative policies need to consider how policy affects expectations and, thereby, behavior. The broad lesson is that policy evaluation is hard, so economists engaged in this task should be sure to show the requisite humility.

The Historical Record

In judging whether government policy should play an active or passive role in the economy, we must give some weight to the historical record. If the economy has experienced many large shocks to aggregate supply and aggregate demand, and if policy has successfully insulated the economy from these shocks, then the case for active policy should be clear. Conversely, if the economy has experienced few large shocks, and if the fluctuations we have observed can be traced to inept economic policy, then the case for passive policy should be clear. In other words, our view of stabilization policy should be influenced by whether policy has historically been stabilizing or destabilizing. For this reason, the debate over macroeconomic policy frequently turns into a debate over macroeconomic history.

Yet history does not settle the debate over stabilization policy. Disagreements over history arise because it is not easy to identify the sources of

[2] Robert E. Lucas, Jr., "Econometric Policy Evaluation: A Critique," *Carnegie Rochester Conference on Public Policy* 1 (Amsterdam: North-Holland, 1976), 19–46.

economic fluctuations. The historical record often permits more than one interpretation.

The Great Depression is a case in point. Economists' views on macroeconomic policy are often related to their views on the cause of the Depression. Some economists believe that a large contractionary shock to private spending caused the Depression. They assert that policymakers should have responded by stimulating aggregate demand. Other economists believe that the large fall in the money supply caused the Depression. They assert that the Depression would have been avoided if the Fed had been pursuing a passive monetary policy of increasing the money supply at a steady rate. Hence, depending on one's beliefs about its cause, the Great Depression can be viewed either as an example of why active monetary and fiscal policy is necessary or as an example of why it is dangerous.

CASE STUDY

Is the Stabilization of the Economy a Figment of the Data?

Keynes wrote *The General Theory* in the 1930s, and in the wake of the Keynesian revolution, governments around the world began to view economic stabilization as a primary responsibility. Some economists believe that the development of Keynesian theory has had a profound influence on the behavior of the economy. Comparing data from before World War I and after World War II, they find that real GDP and unemployment have become much more stable. This, some Keynesians claim, is the best argument for active stabilization policy: it has worked.

In a series of provocative and influential papers, economist Christina Romer has challenged this assessment of the historical record. She argues that the measured reduction in volatility reflects not an improvement in economic policy and performance but rather an improvement in the economic data. The older data are much less accurate than the newer data. Romer claims that the higher volatility of unemployment and real GDP reported for the period before World War I is largely a figment of the data.

Romer uses various techniques to make her case. One is to construct more accurate data for the earlier period. This task is difficult because data sources are not readily available. A second way is to construct *less* accurate data for the recent period—that is, data that are comparable to the older data and thus suffer from the same imperfections. After constructing new "bad" data, Romer finds that the recent period appears almost as volatile as the early period, suggesting that the volatility of the early period may be largely an artifact of data construction.

Romer's work is part of the continuing debate over whether macroeconomic policy has improved the performance of the economy. Although her work remains controversial, most economists now believe that the economy in the aftermath of the Keynesian revolution was only slightly more stable than it had been before.[3]

[3] Christina D. Romer, "Spurious Volatility in Historical Unemployment Data," *Journal of Political Economy* 94 (February 1986): 1–37; and Christina D. Romer, "Is the Stabilization of the Postwar Economy a Figment of the Data?" *American Economic Review* 76 (June 1986): 314–334.

CASE STUDY

The Remarkable Stability of the 1990s

Although economists who take a long historical view debate how much the economy has stabilized over time, there is less controversy about the more recent experience. Everyone agrees that the decade of the 1990s stands out as a period of remarkable stability for the U.S. economy.

Table 14-1 presents some statistics about economic performance for the last five decades of the twentieth century. The three variables are those highlighted in Chapter 2: growth in real GDP, inflation, and unemployment. For each variable, the table presents the average over each decade and the standard deviation. The standard deviation measures the volatility of a variable: the higher the standard deviation, the more volatile the variable is.

table 14-1

The U.S. Macroeconomic Experience, Decade by Decade

	1950s	1960s	1970s	1980s	1990s
Real GDP Growth					
Average	4.18	4.43	3.28	3.02	3.03
Standard deviation	3.89	2.13	2.80	2.68	1.56
Inflation					
Average	2.07	2.33	7.09	5.66	3.00
Standard deviation	2.44	1.48	2.72	3.53	1.12
Unemployment					
Average	4.51	4.78	6.22	7.27	5.76
Standard deviation	1.29	1.07	1.16	1.48	1.05

Note: Real GDP growth is the growth rate of inflation-adjusted gross domestic product from four quarters earlier. Inflation is the rate of change in the consumer price index over the previous 12 months. Unemployment is the monthly, seasonally adjusted percentage of the labor force without a job.
Source: Department of Commerce, Department of Labor, and author's calculations.

One striking result from this table is the low volatility of the 1990s. The averages for real growth, inflation, or unemployment are not unusual by historical standards, but the standard deviations of these variables are the smallest ever seen. Moreover, the changes are large. For instance, the standard deviation of inflation was 24 percent lower in the 1990s than it was in the 1960s—the second most stable decade.

What accounts for the stability of the 1990s? Part of the answer is luck. The U.S. economy did not have to deal with any large, adverse supply shocks, such as the oil-price shocks of the 1970s. Part of the answer is also good policy. Many economists give credit to Alan Greenspan, who was chairman of the Federal

Reserve throughout the 1990s. His decisions about interest rates and the money supply kept the economy on track, avoiding both deep recession and runaway inflation.

14-2 Should Policy Be Conducted by Rule or by Discretion?

A second topic of debate among economists is whether economic policy should be conducted by rule or by discretion. Policy is conducted by rule if policymakers announce in advance how policy will respond to various situations and commit themselves to following through on this announcement. Policy is conducted by discretion if policymakers are free to size up events as they occur and choose whatever policy seems appropriate at the time.

The debate over rules versus discretion is distinct from the debate over passive versus active policy. Policy can be conducted by rule and yet be either passive or active. For example, a passive policy rule might specify steady growth in the money supply of 3 percent per year. An active policy rule might specify that

$$\text{Money Growth} = 3\% + (\text{Unemployment Rate} - 6\%).$$

Under this rule, the money supply grows at 3 percent if the unemployment rate is 6 percent, but for every percentage point by which the unemployment rate exceeds 6 percent, money growth increases by an extra percentage point. This rule tries to stabilize the economy by raising money growth when the economy is in a recession.

We begin this section by discussing why policy might be improved by a commitment to a policy rule. We then examine several possible policy rules.

Distrust of Policymakers and the Political Process

Some economists believe that economic policy is too important to be left to the discretion of policymakers. Although this view is more political than economic, evaluating it is central to how we judge the role of economic policy. If politicians are incompetent or opportunistic, then we may not want to give them the discretion to use the powerful tools of monetary and fiscal policy.

Incompetence in economic policy arises for several reasons. Some economists view the political process as erratic, perhaps because it reflects the shifting power of special interest groups. In addition, macroeconomics is complicated, and politicians often do not have sufficient knowledge of it to make informed judgments. This ignorance allows charlatans to propose incorrect but superficially appealing solutions to complex problems. The political process often cannot weed out the advice of charlatans from that of competent economists.

Opportunism in economic policy arises when the objectives of policymakers conflict with the well-being of the public. Some economists fear that politicians use macroeconomic policy to further their own electoral ends. If citizens vote on the basis of economic conditions prevailing at the time of the election, then politicians have an incentive to pursue policies that will make the economy look good during election years. A president might cause a recession soon after coming into office to lower inflation and then stimulate the economy as the next election approaches to lower unemployment; this would ensure that both inflation and unemployment are low on election day. Manipulation of the economy for electoral gain, called the **political business cycle**, has been the subject of extensive research by economists and political scientists.[4]

Distrust of the political process leads some economists to advocate placing economic policy outside the realm of politics. Some have proposed constitutional amendments, such as a balanced-budget amendment, that would tie the hands of legislators and insulate the economy from both incompetence and opportunism.

CASE STUDY

The Economy Under Republican and Democratic Presidents

How does the political party in power affect the economy? Researchers working at the boundary between economics and political science have been studying this question. One intriguing finding is that the two political parties in the United States appear to conduct systematically different macroeconomic policies.

Table 14-2 presents the growth in real GDP in each of the four years of the presidential terms since 1948. Notice that growth is usually low, and often negative, in the second year of Republican administrations. Six of the eight years in which real GDP fell are second or third years of Republican administrations. By contrast, the economy is usually booming in the second and third years of Democratic administrations.

One interpretation of this finding is that the two parties have different preferences regarding inflation and unemployment. That is, rather than viewing politicians as opportunistic, perhaps we should view them as merely partisan. Republicans seem to dislike inflation more than Democrats do. Therefore, Republicans pursue contractionary policies soon after coming into office and are willing to endure a recession to reduce inflation. Democrats pursue more expansionary policies to reduce unemployment and are willing to endure the higher inflation that results. Examining growth in the money supply shows that monetary policy is, in fact, less inflationary during Republican administrations. Thus, it seems that the two political parties pursue dramatically different policies and that the political process is one source of economic fluctuations.

Even if we accept this interpretation of the evidence, it is not clear whether it argues for or against fixed policy rules. On the one hand, a policy rule would

[4] William Nordhaus, "The Political Business Cycle," *Review of Economic Studies* 42 (1975): 169–190; and Edward Tufte, *Political Control of the Economy* (Princeton, N. J.: Princeton University Press, 1978).

table 14-2

Real GDP Growth During Republican and Democratic Administrations

	YEAR OF TERM			
President	**First**	**Second**	**Third**	**Fourth**
Democratic Administrations				
Truman	–0.6	8.9	7.6	3.7
Kennedy/Johnson	2.3	6.0	4.3	5.8
Johnson	6.4	6.6	2.5	4.8
Carter	4.6	5.5	3.2	–0.2
Clinton I	2.7	4.0	2.7	3.6
Clinton II	4.4	4.4	4.2	5.0
Average	3.3	5.9	4.1	3.8
Republican Administrations				
Eisenhower I	4.6	–0.7	7.1	2.0
Eisenhower II	2.0	–1.0	7.2	2.5
Nixon	3.0	0.2	3.3	5.4
Nixon/Ford	5.8	–0.6	–0.4	5.6
Reagan I	2.5	–2.0	4.3	7.3
Reagan II	3.8	3.4	3.4	4.2
Bush (elder)	3.5	1.8	–0.5	3.0
Average	3.6	0.2	3.5	4.3

Source: Department of Commerce

insulate the economy from these political shocks. Under a fixed rule, the Fed would be unable to alter monetary policy in response to the changing political climate. The economy might be more stable, and long-run economic performance might be improved. On the other hand, a fixed policy rule would reduce the voice of the electorate in influencing macroeconomic policy.[5]

The Time Inconsistency of Discretionary Policy

If we assume that we can trust our policymakers, discretion at first glance appears superior to a fixed policy rule. Discretionary policy is, by its nature, flexible. As long as policymakers are intelligent and benevolent, there might appear to be little reason to deny them flexibility in responding to changing conditions.

Yet a case for rules over discretion arises from the problem of **time inconsistency** of policy. In some situations policymakers may want to announce in

[5] Alberto Alesina, "Macroeconomics and Politics," *NBER Macroeconomics Annual* 3 (1988): 13–52.

advance the policy they will follow in order to influence the expectations of private decisionmakers. But later, after the private decisionmakers have acted on the basis of their expectations, these policymakers may be tempted to renege on their announcement. Understanding that policymakers may be inconsistent over time, private decisionmakers are led to distrust policy announcements. In this situation, to make their announcements credible, policymakers may want to make a commitment to a fixed policy rule.

Time inconsistency is illustrated most simply in a political rather than an economic example—specifically, public policy about negotiating with terrorists over the release of hostages. The announced policy of many nations is that they will not negotiate over hostages. Such an announcement is intended to deter terrorists: if there is nothing to be gained from kidnapping hostages, rational terrorists won't kidnap any. In other words, the purpose of the announcement is to influence the expectations of terrorists and thereby their behavior.

But, in fact, unless the policymakers are credibly committed to the policy, the announcement has little effect. Terrorists know that once hostages are taken, policymakers face an overwhelming temptation to make some concession to obtain the hostages' release. The only way to deter rational terrorists is to take away the discretion of policymakers and commit them to a rule of never negotiating. If policymakers were truly unable to make concessions, the incentive for terrorists to take hostages would be largely eliminated.

The same problem arises less dramatically in the conduct of monetary policy. Consider the dilemma of a Federal Reserve that cares about both inflation and unemployment. According to the Phillips curve, the tradeoff between inflation and unemployment depends on expected inflation. The Fed would prefer everyone to expect low inflation so that it will face a favorable tradeoff. To reduce expected inflation, the Fed might announce that low inflation is the paramount goal of monetary policy.

But an announcement of a policy of low inflation is by itself not credible. Once households and firms have formed their expectations of inflation and set wages and prices accordingly, the Fed has an incentive to renege on its announcement and implement expansionary monetary policy to reduce unemployment. People understand the Fed's incentive to renege and therefore do not believe the announcement in the first place. Just as a president facing a hostage crisis is sorely tempted to negotiate their release, a Federal Reserve with discretion is sorely tempted to inflate in order to reduce unemployment. And just as terrorists discount announced policies of never negotiating, households and firms discount announced policies of low inflation.

The surprising outcome of this analysis is that policymakers can sometimes better achieve their goals by having their discretion taken away from them. In the case of rational terrorists, fewer hostages will be taken and killed if policymakers are committed to following the seemingly harsh rule of refusing to negotiate for hostages' freedom. In the case of monetary policy, there will be lower inflation without higher unemployment if the Fed is committed to a policy of zero inflation. (This conclusion about monetary policy is modeled more explicitly in the appendix to this chapter.)

The time inconsistency of policy arises in many other contexts. Here are some examples:

- To encourage investment, the government announces that it will not tax income from capital. But after factories have been built, the government is tempted to renege on its promise to raise more tax revenue from them.
- To encourage research, the government announces that it will give a temporary monopoly to companies that discover new drugs. But after a drug has been discovered, the government is tempted to revoke the patent or to regulate the price to make the drug more affordable.
- To encourage good behavior, a parent announces that he or she will punish a child whenever the child breaks a rule. But after the child has misbehaved, the parent is tempted to forgive the transgression, because punishment is unpleasant for the parent as well as for the child.
- To encourage you to work hard, your professor announces that this course will end with an exam. But after you have studied and learned all the material, the professor is tempted to cancel the exam so that he or she won't have to grade it.

In each case, rational agents understand the incentive for the policymaker to renege, and this expectation affects their behavior. And in each case, the solution is to take away the policymaker's discretion with a credible commitment to a fixed policy rule.

CASE STUDY

Alexander Hamilton Versus Time Inconsistency

Time inconsistency has long been a problem associated with discretionary policy. In fact, it was one of the first problems that confronted Alexander Hamilton when President George Washington appointed him the first U.S. Secretary of the Treasury in 1789.

Hamilton faced the question of how to deal with the debts that the new nation had accumulated as it fought for its independence from Britain. When the revolutionary government incurred the debts, it promised to honor them when the war was over. But after the war, many Americans advocated defaulting on the debt because repaying the creditors would require taxation, which is always costly and unpopular.

Hamilton opposed the time-inconsistency policy of repudiating the debt. He knew that the nation would likely need to borrow again sometime in the future. In his *First Report on the Public Credit*, which he presented to Congress in 1790, he wrote

> If the maintenance of public credit, then, be truly so important, the next inquiry which suggests itself is: By what means is it to be effected? The ready answer to which question is, by good faith; by a punctual performance of contracts. States,

> like individuals, who observe their engagements are respected and trusted, while the reverse is the fate of those who pursue an opposite conduct.

Thus, Hamilton proposed that the nation make a commitment to the policy rule of honoring its debts.

The policy rule that Hamilton originally proposed has continued for more than two centuries. Today, unlike in Hamilton's time, when Congress debates spending priorities, no one seriously proposes defaulting on the public debt as a way to reduce taxes. In the case of public debt, everyone now agrees that the government should be committed to a fixed policy rule.

Rules for Monetary Policy

Even if we are convinced that policy rules are superior to discretion, the debate over macroeconomic policy is not over. If the Fed were to commit to a rule for monetary policy, what rule should it choose? Let's discuss briefly three policy rules that various economists advocate.

Some economists, called **monetarists**, advocate that the Fed keep the money supply growing at a steady rate. The quotation at the beginning of this chapter from Milton Friedman—the most famous monetarist—exemplifies this view of monetary policy. Monetarists believe that fluctuations in the money supply are responsible for most large fluctuations in the economy. They argue that slow and steady growth in the money supply would yield stable output, employment, and prices.

Although a monetarist policy rule might have prevented many of the economic fluctuations we have experienced historically, most economists believe that it is not the best possible policy rule. Steady growth in the money supply stabilizes aggregate demand only if the velocity of money is stable. But sometimes the economy experiences shocks, such as shifts in money demand, that cause velocity to be unstable. Most economists believe that a policy rule needs to allow the money supply to adjust to various shocks to the economy.

A second policy rule that economists widely advocate is nominal GDP targeting. Under this rule, the Fed announces a planned path for nominal GDP. If nominal GDP rises above the target, the Fed reduces money growth to dampen aggregate demand. If it falls below the target, the Fed raises money growth to stimulate aggregate demand. Because a nominal GDP target allows monetary policy to adjust to changes in the velocity of money, most economists believe it would lead to greater stability in output and prices than a monetarist policy rule.

A third policy rule that is often advocated is inflation targeting. Under this rule, the Fed would announce a target for the inflation rate (usually a low one) and then adjust the money supply when the actual inflation deviates from the target. Like nominal GDP targeting, inflation targeting insulates the economy from changes in the velocity of money. In addition, an inflation target has the political advantage that it is easy to explain to the public.

Notice that all these rules are expressed in terms of some nominal variable—the money supply, nominal GDP, or the price level. One can also imagine policy rules expressed in terms of real variables. For example, the Fed might try to target the unemployment rate at 5 percent. The problem with such a rule is that no one knows exactly what the natural rate of unemployment is. If the Fed chose a target for the unemployment rate below the natural rate, the result would be accelerating inflation. Conversely, if the Fed chose a target for the unemployment rate above the natural rate, the result would be accelerating deflation. For this reason, economists rarely advocate rules for monetary policy expressed solely in terms of real variables, even though real variables such as unemployment and real GDP are the best measures of economic performance.

CASE STUDY

Inflation Targeting: Rule or Constrained Discretion?

Since the late 1980s, many of the world's central banks—including those of Australia, Canada, Finland, Israel, New Zealand, Spain, Sweden, and the United Kingdom—have adopted some form of an inflation target. Sometimes inflation targeting takes the form of a central bank announcing its policy intentions. Other times it takes the form of a national law that spells out the goals of monetary policy. For example, the Reserve Bank of New Zealand Act of 1989 told the central bank "to formulate and implement monetary policy directed to the economic objective of achieving and maintaining stability in the general level of prices." The act conspicuously omitted any mention of any other competing objective, such as stability in output, employment, interest rates, or exchange rates. Although the U.S. Federal Reserve has not adopted inflation targeting, some members of Congress have proposed bills that would require the Fed to do so.

Should we interpret inflation targeting as a type of precommitment to a policy rule? Not completely. In all the countries that have adopted inflation targeting, central banks are left with a fair amount of discretion. Inflation targets are usually set as a range—an inflation rate of 1 to 3 percent, for instance—rather than a particular number. Thus, the central bank can choose where in the range it wants to be. In addition, the central banks are sometimes allowed to adjust their targets for inflation, at least temporarily, if some exogenous event (such as an easily identified supply shock) pushes inflation outside of the range that was previously announced.

In light of this flexibility, what is the purpose of inflation targeting? Although inflation targeting does leave the central bank with some discretion, the policy does constrain how this discretion is used. When a central bank is told to "do the right thing," it is hard to hold the central bank accountable, because people can argue forever about what the right thing is in any specific circumstance. By contrast, when a central bank has announced an inflation target, the public can more easily judge whether the central bank is meeting that target. Thus, although inflation targeting does not tie the hands of the central bank, it does increase the transparency of monetary policy and, by doing so, makes central bankers more accountable for their actions.[6]

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[6] See Ben S. Bernanke and Frederic S. Mishkin, "Inflation Targeting: A New Framework for Monetary Policy?" *Journal of Economic Perspectives* 11 (Spring 1997): 97–116.

CASE STUDY

John Taylor's (and Alan Greenspan's?) Rule for Monetary Policy

If you wanted to set interest rates to achieve stable prices while avoiding large fluctuations in output and employment, how would you do it? This is exactly the question that Alan Greenspan and the other governors of the Federal Reserve must ask themselves every day. The short-term policy instrument that the Fed now sets is the federal funds rate—the short-term interest rate at which banks make loans to one another. Whenever the Federal Open Market Committee meets, it chooses a target for the federal funds rate. The Fed's bond traders are then told to conduct open-market operations in order to hit the desired target.

The hard part of the Fed's job is choosing the target for the federal funds rate. Two guidelines are clear. First, when inflation heats up, the federal funds rate should rise. An increase in the interest rate will mean a smaller money supply and, eventually, lower investment, lower output, higher unemployment, and reduced inflation. Second, when real economic activity slows—as reflected in real GDP or unemployment—the federal funds rate should fall. A decrease in the interest rate will mean a larger money supply and, eventually, higher investment, higher output, and lower unemployment.

The Fed needs to go beyond these general guidelines, however, and decide how much to respond to changes in inflation and real economic activity. To help it make this decision, economist John Taylor has proposed a simple rule for the federal funds rate:

$$\begin{aligned}\text{Nominal Federal Funds Rate} = {} & \text{Inflation} + 2.0 \\ & + 0.5\,(\text{Inflation} - 2.0) - 0.5\,(\text{GDP Gap}).\end{aligned}$$

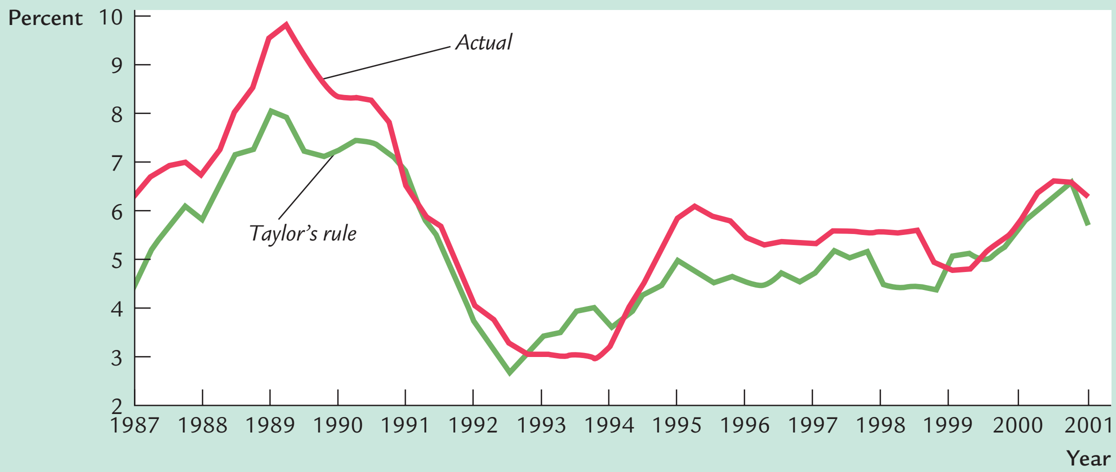
The GDP gap is the percentage shortfall of real GDP from an estimate of its natural rate.

Taylor's rule has the real federal funds rate—the nominal rate minus inflation—responding to inflation and the GDP gap. According to this rule, the real federal funds rate equals 2 percent when inflation is 2 percent and GDP is at its natural rate. For each percentage point by which inflation rises above 2 percent, the real federal funds rate rises by 0.5 percent. For each percentage point by which real GDP falls below its natural rate, the real federal funds rate falls by 0.5 percent. If GDP rises above its natural rate, so that the GDP gap is negative, the real federal funds rate rises accordingly.

One way to view the Taylor rule is as a complement to (rather than a substitute for) inflation targeting. As the previous case study discussed, inflation targeting offers a plan for the central bank in the medium run, but it does not constrain its month-to-month policy decisions. The Taylor rule may be a good short-run operating procedure for hitting a medium-run inflation target. According to the Taylor rule, monetary policy responds directly to inflation—as any inflation-targeting central bank must. But it also responds to the output gap, which can be viewed as a measure of inflationary pressures.

Taylor's rule for monetary policy is not only simple and reasonable, but it also resembles actual Fed behavior in recent years. Figure 14-2 shows the actual fed-

figure 14-2



The Federal Funds Rate: Actual and Suggested This figure shows the federal funds rate—the short-term interest rate at which banks make loans to each other. It also shows the federal funds rate suggested by John Taylor's monetary rule. Notice that the two series move closely together.

Source: Federal Reserve Board, U.S. Department of Commerce, and author's calculations. To implement the Taylor rule, the inflation rate is measured as the percentage change in the GDP deflator over the previous four quarters, and the GDP gap is measured as twice the deviation of the unemployment rate from 6 percent.

eral funds rate and the target rate as determined by Taylor's proposed rule. Notice how closely together the two series move. John Taylor's monetary rule may be more than an academic suggestion. It may be the rule that Alan Greenspan and his colleagues subconsciously follow.[7]

CASE STUDY

Central-Bank Independence

Suppose you were put in charge of writing the constitution and laws for a country. Would you give the president of the country authority over the policies of the central bank? Or would you allow the central bank to make decisions free from such political influence? In other words, assuming that monetary policy is made by discretion rather than by rule, who should exercise that discretion?

Countries vary greatly in how they choose to answer this question. In some countries, the central bank is a branch of the government; in others, the central

[7] John B. Taylor, "The Inflation/Output Variability Tradeoff Revisited," in *Goals, Guidelines, and Constraints Facing Monetary Policymakers* (Federal Reserve Bank of Boston, 1994).

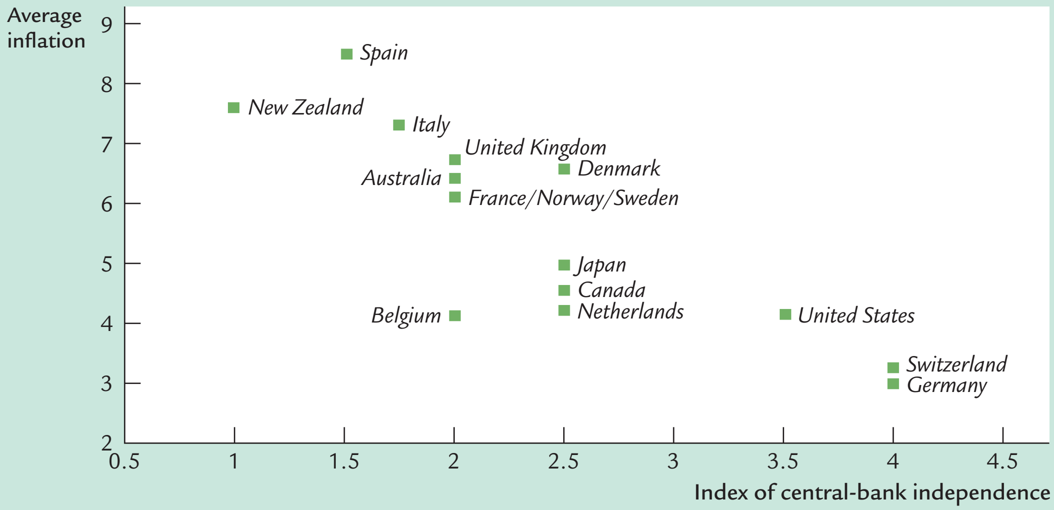
bank is largely independent. In the United States, Fed governors are appointed by the president for 14-year terms, and they cannot be recalled if the president is unhappy with their decisions. This institutional structure gives the Fed a degree of independence similar to that of the Supreme Court.

Many researchers have investigated the effects of constitutional design on monetary policy. They have examined the laws of different countries to construct an index of central-bank independence. This index is based on various characteristics, such as the length of bankers' terms, the role of government officials on the bank board, and the frequency of contact between the government and the central bank. The researchers then examined the correlation between central-bank independence and macroeconomic performance.

The results of these studies are striking: more independent central banks are strongly associated with lower and more stable inflation. Figure 14-3 shows a scatterplot of central-bank independence and average inflation for the period 1955 to 1988. Countries that had an independent central bank, such as Germany, Switzerland, and the United States, tended to have low average inflation. Countries that had central banks with less independence, such as New Zealand and Spain, tended to have higher average inflation.

Researchers have also found there is no relationship between central-bank independence and real economic activity. In particular, central-bank independence is not correlated with average unemployment, the volatility of unem-

figure 14-3



Inflation and Central-Bank Independence This scatterplot presents the international experience with central-bank independence. The evidence shows that more-independent central banks tend to produce lower rates of inflation.

Source: Figure 1a, page 155, of Alberto Alesina and Lawrence H. Summers, "Central Bank Independence and Macroeconomic Performance: Some Comparative Evidence," *Journal of Money, Credit, and Banking* 25 (May 1993): 151–162. Average inflation is for the period 1955–1988.

ployment, the average growth of real GDP, or the volatility of real GDP. Central-bank independence appears to offer countries a free lunch: it has the benefit of lower inflation without any apparent cost. This finding has led some countries, such as New Zealand, to rewrite their laws to give their central banks greater independence.[8]

14-3 Conclusion: Making Policy in an Uncertain World

In this chapter we have examined whether policy should take an active or passive role in responding to economic fluctuations and whether policy should be conducted by rule or by discretion. There are many arguments on both sides of these questions. Perhaps the only clear conclusion is that there is no simple and compelling case for any particular view of macroeconomic policy. In the end, you must weigh the various arguments, both economic and political, and decide for yourself what kind of role the government should play in trying to stabilize the economy.

For better or worse, economists play a key role in the formulation of economic policy. Because the economy is complex, this role is often difficult. Yet it is also inevitable. Economists cannot sit back and wait until our knowledge of the economy has been perfected before giving advice. In the meantime, someone must advise economic policymakers. That job, difficult as it sometimes is, falls to economists.

The role of economists in the policymaking process goes beyond giving advice to policymakers. Even economists cloistered in academia influence policy indirectly through their research and writing. In the conclusion of *The General Theory*, John Maynard Keynes wrote that

> the ideas of economists and political philosophers, both when they are right and when they are wrong, are more powerful than is commonly understood. Indeed, the world is ruled by little else. Practical men, who believe themselves to be quite exempt from intellectual influences, are usually the slaves of some defunct economist. Madmen in authority, who hear voices in the air, are distilling their frenzy from some academic scribbler of a few years back.

This is as true today as it was when Keynes wrote it in 1936—except now that academic scribbler is often Keynes himself.

[8] For a more complete presentation of these findings and references to the large literature on central-bank independence, see Alberto Alesina and Lawrence H. Summers, "Central Bank Independence and Macroeconomic Performance: Some Comparative Evidence," *Journal of Money, Credit, and Banking* 25 (May 1993): 151–162. For a study that questions the link between inflation and central-bank independence, see Marta Campillo and Jeffrey A. Miron, "Why Does Inflation Differ Across Countries?" in Christina D. Romer and David H. Romer, eds., *Reducing Inflation: Motivation and Strategy* (Chicago: University of Chicago Press, 1997), 335–362.

Summary

1. Advocates of active policy view the economy as subject to frequent shocks that will lead to unnecessary fluctuations in output and employment unless monetary or fiscal policy responds. Many believe that economic policy has been successful in stabilizing the economy.
2. Advocates of passive policy argue that because monetary and fiscal policies work with long and variable lags, attempts to stabilize the economy are likely to end up being destabilizing. In addition, they believe that our present understanding of the economy is too limited to be useful in formulating successful stabilization policy and that inept policy is a frequent source of economic fluctuations.
3. Advocates of discretionary policy argue that discretion gives more flexibility to policymakers in responding to various unforeseen situations.
4. Advocates of policy rules argue that the political process cannot be trusted. They believe that politicians make frequent mistakes in conducting economic policy and sometimes use economic policy for their own political ends. In addition, advocates of policy rules argue that a commitment to a fixed policy rule is necessary to solve the problem of time inconsistency.

KEY CONCEPTS

Inside and outside lags
Automatic stabilizers
Leading indicators
Lucas critique
Political business cycle
Time inconsistency
Monetarists

QUESTIONS FOR REVIEW

1. What are the inside lag and the outside lag? Which has the longer inside lag—monetary or fiscal policy? Which has the longer outside lag? Why?
2. Why would more accurate economic forecasting make it easier for policymakers to stabilize the economy? Describe two ways economists try to forecast developments in the economy.
3. Describe the Lucas critique.
4. How does a person's interpretation of macroeconomic history affect his view of macroeconomic policy?
5. What is meant by the "time inconsistency" of economic policy? Why might policymakers be tempted to renege on an announcement they made earlier? In this situation, what is the advantage of a policy rule?
6. List three policy rules that the Fed might follow. Which of these would you advocate? Why?

PROBLEMS AND APPLICATIONS

1. Suppose that the tradeoff between unemployment and inflation is determined by the Phillips curve:

$$u = u^{n} - \alpha(\pi - \pi^{e}),$$

where u denotes the unemployment rate, u^{n} the natural rate, π the rate of inflation, and π^{e} the expected rate of inflation. In addition, suppose that the Democratic party always follows a policy of high money growth and the Republican party always follows a policy of low money growth. What "political business cycle" pattern of inflation and unemployment would you predict under the following conditions?

a. Every four years, one of the parties takes control based on a random flip of a coin. (*Hint*: What will expected inflation be prior to the election?)

b. The two parties take turns.

2. When cities pass laws limiting the rent landlords can charge on apartments, the laws usually apply to existing buildings and exempt any buildings not yet built. Advocates of rent control argue that this exemption ensures that rent control does not discourage the construction of new housing. Evaluate this argument in light of the time-inconsistency problem.

3. Go to the Web site of the Federal Reserve (www.federalreserve.gov). Find and read a press release, congressional testimony, or a report about recent monetary policy. What does it say? What is the Fed doing? Why? What do you think about the Fed's recent policy decisions?

APPENDIX

Time Inconsistency and the Tradeoff Between Inflation and Unemployment

In this appendix, we examine more analytically the time-inconsistency argument for rules rather than discretion. This material is relegated to an appendix because we will need to use some calculus.[9]

Suppose that the Phillips curve describes the relationship between inflation and unemployment. Letting u denote the unemployment rate, u^n the natural rate of unemployment, π the rate of inflation, and π^e the expected rate of inflation, unemployment is determined by

$$u = u^n - \alpha(\pi - \pi^e).$$

Unemployment is low when inflation exceeds expected inflation and high when inflation falls below expected inflation. The parameter α determines how much unemployment responds to surprise inflation.

For simplicity, suppose also that the Fed chooses the rate of inflation. Of course, more realistically, the Fed controls inflation only imperfectly through its control of the money supply. But for purposes of illustration, it is useful to assume that the Fed can control inflation perfectly.

The Fed likes low unemployment and low inflation. Suppose that the cost of unemployment and inflation, as perceived by the Fed, can be represented as

$$L(u, \pi) = u + \gamma\pi^2,$$

where the parameter γ represents how much the Fed dislikes inflation relative to unemployment. $L(u, \pi)$ is called the *loss function*. The Fed's objective is to make the loss as small as possible.

Having specified how the economy works and the Fed's objective, let's compare monetary policy made under a fixed rule and under discretion.

First, consider policy under a fixed rule. A rule commits the Fed to a particular level of inflation. As long as private agents understand that the Fed is committed to this rule, the expected level of inflation will be the level the Fed is committed to produce. Because expected inflation equals actual inflation ($\pi^e = \pi$), unemployment will be at its natural rate ($u = u^n$).

What is the optimal rule? Because unemployment is at its natural rate regardless of the level of inflation legislated by the rule, there is no benefit to having any inflation at all. Therefore, the optimal fixed rule requires that the Fed produce zero inflation.

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[9] The material in this appendix is derived from Finn E. Kydland and Edward C. Prescott, "Rules Rather Than Discretion: The Inconsistency of Optimal Plans," *Journal of Political Economy* 85 (June 1977): 473–492; and Robert J. Barro and David Gordon, "A Positive Theory of Monetary Policy in a Natural Rate Model," *Journal of Political Economy* 91 (August 1983): 589–610.

Second, consider discretionary monetary policy. Under discretion, the economy works as follows:

1. Private agents form their expectations of inflation π^e.
2. The Fed chooses the actual level of inflation π.
3. Based on expected and actual inflation, unemployment is determined.

Under this arrangement, the Fed minimizes its loss $L(u, \pi)$ subject to the constraint that the Phillips curve imposes. When making its decision about the rate of inflation, the Fed takes expected inflation as already determined.

To find what outcome we would obtain under discretionary policy, we must examine what level of inflation the Fed would choose. By substituting the Phillips curve into the Fed's loss function, we obtain

$$L(u, \pi) = u^n - \alpha(\pi - \pi^e) + \gamma\pi^2.$$

Notice that the Fed's loss is negatively related to unexpected inflation (the second term in the equation) and positively related to actual inflation (the third term). To find the level of inflation that minimizes this loss, differentiate with respect to π to obtain

$$dL/d\pi = -\alpha + 2\gamma\pi.$$

The loss is minimized when this derivative equals zero. Solving for π, we get

$$\pi = \alpha/(2\gamma).$$

Whatever level of inflation private agents expected, this is the "optimal" level of inflation for the Fed to choose. Of course, rational private agents understand the objective of the Fed and the constraint that the Phillips curve imposes. They therefore expect that the Fed will choose this level of inflation. Expected inflation equals actual inflation [$\pi^e = \pi = \alpha/(2\gamma)$], and unemployment equals its natural rate ($u = u^n$).

Now compare the outcome under optimal discretion to the outcome under the optimal rule. In both cases, unemployment is at its natural rate. Yet discretionary policy produces more inflation than does policy under the rule. *Thus, optimal discretion is worse than the optimal rule.* This is true even though the Fed under discretion was attempting to minimize its loss, $L(u, \pi)$.

At first it may seem strange that the Fed can achieve a better outcome by being committed to a fixed rule. Why can't the Fed with discretion mimic the Fed committed to a zero-inflation rule? The answer is that the Fed is playing a game against private decisionmakers who have rational expectations. Unless it is committed to a fixed rule of zero inflation, the Fed cannot get private agents to expect zero inflation.

Suppose, for example, that the Fed simply announces that it will follow a zero-inflation policy. Such an announcement by itself cannot be credible. After private agents have formed their expectations of inflation, the Fed has the incentive to renege on its announcement in order to decrease unemployment. (As we have just seen, once expectations are given, the Fed's optimal policy is to set inflation at $\pi = \alpha/(2\gamma)$, regardless of π^e.) Private agents understand the incentive to renege and therefore do not believe the announcement in the first place.

This theory of monetary policy has an important corollary. Under one circumstance, the Fed with discretion achieves the same outcome as the Fed committed to a fixed rule of zero inflation. If the Fed dislikes inflation much more than it dislikes unemployment (so that γ is very large), inflation under discretion is near zero, because the Fed has little incentive to inflate. This finding provides some guidance to those who have the job of appointing central bankers. An alternative to imposing a fixed rule is to appoint an individual with a fervent distaste for inflation. Perhaps this is why even liberal politicians (Jimmy Carter, Bill Clinton) who are more concerned about unemployment than inflation sometimes appoint conservative central bankers (Paul Volcker, Alan Greenspan) who are more concerned about inflation.

MORE PROBLEMS AND APPLICATIONS

1. In the 1970s in the United States, the inflation rate and the natural rate of unemployment both rose. Let's use this model of time inconsistency to examine this phenomenon. Assume that policy is discretionary.

a. In the model as developed so far, what happens to the inflation rate when the natural rate of unemployment rises?

b. Let's now change the model slightly by supposing that the Fed's loss function is quadratic in both inflation and unemployment. That is,

$$L(u, \pi) = u^2 + \gamma\pi^2.$$

Follow steps similar to those in the text to solve for the inflation rate under discretionary policy.

c. Now what happens to the inflation rate when the natural rate of unemployment rises?

d. In 1979, President Jimmy Carter appointed the conservative central banker Paul Volcker to head the Federal Reserve. According to this model, what should have happened to inflation and unemployment?

CHAPTER FIFTEEN

Government Debt

> *Blessed are the young, for they shall inherit the national debt.*
>
> — *Herbert Hoover*

When a government spends more than it collects in taxes, it borrows from the private sector to finance the budget deficit. The accumulation of past borrowing is the government debt. Debate about the appropriate amount of government debt in the United States is as old as the country itself. Alexander Hamilton believed that "a national debt, if it is not excessive, will be to us a national blessing," whereas James Madison argued that "a public debt is a public curse." Indeed, the location of the nation's capital was chosen as part of a deal in which the federal government assumed the Revolutionary War debts of the states: because the Northern states had larger outstanding debts, the capital was located in the South.

Although attention to the government debt has waxed and waned over the years, it was especially intense during the last two decades of the twentieth century. Beginning in the early 1980s, the U.S. federal government began running large budget deficits—in part because of increased spending and in part because of reduced taxes. As a result, the government debt expressed as a percentage of GDP roughly doubled from 26 percent in 1980 to 50 percent in 1995. By the late 1990s, the budget deficit had come under control and had even turned into a budget surplus. Policymakers then turned to the question of how rapidly the debt should be paid off.

The large increase in government debt from 1980 to 1995 is without precedent in U.S. history. Government debt most often rises in periods of war or depression, but the United States experienced neither during this time. Not surprisingly, the episode sparked a renewed interest among economists and policymakers in the economic effects of government debt. Some view the large budget deficits of the 1980s and 1990s as the worst mistake of economic policy since the Great Depression, whereas others think that the deficits matter very little. This chapter considers various facets of this debate.

We begin by looking at the numbers. Section 15-1 examines the size of the U.S. government debt, comparing it to the debt of other countries and to the debt that the United States has had during its own past. It also takes a brief look at what the future may hold. Section 15-2 discusses why measuring changes in government indebtedness is not as straightforward as it might seem. Indeed, some economists argue that traditional measures are so misleading that they should be completely ignored.

We then look at how government debt affects the economy. Section 15-3 describes the traditional view of government debt, according to which government borrowing reduces national saving and crowds out capital accumulation. This view is held by most economists and has been implicit in the discussion of fiscal policy throughout this book. Section 15-4 discusses an alternative view, called *Ricardian equivalence*, which is held by a small but influential minority of economists. According to the Ricardian view, government debt does not influence national saving and capital accumulation. As we will see, the debate between the traditional and Ricardian views of government debt arises from disagreements over how consumers respond to the government's debt policy.

Section 15-5 then looks at other facets of the debate over government debt. It begins by discussing whether the government should try to always balance its budget and, if not, when a budget deficit or surplus is desirable. It also examines the effects of government debt on monetary policy, the political process, and the role of a country in the world economy.

15-1 The Size of the Government Debt

Let's begin by putting the government debt in perspective. In 2001, the debt of the U.S. federal government was $3.2 trillion. If we divide this number by 276 million, the number of people in the United States, we find that each person's share of the government debt was about $11,600. Obviously, this is not a trivial number—few people sneeze at $11,600. Yet if we compare this debt to

table 15-1

How Indebted Are the World's Governments?

Country	Government Debt as a Percentage of GDP	Country	Government Debt as a Percentage of GDP
Japan	119	Ireland	54
Italy	108	Spain	53
Belgium	105	Finland	51
Canada	101	Sweden	49
Greece	100	Germany	46
Denmark	67	Austria	40
United Kingdom	64	Netherlands	27
United States	62	Australia	26
France	58	Norway	24
Portugal	55		

Source: OECD Economic Outlook. Figures are based on estimates of gross government debt and GDP for 2001.

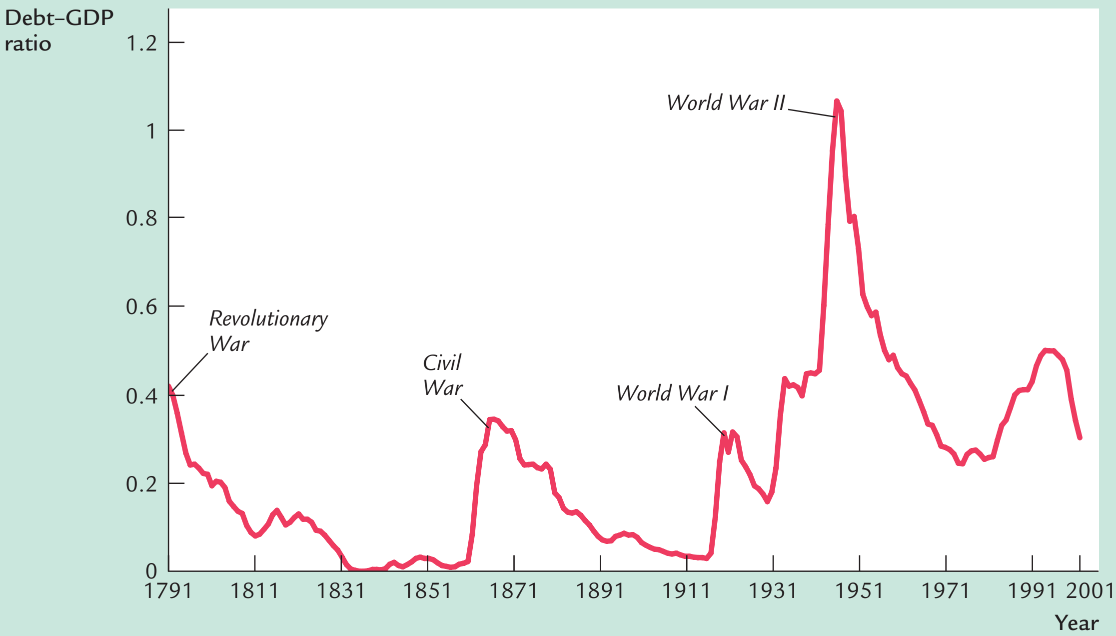
the roughly $1 million a typical person will earn over his or her working life, the government debt does not look like the catastrophe it is sometimes made out to be.

One way to judge the size of a government's debt is to compare it to the amount of debt other countries have accumulated. Table 15-1 shows the amount of government debt for 19 major countries expressed as a percentage of each country's GDP. On the top of the list are the heavily indebted countries of Japan and Italy, which have accumulated a debt that exceeds annual GDP. At the bottom are Norway and Australia, which have accumulated relatively small debts. The United States is in the middle of the pack. By international standards, the U.S. government is neither especially profligate nor especially frugal.

Over the course of U.S. history, the indebtedness of the federal government has varied substantially. Figure 15-1 shows the ratio of the federal debt to GDP since 1791. The government debt, relative to the size of the economy, varies from close to zero in the 1830s to a maximum of 107 percent of GDP in 1945.

Historically, the primary cause of increases in the government debt is war. The debt–GDP ratio rises sharply during major wars and falls slowly during peacetime. Many economists think that this historical pattern is the appropriate

figure 15-1



The Ratio of Government Debt to GDP Since 1790 The U.S. federal government debt held by the public, relative to the size of the U.S. economy, rises sharply during wars and declines slowly during peacetime. The exception is the period since 1980, when the debt–GDP ratio rose without the occurrence of a major military conflict.

Source: U.S. Department of Treasury, U.S. Department of Commerce, and T.S. Berry, "Production and Population Since 1789," Bostwick Paper No. 6, Richmond, 1988.

way to run fiscal policy. As we discuss more fully later in this chapter, deficit financing of wars appears optimal for reasons of both tax smoothing and generational equity. One instance of a large increase in government debt in peacetime occurred during the 1980s and early 1990s, when the federal government ran substantial budget deficits. Many economists have criticized this increase in government debt as imposing a burden on future generations without justification.

During the middle of the 1990s, the U.S. federal government started to get its budget deficit under control. A combination of tax hikes, spending cuts, and rapid economic growth caused the ratio of debt to GDP to stabilize and then decline. Recent experience has tempted some observers to think that exploding government debt is a thing of the past. But as the next case study suggests, the worst may be yet to come.

CASE STUDY

The Fiscal Future: Good News and Bad News

What does the future hold for fiscal policymakers? Economic forecasting is far from precise, and it is easy to be cynical about economic predictions. But good policy cannot be made if policymakers only look backwards. As a result, economists in the Congressional Budget Office (CBO) and other government agencies are always trying to look ahead to see what problems and opportunities are likely to develop.

When George W. Bush moved into the White House in 2001, the fiscal picture facing the U.S. government was mixed. In particular, it depended on how far one looked ahead.

Over a ten- or twenty-year horizon, the picture looked good. The U.S. federal government was running a large budget surplus. As a percentage of GDP, the projected surplus for 2001 was the largest since 1948. Moreover, the surplus was expected to grow even larger over time. The surplus was large enough so that, without any policy changes, the government debt would be paid off by 2008.

These surpluses arose from various sources. The elder George Bush had signed a tax increase in 1990, and Bill Clinton had signed another in 1993. Because of these tax hikes, federal tax revenue as a percentage of GDP reached its highest level since World War II. Then, in the late 1990s, productivity accelerated, most likely because of advances in information technology. The high growth in incomes led to rising tax revenue, which pushed the federal government's budget from deficit to surplus.

A debate arose over how to respond to the budget surplus. The government could use the large projected surpluses to repay debt, increase spending, cut taxes, or some combination of these. The new Republican president George W. Bush advocated a tax cut of $1.6 trillion over 10 years, which was about one-fourth of the projected surpluses. Democrats in Congress argued for a smaller tax cut and greater government spending. The end result was a compromise bill that cut taxes by a bit less than Bush had advocated.

While the 10-year horizon looked rosy, the longer-term fiscal picture was more troublesome. The problem was demographic. Advances in medical technology have been increasing life expectancy, while improvements in birth-control techniques and changing social norms have reduced the number of children people have. Because of these developments, the elderly are becoming a larger share of the population. In 1990, there were 21 elderly for every 100 people of working age (ages 20 to 64); this figure is projected to rise to 36 by the year 2030. Such a demographic change has profound implications for fiscal policy. About one-third of the budget of the U.S. federal government is devoted to pensions and health care for the elderly. As more people become eligible for these "entitlements," as they are sometimes called, government spending automatically rises over time, pushing the budget toward deficit.

The magnitude of these budgetary pressures was documented in a CBO report released in October 2000. According to the CBO, if no changes in fiscal policy are enacted, the government debt as a percentage of GDP will start rising around 2030 and reach historic highs around 2060. At that point, the government's budget will spiral out of control.[1]

Of course, all economic forecasts need to be greeted with a bit of skepticism, especially those that try to look ahead half a century. Shocks to the economy can alter the government's revenue and spending. In fact, only months after moving into the White House, George W. Bush saw the fiscal picture start to change. First, the economic slowdown in 2001 reduced tax revenue. Then, the terrorist attacks in September 2001 induced an increase in government spending. Both developments reduced the projected near-term government surpluses. As this book was going to press, there was great uncertainty about future government spending and the rate of technological advance—two key determinants of the fiscal situation.

Yet one thing is clear: the elderly are making up a larger share of the population, and this fact will shape the fiscal challenges in the decades ahead.

15-2 Problems in Measurement

The government budget deficit equals government spending minus government revenue, which in turn equals the amount of new debt the government needs to issue to finance its operations. This definition may sound simple enough, but in fact debates over fiscal policy sometimes arise over how the budget deficit should be measured. Some economists believe that the deficit as currently measured is not a good indicator of the stance of fiscal policy. That is, they believe that the budget deficit does not accurately gauge either the impact of fiscal policy on today's economy or the burden being placed on future generations of taxpayers. In this section we discuss four problems with the usual measure of the budget deficit.

[1] Congressional Budget Office, *The Long-Term Budget Outlook*, October 2000.

Measurement Problem 1: Inflation

The least controversial of the measurement issues is the correction for inflation. Almost all economists agree that the government's indebtedness should be measured in real terms, not in nominal terms. The measured deficit should equal the change in the government's real debt, not the change in its nominal debt.

The budget deficit as commonly measured, however, does not correct for inflation. To see how large an error this induces, consider the following example. Suppose that the real government debt is not changing; in other words, in real terms, the budget is balanced. In this case, the nominal debt must be rising at the rate of inflation. That is,

$$\Delta D/D = \pi,$$

where π is the inflation rate and D is the stock of government debt. This implies

$$\Delta D = \pi D.$$

The government would look at the change in the nominal debt ΔD and would report a budget deficit of πD. Hence, most economists believe that the reported budget deficit is overstated by the amount πD.

We can make the same argument in another way. The deficit is government expenditure minus government revenue. Part of expenditure is the interest paid on the government debt. Expenditure should include only the real interest paid on the debt rD, not the nominal interest paid iD. Because the difference between the nominal interest rate i and the real interest rate r is the inflation rate π, the budget deficit is overstated by πD.

This correction for inflation can be large, especially when inflation is high, and it can often change our evaluation of fiscal policy. For example, in 1979, the federal government reported a budget deficit of \$28 billion. Inflation was 8.6 percent, and the government debt held at the beginning of the year by the public (excluding the Federal Reserve) was \$495 billion. The deficit was therefore overstated by

$$\begin{aligned} \pi D &= 0.086 \times \$495 \text{ billion} \\ &= \$43 \text{ billion.} \end{aligned}$$

Corrected for inflation, the reported budget deficit of \$28 billion turns into a budget surplus of \$15 billion! In other words, even though nominal government debt was rising, real government debt was falling.

Measurement Problem 2: Capital Assets

Many economists believe that an accurate assessment of the government's budget deficit requires accounting for the government's assets as well as its liabilities. In particular, when measuring the government's overall indebtedness, we should subtract government assets from government debt. Therefore, the budget deficit should be measured as the change in debt minus the change in assets.

Certainly, individuals and firms treat assets and liabilities symmetrically. When a person borrows to buy a house, we do not say that he is running a budget deficit. Instead, we offset the increase in assets (the house) against the increase in debt (the mortgage) and record no change in net wealth. Perhaps we should treat the government's finances the same way.

A budget procedure that accounts for assets as well as liabilities is called **capital budgeting**, because it takes into account changes in capital. For example, suppose that the government sells one of its office buildings or some of its land and uses the proceeds to reduce the government debt. Under current budget procedures, the reported deficit would be lower. Under capital budgeting, the revenue received from the sale would not lower the deficit, because the reduction in debt would be offset by a reduction in assets. Similarly, under capital budgeting, government borrowing to finance the purchase of a capital good would not raise the deficit.

The major difficulty with capital budgeting is that it is hard to decide which government expenditures should count as capital expenditures. For example, should the interstate highway system be counted as an asset of the government? If so, what is its value? What about the stockpile of nuclear weapons? Should spending on education be treated as expenditure on human capital? These difficult questions must be answered if the government is to adopt a capital budget.

Economists and policymakers disagree about whether the federal government should use capital budgeting. (Many state governments already use it.) Opponents of capital budgeting argue that, although the system is superior in principle to the current system, it is too difficult to implement in practice. Proponents of capital budgeting argue that even an imperfect treatment of capital assets would be better than ignoring them altogether.

Measurement Problem 3: Uncounted Liabilities

Some economists argue that the measured budget deficit is misleading because it excludes some important government liabilities. For example, consider the pensions of government workers. These workers provide labor services to the government today, but part of their compensation is deferred to the future. In essence, these workers are providing a loan to the government. Their future pension benefits represent a government liability not very different from government debt. Yet this liability is not included as part of the government debt, and the accumulation of this liability is not included as part of the budget deficit. According to some estimates, this implicit liability is almost as large as the official government debt.

Similarly, consider the Social Security system. In some ways, the system is like a pension plan. People pay some of their income into the system when young and expect to receive benefits when old. Perhaps accumulated future Social Security benefits should be included in the government's liabilities. Estimates suggest that the government's future Social Security liabilities (less future Social Security taxes) are more than three times the government debt as officially measured.

One might argue that Social Security liabilities are different from government debt because the government can change the laws determining Social Security benefits. Yet, in principle, the government could always choose not to repay all of its debt: the government honors its debt only because it chooses to do so. Promises to pay the holders of government debt may not be fundamentally different from promises to pay the future recipients of Social Security.

A particularly difficult form of government liability to measure is the *contingent liability*—the liability that is due only if a specified event occurs. For example, the government guarantees many forms of private credit, such as student loans, mortgages for low- and moderate-income families, and deposits in banks and savings-and-loan institutions. If the borrower repays the loan, the government pays nothing; if the borrower defaults, the government makes the repayment. When the government provides this guarantee, it undertakes a liability contingent on the borrower's default. Yet this contingent liability is not reflected in the budget deficit, in part because it is not clear what dollar value to attach to it.

Measurement Problem 4: The Business Cycle

Many changes in the government's budget deficit occur automatically in response to a fluctuating economy. For example, when the economy goes into a recession, incomes fall, so people pay less in personal income taxes. Profits fall, so corporations pay less in corporate income taxes. More people become eligible for government assistance, such as welfare and unemployment insurance, so government spending rises. Even without any change in the laws governing taxation and spending, the budget deficit increases.

These automatic changes in the deficit are not errors in measurement, because the government truly borrows more when a recession depresses tax revenue and boosts government spending. But these changes do make it more difficult to use the deficit to monitor changes in fiscal policy. That is, the deficit can rise or fall either because the government has changed policy or because the economy has changed direction. For some purposes, it would be good to know which is occurring.

To solve this problem, the government calculates a **cyclically adjusted budget deficit** (sometimes called the *full-employment budget deficit*). The cyclically adjusted deficit is based on estimates of what government spending and tax revenue would be if the economy were operating at its natural rate of output and employment. The cyclically adjusted deficit is a useful measure because it reflects policy changes but not the current stage of the business cycle.

Summing Up

Economists differ in the importance they place on these measurement problems. Some believe that the problems are so severe that the measured budget deficit is almost meaningless. Most take these measurement problems seriously but still view the measured budget deficit as a useful indicator of fiscal policy.

The undisputed lesson is that to evaluate fully what fiscal policy is doing, economists and policymakers must look at more than only the measured budget deficit. And, in fact, they do. The budget documents prepared annually by the Office of Management and Budget contain much detailed information about the government's finances, including data on capital expenditures and credit programs.

No economic statistic is perfect. Whenever we see a number reported in the media, we need to know what it is measuring and what it is leaving out. This is especially true for data on government debt and budget deficits.

CASE STUDY

Generational Accounting

One harsh critic of current measures of the budget deficit is economist Laurence Kotlikoff. Kotlikoff argues that the budget deficit is like the fabled emperor who wore no clothes: everyone should plainly see the problem, but no one is willing to admit to it. He writes, "On the conceptual level, the budget deficit is intellectually bankrupt. On the practical level, there are so many official deficits that 'balanced budget' has lost any true meaning." He sees an "urgent need to switch from an outdated, misleading, and fundamentally noneconomic measure of fiscal policy, namely the budget deficit, to generational accounting."

Generational accounting, Kotlikoff's new way to gauge the influence of fiscal policy, is based on the idea that a person's economic well-being depends on his or her lifetime income. (This idea is founded on Modigliani's life-cycle theory of consumer behavior, which we examine in Chapter 16.) When evaluating fiscal policy, therefore, we should not be concerned with taxes or spending in any single year. Instead, we should look at the taxes paid, and transfers received, by people over their entire lives. Generational accounts measure the impact of fiscal policy on the lifetime incomes of different generations.

Generational accounts tell a very different story than the budget deficit about the history of U.S. fiscal policy. In the early 1980s, the U.S. government cut taxes, beginning a long period of large budget deficits. Most commentators claim that older generations benefited at the expense of younger generations during this period, because the young inherited the government debt. Kotlikoff agrees that these tax cuts raised the burden on the young, but he claims that this standard analysis ignores the impact of many other policy changes. His generational accounts show that the young were hit even harder during the 1950s, 1960s, and 1970s. During these years, the government raised Social Security benefits for the elderly and financed the higher spending by taxing the working-age population. This policy redistributed income away from the young, even though it did not affect the budget deficit. During the 1980s, Social Security reforms reversed this trend, benefiting younger generations.

Despite Kotlikoff's advocacy, generational accounting is not likely to replace the budget deficit. This alternative system also has flaws. For example, to calculate the total tax burden on different generations, one needs to make assumptions about future policy, which are open to dispute. Nonetheless, generational accounting offers a useful perspective in the debate over fiscal policy.[2]

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[2] Laurence J. Kotlikoff, *Generational Accounting: Knowing Who Pays, and When, for What We Spend* (New York: The Free Press, 1992). For an appraisal of the book, see David M. Cutler, Book Review, *National Tax Journal* 56 (March 1993): 61–67. See also the symposium on generational accounting in the Winter 1994 issue of the *Journal of Economic Perspectives*.

15-3 The Traditional View of Government Debt

Imagine that you are an economist working for the Congressional Budget Office (CBO). You receive a letter from the chair of the Senate Budget Committee:

> Dear CBO Economist:
>
> Congress is about to consider the president's request to cut all taxes by 20 percent. Before deciding whether to endorse the request, my committee would like your analysis. We see little hope of reducing government spending, so the tax cut would mean an increase in the budget deficit. How would the tax cut and budget deficit affect the economy and the economic well-being of the country?
>
> Sincerely,
> Committee Chair

Before responding to the senator, you open your favorite economics textbook—this one, of course—to see what the models predict for such a change in fiscal policy.

To analyze the long-run effects of this policy change, you turn to the models in Chapters 3 through 8. The model in Chapter 3 shows that a tax cut stimulates consumer spending and reduces national saving. The reduction in saving raises the interest rate, which crowds out investment. The Solow growth model introduced in Chapter 7 shows that lower investment eventually leads to a lower steady-state capital stock and a lower level of output. Because we concluded in Chapter 8 that the U.S. economy has less capital than in the Golden Rule steady state (the steady state with maximium consumption), the fall in steady-state capital means lower consumption and reduced economic well-being.

To analyze the short-run effects of the policy change, you turn to the *IS–LM* model in Chapters 10 and 11. This model shows that a tax cut stimulates consumer spending, which implies an expansionary shift in the *IS* curve. If there is no change in monetary policy, the shift in the *IS* curve leads to an expansionary shift in the aggregate demand curve. In the short run, when prices are sticky, the expansion in aggregate demand leads to higher output and lower unemployment. Over time, as prices adjust, the economy returns to the natural rate of output, and the higher aggregate demand results in a higher price level.

To see how international trade affects your analysis, you turn to the open-economy models in Chapters 5 and 12. The model in Chapter 5 shows that when national saving falls, people start financing investment by borrowing from abroad, causing a trade deficit. Although the inflow of capital from abroad lessens the effect of the fiscal-policy change on U.S. capital accumulation, the United States becomes indebted to foreign countries. The fiscal-policy change also causes the dollar to appreciate, which makes foreign goods cheaper in the United States and domestic goods more expensive abroad. The Mundell–Fleming model in Chapter 12 shows that the appreciation of the dollar and the resulting fall in net exports reduce the short-run expansionary impact of the fiscal change on output and employment.

With all these models in mind, you draft a response:

Dear Senator:

A tax cut financed by government borrowing would have many effects on the economy. The immediate impact of the tax cut would be to stimulate consumer spending. Higher consumer spending affects the economy in both the short run and the long run.

In the short run, higher consumer spending would raise the demand for goods and services and thus raise output and employment. Interest rates would also rise, however, as investors competed for a smaller flow of saving. Higher interest rates would discourage investment and would encourage capital to flow in from abroad. The dollar would rise in value against foreign currencies, and U.S. firms would become less competitive in world markets.

In the long run, the smaller national saving caused by the tax cut would mean a smaller capital stock and a greater foreign debt. Therefore, the output of the nation would be smaller, and a greater share of that output would be owed to foreigners.

The overall effect of the tax cut on economic well-being is hard to judge. Current generations would benefit from higher consumption and higher employment, although inflation would likely be higher as well. Future generations would bear much of the burden of today's budget deficits: they would be born into a nation with a smaller capital stock and a larger foreign debt.

Your faithful servant,
CBO Economist

The senator replies:

Dear CBO Economist:

Thank you for your letter. It made sense to me. But yesterday my committee heard testimony from a prominent economist who called herself a "Ricardian" and who reached quite a different conclusion. She said that a tax cut by itself would not stimulate consumer spending. She concluded that the budget deficit would therefore not have all the effects you listed. What's going on here?

Sincerely,
Committee Chair

After studying the next section, you write back to the senator, explaining in detail the debate over Ricardian equivalence.

15-4 The Ricardian View of Government Debt

The traditional view of government debt presumes that when the government cuts taxes and runs a budget deficit, consumers respond to their higher after-tax income by spending more. An alternative view, called **Ricardian equivalence**, questions this presumption. According to the Ricardian view, consumers are forward-looking and, therefore, base their spending not only on their current income but also on their expected future income. As we explore more fully in Chapter 16, the forward-looking consumer is at the heart of many modern theories of consumption. The Ricardian view of government debt applies the logic of the forward-looking consumer to analyze the effects of fiscal policy.

The Basic Logic of Ricardian Equivalence

Consider the response of a forward-looking consumer to the tax cut that the Senate Budget Committee is considering. The consumer might reason as follows:

> The government is cutting taxes without any plans to reduce government spending. Does this policy alter my set of opportunities? Am I richer because of this tax cut? Should I consume more?
>
> Maybe not. The government is financing the tax cut by running a budget deficit. At some point in the future, the government will have to raise taxes to pay off the debt and accumulated interest. So the policy really represents a tax cut today coupled with a tax hike in the future. The tax cut merely gives me transitory income that eventually will be taken back. I am not any better off, so I will leave my consumption unchanged.

The forward-looking consumer understands that government borrowing today means higher taxes in the future. A tax cut financed by government debt does not reduce the tax burden; it merely reschedules it. It therefore should not encourage the consumer to spend more.

One can view this argument another way. Suppose that the government borrows $1,000 from the typical citizen to give that citizen a $1,000 tax cut. In essence, this policy is the same as giving the citizen a $1,000 government bond as a gift. One side of the bond says, "The government owes you, the bondholder, $1,000 plus interest." The other side says, "You, the taxpayer, owe the government $1,000 plus interest." Overall, the gift of a bond from the government to the typical citizen does not make the citizen richer or poorer, because the value of the bond is offset by the value of the future tax liability.

The general principle is that government debt is equivalent to future taxes, and if consumers are sufficiently forward-looking, future taxes are equivalent to current taxes. Hence, financing the government by debt is equivalent to financing it by taxes. This view is called *Ricardian equivalence* after the famous nineteenth-century economist David Ricardo, because he first noted the theoretical argument.

The implication of Ricardian equivalence is that a debt-financed tax cut leaves consumption unaffected. Households save the extra disposable income to pay the future tax liability that the tax cut implies. This increase in private saving exactly offsets the decrease in public saving. National saving—the sum of private and public saving—remains the same. The tax cut therefore has none of the effects that the traditional analysis predicts.

The logic of Ricardian equivalence does not mean that all changes in fiscal policy are irrelevant. Changes in fiscal policy do influence consumer spending if they influence present or future government purchases. For example, suppose that the government cuts taxes today because it plans to reduce government purchases in the future. If the consumer understands that this tax cut does not require an increase in future taxes, he feels richer and raises his consumption. But note that it is the reduction in government purchases, rather than the reduction in taxes, that stimulates consumption: the announcement of a future reduction in government purchases would raise consumption today even if current taxes were unchanged, because it would imply lower taxes at some time in the future.

Consumers and Future Taxes

The essence of the Ricardian view is that when people choose their consumption, they rationally look ahead to the future taxes implied by government debt. But how forward-looking are consumers? Defenders of the traditional view of government debt believe that the prospect of future taxes does not have as large an influence on current consumption as the Ricardian view assumes. Here are some of their arguments.[3]

Myopia Proponents of the Ricardian view of fiscal policy assume that people are rational when making decisions such as choosing how much of their income to consume and how much to save. When the government borrows to pay for current spending, rational consumers look ahead to the future taxes required to support this debt. Thus, the Ricardian view presumes that people have substantial knowledge and foresight.

One possible argument for the traditional view of tax cuts is that people are shortsighted, perhaps because they do not fully comprehend the implications of government budget deficits. It is possible that some people follow simple and not fully rational rules of thumb when choosing how much to save. Suppose, for example, that a person acts on the assumption that future taxes will be the same as current taxes. This person will fail to take account of future changes in taxes required by current government policies. A debt-financed tax cut will lead this person to believe that his lifetime income has increased, even if it hasn't. The tax cut will therefore lead to higher consumption and lower national saving.

Borrowing Constraints The Ricardian view of government debt assumes that consumers base their spending not only on current income but on their lifetime income, which includes both current and expected future income. According to the Ricardian view, a debt-financed tax cut increases current income, but it does not alter lifetime income or consumption. Advocates of the traditional view of government debt argue that current income is more important than lifetime income for those consumers who face binding borrowing constraints. A *borrowing constraint* is a limit on how much an individual can borrow from banks or other finanical institutions.

A person who would like to consume more than his current income—perhaps because he expects higher income in the future—has to do so by borrowing. If he cannot borrow to finance current consumption, or can borrow only a

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[3] For a survey of the debate over Ricardian equivalence, see Douglas Bernheim, "Ricardian Equivalence: An Evaluation of Theory and Evidence," *NBER Macroeconomics Annual* (1987): 263–303. See also the symposium on budget deficits in the Spring 1989 issue of the *Journal of Economic Perspectives*.

limited amount, his current income determines his spending, regardless of what his lifetime income might be. In this case, a debt-financed tax cut raises current income and thus consumption, even though future income is lower. In essence, when the government cuts current taxes and raises future taxes, it is giving taxpayers a loan. For a person who wanted to obtain a loan but was unable to, the tax cut expands his opportunities and stimulates consumption.

CASE STUDY

George Bush's Withholding Experiment

In early 1992, President George Bush pursued a novel policy to deal with the lingering recession in the United States. By executive order, he lowered the amount of income taxes that were being withheld from workers' paychecks. The order did not reduce the amount of taxes that workers owed; it merely delayed payment. The higher take-home pay that workers received during 1992 was to be offset by higher tax payments, or smaller tax refunds, when income taxes were due in April 1993.

What effect would you predict for this policy? According to the logic of Ricardian equivalence, consumers should realize that their lifetime resources were unchanged and, therefore, save the extra take-home pay to meet the upcoming tax liability. Yet George Bush claimed his policy would provide "money people can use to help pay for clothing, college, or to get a new car." That is, he believed that consumers would spend the extra income, thereby stimulating aggregate demand and helping the economy recover from the recession. Bush seemed to be assuming that consumers were shortsighted or faced binding borrowing constraints.

Gauging the actual effects of this policy is difficult with aggregate data, because many other things were happening at the same time. Yet some evidence comes from a survey two economists conducted shortly after the policy was announced. The survey asked people what they would do with the extra income. Fifty-seven percent of the respondents said they would save it, use it to repay debts, or adjust their withholding in order to reverse the effect of Bush's executive order. Forty-three percent said they would spend the extra income. Thus, for this policy change, a majority of the population was planning to act as Ricardian theory posits. Nonetheless, Bush was partly right: many people planned to spend the extra income, even though they understood that the following year's tax bill would be higher.[4]

Future Generations Besides myopia and borrowing constraints, a third argument for the traditional view of government debt is that consumers expect the implied future taxes to fall not on them but on future generations. Suppose,

[4] Matthew D. Shapiro and Joel Slemrod, "Consumer Response to the Timing of Income: Evidence From a Change in Tax Withholding," *American Economic Review* 85 (March 1995): 274–283.

for example, that the government cuts taxes today, issues 30-year bonds to finance the budget deficit, and then raises taxes in 30 years to repay the loan. In this case, the government debt represents a transfer of wealth from the next generation of taxpayers (which faces the tax hike) to the current generation of taxpayers (which gets the tax cut). This transfer raises the lifetime resources of the current generation, so it raises their consumption. In essence, a debt-financed tax cut stimulates consumption because it gives the current generation the opportunity to consume at the expense of the next generation.

"What's this I hear about you adults mortgaging my future?"

Drawing by Dave Carpenter. From the *Wall Street Journal*. Permission, Cartoon Features Syndicate.

Economist Robert Barro has provided a clever rejoinder to this argument to support the Ricardian view. Barro argues that because future generations are the children and grandchildren of the current generation, we should not view them as independent economic actors. Instead, he argues, the appropriate assumption is that current generations care about future generations. This altruism between generations is evidenced by the gifts that many people give their children, often in the form of bequests at the time of their deaths. The existence of bequests suggests that many people are not eager to take advantage of the opportunity to consume at their children's expense.

According to Barro's analysis, the relevant decisionmaking unit is not the individual, whose life is finite, but the family, which continues forever. In other words, an individual decides how much to consume based not only on his own income but also on the income of future members of his family. A debt-financed tax cut may raise the income an individual receives in his lifetime, but it does not raise his family's overall resources. Instead of consuming the extra income from the tax cut, the individual saves it and leaves it as a bequest to his children, who will bear the future tax liability.

We can see now that the debate over government debt is really a debate over consumer behavior. The Ricardian view assumes that consumers have a long time horizon. Barro's analysis of the family implies that the consumer's time horizon, like the government's, is effectively infinite. Yet it is possible that consumers do not look ahead to the tax liabilities of future generations. Perhaps they expect their children to be richer than they are and therefore welcome the opportunity to consume at their children's expense. The fact that many people leave zero or minimal bequests to their children is consistent with this hypothesis. For these zero-bequest families, a debt-financed tax cut alters consumption by redistributing wealth among generations.[5]

[5] Robert J. Barro, "Are Government Bonds Net Wealth?" *Journal of Political Economy* 81 (1974): 1095–1117.

CASE STUDY

Why Do Parents Leave Bequests?

The debate over Ricardian equivalence is partly a debate over how different generations are linked to one another. Robert Barro's defense of the Ricardian view is based on the assumption that parents leave their children bequests because they care about them. But is altruism really the reason that parents leave bequests?

One group of economists has suggested that parents use bequests to control their children. Parents often want their children to do certain things for them, such as phoning home regularly and visiting on holidays. Perhaps parents use the implicit threat of disinheritance to induce their children to be more attentive.

To test this "strategic bequest motive," these economists examined data on how often children visit their parents. They found that the more wealthy the parent, the more often the children visit. Even more striking was another result: only wealth that can be left as a bequest induces more frequent visits. Wealth that cannot be bequeathed, such as pension wealth which reverts to the pension company in the event of an early death, does not encourage children to visit. These findings suggest that there may be more to the relationships among generations than mere altruism.[6]

Making a Choice

Having seen the traditional and Ricardian views of government debt, you should ask yourself two sets of questions.

First, with which view do you agree? If the government cuts taxes today, runs a budget deficit, and raises taxes in the future, how will the policy affect the economy? Will it stimulate consumption, as the traditional view holds? Or will consumers understand that their lifetime income is unchanged and, therefore, offset the budget deficit with higher private saving?

Second, why do you hold the view that you do? If you agree with the traditional view of government debt, what is the reason? Do consumers fail to understand that higher government borrowing today means higher taxes tomorrow? Or do they ignore future taxes, either because they are borrowing-constrained or because future taxes fall on future generations with which they do not feel an economic link? If you hold the Ricardian view, do you believe that consumers have the foresight to see that government borrowing today will result in future taxes levied on them or their descendants? Do you believe that consumers will save the extra income to offset that future tax liability?

We might hope that the evidence could help us decide between these two views of government debt. Yet when economists examine historical episodes of large budget deficits, the evidence is inconclusive. History can be interpreted in different ways.

[6] B. Douglas Bernheim, Andrei Shleifer, and Lawrence H. Summers, "The Strategic Bequest Motive," *Journal of Political Economy* 93 (1985): 1045–1076.

FYI Ricardo on Ricardian Equivalence

David Ricardo was a millionaire stockbroker and one of the great economists of all time. His most important contribution to the field was his 1817 book *Principles of Political Economy and Taxation*, in which he developed the theory of comparative advantage, which economists still use to explain the gains from international trade. Ricardo was also a member of the British Parliament, where he put his own theories to work and opposed the corn laws, which restricted international trade in grain.

Ricardo was interested in the alternative ways in which a government might pay for its expenditure. In an 1820 article called *Essay on the Funding System*, he considered an example of a war that cost 20 million pounds. He noted that if the interest rate were 5 percent, this expense could be financed with a one-time tax of 20 million pounds, a perpetual tax of 1 million pounds, or a tax of 1.2 million pounds for 45 years. He wrote

> In point of economy, there is no real difference in either of the modes; for twenty million in one payment, one million per annum for ever, or 1,200,0000 pounds for 45 years, are precisely of the same value.

Ricardo was aware that the issue involved the linkages among generations:

> It would be difficult to convince a man possessed of 20,000 pounds, or any other sum, that a perpetual payment of 50 pounds per annum was equally burdensome with a single tax of 1000 pounds. He would have some vague notion that the 50 pounds per annum would be paid by posterity, and would not be paid by him; but if he leaves his fortune to his son, and leaves it charged with this perpetual tax, where is the difference whether he leaves him 20,000 pounds with the tax, or 19,000 pounds without it?

Although Ricardo viewed these alternative methods of government finance as equivalent, he did not think other people would view them as such:

> The people who pay taxes . . . do not manage their private affairs accordingly. We are apt to think that the war is burdensome only in proportion to what we are at the moment called to pay for it in taxes, without reflecting on the probable duration of such taxes.

Thus, Ricardo doubted that people were rational and farsighted enough to look ahead fully to their future tax liabilities.

As a policymaker, Ricardo took seriously the government debt. Before the British Parliament, he once declared,

> This would be the happiest country in the world, and its progress in prosperity would go beyond the powers of imagination to conceive, if we got rid of two great evils—the national debt and the corn laws.

It is one of the great ironies in the history of economic thought that Ricardo rejected the theory that now bears his name!

Consider, for example, the experience of the 1980s. The large budget deficits, caused partly by the Reagan tax cut of 1981, seem to offer a natural experiment to test the two views of government debt. At first glance, this episode appears decisively to support the traditional view. The large budget deficits coincided with low national saving, high real interest rates, and a large trade deficit. Indeed, advocates of the traditional view of government debt often claim that the experience of the 1980s confirms their position.

Yet those who hold the Ricardian view of government debt interpret these events differently. Perhaps saving was low in the 1980s because people were optimistic about future economic growth—an optimism that was also reflected in a booming stock market. Or perhaps saving was low because people expected that the tax cut would eventually lead not to higher taxes but, as Reagan promised, to lower government spending. Because it is hard to rule out any of these interpretations, both views of government debt survive.

15-5 Other Perspectives on Government Debt

The policy debates over government debt have many facets. So far we have considered the traditional and Ricardian views of government debt. According to the traditional view, a government budget deficit expands aggregate demand and stimulates output in the short run but crowds out capital and depresses economic growth in the long run. According to the Ricardian view, a government budget deficit has none of these effects, because consumers understand that a budget deficit represents merely the postponement of a tax burden. With these two theories as background, we now consider several other perspectives on government debt.

Balanced Budgets Versus Optimal Fiscal Policy

In the United States, many state constitutions require the state government to run a balanced budget. A recurring topic of political debate is whether the federal Constitution should require a balanced budget for the federal government as well. Most economists oppose a strict rule requiring the government to balance its budget. There are three reasons why optimal fiscal policy may at times call for a budget deficit or surplus.

Stabilization A budget deficit or surplus can help stabilize the economy. In essence, a balanced-budget rule would revoke the automatic stabilizing powers of the system of taxes and transfers. When the economy goes into a recession, taxes automatically fall, and transfers automatically rise. Although these automatic responses help stabilize the economy, they push the budget into deficit. A strict balanced-budget rule would require that the government raise taxes or reduce spending in a recession, but these actions would further depress aggregate demand.

Tax Smoothing A budget deficit or surplus can be used to reduce the distortion of incentives caused by the tax system. As you probably learned in microeconomics courses, high tax rates impose a cost on society by discouraging economic activity. A tax on labor earnings, for instance, reduces the incentive that people have to work long hours. Because this disincentive becomes particularly large at very high tax rates, the total social cost of taxes is minimized by keeping tax rates relatively stable rather than making them high in some years and low in others. Economists call this policy *tax smoothing*. To keep tax rates smooth, a deficit is necessary in years of unusually low income (recessions) or unusually high expenditure (wars).

Intergenerational Redistribution A budget deficit can be used to shift a tax burden from current to future generations. For example, some economists argue that if the current generation fights a war to maintain freedom, future generations benefit as well and should bear some of the burden. To pass on some of the war's costs, the current generation can finance the war with a budget deficit. The government can later retire the debt by levying taxes on the next generation.

These considerations lead most economists to reject a strict balanced-budget rule. At the very least, a rule for fiscal policy needs to take account of the recurring episodes, such as recessions and wars, during which a budget deficit is a reasonable policy response.

Fiscal Effects on Monetary Policy

In 1985, Paul Volcker told Congress that "the actual and prospective size of the budget deficit . . . heightens skepticism about our ability to control the money supply and contain inflation." A decade later, Alan Greenspan claimed that "a substantial reduction in the long-term prospective deficit of the United States will significantly lower very long-term inflation expectations." Both of these Fed chairmen apparently saw a link between fiscal policy and monetary policy.

We first discussed such a possibility in Chapter 4. As we saw, one way for a government to finance a budget deficit is simply to print money—a policy that leads to higher inflation. Indeed, when countries experience hyperinflation, the typical reason is that fiscal policymakers are relying on the inflation tax to pay for some of their spending. The ends of hyperinflations almost always coincide with fiscal reforms that include large cuts in government spending and therefore a reduced need for seigniorage.

In addition to this link between the budget deficit and inflation, some economists have suggested that a high level of debt might also encourage the government to create inflation. Because most government debt is specified in nominal terms, the real value of the debt falls when the price level rises. This is the usual redistribution between creditors and debtors caused by unexpected inflation—here the debtor is the government and the creditor is the private sector. But this debtor, unlike others, has access to the monetary printing press. A high level of debt might encourage the government to print money, thereby raising the price level and reducing the real value of its debts.

Despite these concerns about a possible link between government debt and monetary policy, there is little evidence that this link is important in most developed countries. In the United States, for instance, inflation was high in the 1970s, even though government debt was low relative to GDP. Monetary policymakers got inflation under control in the early 1980s, just as fiscal policymakers started running large budget deficits and increasing the government debt. Thus, although monetary policy might be driven by fiscal policy in some situations, such as during the classic hyperinflations, this situation appears not to be the norm in most countries today. There are several reasons for this. First, most governments can finance deficits by selling debt and don't need to rely on seigniorage. Second, central banks often have enough independence to resist political pressure for more expansionary monetary policy. Third, and most important, policymakers in all parts of government know that inflation is a poor solution to fiscal problems.

Debt and the Political Process

Fiscal policy is made not by angels but by an imperfect political process. Some economists worry that the possibility of financing government spending by issuing debt makes that political process all the worse.

This idea has a long history. Nineteenth-century economist Knut Wicksell claimed that if the benefit of some type of government spending exceeded its cost, it should be possible to finance that spending in a way that would receive unanimous support from the voters. He concluded that government spending should be undertaken only when support was, in fact, nearly unanimous. In the case of debt finance, however, Wicksell was concerned that "the interests [of future taxpayers] are not represented at all or are represented inadequately in the tax-approving assembly."

Many economists have echoed this theme more recently. In their 1977 book *Democracy in Deficit*, James Buchanan and Richard Wagner argued for a balanced-budget rule for fiscal policy on the grounds that it "will have the effect of bringing the real costs of public outlays to the awareness of decision makers; it will tend to dispel the illusory 'something for nothing' aspects of fiscal choice." Similarly, Martin Feldstein (once an economic adviser to Ronald Reagan and a long-time critic of budget deficits) argues that "only the 'hard budget constraint' of having to balance the budget" can force politicians to judge whether spending's "benefits really justify its costs."

These arguments have led some economists to favor a constitutional amendment that would require Congress to pass a balanced budget. Often these proposals have escape clauses for times of national emergency, such as wars and depressions, when a budget deficit is a reasonable policy response. Some critics of these proposals argue that, even with the escape clauses, such a constitutional amendment would tie the hands of policymakers too severely. Others claim that Congress would easily evade the balanced-budget requirement with accounting tricks. As this discussion makes clear, the debate over the desirability of a balanced-budget amendment is as much political as economic.

International Dimensions

Government debt may affect a nation's role in the world economy. As we first saw in Chapter 5, when a government budget deficit reduces national saving, it often leads to a trade deficit, which in turn is financed by borrowing from abroad. For instance, many observers have blamed U.S. fiscal policy for the recent switch of the United States from a major creditor in the world economy to a major debtor. This link between the budget deficit and the trade deficit leads to two further effects of government debt.

First, high levels of government debt may increase the risk that an economy will experience capital flight—an abrupt decline in the the demand for a country's assets in world financial markets. International investors are aware that a government can always deal with its debt simply by defaulting. This approach was used as far back as 1335, when England's King Edward III defaulted on his debt to Italian bankers. More recently, several Latin American countries defaulted on their debts in the 1980s, and Russia did the same in 1998. The higher the level of the government debt, the greater the temptation of default. Thus, as government debt increases, international investors may come to fear default and curtail their lending. If this loss of confidence occurs suddenly, the result could be the classic symptoms of capital flight: a collapse in the value of the currency and an increase in interest rates. As we discussed in Chapter 12, this is precisely what happened to Mexico in the early 1990s when default appeared likely.

Second, high levels of government debt financed by foreign borrowing may reduce a nation's political clout in world affairs. This fear was emphasized by economist Ben Friedman in his 1988 book *Day of Reckoning*. He wrote, "World power and influence have historically accrued to creditor countries. It is not coincidental that America emerged as a world power simultaneously with our transition from a debtor nation . . . to a creditor supplying investment capital to the rest of the world." Friedman suggests that if the United States continues to run large trade deficits, it will eventually lose some of its international influence. So far, the record has not been kind to this hypothesis: the United States has run another decade of trade deficits and remains a leading superpower. But perhaps other events—such as the collapse of the Soviet Union—offset the fall in political clout that the United States would have experienced from its increased indebtedness.

CASE STUDY

The Benefits of Indexed Bonds

In 1997, the U.S. Treasury Department started to issue bonds that pay a return based on the consumer price index. These bonds pay a low interest rate of about 3.5 percent, so a $1,000 bond pays only $35 per year in interest. But that interest payment grows with the overall price level as measured by the CPI. In addition, when the $1,000 of principal is repaid, that amount is also adjusted for changes in the CPI. The 3.5 percent, therefore, is a real interest rate. No longer do professors of macroeconomics need to define the real interest rate as an abstract construct. They can open the *New York Times*, point to the credit report, and say, "Look here, this is a nominal interest rate, and this is a real interest rate." (Professors in the United Kingdom and several other countries have long enjoyed this luxury because indexed bonds have been trading in other countries for years.)

Of course, making macroeconomics easier to teach was not the reason that the Treasury chose to index some of the government debt. That was just a positive externality. Its goal was to introduce a new type of government bond that should benefit bondholder and taxpayer alike. These bonds are a win–win proposition because they insulate both sides of the transaction from inflation risk. Bondholders should care about the real interest rate they earn, and taxpayers should care about the real interest rate they pay. When government bonds are specified in nominal terms, both sides take on risk that is neither productive nor necessary. The new indexed bonds eliminate this inflation risk.

In addition, the new bonds have three other benefits:

First, the bonds may encourage the private sector to begin issuing its own indexed securities. Financial innovation is, to some extent, a public good. Once an innovation has been introduced into the market, the idea is nonexcludable (people cannot be prevented from using it) and nonrival (one person's use of the idea does not diminish other people's use of it). Just as a free market will not adequately supply the public goods of national defense and basic research, it will not adequately supply financial innovation. The Treasury's new bonds can be viewed as a remedy for that market failure.

Second, the bonds reduce the government's incentive to produce surprise inflation. After the large budget deficits of the 1980s and 1990s, the U.S. government is now a substantial debtor, and its debts are specified almost entirely in dollar terms. What is unique about the federal government, in contrast to most debtors, is that it can print the money it needs. The greater the government's nominal debts, the more incentive the government has to inflate away its debt. The Treasury's switch toward indexed debt reduces this potentially problematic incentive.

Third, the bonds provide data that might be useful for monetary policy. Many macroeconomic theories point to expected inflation as a key variable to explain the relationship between inflation and unemployment. But what is expected inflation? One way to measure it is to survey private forecasters. Another way is to look at the difference between the yield on nominal bonds and the yield on real bonds.

In the past, economists have proposed a variety of rules that could be used to conduct monetary policy, as we discussed in the preceding chapter. The new indexed bonds expand the number of possible rules. Here is one idea: the Fed announces a target for the inflation rate. Then, every day, the Fed measures expected inflation as the spread between the yield on nominal debt and the yield on indexed debt. If expected inflation is above the target, the Fed contracts the money supply. If expected inflation is below the target, the Fed expands the money supply. In this way, the Fed can use the bond market's inflation forecast to ensure that the money supply is growing at the rate needed to keep inflation close to its target.

The Treasury's new indexed bonds, therefore, will likely produce many benefits: less inflation risk, more financial innovation, better government incentives, more informed monetary policy, and easier lives for students and teachers of macroeconomics.[7]

[7] To read more about indexed bonds, see John Y. Campbell and Robert J. Shiller, "A Scorecard for Indexed Government Debt," *NBER Macroeconomics Annual* (1996): 155–197; and David W. Wilcox, "Policy Watch: The Introduction of Indexed Government Debt in the United States," *The Journal of Economic Perspectives* 12 (Winter 1998): 219–227.

15-6 Conclusion

Fiscal policy and government debt are central in the U.S. political debate. When Bill Clinton became president in 1993, he made reducing the budget deficit a high priority of his administration. When the Republicans took control of Congress in 1995, they pushed for even faster deficit reduction than Clinton had advocated. These efforts together with some good luck turned the federal government budget from deficit to surplus by the late 1990s. When George W. Bush moved into the White House in 2001, the policy debate was over how quickly the government should pay off its debts.

This chapter discussed some of the economic issues that lie behind these policy decisions. As we have seen, economists are not in complete agreement about the measurement or effects of government indebtedness. Given the profound importance of this topic, there seems little doubt that the debates will continue in the years to come.

Summary

1. The current debt of the U.S. federal government is of moderate size compared to the debt of other countries or compared to the debt that the United States has had throughout its own history. The 1980s and early 1990s were unusual in that the ratio of debt to GDP increased during a period of peace and prosperity. Since 1995, the debt–GDP ratio has declined substantially.

2. Standard measures of the budget deficit are imperfect measures of fiscal policy because they do not correct for the effects of inflation, do not offset changes in government liabilities with changes in government assets, omit some liabilities altogether, and do not correct for the effects of the business cycle.

3. According to the traditional view of government debt, a debt-financed tax cut stimulates consumer spending and lowers national saving. This increase in consumer spending leads to greater aggregate demand and higher income in the short run, but it leads to a lower capital stock and lower income in the long run.

4. According to the Ricardian view of government debt, a debt-financed tax cut does not stimulate consumer spending because it does not raise consumers' overall resources—it merely reschedules taxes from the present to the future. The debate between the traditional and Ricardian views of government debt is ultimately a debate over how consumers behave. Are consumers rational or shortsighted? Do they face binding borrowing constraints? Are they economically linked to future generations through altruistic bequests? Economists' views of government debt hinge on their answers to these questions.

5. Most economists oppose a strict rule requiring a balanced budget. A budget deficit can sometimes be justified on the basis of short-run stabilization, tax smoothing, or intergenerational redistribution of the tax burden.

6. Government debt can potentially have other effects. Large government debt or budget deficits may encourage excessive monetary expansion and, therefore, lead to greater inflation. The possibility of running budget deficits may encourage politicians to unduly burden future generations when setting government spending and taxes. A high level of government debt may risk capital flight and diminish a nation's influence around the world. Economists differ in which of these effects they consider most important.

KEY CONCEPTS

Capital budgeting

Cyclically adjusted budget deficit

Ricardian equivalence

QUESTIONS FOR REVIEW

1. What was unusual about U.S. fiscal policy from 1980 to 1995?
2. Why do many economists project increasing budget deficits and government debt over the next several decades?
3. Describe four problems affecting measurement of the government budget deficit.
4. According to the traditional view of government debt, how does a debt-financed tax cut affect public saving, private saving, and national saving?
5. According to the Ricardian view of government debt, how does a debt-financed tax cut affect public saving, private saving, and national saving?
6. Do you believe the traditional or the Ricardian view of government debt? Why?
7. Give three reasons why a budget deficit might be a good policy choice.
8. Why might the level of government debt affect the government's incentives regarding money creation?

PROBLEMS AND APPLICATIONS

1. On April 1, 1996, Taco Bell, the fast-food chain, ran a full-page ad in the *New York Times* with this news: "In an effort to help the national debt, Taco Bell is pleased to announce that we have agreed to purchase the Liberty Bell, one of our country's most historic treasures. It will now be called the *Taco Liberty Bell* and will still be accessible to the American public for viewing. We hope our move will prompt other corporations to take similar action to do their part to reduce the country's debt." Would such actions by U.S. corporations actually reduce the national debt as it is now measured? How would your answer change if the U.S. government adopted capital budgeting? Do you think these actions represent a true reduction in the government's indebtedness? Do you think Taco Bell was serious about this plan? (*Hint:* Note the date.)
2. Draft a letter to the senator described in Section 15-3, explaining and evaluating the Ricardian view of government debt.
3. The Social Security system levies a tax on workers and pays benefits to the elderly. Suppose that

Congress increases both the tax and the benefits. For simplicity, assume that the Congress announces that the increases will last for one year only.

a. How do you suppose this change would affect the economy? (*Hint:* Think about the marginal propensities to consume of the young and the old.)

b. Does your answer depend on whether generations are altruistically linked?

4. Evaluate the usefulness of generational accounting from the perspective of someone who believes that generations are altruistically linked. Now evaluate the usefulness of generational accounting from the perspective of someone who believes that many consumers face binding borrowing constraints.

5. The *cyclically adjusted budget deficit* is the budget deficit corrected for the effects of the business cycle. In other words, it is the budget deficit that the government would be running if unemployment were at the natural rate. (It is also called the *full-employment budget deficit*.) Some economists have proposed the rule that the cyclically adjusted budget deficit always be balanced. Compare this proposal to a strict balanced-budget rule. Which is preferable? What problems do you see with the rule requiring a balanced cyclically adjusted budget?

6. Using the library or the Internet, find some recent projections for the future path of the U.S. government debt as a percentage of GDP. What assumptions are made about government spending, taxes, and economic growth? Do you think these assumptions are reasonable? If the U.S. experiences a productivity slowdown, how will reality differ from this projection? (*Hint*: A good place to look is www.cbo.gov.)

part VI

More on the Microeconomics Behind Macroeconomics

CHAPTER 16 SIXTEEN

Consumption

> *Consumption is the sole end and purpose of all production.*
>
> *— Adam Smith*

How do households decide how much of their income to consume today and how much to save for the future? This is a microeconomic question because it addresses the behavior of individual decisionmakers. Yet its answer has macroeconomic consequences. As we have seen in previous chapters, households' consumption decisions affect the way the economy as a whole behaves both in the long run and in the short run.

The consumption decision is crucial for long-run analysis because of its role in economic growth. The Solow growth model of Chapters 7 and 8 shows that the saving rate is a key determinant of the steady-state capital stock and thus of the level of economic well-being. The saving rate measures how much of its income the present generation is putting aside for its own future and for future generations.

The consumption decision is crucial for short-run analysis because of its role in determining aggregate demand. Consumption is two-thirds of GDP, so fluctuations in consumption are a key element of booms and recessions. The *IS–LM* model of Chapters 10 and 11 shows that changes in consumers' spending plans can be a source of shocks to the economy, and that the marginal propensity to consume is a determinant of the fiscal-policy multipliers.

In previous chapters we explained consumption with a function that relates consumption to disposable income: $C = C(Y - T)$. This approximation allowed us to develop simple models for long-run and short-run analysis, but it is too simple to provide a complete explanation of consumer behavior. In this chapter we examine the consumption function in greater detail and develop a more thorough explanation of what determines aggregate consumption.

Since macroeconomics began as a field of study, many economists have written about the theory of consumer behavior and suggested alternative ways of interpreting the data on consumption and income. This chapter presents the views of six prominent economists to show the diverse approaches to explaining consumption.

16-1 John Maynard Keynes and the Consumption Function

We begin our study of consumption with John Maynard Keynes's *General Theory*, which was published in 1936. Keynes made the consumption function central to his theory of economic fluctuations, and it has played a key role in macroeconomic analysis ever since. Let's consider what Keynes thought about the consumption function, and then see what puzzles arose when his ideas were confronted with the data.

Keynes's Conjectures

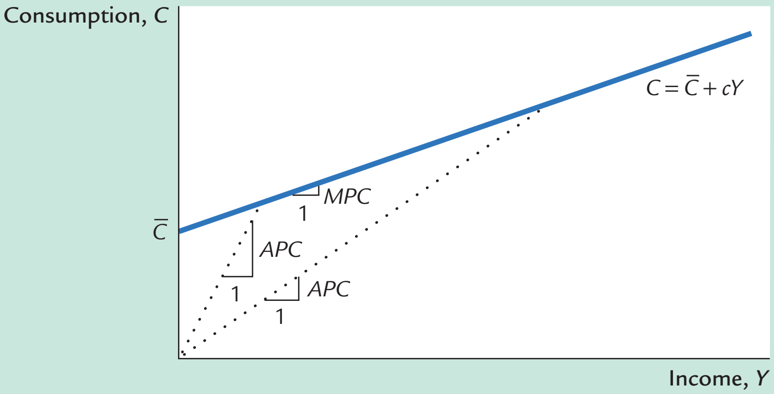
Today, economists who study consumption rely on sophisticated techniques of data analysis. With the help of computers, they analyze aggregate data on the behavior of the overall economy from the national income accounts and detailed data on the behavior of individual households from surveys. Because Keynes wrote in the 1930s, however, he had neither the advantage of these data nor the computers necessary to analyze such large data sets. Instead of relying on statistical analysis, Keynes made conjectures about the consumption function based on introspection and casual observation.

First and most important, Keynes conjectured that the **marginal propensity to consume**—the amount consumed out of an additional dollar of income—is between zero and one. He wrote that the "fundamental psychological law, upon which we are entitled to depend with great confidence, . . . is that men are disposed, as a rule and on the average, to increase their consumption as their income increases, but not by as much as the increase in their income." That is, when a person earns an extra dollar, he typically spends some of it and saves some of it. As we saw in Chapter 10 when we developed the Keynesian cross, the marginal propensity to consume was crucial to Keynes's policy recommendations for how to reduce widespread unemployment. The power of fiscal policy to influence the economy—as expressed by the fiscal-policy multipliers—arises from the feedback between income and consumption.

Second, Keynes posited that the ratio of consumption to income, called the **average propensity to consume**, falls as income rises. He believed that saving was a luxury, so he expected the rich to save a higher proportion of their income than the poor. Although not essential for Keynes's own analysis, the postulate that the average propensity to consume falls as income rises became a central part of early Keynesian economics.

Third, Keynes thought that income is the primary determinant of consumption and that the interest rate does not have an important role. This conjecture stood in stark contrast to the beliefs of the classical economists who preceded him. The classical economists held that a higher interest rate encourages saving and discourages consumption. Keynes admitted that the interest rate could influence consumption as a matter of theory. Yet he wrote that "the main conclusion suggested

figure 16-1



The Keynesian Consumption Function This figure graphs a consumption function with the three properties that Keynes conjectured. First, the marginal propensity to consume c is between zero and one. Second, the average propensity to consume falls as income rises. Third, consumption is determined by current income.

Note: The marginal propensity to consume, *MPC*, is the slope of the consumption function. The average propensity to consume, $APC = C/Y$, equals the slope of a line drawn from the origin to a point on the consumption function.

by experience, I think, is that the short-period influence of the rate of interest on individual spending out of a given income is secondary and relatively unimportant."

On the basis of these three conjectures, the Keynesian consumption function is often written as

$$C = \overline{C} + cY, \qquad \overline{C} > 0, \quad 0 < c < 1,$$

where C is consumption, Y is disposable income, $\overline{C}$ is a constant, and c is the marginal propensity to consume. This consumption function, shown in Figure 16-1, is graphed as a straight line.

Notice that this consumption function exhibits the three properties that Keynes posited. It satisfies Keynes's first property because the marginal propensity to consume c is between zero and one, so that higher income leads to higher consumption and also to higher saving. This consumption function satisfies Keynes's second property because the average propensity to consume APC is

$$APC = C/Y = \overline{C}/Y + c.$$

As Y rises, $\overline{C}/Y$ falls, and so the average propensity to consume C/Y falls. And finally, this consumption function satisfies Keynes's third property because the interest rate is not included in this equation as a determinant of consumption.

The Early Empirical Successes

Soon after Keynes proposed the consumption function, economists began collecting and examining data to test his conjectures. The earliest studies indicated that the Keynesian consumption function is a good approximation of how consumers behave.

In some of these studies, researchers surveyed households and collected data on consumption and income. They found that households with higher income consumed more, which confirms that the marginal propensity to consume is greater than zero. They also found that households with higher income saved more, which confirms that the marginal propensity to consume is less than one. In addition, these researchers found that higher-income households saved a larger fraction of their income, which confirms that the average propensity to consume falls as income rises. Thus, these data verified Keynes's conjectures about the marginal and average propensities to consume.

In other studies, researchers examined aggregate data on consumption and income for the period between the two world wars. These data also supported the Keynesian consumption function. In years when income was unusually low, such as during the depths of the Great Depression, both consumption and saving were low, indicating that the marginal propensity to consume is between zero and one. In addition, during those years of low income, the ratio of consumption to income was high, confirming Keynes's second conjecture. Finally, because the correlation between income and consumption was so strong, no other variable appeared to be important for explaining consumption. Thus, the data also confirmed Keynes's third conjecture that income is the primary determinant of how much people choose to consume.

Secular Stagnation, Simon Kuznets, and the Consumption Puzzle

Although the Keynesian consumption function met with early successes, two anomalies soon arose. Both concern Keynes's conjecture that the average propensity to consume falls as income rises.

The first anomaly became apparent after some economists made a dire—and, it turned out, erroneous—prediction during World War II. On the basis of the Keynesian consumption function, these economists reasoned that as incomes in the economy grew over time, households would consume a smaller and smaller fraction of their incomes. They feared that there might not be enough profitable investment projects to absorb all this saving. If so, the low consumption would lead to an inadequate demand for goods and services, resulting in a depression once the wartime demand from the government ceased. In other words, on the basis of the Keynesian consumption function, these economists predicted that the economy would experience what they called *secular stagnation*—a long depression of indefinite duration—unless fiscal policy was used to expand aggregate demand.

Fortunately for the economy, but unfortunately for the Keynesian consumption function, the end of World War II did not throw the country into another depression. Although incomes were much higher after the war than before, these higher incomes did not lead to large increases in the rate of saving. Keynes's conjecture that the average propensity to consume would fall as income rose appeared not to hold.

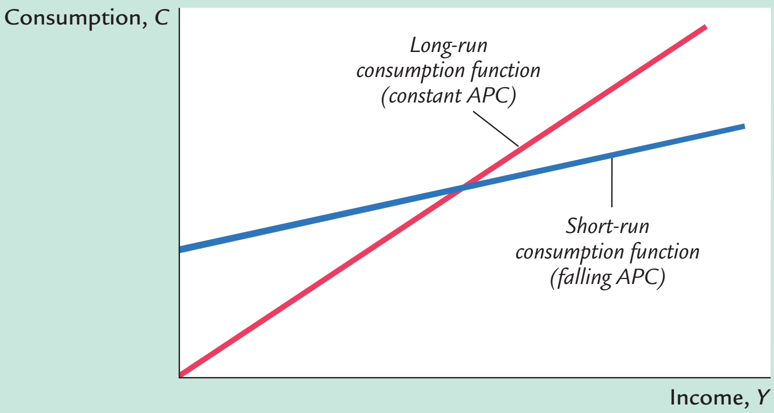
The second anomaly arose when economist Simon Kuznets constructed new aggregate data on consumption and income dating back to 1869. Kuznets assembled these data in the 1940s and would later receive the Nobel Prize for this work. He discovered that the ratio of consumption to income was remarkably stable from decade to decade, despite large increases in income over the period he studied. Again, Keynes's conjecture that the average propensity to consume would fall as income rose appeared not to hold.

The failure of the secular-stagnation hypothesis and the findings of Kuznets both indicated that the average propensity to consume is fairly constant over long periods of time. This fact presented a puzzle that motivated much of the subsequent work on consumption. Economists wanted to know why some studies confirmed Keynes's conjectures and others refuted them. That is, why did Keynes's conjectures hold up well in the studies of household data and in the studies of short time-series, but fail when long time-series were examined?

Figure 16-2 illustrates the puzzle. The evidence suggested that there were two consumption functions. For the household data or for the short time-series, the Keynesian consumption function appeared to work well. Yet for the long time-series, the consumption function appeared to have a constant average propensity to consume. In Figure 16-2, these two relationships between consumption and income are called the short-run and long-run consumption functions. Economists needed to explain how these two consumption functions could be consistent with each other.

In the 1950s, Franco Modigliani and Milton Friedman each proposed explanations of these seemingly contradictory findings. Both economists later won

figure 16-2



The Consumption Puzzle Studies of household data and short time-series found a relationship between consumption and income similar to the one Keynes conjectured. In the figure, this relationship is called the short-run consumption function. But studies of long time-series found that the average propensity to consume did not vary systematically with income. This relationship is called the long-run consumption function. Notice that the short-run consumption function has a falling average propensity to consume, whereas the long-run consumption function has a constant average propensity to consume.

Nobel Prizes, in part because of their work on consumption. But before we see how Modigliani and Friedman tried to solve the consumption puzzle, we must discuss Irving Fisher's contribution to consumption theory. Both Modigliani's life-cycle hypothesis and Friedman's permanent-income hypothesis rely on the theory of consumer behavior proposed much earlier by Irving Fisher.

16-2 Irving Fisher and Intertemporal Choice

The consumption function introduced by Keynes relates current consumption to current income. This relationship, however, is incomplete at best. When people decide how much to consume and how much to save, they consider both the present and the future. The more consumption they enjoy today, the less they will be able to enjoy tomorrow. In making this tradeoff, households must look ahead to the income they expect to receive in the future and to the consumption of goods and services they hope to be able to afford.

The economist Irving Fisher developed the model with which economists analyze how rational, forward-looking consumers make intertemporal choices—that is, choices involving different periods of time. Fisher's model illuminates the constraints consumers face, the preferences they have, and how these constraints and preferences together determine their choices about consumption and saving.

The Intertemporal Budget Constraint

Most people would prefer to increase the quantity or quality of the goods and services they consume—to wear nicer clothes, eat at better restaurants, or see more movies. The reason people consume less than they desire is that their consumption is constrained by their income. In other words, consumers face a limit on how much they can spend, called a *budget constraint*. When they are deciding how much to consume today versus how much to save for the future, they face an **intertemporal budget constraint**, which measures the total resources available for consumption today and in the future. Our first step in developing Fisher's model is to examine this constraint in some detail.

To keep things simple, we examine the decision facing a consumer who lives for two periods. Period one represents the consumer's youth, and period two represents the consumer's old age. The consumer earns income Y_1 and consumes C_1 in period one, and earns income Y_2 and consumes C_2 in period two. (All variables are real—that is, adjusted for inflation.) Because the consumer has the opportunity to borrow and save, consumption in any single period can be either greater or less than income in that period.

Consider how the consumer's income in the two periods constrains consumption in the two periods. In the first period, saving equals income minus consumption. That is,

$$S = Y_1 - C_1,$$

where S is saving. In the second period, consumption equals the accumulated saving, including the interest earned on that saving, plus second-period income. That is,

$$C_2 = (1 + r)S + Y_2,$$

where r is the real interest rate. For example, if the interest rate is 5 percent, then for every \$1 of saving in period one, the consumer enjoys an extra \$1.05 of consumption in period two. Because there is no third period, the consumer does not save in the second period.

Note that the variable S can represent either saving or borrowing and that these equations hold in both cases. If first-period consumption is less than first-period income, the consumer is saving, and S is greater than zero. If first-period consumption exceeds first-period income, the consumer is borrowing, and S is less than zero. For simplicity, we assume that the interest rate for borrowing is the same as the interest rate for saving.

To derive the consumer's budget constraint, combine the two preceding equations. Substitute the first equation for S into the second equation to obtain

$$C_2 = (1 + r)(Y_1 - C_1) + Y_2.$$

To make the equation easier to interpret, we must rearrange terms. To place all the consumption terms together, bring $(1 + r)C_1$ from the right-hand side to the left-hand side of the equation to obtain

$$(1 + r)C_1 + C_2 = (1 + r)Y_1 + Y_2.$$

Now divide both sides by $1 + r$ to obtain

$$C_1 + \frac{C_2}{1 + r} = Y_1 + \frac{Y_2}{1 + r}.$$

This equation relates consumption in the two periods to income in the two periods. It is the standard way of expressing the consumer's intertemporal budget constraint.

The consumer's budget constraint is easily interpreted. If the interest rate is zero, the budget constraint shows that total consumption in the two periods equals total income in the two periods. In the usual case in which the interest rate is greater than zero, future consumption and future income are discounted by a factor $1 + r$. This **discounting** arises from the interest earned on savings. In essence, because the consumer earns interest on current income that is saved, future income is worth less than current income. Similarly, because future consumption is paid for out of savings that have earned interest, future consumption costs less than current consumption. The factor $1/(1 + r)$ is the price of second-period consumption measured in terms of first-period consumption: it is the amount of first-period consumption that the consumer must forgo to obtain 1 unit of second-period consumption.

Figure 16-3 graphs the consumer's budget constraint. Three points are marked on this figure. At point A, the consumer consumes exactly his income in each

FYI Present Value, or Why a \$1,000,000 Prize Is Worth Only \$623,000

The use of discounting in the consumer's budget constraint illustrates an important fact of economic life: a dollar in the future is less valuable than a dollar today. This is true because a dollar today can be deposited in an interest-bearing bank account and produce more than one dollar in the future. If the interest rate is 5 percent, for instance, then a dollar today can be turned to \$1.05 dollars next year, \$1.1025 in two years, \$1.1576 in three years, ... , or \$2.65 in 20 years.

Economists use a concept called *present value* to compare dollar amounts from different times. The present value of any amount in the future is the amount that would be needed today, given available interest rates, to produce that future amount. Thus, if you are going to be paid X dollars in T years and the interest rate is r, then the present value of that payment is

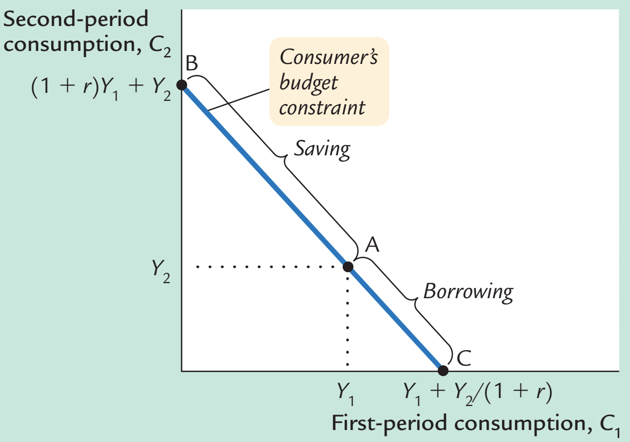
$$\text{Present Value} = X/(1 + r)^T.$$

In light of this definition, we can see a new interpretation of the consumer's budget constraint in our two-period consumption problem. The intertemporal budget constraint states that the present value of consumption must equal the present value of income.

The concept of present value has many applications. Suppose, for instance, that you won a million-dollar lottery. Such prizes are usually paid out over time—say, \$50,000 a year for 20 years. What is the present value of such a delayed prize? By applying the preceding formula for each of the 20 payments and adding up the result, we learn that the million-dollar prize, discounted at an interest rate of 5 percent, has a present value of only \$623,000. (If the prize were paid out as a dollar a year for a million years, the present value would be a mere \$20!) Sometimes a million dollars isn't all it's cracked up to be.

period ($C_1 = Y_1$ and $C_2 = Y_2$), so there is neither saving nor borrowing between the two periods. At point B, the consumer consumes nothing in the first period ($C_1 = 0$) and saves all income, so second-period consumption C_2 is $(1 + r)Y_1 + Y_2$. At point C, the consumer plans to consume nothing in the second period ($C_2 = 0$) and borrows as much as possible against second-period income, so first-period

figure 16-3



The Consumer's Budget Constraint This figure shows the combinations of first-period and second-period consumption the consumer can choose. If he chooses points between A and B, he consumes less than his income in the first period and saves the rest for the second period. If he chooses points between A and C, he consumes more than his income in the first period and borrows to make up the difference.

consumption C_1 is $Y_1 + Y_2/(1 + r)$. Of course, these are only three of the many combinations of first- and second-period consumption that the consumer can afford: all the points on the line from B to C are available to the consumer.

Consumer Preferences

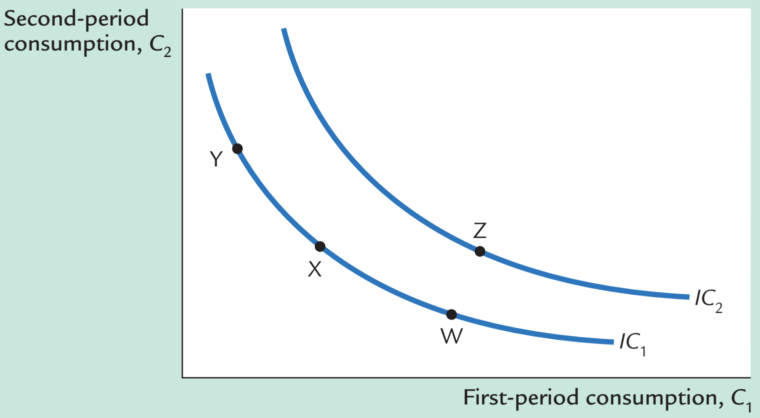
The consumer's preferences regarding consumption in the two periods can be represented by **indifference curves**. An indifference curve shows the combinations of first-period and second-period consumption that make the consumer equally happy.

Figure 16-4 shows two of the consumer's many indifference curves. The consumer is indifferent among combinations W, X, and Y, because they are all on the same curve. Not surprisingly, if the consumer's first-period consumption is reduced, say from point W to point X, second-period consumption must increase to keep him equally happy. If first-period consumption is reduced again, from point X to point Y, the amount of extra second-period consumption he requires for compensation is greater.

The slope at any point on the indifference curve shows how much second-period consumption the consumer requires in order to be compensated for a 1-unit reduction in first-period consumption. This slope is the **marginal rate of substitution** between first-period consumption and second-period consumption. It tells us the rate at which the consumer is willing to substitute second-period consumption for first-period consumption.

Notice that the indifference curves in Figure 16-4 are not straight lines and, as a result, the marginal rate of substitution depends on the levels of consumption in the two periods. When first-period consumption is high and second-period consumption is low, as at point W, the marginal rate of substitution is low: the consumer requires only a little extra second-period consumption to give up

figure 16-4



The Consumer's Preferences Indifference curves represent the consumer's preferences over first-period and second-period consumption. An indifference curve gives the combinations of consumption in the two periods that make the consumer equally happy. This figure shows two of many indifference curves. Higher indifference curves such as IC_2 are preferred to lower curves such as IC_1. The consumer is equally happy at points W, X, and Y, but prefers point Z to points W, X, or Y.

1 unit of first-period consumption. When first-period consumption is low and second-period consumption is high, as at point Y, the marginal rate of substitution is high: the consumer requires much additional second-period consumption to give up 1 unit of first-period consumption.

The consumer is equally happy at all points on a given indifference curve, but he prefers some indifference curves to others. Because he prefers more consumption to less, he prefers higher indifference curves to lower ones. In Figure 16-4, the consumer prefers the points on curve IC_2 to the points on curve IC_1.

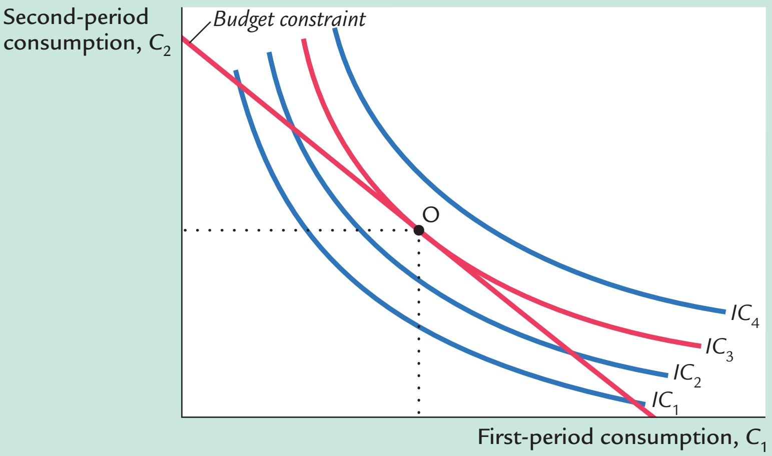
The set of indifference curves gives a complete ranking of the consumer's preferences. It tells us that the consumer prefers point Z to point W, but that may be obvious because point Z has more consumption in both periods. Yet compare point Z and point Y: point Z has more consumption in period one and less in period two. Which is preferred, Z or Y? Because Z is on a higher indifference curve than Y, we know that the consumer prefers point Z to point Y. Hence, we can use the set of indifference curves to rank any combinations of first-period and second-period consumption.

Optimization

Having discussed the consumer's budget constraint and preferences, we can consider the decision about how much to consume. The consumer would like to end up with the best possible combination of consumption in the two periods—that is, on the highest possible indifference curve. But the budget constraint requires that the consumer also end up on or below the budget line, because the budget line measures the total resources available to him.

Figure 16-5 shows that many indifference curves cross the budget line. The highest indifference curve that the consumer can obtain without violating the budget constraint is the indifference curve that just barely touches the budget

figure 16-5



The Consumer's Optimum The consumer achieves his highest level of satisfaction by choosing the point on the budget constraint that is on the highest indifference curve. At the optimum, the indifference curve is tangent to the budget constraint.

line, which is curve IC_3 in the figure. The point at which the curve and line touch—point O for "optimum"—is the best combination of consumption in the two periods that the consumer can afford.

Notice that, at the optimum, the slope of the indifference curve equals the slope of the budget line. The indifference curve is *tangent* to the budget line. The slope of the indifference curve is the marginal rate of substitution *MRS*, and the slope of the budget line is 1 plus the real interest rate. We conclude that at point O,

$$MRS = 1 + r.$$

The consumer chooses consumption in the two periods so that the marginal rate of substitution equals 1 plus the real interest rate.

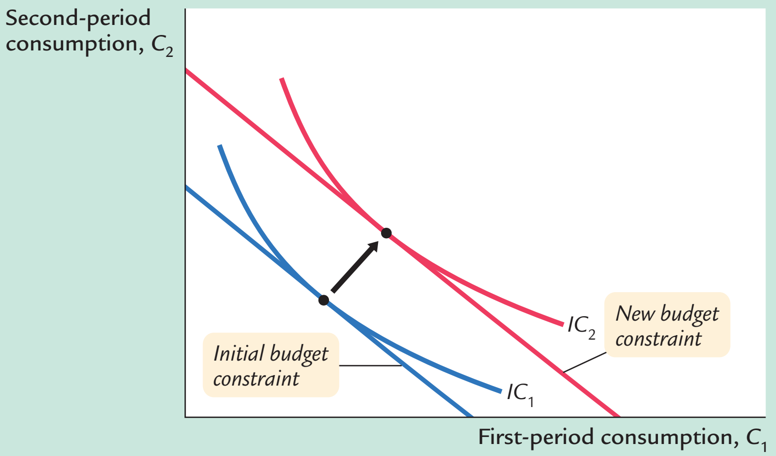
How Changes in Income Affect Consumption

Now that we have seen how the consumer makes the consumption decision, let's examine how consumption responds to an increase in income. An increase in either Y_1 or Y_2 shifts the budget constraint outward, as in Figure 16-6. The higher budget constraint allows the consumer to choose a better combination of first- and second-period consumption—that is, the consumer can now reach a higher indifference curve.

In Figure 16-6, the consumer responds to the shift in his budget constraint by choosing more consumption in both periods. Although it is not implied by the logic of the model alone, this situation is the most usual. If a consumer wants more of a good when his or her income rises, economists call it a **normal good**. The indifference curves in Figure 16-6 are drawn under the assumption that consumption in period one and consumption in period two are both normal goods.

The key conclusion from Figure 16-6 is that regardless of whether the increase in income occurs in the first period or the second period, the consumer spreads it over consumption in both periods. This behavior is sometimes called

figure 16-6



An Increase in Income An increase in either first-period income or second-period income shifts the budget constraint outward. If consumption in period one and consumption in period two are both normal goods, this increase in income raises consumption in both periods.

consumption smoothing. Because the consumer can borrow and lend between periods, the timing of the income is irrelevant to how much is consumed today (except, of course, that future income is discounted by the interest rate). The lesson of this analysis is that consumption depends on the present value of current and future income—that is, on

$$\text{Present Value of Income} = Y_1 + \frac{Y_2}{1 + r}.$$

Notice that this conclusion is quite different from that reached by Keynes. *Keynes posited that a person's current consumption depends largely on his current income. Fisher's model says, instead, that consumption is based on the resources the consumer expects over his lifetime.*

How Changes in the Real Interest Rate Affect Consumption

Let's now use Fisher's model to consider how a change in the real interest rate alters the consumer's choices. There are two cases to consider: the case in which the consumer is initially saving and the case in which he is initially borrowing. Here we discuss the saving case; Problem 1 at the end of the chapter asks you to analyze the borrowing case.

Figure 16-7 shows that an increase in the real interest rate rotates the consumer's budget line around the point (Y_1, Y_2) and, thereby, alters the amount of consumption he chooses in both periods. Here, the consumer moves from point A to point B. You can see that for the indifference curves drawn in this figure first-period consumption falls and second-period consumption rises.

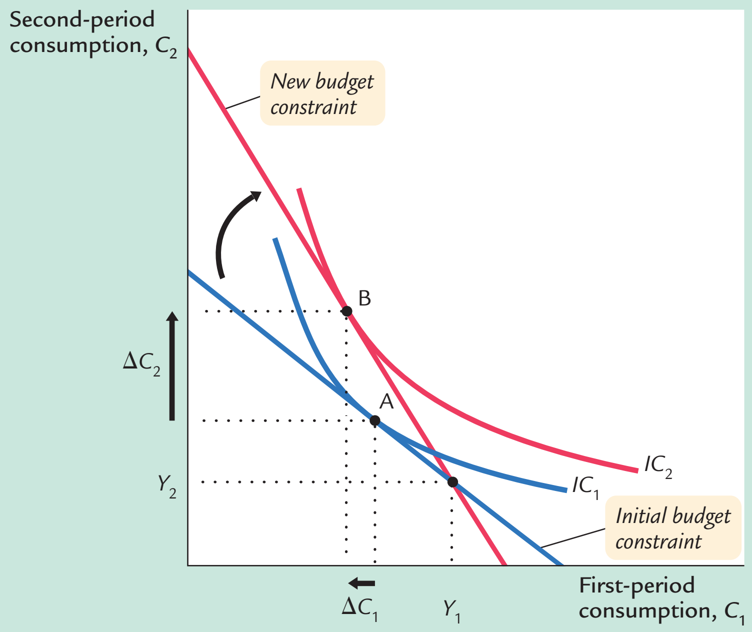
Economists decompose the impact of an increase in the real interest rate on consumption into two effects: an **income effect** and a **substitution effect**. Textbooks in microeconomics discuss these effects in detail. We summarize them briefly here.

The income effect is the change in consumption that results from the movement to a higher indifference curve. Because the consumer is a saver rather than a borrower (as indicated by the fact that first-period consumption is less than first-period income), the increase in the interest rate makes him better off (as reflected by the movement to a higher indifference curve). If consumption in period one and consumption in period two are both normal goods, the consumer will want to spread this improvement in his welfare over both periods. This income effect tends to make the consumer want more consumption in both periods.

The substitution effect is the change in consumption that results from the change in the relative price of consumption in the two periods. In particular, consumption in period two becomes less expensive relative to consumption in period one when the interest rate rises. That is, because the real interest rate earned on saving is higher, the consumer must now give up less first-period consumption to obtain an extra unit of second-period consumption. This substitution effect tends to make the consumer choose more consumption in period two and less consumption in period one.

The consumer's choice depends on both the income effect and the substitution effect. Both effects act to increase the amount of second-period consumption;

figure 16-7



An Increase in the Interest Rate An increase in the interest rate rotates the budget constraint around the point (Y_1, Y_2). In this figure, the higher interest rate reduces first-period consumption by ΔC_1 and raises second-period consumption by ΔC_2.

hence, we can confidently conclude that an increase in the real interest rate raises second-period consumption. But the two effects have opposite impacts on first-period consumption, so the increase in the interest rate could either raise or lower it. *Hence, depending on the relative size of the income and substitution effects, an increase in the interest rate could either stimulate or depress saving.*

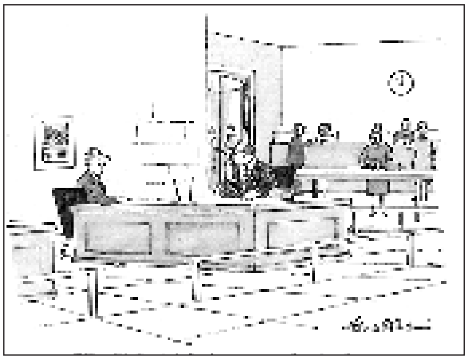
Constraints on Borrowing

Fisher's model assumes that the consumer can borrow as well as save. The ability to borrow allows current consumption to exceed current income. In essence, when the consumer borrows, he consumes some of his future income today. Yet for many people such borrowing is impossible. For example, a student wishing to enjoy spring break in Florida would probably be unable to finance this vacation with a bank loan. Let's examine how Fisher's analysis changes if the consumer cannot borrow.

The inability to borrow prevents current consumption from exceeding current income. A constraint on borrowing can therefore be expressed as

$$C_1 \le Y_1.$$

This inequality states that consumption in period one must be less than or equal to income in period one. This additional constraint on the consumer is called a **borrowing constraint** or, sometimes, a *liquidity constraint*.



"What I'd like, basically, is a temporary line of credit just to tide me over the rest of my life."

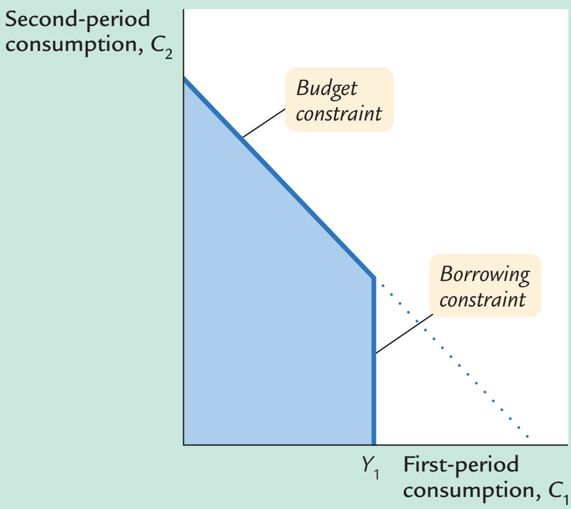
Drawing by Handelsman; © 1985 The New Yorker Magazine, Inc.

Figure 16-8 shows how this borrowing constraint restricts the consumer's set of choices. The consumer's choice must satisfy both the intertemporal budget constraint and the borrowing constraint. The shaded area represents the combinations of first-period consumption and second-period consumption that satisfy both constraints.

Figure 16-9 shows how this borrowing constraint affects the consumption decision. There are two possibilities. In panel (a), the consumer wishes to consume less in period one than he earns. The borrowing constraint is not binding and, therefore, does not affect consumption. In panel (b), the consumer would like to choose point D, where he consumes more in period one than he earns, but the borrowing constraint prevents this outcome. The best the consumer can do is to consume his first-period income, represented by point E.

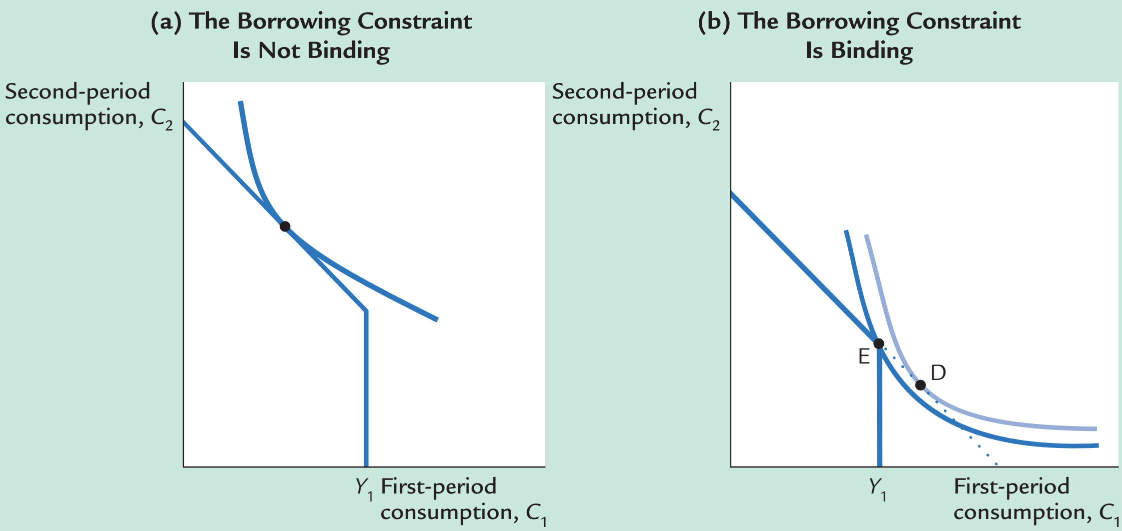
The analysis of borrowing constraints leads us to conclude that there are two consumption functions. For some consumers, the borrowing constraint is not binding, and consumption in both periods depends on the present value of lifetime income, $Y_1 + [Y_2/(1 + r)]$. For other consumers, the borrowing constraint binds, and the consumption function is $C_1 = Y_1$ and $C_2 = Y_2$. *Hence, for those consumers who would like to borrow but cannot, consumption depends only on current income.*

figure 16-8



A Borrowing Constraint If the consumer cannot borrow, he faces the additional constraint that first-period consumption cannot exceed first-period income. The shaded area represents the combination of first-period and second-period consumption the consumer can choose.

figure 16-9



The Consumer's Optimum With a Borrowing Constraint When the consumer faces a borrowing constraint, there are two possible situations. In panel (a), the consumer chooses first-period consumption to be less than first-period income, so the borrowing constraint is not binding and does not affect consumption in either period. In panel (b), the borrowing constraint is binding. The consumer would like to borrow and choose point D. But because borrowing is not allowed, the best available choice is point E. When the borrowing constraint is binding, first-period consumption equals first-period income.

CASE STUDY

The High Japanese Saving Rate

Japan has one of the world's highest saving rates, and this fact is important for understanding both the long-run and short-run performance of its economy. On the one hand, many economists believe that the high Japanese saving rate is a key to the rapid growth Japan experienced in the decades after World War II. Indeed, the Solow growth model developed in Chapters 7 and 8 shows that the saving rate is a primary determinant of a country's steady-state level of income. On other other hand, some economists have argued that the high Japanese saving rate contributed to Japan's slump during the 1990s. High saving means low consumer spending, which according to the *IS–LM* model of Chapters 10 and 11 translates into low aggregate demand and reduced income.

Why do the Japanese consume a much smaller fraction of their income than Americans? One reason is that it is harder for households to borrow in

Japan. As Fisher's model shows, a household facing a binding borrowing constraint consumes less than it would without the borrowing constraint. Hence, societies in which borrowing constraints are common will tend to have higher rates of saving.

One reason that households often wish to borrow is to buy a home. In the United States, a person can usually buy a home with a down payment of 10 percent. A homebuyer in Japan cannot borrow nearly this much: down payments of 40 percent are common. Moreover, housing prices are very high in Japan, primarily because land prices are high. A Japanese family must save a great deal if it is ever to afford its own home.

Although constraints on borrowing are part of the explanation of high Japanese saving, there are many other differences between Japan and the United States that contribute to the difference in the saving rates. The Japanese tax system encourages saving by taxing capital income very lightly. In addition, cultural differences may lead to differences in consumer preferences regarding present and future consumption. One prominent Japanese economist writes, "The Japanese are simply *different*. They are more risk averse and more patient. If this is true, the long-run implication is that Japan will absorb all the wealth in the world. I refuse to comment on this explanation."[1]

16-3 Franco Modigliani and the Life-Cycle Hypothesis

In a series of papers written in the 1950s, Franco Modigliani and his collaborators Albert Ando and Richard Brumberg used Fisher's model of consumer behavior to study the consumption function. One of their goals was to solve the consumption puzzle—that is, to explain the apparently conflicting pieces of evidence that came to light when Keynes's consumption function was brought to the data. According to Fisher's model, consumption depends on a person's lifetime income. Modigliani emphasized that income varies systematically over people's lives and that saving allows consumers to move income from those times in life when income is high to those times when it is low. This interpretation of consumer behavior formed the basis for his **life-cycle hypothesis**.[2]

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[1] Fumio Hayashi, "Why Is Japan's Saving Rate So Apparently High?" *NBER Macroeconomics Annual* (1986): 147–210.

[2] For references to the large body of work on the life-cycle hypothesis, a good place to start is the lecture Modigliani gave when he won the Nobel Prize. Franco Modigliani, "Life Cycle, Individual Thrift, and the Wealth of Nations," *American Economic Review* 76 (June 1986): 297–313.

The Hypothesis

One important reason that income varies over a person's life is retirement. Most people plan to stop working at about age 65, and they expect their incomes to fall when they retire. Yet they do not want a large drop in their standard of living, as measured by their consumption. To maintain consumption after retirement, people must save during their working years. Let's see what this motive for saving implies for the consumption function.

Consider a consumer who expects to live another T years, has wealth of W, and expects to earn income Y until she retires R years from now. What level of consumption will the consumer choose if she wishes to maintain a smooth level of consumption over her life?

The consumer's lifetime resources are composed of initial wealth W and lifetime earnings of $R \times Y$. (For simplicity, we are assuming an interest rate of zero; if the interest rate were greater than zero, we would need to take account of interest earned on savings as well.) The consumer can divide up her lifetime resources among her T remaining years of life. We assume that she wishes to achieve the smoothest possible path of consumption over her lifetime. Therefore, she divides this total of $W + RY$ equally among the T years and each year consumes

$$C = (W + RY)/T.$$

We can write this person's consumption function as

$$C = (1/T)W + (R/T)Y.$$

For example, if the consumer expects to live for 50 more years and work for 30 of them, then $T = 50$ and $R = 30$, so her consumption function is

$$C = 0.02W + 0.6Y.$$

This equation says that consumption depends on both income and wealth. An extra \$1 of income per year raises consumption by \$0.60 per year, and an extra \$1 of wealth raises consumption by \$0.02 per year.

If every individual in the economy plans consumption like this, then the aggregate consumption function is much the same as the individual one. In particular, aggregate consumption depends on both wealth and income. That is, the economy's consumption function is

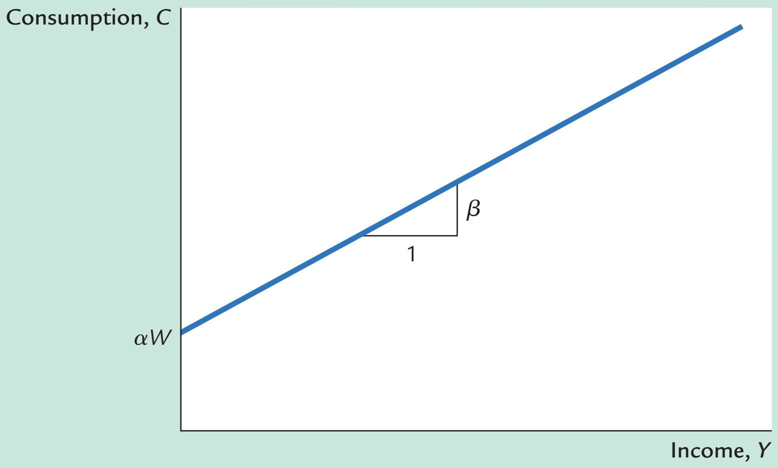
$$C = \alpha W + \beta Y,$$

where the parameter α is the marginal propensity to consume out of wealth, and the parameter β is the marginal propensity to consume out of income.

Implications

Figure 16-10 graphs the relationship between consumption and income predicted by the life-cycle model. For any given level of wealth W, the model yields a conventional consumption function similar to the one shown in Figure 16-1.

figure 16-10



The Life-Cycle Consumption Function The life-cycle model says that consumption depends on wealth as well as income. In other words, the intercept of the consumption function depends on wealth.

Notice, however, that the intercept of the consumption function, which shows what would happen to consumption if income ever fell to zero, is not a fixed value, as it is in Figure 16-1. Instead, the intercept here is αW and, thus, depends on the level of wealth.

This life-cycle model of consumer behavior can solve the consumption puzzle. According to the life-cycle consumption function, the average propensity to consume is

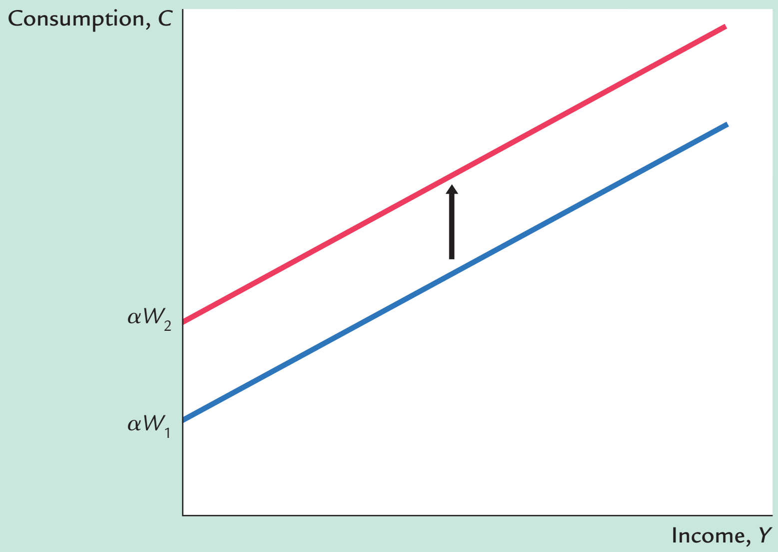
$$C/Y = \alpha(W/Y) + \beta.$$

Because wealth does not vary proportionately with income from person to person or from year to year, we should find that high income corresponds to a low average propensity to consume when looking at data across individuals or over short periods of time. But, over long periods of time, wealth and income grow together, resulting in a constant ratio W/Y and thus a constant average propensity to consume.

To make the same point somewhat differently, consider how the consumption function changes over time. As Figure 16-10 shows, for any given level of wealth, the life-cycle consumption function looks like the one Keynes suggested. But this function holds only in the short run when wealth is constant. In the long run, as wealth increases, the consumption function shifts upward, as in Figure 16-11. This upward shift prevents the average propensity to consume from falling as income increases. In this way, Modigliani resolved the consumption puzzle posed by Simon Kuznets's data.

The life-cycle model makes many other predictions as well. Most important, it predicts that saving varies over a person's lifetime. If a person begins adulthood with no wealth, she will accumulate wealth during her working

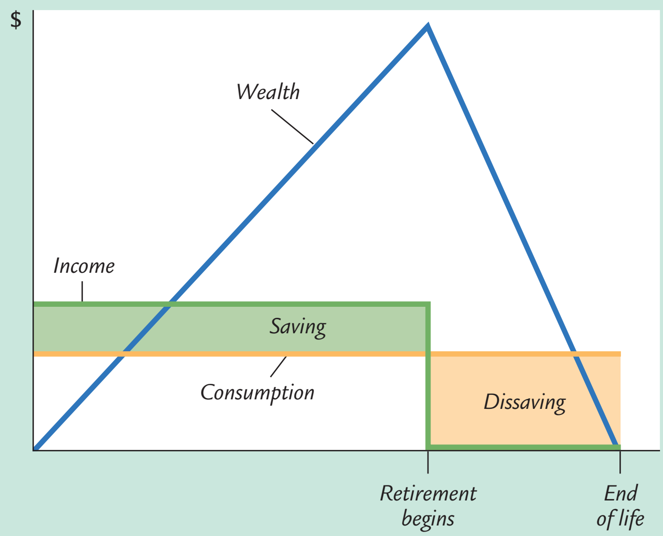
figure 16-11



How Changes in Wealth Shift the Consumption Function If consumption depends on wealth, then an increase in wealth shifts the consumption function upward. Thus, the short-run consumption function (which holds wealth constant) will not continue to hold in the long run (as wealth rises over time).

years and then run down her wealth during her retirement years. Figure 16-12 illustrates the consumer's income, consumption, and wealth over her adult life. According to the life-cycle hypothesis, because people want to smooth consumption over their lives, the young who are working save, while the old who are retired dissave.

figure 16-12



Consumption, Income, and Wealth Over the Life Cycle If the consumer smooths consumption over her life (as indicated by the horizontal consumption line), she will save and accumulate wealth during her working years and then dissave and run down her wealth during retirement.

CASE STUDY

The Consumption and Saving of the Elderly

Many economists have studied the consumption and saving of the elderly. Their findings present a problem for the life-cycle model. It appears that the elderly do not dissave as much as the model predicts. In other words, the elderly do not run down their wealth as quickly as one would expect if they were trying to smooth their consumption over their remaining years of life.

There are two chief explanations for why the elderly do not dissave to the extent that the model predicts. Each suggests a direction for further research on consumption.

The first explanation is that the elderly are concerned about unpredictable expenses. Additional saving that arises from uncertainty is called **precautionary saving**. One reason for precautionary saving by the elderly is the possibility of living longer than expected and thus having to provide for a longer than average span of retirement. Another reason is the possibility of illness and large medical bills. The elderly may respond to this uncertainty by saving more in order to be better prepared for these contingencies.

The precautionary-saving explanation is not completely persuasive, because the elderly can largely insure against these risks. To protect against uncertainty regarding life span, they can buy *annuities* from insurance companies. For a fixed fee, annuities offer a stream of income that lasts as long as the recipient lives. Uncertainty about medical expenses should be largely eliminated by Medicare, the government's health insurance plan for the elderly, and by private insurance plans.

The second explanation for the failure of the elderly to dissave is that they may want to leave bequests to their children. Economists have proposed various theories of the parent–child relationship and the bequest motive. In Chapter 15 we discussed some of these theories and their implications for consumption and fiscal policy.

Overall, research on the elderly suggests that the simplest life-cycle model cannot fully explain consumer behavior. There is no doubt that providing for retirement is an important motive for saving, but other motives, such as precautionary saving and bequests, appear important as well.[3]

16-4 Milton Friedman and the Permanent-Income Hypothesis

In a book published in 1957, Milton Friedman proposed the **permanent-income hypothesis** to explain consumer behavior. Friedman's permanent-income hypothesis complements Modigliani's life-cycle hypothesis: both use

[3] To read more about the consumption and saving of the elderly, see Albert Ando and Arthur Kennickell, "How Much (or Little) Life Cycle Saving Is There in Micro Data?" in Rudiger Dornbusch, Stanley Fischer, and John Bossons, eds., *Macroeconomics and Finance: Essays in Honor of Franco Modigliani* (Cambridge, Mass.: MIT Press, 1986); and Michael Hurd, "Research on the Elderly: Economic Status, Retirement, and Consumption and Saving," *Journal of Economic Literature* 28 (June 1990): 565–589.

Irving Fisher's theory of the consumer to argue that consumption should not depend on current income alone. But unlike the life-cycle hypothesis, which emphasizes that income follows a regular pattern over a person's lifetime, the permanent-income hypothesis emphasizes that people experience random and temporary changes in their incomes from year to year.[4]

The Hypothesis

Friedman suggested that we view current income Y as the sum of two components, **permanent income** Y^P and **transitory income** Y^T. That is,

$$Y = Y^P + Y^T.$$

Permanent income is the part of income that people expect to persist into the future. Transitory income is the part of income that people do not expect to persist. Put differently, permanent income is average income, and transitory income is the random deviation from that average.

To see how we might separate income into these two parts, consider these examples:

- Maria, who has a law degree, earned more this year than John, who is a high-school dropout. Maria's higher income resulted from higher permanent income, because her education will continue to provide her a higher salary.
- Sue, a Florida orange grower, earned less than usual this year because a freeze destroyed her crop. Bill, a California orange grower, earned more than usual because the freeze in Florida drove up the price of oranges. Bill's higher income resulted from higher transitory income, because he is no more likely than Sue to have good weather next year.

These examples show that different forms of income have different degrees of persistence. A good education provides a permanently higher income, whereas good weather provides only transitorily higher income. Although one can imagine intermediate cases, it is useful to keep things simple by supposing that there are only two kinds of income: permanent and transitory.

Friedman reasoned that consumption should depend primarily on permanent income, because consumers use saving and borrowing to smooth consumption in response to transitory changes in income. For example, if a person received a permanent raise of \$10,000 per year, his consumption would rise by about as much. Yet if a person won \$10,000 in a lottery, he would not consume it all in one year. Instead, he would spread the extra consumption over the rest of his life. Assuming an interest rate of zero and a remaining life span of 50 years,

[4] Milton Friedman, *A Theory of the Consumption Function* (Princeton, N.J.: Princeton University Press, 1957).

consumption would rise by only $200 per year in response to the $10,000 prize. Thus, consumers spend their permanent income, but they save rather than spend most of their transitory income.

Friedman concluded that we should view the consumption function as approximately

$$C = \alpha Y^{\mathrm{P}},$$

where α is a constant that measures the fraction of permanent income consumed. The permanent-income hypothesis, as expressed by this equation, states that consumption is proportional to permanent income.

Implications

The permanent-income hypothesis solves the consumption puzzle by suggesting that the standard Keynesian consumption function uses the wrong variable. According to the permanent-income hypothesis, consumption depends on permanent income; yet many studies of the consumption function try to relate consumption to current income. Friedman argued that this *errors-in-variables problem* explains the seemingly contradictory findings.

Let's see what Friedman's hypothesis implies for the average propensity to consume. Divide both sides of his consumption function by Y to obtain

$$APC = C/Y = \alpha Y^{\mathrm{P}}/Y.$$

According to the permanent-income hypothesis, the average propensity to consume depends on the ratio of permanent income to current income. When current income temporarily rises above permanent income, the average propensity to consume temporarily falls; when current income temporarily falls below permanent income, the average propensity to consume temporarily rises.

Now consider the studies of household data. Friedman reasoned that these data reflect a combination of permanent and transitory income. Households with high permanent income have proportionately higher consumption. If all variation in current income came from the permanent component, the average propensity to consume would be the same in all households. But some of the variation in income comes from the transitory component, and households with high transitory income do not have higher consumption. Therefore, researchers find that high-income households have, on average, lower average propensities to consume.

Similarly, consider the studies of time-series data. Friedman reasoned that year-to-year fluctuations in income are dominated by transitory income. Therefore, years of high income should be years of low average propensities to consume. But over long periods of time—say, from decade to decade—the variation in income comes from the permanent component. Hence, in long time-series, one should observe a constant average propensity to consume, as in fact Kuznets found.

CASE STUDY

The 1964 Tax Cut and the 1968 Tax Surcharge

The permanent-income hypothesis can help us to interpret how the economy responds to changes in fiscal policy. According to the *IS–LM* model of Chapters 10 and 11, tax cuts stimulate consumption and raise aggregate demand, and tax increases depress consumption and reduce aggregate demand. The permanent-income hypothesis, however, predicts that consumption responds only to changes in permanent income. Therefore, transitory changes in taxes will have only a negligible effect on consumption and aggregate demand. If a change in taxes is to have a large effect on aggregate demand, it must be permanent.

Two changes in fiscal policy—the tax cut of 1964 and the tax surcharge of 1968—illustrate this principle. The tax cut of 1964 was popular. It was announced to be a major and permanent reduction in tax rates. As we discussed in Chapter 10, this policy change had the intended effect of stimulating the economy.

The tax surcharge of 1968 arose in a very different political climate. It became law because the economic advisers of President Lyndon Johnson believed that the increase in government spending from the Vietnam War had excessively stimulated aggregate demand. To offset this effect, they recommended a tax increase. But Johnson, aware that the war was already unpopular, feared the political repercussions of higher taxes. He finally agreed to a temporary tax surcharge—in essence, a one-year increase in taxes. The tax surcharge did not have the desired effect of reducing aggregate demand. Unemployment continued to fall, and inflation continued to rise.

The lesson to be learned from these episodes is that a full analysis of tax policy must go beyond the simple Keynesian consumption function; it must take into account the distinction between permanent and transitory income. If consumers expect a tax change to be temporary, it will have a smaller impact on consumption and aggregate demand.

16-5 Robert Hall and the Random-Walk Hypothesis

The permanent-income hypothesis is based on Fisher's model of intertemporal choice. It builds on the idea that forward-looking consumers base their consumption decisions not only on their current income but also on the income they expect to receive in the future. Thus, the permanent-income hypothesis highlights that consumption depends on people's expectations.

Recent research on consumption has combined this view of the consumer with the assumption of rational expectations. The rational-expectations assumption states that people use all available information to make optimal forecasts about the future. As we saw in Chapter 13, this assumption can have profound implications for the costs of stopping inflation. It can also have profound implications for the study of consumer behavior.

The Hypothesis

The economist Robert Hall was the first to derive the implications of rational expectations for consumption. He showed that if the permanent-income hypothesis is correct, and if consumers have rational expectations, then changes in consumption over time should be unpredictable. When changes in a variable are unpredictable, the variable is said to follow a **random walk**. According to Hall, the combination of the permanent-income hypothesis and rational expectations implies that consumption follows a random walk.

Hall reasoned as follows. According to the permanent-income hypothesis, consumers face fluctuating income and try their best to smooth their consumption over time. At any moment, consumers choose consumption based on their current expectations of their lifetime incomes. Over time, they change their consumption because they receive news that causes them to revise their expectations. For example, a person getting an unexpected promotion increases consumption, whereas a person getting an unexpected demotion decreases consumption. In other words, changes in consumption reflect "surprises" about lifetime income. If consumers are optimally using all available information, then they should be surprised only by events that were entirely unpredictable. Therefore, changes in their consumption should be unpredictable as well.[5]

Implications

The rational-expectations approach to consumption has implications not only for forecasting but also for the analysis of economic policies. *If consumers obey the permanent-income hypothesis and have rational expectations, then only unexpected policy changes influence consumption. These policy changes take effect when they change expectations*. For example, suppose that today Congress passes a tax increase to be effective next year. In this case, consumers receive the news about their lifetime incomes when Congress passes the law (or even earlier if the law's passage was predictable). The arrival of this news causes consumers to revise their expectations and reduce their consumption. The following year, when the tax hike goes into effect, consumption is unchanged because no news has arrived.

Hence, if consumers have rational expectations, policymakers influence the economy not only through their actions but also through the public's expectation of their actions. Expectations, however, cannot be observed directly. Therefore, it is often hard to know how and when changes in fiscal policy alter aggregate demand.

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[5] Robert E. Hall, "Stochastic Implications of the Life Cycle–Permanent Income Hypothesis: Theory and Evidence," *Journal of Political Economy* 86 (April 1978): 971–987.

CASE STUDY

Do Predictable Changes in Income Lead to Predictable Changes in Consumption?

Of the many facts about consumer behavior, one is impossible to dispute: income and consumption fluctuate together over the business cycle. When the economy goes into a recession, both income and consumption fall, and when the economy booms, both income and consumption rise rapidly.

By itself, this fact doesn't say much about the rational-expectations version of the permanent-income hypothesis. Most short-run fluctuations are unpredictable. Thus, when the economy goes into a recession, the typical consumer is receiving bad news about his lifetime income, so consumption naturally falls. And when the economy booms, the typical consumer is receiving good news, so consumption rises. This behavior does not necessarily violate the random-walk theory that changes in consumption are impossible to forecast.

Yet suppose we could identify some *predictable* changes in income. According to the random-walk theory, these changes in income should not cause consumers to revise their spending plans. If consumers expected income to rise or fall, they should have adjusted their consumption already in response to that information. Thus, predictable changes in income should not lead to predictable changes in consumption.

Data on consumption and income, however, appear not to satisfy this implication of the random-walk theory. When income is expected to fall by $1, consumption will on average fall at the same time by about $0.50. In other words, predictable changes in income lead to predictable changes in consumption that are roughly half as large.

Why is this so? One possible explanation of this behavior is that some consumers may fail to have rational expectations. Instead, they may base their expectations of future income excessively on current income. Thus, when income rises or falls (even predictably), they act as if they received news about their lifetime resources and change their consumption accordingly. Another possible explanation is that some consumers are borrowing-constrained and, therefore, base their consumption on current income alone. Regardless of which explanation is correct, Keynes's original consumption function starts to look more attractive. That is, current income has a larger role in determining consumer spending than the random-walk hypothesis suggests.[6]

[6] John Y. Campbell and N. Gregory Mankiw, "Consumption, Income, and Interest Rates: Reinterpreting the Time-Series Evidence," *NBER Macroeconomics Annual* (1989): 185–216; Jonathan Parker, "The Response of Household Consumption to Predictable Changes in Social Security Taxes," *American Economic Review* 89 (September 1999): 959–973; and Nicholas S. Souleles, "The Response of Household Consumption to Income Tax Refunds," *American Economic Review* 89 (September 1999): 947–958.

16.6 David Laibson and the Pull of Instant Gratification

Keynes called the consumption function a "fundamental psychological law." Yet, as we have seen, psychology has played little role in the subsequent study of consumption. Most economists assume that consumers are rational maximizers of utility who are always evaluating their opportunities and plans in order to obtain the highest lifetime satisfaction. This model of human behavior was the basis for all the work on consumption theory from Irving Fisher to Robert Hall.

More recently, economists have started to return to psychology. They have suggested that consumption decisions are not made by the ultrarational *homo economicus* but by real human beings whose behavior can be far from rational. The most prominent economist infusing psychology into the study of consumption is Harvard professor David Laibson.

Laibson notes that many consumers judge themselves to be imperfect decisionmakers. In one survey of the American public, 76 percent said they were not saving enough for retirement. In another survey of the baby-boom generation, respondents were asked the percentage of income that they save and the percentage that they thought they should save. The saving shortfall averaged 11 percentage points.

According to Laibson, the insufficiency of saving is related to another phenomenon: the pull of instant gratification. Consider the following two questions:

Question 1: Would you prefer (A) a candy today or (B) two candies tomorrow.

Question 2: Would you prefer (A) a candy in 100 days or (B) two candies in 101 days.

Many people confronted with such choices will answer A to the first question and B to the second. In a sense, they are more patient in the long run than they are in the short run.

This raises the possibility that consumers' preferences may be *time-inconsistent*: they may alter their decisions simply because time passes. A person confronting question 2 may choose B and wait the extra day for the extra candy. But after 100 days pass, he then confronts question 1. The pull of instant gratification may induce him to change his mind.

We see this kind of behavior in many situations in life. A person on a diet may have a second helping at dinner, while promising himself that he will eat less tomorrow. A person may smoke one more cigarette, while promising himself that this is the last one. And a consumer may splurge at the shopping center, while promising himself that tomorrow he will cut back his spending and start saving more for retirement. But when tomorrow arrives, the promises are in the past, and a new self takes control of the decisionmaking, with its own desire for instant gratification.

These observations raise as many questions as they answer. Will the renewed focus on psychology among economists offer a better understanding of consumer behavior? Will it offer new prescriptions regarding, for instance, tax policy toward saving? It is too early to say, but without doubt, these questions are on the forefront of the research agenda.[7]

16.7 Conclusion

In the work of six prominent economists, we have seen a progression of views on consumer behavior. Keynes proposed that consumption depends largely on current income. Since then, economists have argued that consumers understand that they face an intertemporal decision. Consumers look ahead to their future resources and needs, implying a more complex consumption function than the one that Keynes proposed. Keynes suggested a consumption function of the form

$$\text{Consumption} = f(\text{Current Income}).$$

Recent work suggests instead that

$$\text{Consumption} = f(\text{Current Income, Wealth, Expected Future Income, Interest Rates}).$$

In other words, current income is only one determinant of aggregate consumption.

Economists continue to debate the importance of these determinants of consumption. There remains disagreement about, for example, the influence of interest rates on consumer spending, the prevalence of borrowing constraints, and the importance of psychological effects. Economists sometimes disagree about economic policy because they assume different consumption functions. For instance, as we saw in the previous chapter, the debate over the effects of government debt is in part a debate over the determinants of consumer spending. The key role of consumption in policy evaluation is sure to maintain economists' interest in studying consumer behavior for many years to come.

Summary

1. Keynes conjectured that the marginal propensity to consume is between zero and one, that the average propensity to consume falls as income rises, and that current income is the primary determinant of consumption. Studies of household data and short time-series confirmed Keynes's conjectures. Yet studies of long time-series found no tendency for the average propensity to consume to fall as income rises over time.

2. Recent work on consumption builds on Irving Fisher's model of the consumer. In this model, the consumer faces an intertemporal budget constraint

[7] For more on this topic, see David Laibson, "Golden Eggs and Hyperbolic Discounting," *Quarterly Journal of Economics* 62 (May 1997): 443–477; and George-Marios Angeletos, David Laibson, Andrea Repetto, Jeremy Tobacman, and Stephen Weinberg, "The Hyperbolic Buffer Stock Model: Calibration, Simulation, and Empirical Evidence," *Journal of Economic Perspectives*, 15(3) (Summer 2001): 47–68.

and chooses consumption for the present and the future to achieve the highest level of lifetime satisfaction. As long as the consumer can save and borrow, consumption depends on the consumer's lifetime resources.

3. Modigliani's life-cycle hypothesis emphasizes that income varies somewhat predictably over a person's life and that consumers use saving and borrowing to smooth their consumption over their lifetimes. According to this hypothesis, consumption depends on both income and wealth.
4. Friedman's permanent-income hypothesis emphasizes that individuals experience both permanent and transitory fluctuations in their income. Because consumers can save and borrow, and because they want to smooth their consumption, consumption does not respond much to transitory income. Consumption depends primarily on permanent income.
5. Hall's random-walk hypothesis combines the permanent-income hypothesis with the assumption that consumers have rational expectations about future income. It implies that changes in consumption are unpredictable, because consumers change their consumption only when they receive news about their lifetime resources.
6. Laibson has suggested that psychological effects are important for understanding consumer behavior. In particular, because people have a strong desire for instant gratification, they may exhibit time-inconsistent behavior and may end up saving less than they would like.

KEY CONCEPTS

Marginal propensity to consume
Average propensity to consume
Intertemporal budget constraint
Discounting
Indifference curves
Marginal rate of substitution
Normal good
Income effect
Substitution effect
Borrowing constraint
Life-cycle hypothesis
Precautionary saving
Permanent-income hypothesis
Permanent income
Transitory income
Random walk

QUESTIONS FOR REVIEW

1. What were Keynes's three conjectures about the consumption function?
2. Describe the evidence that was consistent with Keynes's conjectures and the evidence that was inconsistent with them.
3. How do the life-cycle and permanent-income hypotheses resolve the seemingly contradictory pieces of evidence regarding consumption behavior?
4. Use Fisher's model of consumption to analyze an increase in second-period income. Compare the case in which the consumer faces a binding borrowing constraint and the case in which he does not.
5. Explain why changes in consumption are unpredictable if consumers obey the permanent-income hypothesis and have rational expectations.
6. Give an example in which someone might exhibit time-inconsistent preferences.

PROBLEMS AND APPLICATIONS

1. The chapter uses the Fisher model to discuss a change in the interest rate for a consumer who saves some of his first-period income. Suppose, instead, that the consumer is a borrower. How does that alter the analysis? Discuss the income and substitution effects on consumption in both periods.

2. Jack and Jill both obey the two-period Fisher model of consumption. Jack earns \$100 in the first period and \$100 in the second period. Jill earns nothing in the first period and \$210 in the second period. Both of them can borrow or lend at the interest rate r.

   a. You observe both Jack and Jill consuming \$100 in the first period and \$100 in the second period. What is the interest rate r?

   b. Suppose the interest rate increases. What will happen to Jack's consumption in the first period? Is Jack better off or worse off than before the interest rate rise?

   c. What will happen to Jill's consumption in the first period when the interest rate increases? Is Jill better off or worse off than before the interest-rate increase?

3. The chapter analyzes Fisher's model for the case in which the consumer can save or borrow at an interest rate of r and for the case in which the consumer can save at this rate but cannot borrow at all. Consider now the intermediate case in which the consumer can save at rate r_s and borrow at rate r_b, where $r_s < r_b$.

   a. What is the consumer's budget constraint in the case in which he consumes less than his income in period one?

   b. What is the consumer's budget constraint in the case in which he consumes more than his income in period one?

   c. Graph the two budget constraints and shade the area that represents the combination of first-period and second-period consumption the consumer can choose.

   d. Now add to your graph the consumer's indifference curves. Show three possible outcomes: one in which the consumer saves, one in which he borrows, and one in which he neither saves nor borrows.

   e. What determines first-period consumption in each of the three cases?

4. Explain whether borrowing constraints increase or decrease the potency of fiscal policy to influence aggregate demand in each of the following two cases:

   a. A temporary tax cut.

   b. An announced future tax cut.

5. In the discussion of the life-cycle hypothesis in the text, income is assumed to be constant during the period before retirement. For most people, however, income grows over their lifetimes. How does this growth in income influence the lifetime pattern of consumption and wealth accumulation shown in Figure 16-12 under the following conditions?

   a. Consumers can borrow, so their wealth can be negative.

   b. Consumers face borrowing constraints that prevent their wealth from falling below zero.

   Do you consider case (a) or case (b) to be more realistic? Why?

6. Demographers predict that the fraction of the population that is elderly will increase over the next 20 years. What does the life-cycle model predict for the influence of this demographic change on the national saving rate?

7. One study found that the elderly who do not have children dissave at about the same rate as the elderly who do have children. What might this finding imply about the reason the elderly do not dissave as much as the life-cycle model predicts?

8. Consider two savings accounts that pay the same interest rate. One account lets you take your money out on demand. The second requires that you give 30-day advance notification before withdrawals. Which account would you prefer? Why? Can you imagine a person who might make the opposite choice? What do these choices say about the theory of the consumption function?

Answers to Textbook Questions and Problems

CHAPTER 1 The Science of Macroeconomics

Questions for Review

1. Microeconomics is the study of how individual firms and households make decisions, and how they interact with one another. Microeconomic models of firms and households are based on principles of optimization—firms and households do the best they can given the constraints they face. For example, households choose which goods to purchase in order to maximize their utility, whereas firms decide how much to produce in order to maximize profits. In contrast, macroeconomics is the study of the economy as a whole; it focuses on issues such as how total output, total employment, and the overall price level are determined. These economy-wide variables are based on the interaction of many households and many firms; therefore, microeconomics forms the basis for macroeconomics.
2. Economists build models as a means of summarizing the relationships among economic variables. Models are useful because they abstract from the many details in the economy and allow one to focus on the most important economic connections.
3. A market-clearing model is one in which prices adjust to equilibrate supply and demand. Market-clearing models are useful in situations where prices are flexible. Yet in many situations, flexible prices may not be a realistic assumption. For example, labor contracts often set wages for up to three years. Or, firms such as magazine publishers change their prices only every three to four years. Most macroeconomists believe that price flexibility is a reasonable assumption for studying long-run issues. Over the long run, prices respond to changes in demand or supply, even though in the short run they may be slow to adjust.

Problems and Applications

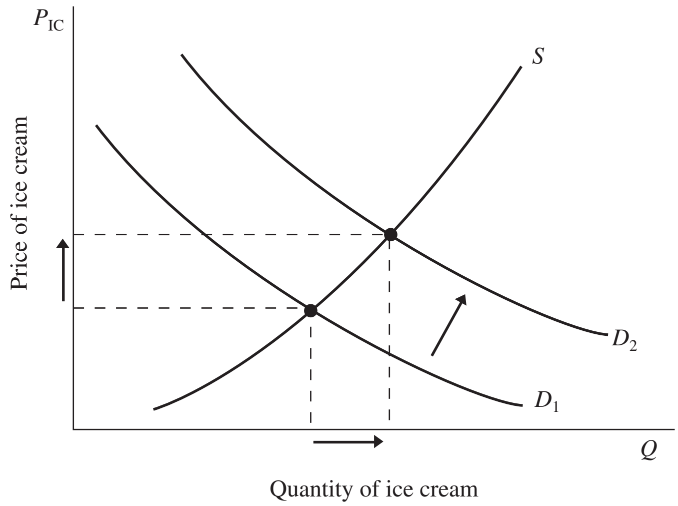
1. The many recent macroeconomic issues that have been in the news lately (early 2002) include the recession that began in March 2001, sharp reductions in the Federal Reserve's target interest rate (the so-called *Federal Funds rate*) in 2001, whether the government should implement tax cuts or spending increases to stimulate the economy, and a financial crisis in Argentina.
2. Many philosophers of science believe that the defining characteristic of a science is the use of the scientific method of inquiry to establish stable relationships. Scientists examine data, often provided by controlled experiments, to support or disprove a hypothesis. Economists are more limited in their use of experiments. They cannot conduct controlled experiments on the economy; they must rely on the natural course of developments in the economy to collect data. To the extent that economists use the scientific method of inquiry, that is, developing hypotheses and testing them, economics has the characteristics of a science.
3. We can use a simple variant of the supply-and-demand model for pizza to answer this question. Assume that the quantity of ice cream demanded depends not only on the price of ice cream and income, but also on the price of frozen yogurt:

$$Q^d = D(P_{IC}, P_{FY}, Y).$$

We expect that demand for ice cream rises when the price of frozen yogurt rises, because ice cream and frozen yogurt are substitutes. That is, when the price of frozen yogurt goes up, I consume less of it and, instead, fulfill more of my frozen dessert urges through the consumption of ice cream.

The next part of the model is the supply function for ice cream, $Q^s = S(P_{IC})$. Finally, in equilibrium, supply must equal demand, so that $Q^s = Q^d$. Y and P_{FY} are the exogenous variables, and Q and P_{IC} are the endogenous variables. Figure 1–1 uses this model to show that a fall in the price of frozen yogurt results in an inward shift of the demand curve for ice cream. The new equilibrium has a lower price and quantity of ice cream.

Figure 1–1



4. The price of haircuts changes rather infrequently. From casual observation, hairstylists tend to charge the same price over a one- or two-year period irrespective of the demand for haircuts or the supply of cutters. A market-clearing model for analyzing the market for haircuts has the unrealistic assumption of flexible prices. Such an assumption is unrealistic in the short run when we observe that prices are inflexible. Over the long run, however, the price of haircuts does tend to adjust; a market-clearing model is therefore appropriate.

CHAPTER 2 The Data of Macroeconomics

Questions for Review

1. GDP measures both the total income of everyone in the economy and the total expenditure on the economy's output of goods and services. GDP can measure two things at once because both are really the same thing: for an economy as a whole, income must equal expenditure. As the circular flow diagram in the text illustrates, these are alternative, equivalent ways of measuring the flow of dollars in the economy.
2. The consumer price index measures the overall level of prices in the economy. It tells us the price of a fixed basket of goods relative to the price of the same basket in the base year.
3. The Bureau of Labor Statistics classifies each person into one of the following three categories: employed, unemployed, or not in the labor force. The unemployment rate, which is the percentage of the labor force that is unemployed, is computed as follows:

   $$\text{Unemployment Rate} = \frac{\text{Number of Unemployed} \times 100}{\text{Labor Force}}.$$

   Note that the labor force is the number of people employed plus the number of people unemployed.
4. Okun's law refers to the negative relationship that exists between unemployment and real GDP. Employed workers help produce goods and services whereas unemployed workers do not. Increases in the unemployment rate are therefore associated with decreases in real GDP. Okun's law can be summarized by the equation:

   $$\%\Delta\text{Real GDP} = 3\% - 2 \times (\Delta\text{Unemployment Rate}).$$

   That is, if unemployment does not change, the growth rate of real GDP is 3 percent. For every percentage-point change in unemployment (for example, a fall from 6 percent to 5 percent, or an increase from 6 percent to 7 percent), output changes by 2 percent in the opposite direction.

Problems and Applications

1. A large number of economic statistics are released regularly. These include the following:

   Gross Domestic Product—the market value of all final goods and services produced in a year.

   The Unemployment Rate—the percentage of the civilian labor force who do not have a job.

   Corporate Profits—the accounting profits remaining after taxes of all manufacturing corporations. It gives an indication of the general financial health of the corporate sector.

   The Consumer Price Index (CPI)—a measure of the average price that consumers pay for the goods they buy; changes in the CPI are a measure of inflation.

   The Trade Balance—the difference between the value of goods exported abroad and the value of goods imported from abroad.

2. Value added by each person is the value of the good produced minus the amount th person paid for the materials necessary to make the good. Therefore, the value adde by the farmer is $1.00 ($1 – 0 = $1). The value added by the miller is $2: she sells th flour to the baker for $3 but paid $1 for the flour. The value added by the baker is $3 she sells the bread to the engineer for $6 but paid the miller $3 for the flour. GDP is th total value added, or $1 + $2 + $3 = $6. Note that GDP equals the value of the fina good (the bread).

3. When a woman marries her butler, GDP falls by the amount of the butler's salary. Thi happens because measured total income, and therefore measured GDP, falls by th amount of the butler's loss in salary. If GDP truly measured the value of all goods an services, then the marriage would not affect GDP since the total amount of economi activity is unchanged. Actual GDP, however, is an imperfect measure of economic activ ity because the value of some goods and services is left out. Once the butler's wor becomes part of his household chores, his services are no longer counted in GDP. A this example illustrates, GDP does not include the value of any output produced in th home. Similarly, GDP does not include other goods and services, such as the impute rent on durable goods (e.g., cars and refrigerators) and any illegal trade.

4. a. government purchases
   b. investment
   c. net exports
   d. consumption
   e. investment

5. Data on parts (a) to (g) can be downloaded from the Bureau of Economic Analysi (www.bea.doc.gov—follow the links to GDP and related data). Most of the data (no necessarily the earliest year) can also be found in the *Economic Report of the Presiden* By dividing each component (a) to (g) by nominal GDP and multiplying by 100, w obtain the following percentages:

	1950	1975	2000
a. Personal consumption expenditures	65.5%	63.0%	68.2%
b. Gross private domestic investment	18.4%	14.1%	17.9%
c. Government consumption purchases	15.9%	22.1%	17.6%
d. Net exports	0.2%	0.8%	–3.7%
e. National defense purchases	6.7%	6.6%	3.8%
f. State and local purchases	7.1%	12.8%	11.7%
g. Imports	3.9%	7.5%	14.9%

(Note: These data were downloaded February 5, 2002 from the BEA web site.)

Among other things, we observe the following trends in the economy over the perio 1950–2000:

(a) Personal consumption expenditures have been around two-thirds of GDP, although th share increased about 5 percentage points between 1975 and 2000.

(b) The share of GDP going to gross private domestic investment fell from 1950 to 1975 bu then rebounded.

(c) The share going to government consumption purchases rose more than 6 percentag points from 1950 to 1975 but has receded somewhat since then.

(d) Net exports, which were positive in 1950 and 1975, were substantially negative i 2000.

(e) The share going to national defense purchases fell from 1975 to 2000.

(f) The share going to state and local purchases rose from 1950 to 1975.

(g) Imports have grown rapidly relative to GDP.

6. a. i. Nominal GDP is the total value of goods and services measured at current prices. Therefore,

$$\begin{aligned}
\text{Nominal GDP}_{2000} &= (P^{2000}_{\text{cars}} \times Q^{2000}_{\text{cars}}) + (P^{2000}_{\text{bread}} \times Q^{2000}_{\text{bread}}) \\
&= (\$50{,}000 \times 100) + (\$10 \times 500{,}000) \\
&= \$5{,}000{,}000 + \$5{,}000{,}000 \\
&= \$10{,}000{,}000. \\
\text{Nominal GDP}_{2010} &= (P^{2010}_{\text{cars}} \times Q^{2010}_{\text{cars}}) + (P^{2010}_{\text{bread}} \times Q^{2010}_{\text{bread}}) \\
&= (\$60{,}000 \times 120) + (\$20 \times 400{,}000) \\
&= \$7{,}200{,}000 + \$8{,}000{,}000 \\
&= \$15{,}200{,}000.
\end{aligned}$$

ii. Real GDP is the total value of goods and services measured at constant prices. Therefore, to calculate real GDP in 2010 (with base year 2000), multiply the quantities purchased in the year 2010 by the 2000 prices:

$$\begin{aligned}
\text{Real GDP}_{2010} &= (P^{2000}_{\text{cars}} \times Q^{2010}_{\text{cars}}) + (P^{2000}_{\text{bread}} \times Q^{2010}_{\text{bread}}) \\
&= (\$50{,}000 \times 120) + (\$10 \times 400{,}000) \\
&= \$6{,}000{,}000 + \$4{,}000{,}000 \\
&= \$10{,}000{,}000.
\end{aligned}$$

Real GDP for 2000 is calculated by multiplying the quantities in 2000 by the prices in 2000. Since the base year is 2000, real GDP_{2000} equals nominal GDP_{2000}, which is \$10,000,000. Hence, real GDP stayed the same between 2000 and 2010.

iii. The implicit price deflator for GDP compares the current prices of all goods and services produced to the prices of the same goods and services in a base year. It is calculated as follows:

$$\text{Implicit Price Deflator}_{2010} = \frac{\text{Nominal GDP}_{2010}}{\text{Real GDP}_{2010}}.$$

Using the values for Nominal GDP_{2010} and real GDP_{2010} calculated above:

$$\begin{aligned}
\text{Implicit Price Deflator}_{2010} &= \frac{\$15{,}200{,}000}{\$10{,}000{,}000} \\
&= 1.52.
\end{aligned}$$

This calculation reveals that prices of the goods produced in the year 2010 increased by 52 percent compared to the prices that the goods in the economy sold for in 2000. (Because 2000 is the base year, the value for the implicit price deflator for the year 2000 is 1.0 because nominal and real GDP are the same for the base year.)

iv. The consumer price index (CPI) measures the level of prices in the economy. The CPI is called a fixed-weight index because it uses a fixed basket of goods over time to weight prices. If the base year is 2000, the CPI in 2010 is an average of prices in 2010, but weighted by the composition of goods produced in 2000. The CPI_{2010} is calculated as follows:

$$\begin{aligned}
\text{CPI}_{2010} &= \frac{(P^{2010}_{\text{cars}} \times Q^{2000}_{\text{cars}}) + (P^{2010}_{\text{bread}} \times Q^{2000}_{\text{bread}})}{(P^{2000}_{\text{cars}} \times Q^{2000}_{\text{cars}}) + (P^{2000}_{\text{bread}} \times Q^{2000}_{\text{bread}})} \\
&= \frac{(\$60{,}000 \times 100) + (\$20 \times 500{,}000)}{(\$50{,}000 \times 100) + (\$10 \times 500{,}000)} \\
&= \frac{\$16{,}000{,}000}{\$10{,}000{,}000} \\
&= 1.6.
\end{aligned}$$

This calculation shows that the price of goods purchased in 2010 increased by 6 percent compared to the prices these goods would have sold for in 2000. The CP for 2000, the base year, equals 1.0.

b. The implicit price deflator is a Paasche index because it is computed with a chang ing basket of goods; the CPI is a Laspeyres index because it is computed with fixed basket of goods. From (5.a.iii), the implicit price deflator for the year 2010 i 1.52, which indicates that prices rose by 52 percent from what they were in th year 2000. From (5.a.iv.), the CPI for the year 2010 is 1.6, which indicates tha prices rose by 60 percent from what they were in the year 2000.

If prices of all goods rose by, say, 50 percent, then one could say unam biguously that the price level rose by 50 percent. Yet, in our example, relativ prices have changed. The price of cars rose by 20 percent; the price of bread ros by 100 percent, making bread relatively more expensive.

As the discrepancy between the CPI and the implicit price deflator illus trates, the change in the price level depends on how the goods' prices are weight ed. The CPI weights the price of goods by the quantities purchased in the yea 2000. The implicit price deflator weights the price of goods by the quantities pur chased in the year 2010. The quantity of bread consumed was higher in 2000 tha in 2010, so the CPI places a higher weight on bread. Since the price of brea increased relatively more than the price of cars, the CPI shows a larger increas in the price level.

c. There is no clear-cut answer to this question. Ideally, one wants a measure of th price level that accurately captures the cost of living. As a good becomes relativel more expensive, people buy less of it and more of other goods. In this exampl consumers bought less bread and more cars. An index with fixed weights, such a the CPI, overestimates the change in the cost of living because it does not tak into account that people can substitute less expensive goods for the ones tha become more expensive. On the other hand, an index with changing weights, suc as the GDP deflator, underestimates the change in the cost of living because i does not take into account that these induced substitutions make people less we off.

7. a. The consumer price index uses the consumption bundle in year 1 to figure out ho much weight to put on the price of a given good:

$$\begin{aligned}\text{CPI}^2 &= \frac{(P^2_{\text{red}} \times Q^1_{\text{red}}) + (P^2_{\text{green}} \times Q^1_{\text{green}})}{(P^1_{\text{red}} \times Q^1_{\text{red}}) + (P^1_{\text{green}} \times Q^1_{\text{green}})} \\ &= \frac{(\$2 \times 10) + (\$1 \times 0)}{(\$1 \times 10) + (\$2 \times 0)} \\ &= 2.\end{aligned}$$

According to the CPI, prices have doubled.

b. Nominal spending is the total value of output produced in each year. In year 1 an year 2, Abby buys 10 apples for \$1 each, so her nominal spending remains con stant at \$10. For example,

$$\begin{aligned}\text{Nominal Spending}_2 &= (P^2_{\text{red}} \times Q^2_{\text{red}}) + (P^2_{\text{green}} \times Q^2_{\text{green}}) \\ &= (\$2 \times 0) + (\$1 \times 10) \\ &= \$10.\end{aligned}$$

c. Real spending is the total value of output produced in each year valued at the prices prevailing in year 1. In year 1, the base year, her real spending equals her nominal spending of \$10. In year 2, she consumes 10 green apples that are each valued at their year 1 price of \$2, so her real spending is \$20. That is,

$$\begin{aligned}\text{Real Spending}_2 &= (P^1_{\text{red}} \times Q^2_{\text{red}}) + (P^1_{\text{green}} \times Q^2_{\text{green}})\\ &= (\$1 \times 0) + (\$2 \times 10)\\ &= \$20.\end{aligned}$$

Hence, Abby's real spending rises from \$10 to \$20.

d. The implicit price deflator is calculated by dividing Abby's nominal spending in year 2 by her real spending that year:

$$\begin{aligned}\text{Implicit Price Deflator}_2 &= \frac{\text{Nominal Spending}_2}{\text{Real Spending}_2}\\ &= \frac{\$10}{\$20}\\ &= 0.5.\end{aligned}$$

Thus, the implicit price deflator suggests that prices have fallen by half. The reason for this is that the deflator estimates how much Abby values her apples using prices prevailing in year 1. From this perspective green apples appear very valuable. In year 2, when Abby consumes 10 green apples, it appears that her consumption has increased because the deflator values green apples more highly than red apples. The only way she could still be spending \$10 on a higher consumption bundle is if the price of the good she was consuming feel.

e. If Abby thinks of red apples and green apples as perfect substitutes, then the cost of living in this economy has not changed—in either year it costs \$10 to consume 10 apples. According to the CPI, however, the cost of living has doubled. This is because the CPI only takes into account the fact that the red apple price has doubled; the CPI ignores the fall in the price of green apples because they were not in the consumption bundle in year 1. In contrast to the CPI, the implicit price deflator estimates the cost of living has halved. Thus, the CPI, a Laspeyres index, overstates the increase in the cost of living and the deflator, a Paasche index, understates it. This chapter of the text discusses the difference between Laspeyres and Paasche indices in more detail.

8. a. Real GDP falls because Disney does not produce any services while it is closed. This corresponds to a decrease in economic well-being because the income of workers and shareholders of Disney falls (the income side of the national accounts), and people's consumption of Disney falls (the expenditure side of the national accounts).

b. Real GDP rises because the original capital and labor in farm production now produce more wheat. This corresponds to an increase in the economic well-being of society, since people can now consume more wheat. (If people do not want to consume more wheat, then farmers and farmland can be shifted to producing other goods that society values.)

c. Real GDP falls because with fewer workers on the job, firms produce less. This accurately reflects a fall in economic well-being.

d. Real GDP falls because the firms that lay off workers produce less. This decreases economic well-being because workers' incomes fall (the income side), and there are fewer goods for people to buy (the expenditure side).

e. Real GDP is likely to fall, as firms shift toward production methods that produce fewer goods but emit less pollution. Economic well-being, however, may rise. The economy now produces less measured output but more clean air; clean air is not traded in markets and, thus, does not show up in measured GDP, but is neverthe less a good that people value.

f. Real GDP rises because the high-school students go from an activity in which the are not producing market goods and services to one in which they are. Economi well-being, however, may decrease. In ideal national accounts, attending schoo would show up as investment because it presumably increases the future produc tivity of the worker. Actual national accounts do not measure this type of invest ment. Note also that future GDP may be lower than it would be if the student stayed in school, since the future work force will be less educated.

g. Measured real GDP falls because fathers spend less time producing market good and services. The actual production of goods and services need not have faller however. Measured production (what the fathers are paid to do) falls, but unmea sured production of child-rearing services rises.

9. As Senator Robert Kennedy pointed out, GDP is an imperfect measure of economic per formance or well-being. In addition to the left-out items that Kennedy cited, GDP als ignores the imputed rent on durable goods such as cars, refrigerators, and lawnmowers many services and products produced as part of household activity, such as cooking an cleaning; and the value of goods produced and sold in illegal activities, such as the dru trade. These imperfections in the measurement of GDP do not necessarily reduce it usefulness. As long as these measurement problems stay constant over time, then GD is useful in comparing economic activity from year to year. Moreover, a large GD allows us to afford better medical care for our children, newer books for their education and more toys for their play.

CHAPTER 3 National Income: Where It Comes From and Where It Goes

Questions for Review

1. Factors of production and the production technology determine the amount of output an economy can produce. Factors of production are the inputs used to produce goods and services: the most important factors are capital and labor. The production technology determines how much output can be produced from any given amounts of these inputs. An increase in one of the factors of production or an improvement in technology leads to an increase in the economy's output.

2. When a firm decides how much of a factor of production to hire, it considers how this decision affects profits. For example, hiring an extra unit of labor increases output and therefore increases revenue; the firm compares this additional revenue to the additional cost from the higher wage bill. The additional revenue the firm receives depends on the marginal product of labor (MPL) and the price of the good produced (P). An additional unit of labor produces MPL units of additional output, which sells for P dollars. Therefore, the additional revenue to the firm is $P \times MPL$. The cost of hiring the additional unit of labor is the wage W. Thus, this hiring decision has the following effect on profits:

$$\begin{aligned}\Delta\text{Profit} &= \Delta\text{Revenue} - \Delta\text{Cost} \\ &= (P \times MPL) - W.\end{aligned}$$

If the additional revenue, $P \times MPL$, exceeds the cost (W) of hiring the additional unit of labor, then profit increases. The firm will hire labor until it is no longer profitable to do so—that is, until the MPL falls to the point where the change in profit is zero. In the equation above, the firm hires labor until Δprofit = 0, which is when $(P \times MPL) = W$.

This condition can be rewritten as:

$$MPL = W/P.$$

Therefore, a competitive profit-maximizing firm hires labor until the marginal product of labor equals the real wage. The same logic applies to the firm's decision to hire capital: the firm will hire capital until the marginal product of capital equals the real rental price.

3. A production function has constant returns to scale if an equal percentage increase in all factors of production causes an increase in output of the same percentage. For example, if a firm increases its use of capital and labor by 50 percent, and output increases by 50 percent, then the production function has constant returns to scale.

If the production function has constant returns to scale, then total income (or equivalently, total output) in an economy of competitive profit-maximizing firms is divided between the return to labor, $MPL \times L$, and the return to capital, $MPK \times K$. That is, under constant returns to scale, economic profit is zero.

4. Consumption depends positively on disposable income—the amount of income after all taxes have been paid. The higher disposable income is, the greater consumption is.

The quantity of investment goods demanded depends negatively on the real interest rate. For an investment to be profitable, its return must be greater than its cost. Because the real interest rate measures the cost of funds, a higher real interest rate makes it more costly to invest, so the demand for investment goods falls.

5. Government purchases are those goods and services purchased directly by the government. For example, the government buys missiles and tanks, builds roads, and provides

services such as air traffic control. All of these activities are part of GDP. Transfer pay ments are government payments to individuals that are not in exchange for goods o services. They are the opposite of taxes: taxes reduce household disposable income whereas transfer payments increase it. Examples of transfer payments include Socia Security payments to the elderly, unemployment insurance, and veterans' benefits.

6. Consumption, investment, and government purchases determine demand for the econo my's output, whereas the factors of production and the production function determin the supply of output. The real interest rate adjusts to ensure that the demand for th economy's goods equals the supply. At the equilibrium interest rate, the demand fo goods and services equals the supply.

7. When the government increases taxes, disposable income falls, and therefore consump tion falls as well. The decrease in consumption equals the amount that taxes increas multiplied by the marginal propensity to consume (*MPC*). The higher the *MPC* is, th greater is the negative effect of the tax increase on consumption. Because output i fixed by the factors of production and the production technology, and government pur chases have not changed, the decrease in consumption must be offset by an increase i investment. For investment to rise, the real interest rate must fall. Therefore, a ta increase leads to a decrease in consumption, an increase in investment, and a fall in th real interest rate.

Problems and Applications

1. a. According to the neoclassical theory of distribution, the real wage equals the mar ginal product of labor. Because of diminishing returns to labor, an increase in th labor force causes the marginal product of labor to fall. Hence, the real wage falls.

   b. The real rental price equals the marginal product of capital. If an earthquak destroys some of the capital stock (yet miraculously does not kill anyone and lowe the labor force), the marginal product of capital rises and, hence, the real renta price rises.

   c. If a technological advance improves the production function, this is likely t increase the marginal products of both capital and labor. Hence, the real wage an the real rental price both increase.

2. A production function has decreasing returns to scale if an equal percentage increase i all factors of production leads to a smaller percentage increase in output. For example if we double the amounts of capital and labor, and output less than doubles, then th production function has decreasing returns to capital and labor. This may happen i there is a fixed factor such as land in the production function, and this fixed facto becomes scarce as the economy grows larger.

   A production function has increasing returns to scale if an equal percentag increase in all factors of production leads to a larger percentage increase in output. Fo example, if doubling inputs of capital and labor more than doubles output, then the pro duction function has increasing returns to scale. This may happen if specialization o labor becomes greater as population grows. For example, if one worker builds a car then it takes him a long time because he has to learn many different skills, and h must constantly change tasks and tools; all of this is fairly slow. But if many worker build a car, then each one can specialize in a particular task and become very fast at it.

3. a. According to the neoclassical theory, technical progress that increases the margin al product of farmers causes their real wage to rise.

   b. The real wage in (a) is measured in terms of farm goods. That is, if the nomina wage is in dollars, then the real wage is W/PF, where PF is the dollar price o farm goods.

c. If the marginal productivity of barbers is unchanged, then their real wage is unchanged.

d. The real wage in (c) is measured in terms of haircuts. That is, if the nominal wage is in dollars, then the real wage is W/PH, where PH is the dollar price of a haircut.

e. If workers can move freely between being farmers and being barbers, then they must be paid the same wage W in each sector.

f. If the nominal wage W is the same in both sectors, but the real wage in terms of farm goods is greater than the real wage in terms of haircuts, then the price of haircuts must have risen relative to the price of farm goods.

g. Both groups benefit from technological progress in farming.

4. The effect of a government tax increase of $100 billion on (a) public saving, (b) private saving, and (c) national saving can be analyzed by using the following relationships:

$$\begin{aligned}\text{National Saving} &= [\text{Private Saving}] + [\text{Public Saving}]\\ &= [Y - T - C(Y - T)] + [T - G]\\ &= Y - C(Y - T) - G.\end{aligned}$$

a. **Public Saving**—The tax increase causes a 1-for-1 increase in public saving. T increases by $100 billion and, therefore, public saving increases by $100 billion.

b. **Private Saving**—The increase in taxes decreases disposable income, $Y - T$, by $100 billion. Since the marginal propensity to consume (MPC) is 0.6, consumption falls by $0.6 \times \$100$ billion, or $60 billion. Hence,

$$\Delta\text{Private Saving} = -\$100b - 0.6\,(-\$100b) = -\$40b.$$

Private saving falls $40 billion.

c. **National Saving**—Because national saving is the sum of private and public saving, we can conclude that the $100 billion tax increase leads to a $60 billion increase in national saving.

Another way to see this is by using the third equation for national saving expressed above, that national saving equals $Y - C(Y - T) - G$. The $100 billion tax increase reduces disposable income and causes consumption to fall by $60 billion. Since neither G nor Y changes, national saving thus rises by $60 billion.

d. **Investment**—To determine the effect of the tax increase on investment, recall the national accounts identity:

$$Y = C(Y - T) + I(r) + G.$$

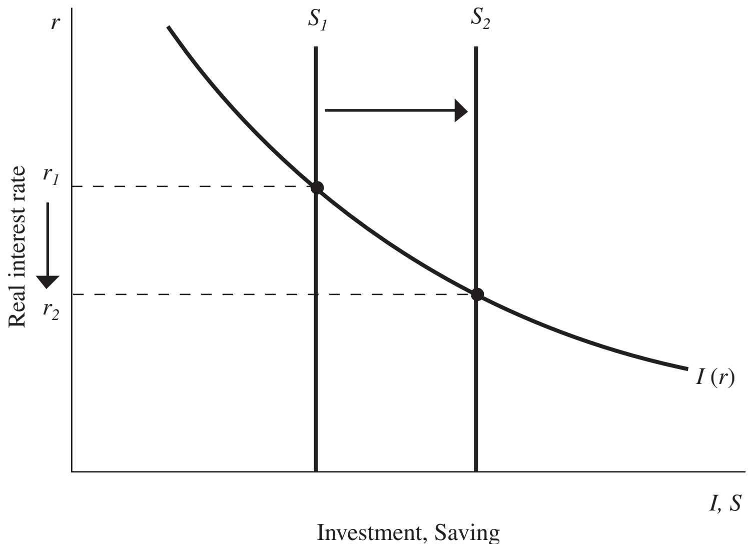
Rearranging, we find

$$Y - C(Y - T) - G = I(r).$$

The left-hand side of this equation is national saving, so the equation just says the national saving equals investment. Since national saving increases by $60 billion, investment must also increase by $60 billion.

How does this increase in investment take place? We know that investmen depends on the real interest rate. For investment to rise, the real interest rat must fall. Figure 3–1 graphs saving and investment as a function of the real inter est rate.

Figure 3–1



The tax increase causes national saving to rise, so the supply curve for loan able funds shifts to the right. The equilibrium real interest rate falls, and invest ment rises.

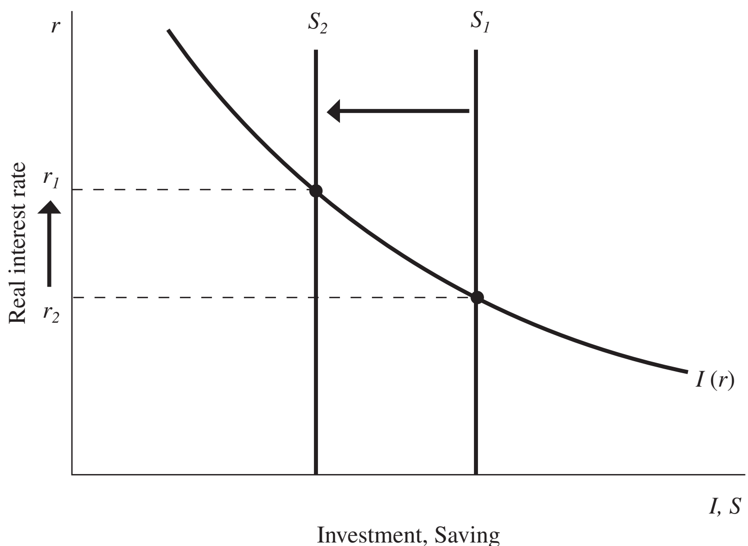
5. If consumers increase the amount that they consume today, then private saving and therefore, national saving will fall. We know this from the definition of national saving

$$\text{National Saving} = [\text{Private Saving}] + [\text{Public Saving}]$$
$$= [Y - T - C(Y - T)] + [T - G].$$

An increase in consumption decreases private saving, so national saving falls.

Figure 3–2 graphs saving and investment as a function of the real interest rate. I national saving decreases, the supply curve for loanable funds shifts to the left, thereb raising the real interest rate and reducing investment.

Figure 3–2



6. a. Private saving is the amount of disposable income, $Y - T$, that is not consumed:

$$\begin{aligned} S^{\text{private}} &= Y - T - C \\ &= 5{,}000 - 1{,}000 - (250 + 0.75(5{,}000 - 1{,}000)) \\ &= 750. \end{aligned}$$

Public saving is the amount of taxes the government has left over after it makes its purchases:

$$\begin{aligned} S^{\text{public}} &= T - G \\ &= 1{,}000 - 1{,}000 \\ &= 0. \end{aligned}$$

Total saving is the sum of private saving and public saving:

$$\begin{aligned} S &= S^{\text{private}} + S^{\text{public}} \\ &= 750 + 0 \\ &= 750. \end{aligned}$$

b. The equilibrium interest rate is the value of r that clears the market for loanable funds. We already know that national saving is 750, so we just need to set it equal to investment:

$$\begin{aligned} S &= I \\ 750 &= 1{,}000 - 50r \end{aligned}$$

Solving this equation for r, we find:

$$r = 5\%.$$

c. When the government increases its spending, private saving remains the same as before (notice that G does not appear in the S^{private} above) while government saving decreases. Putting the new G into the equations above:

$$S^{\text{private}} = 750$$

$$\begin{aligned} S^{\text{public}} &= T - G \\ &= 1{,}000 - 1{,}250 \\ &= -250. \end{aligned}$$

Thus,

$$\begin{aligned} S &= S^{\text{private}} + S^{\text{public}} \\ &= 750 + (-250) \\ &= 500. \end{aligned}$$

d. Once again the equilibrium interest rate clears the market for loanable funds:

$$\begin{aligned} S &= I \\ 500 &= 1{,}000 - 50r \end{aligned}$$

Solving this equation for r, we find:

$$r = 10\%.$$

7. To determine the effect on investment of an equal increase in both taxes and government spending, consider the national income accounts identity for national saving:

$$\begin{aligned} \text{National Saving} &= [\text{Private Saving}] + [\text{Public Saving}] \\ &= [Y - T - C(Y - T)] + [T - G]. \end{aligned}$$

We know that Y is fixed by the factors of production. We also know that the change in consumption equals the marginal propensity to consume (MPC) times the change in disposable income. This tells us that

$$\begin{aligned} \Delta\text{National Saving} &= [-\Delta T - (MPC \times (-\Delta T))] + [\Delta T - \Delta G] \\ &= [-\Delta T + (MPC \times \Delta T)] + 0 \\ &= (MPC - 1)\,\Delta T. \end{aligned}$$

The above expression tells us that the impact on saving of an equal increase in T
and G depends on the size of the marginal propensity to consume. The closer the MPC is to 1, the smaller is the fall in saving. For example, if the MPC equals 1, then the fall in consumption equals the rise in government purchases, so national saving $[Y - C(Y - T) - G]$ is unchanged. The closer the MPC is to 0 (and therefore the larger is the amount saved rather than spent for a one-dollar change in disposable income), the greater is the impact on saving. Because we assume that the MPC is less than 1, we expect that national saving falls in response to an equal increase in taxes and government spending.

The reduction in saving means that the supply of loanable funds curve shifts to the left in Figure 3–3. The real interest rate rises, and investment falls.

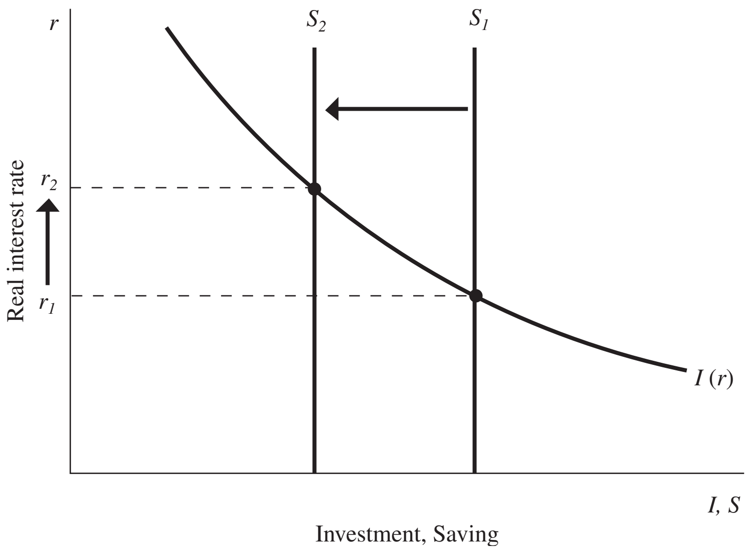


Figure 3–3

8. a. The demand curve for business investment shifts out because the subsidy increases the number of profitable investment opportunities for any given interest rate. The demand curve for residential investment remains unchanged.

   b. The total demand curve for investment in the economy shifts out since it represents the sum of business investment, which shifts out, and residential investment, which is unchanged. As a result the real interest rate rises as in Figure 3–4

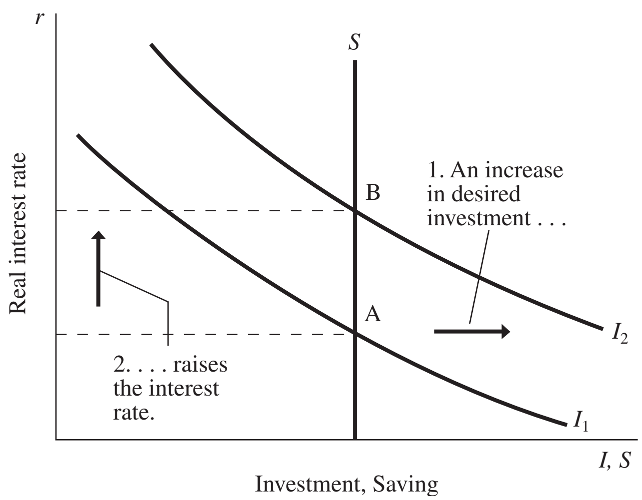
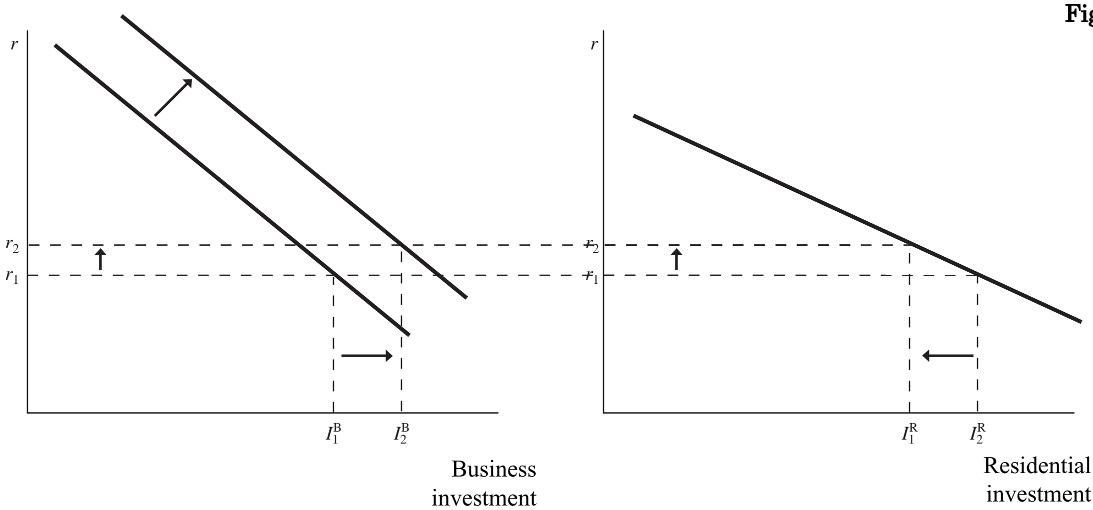


Figure 3–4

c. The total quantity of investment does not change because it is constrained by the inelastic supply of savings. The investment tax credit leads to a rise in business investment, but an offsetting fall in residential investment. That is, the higher interest rate means that residential investment falls (a shift along the curve), whereas the outward shift of the business investment curve leads business investment to rise by an equal amount. Figure 3–5 shows this change. Note that $I_1^B + I_1^R = I_2^B + I_2^R = \bar{S}$

Figure 3–5



9. In this chapter, we concluded that an increase in government expenditures reduces national saving and raises the interest rate; it therefore crowds out investment by the full amount of the increase in government expenditure. Similarly, a tax cut increases disposable income and hence consumption; this increase in consumption translates into a fall in national saving—again, it crowds out investment.

If consumption depends on the interest rate, then these conclusions about fisca policy are modified somewhat. If consumption depends on the interest rate, then s does saving. The higher the interest rate, the greater the return to saving. Hence, i seems reasonable to think that an increase in the interest rate might increase savin and reduce consumption. Figure 3–6 shows saving as an increasing function of th interest rate.

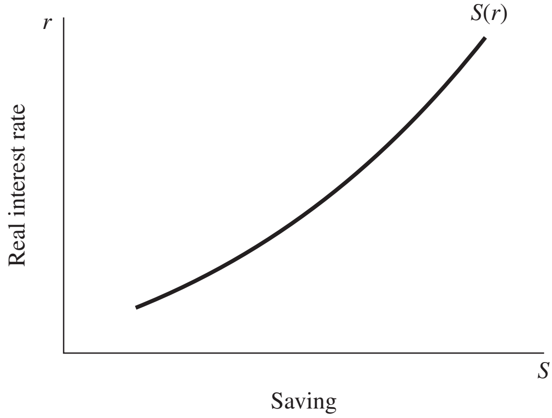


Figure 3–6

Consider what happens when government purchases increase. At any given leve of the interest rate, national saving falls by the change in government purchases, a shown in Figure 3–7. The figure shows that if the saving function slopes upward investment falls by less than the amount that government purchases rise; this happen because consumption falls and saving increases in response to the higher interest rate Hence, the more responsive consumption is to the interest rate, the less governmen purchases crowd out investment.

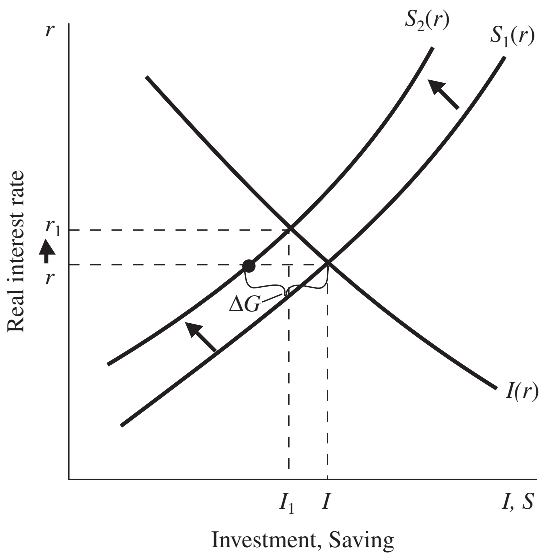


Figure 3–7

More Problems and Applications to Chapter 3

1. a. A Cobb–Douglas production function has the form $Y = AK^{\alpha}L^{1-\alpha}$. In the appendix we showed that the marginal products for the Cobb–Douglas production function are:

$$MPL = (1 - \alpha)Y/L.$$

$$MPK = \alpha Y/K.$$

Competitive profit-maximizing firms hire labor until its marginal product equals the real wage, and hire capital until its marginal product equals the real rental rate. Using these facts and the above marginal products for the Cobb–Douglas production function, we find:

$$W/P = MPL = (1 - \alpha)Y/L.$$

$$R/P = MPK = \alpha Y/K.$$

Rewriting this:

$$(W/P)L = MPL \times L = (1 - \alpha)Y.$$

$$(R/P)K = MPK \times K = \alpha Y.$$

Note that the terms $(W/P)L$ and $(R/P)K$ are the wage bill and total return to capital, respectively. Given that the value of $\alpha = 0.3$, then the above formulas indicate that labor receives 70 percent of total output, which is $(1 - 0.3)$, and capital receives 30 percent of total output.

b. To determine what happens to total output when the labor force increases by 10 percent, consider the formula for the Cobb–Douglas production function:

$$Y = AK^{\alpha}L^{1-\alpha}.$$

Let Y_1 equal the initial value of output and Y_2 equal final output. We know that $\alpha = 0.3$. We also know that labor L increases by 10 percent:

$$Y_1 = AK^{0.3}L^{0.7}.$$

$$Y_2 = AK^{0.3}(1.1L)^{0.7}.$$

Note that we multiplied L by 1.1 to reflect the 10-percent increase in the labor force.

To calculate the percentage change in output, divide Y_2 by Y_1:

$$\frac{Y_2}{Y_1} = \frac{AK^{0.3}(1.1L)^{0.7}}{AK^{0.3}L^{0.7}}$$

$$= (1.1)^{0.7}$$

$$= 1.069.$$

That is, output increases by 6.9 percent.

To determine how the increase in the labor force affects the rental price of capital, consider the formula for the real rental price of capital R/P:

$$R/P = MPK = \alpha AK^{\alpha-1}L^{1-\alpha}.$$

We know that $\alpha = 0.3$. We also know that labor (L) increases by 10 percent. Let $(R/P)_1$ equal the initial value of the rental price of capital, and $(R/P)_2$ equal the final rental price of capital after the labor force increases by 10 percent. To find $(R/P)_2$, multiply L by 1.1 to reflect the 10-percent increase in the labor force:

$$(R/P)_1 = 0.3AK^{-0.7}L^{0.7}.$$

$$(R/P)_2 = 0.3AK^{-0.7}(1.1L)^{0.7}.$$

The rental price increases by the ratio

$$\frac{(R/P)_2}{(R/P)_1} = \frac{0.3AK^{-0.7}(1.1L)^{0.7}}{0.3AK^{-0.7}L^{0.7}}$$

$$= (1.1)^{0.7}$$

$$= 1.069.$$

So the rental price increases by 6.9 percent.

To determine how the increase in the labor force affects the real wage, con sider the formula for the real wage W/P:

$$W/P = MPL = (1 - \alpha)AK^{\alpha}L^{-\alpha}.$$

We know that $\alpha = 0.3$. We also know that labor (L) increases by 10 percent. Le $(W/P)_1$ equal the initial value of the real wage and $(W/P)_2$ equal the final value o the real wage. To find $(W/P)_2$, multiply L by 1.1 to reflect the 10-percent increas in the labor force:

$$(W/P)_1 = (1 - 0.3)AK^{0.3}L^{-0.3}.$$

$$(W/P)_2 = (1 - 0.3)AK^{0.3}(1.1L)^{-0.3}.$$

To calculate the percentage change in the real wage, divide $(W/P)_2$ b $(W/P)_1$:

$$\frac{(W/P)_2}{(W/P)_1} = \frac{(1-0.3)AK^{0.3}(1.1L)^{-0.3}}{(1-0.3)AK^{0.3}L^{-0.3}}$$

$$= (1.1)^{-0.3}$$

$$= 0.972.$$

That is, the real wage falls by 2.8 percent.

c. We can use the same logic as (b) to set

$$Y_1 = AK^{0.3}L^{0.7}.$$

$$Y_2 = A(1.1K)^{0.3}L^{0.7}.$$

Therefore, we have:

$$\frac{Y_2}{Y_1} = \frac{A(1.1K)^{0.3}L^{1.7}}{AK^{0.3}L^{0.7}}$$

$$= (1.1)^{0.3}$$

$$= 1.029.$$

This equation shows that output increases by 2 percent. Notice that $\alpha < 0.5$ mean that proportional increases to capital will increase output by less than the same proportional increase to labor.

Again using the same logic as (b) for the change in the real rental price of capital:

$$\frac{(R/P)_2}{(R/P)_1} = \frac{0.3A(1.1K)^{-0.7}L^{0.7}}{0.3AK^{-0.7}L^{0.7}}$$

$$= (1.1)^{-0.7}$$

$$= 0.935.$$

The real rental price of capital falls by 6.5 percent because there are diminishing returns to capital; that is, when capital increases, its marginal product falls.

Finally, the change in the real wage is:

$$\frac{(W/P)_2}{(W/P)_1} = \frac{0.7A(1.1K)^{-0.7}L^{0.7}}{0.7AK^{-0.7}L^{0.7}}$$

$$(1.1)^{0.3}$$

$$= 1.029.$$

Hence, real wages increase by 2.9 percent because the added capital increases the marginal productivity of the existing workers. (Notice that the wage and output have both increased by the same amount, leaving the labor share unchanged—a feature of Cobb–Douglas technologies.)

d. Using the same formula, we find that the change in output is:

$$\frac{Y_2}{Y_1} = \frac{(1.1A)K^{0.3}L^{0.7}}{AK^{0.3}L^{0.7}}$$

$$= 1.1.$$

This equation shows that output increases by 10 percent. Similarly, the rental price of capital and the real wage also increase by 10 percent:

$$\frac{(R/P)_2}{(R/P)_1} = \frac{0.3(1.1A)K^{-0.7}L^{0.7}}{0.3AK^{-0.7}L^{0.7}}$$

$$= 1.1.$$

$$\frac{(W/P)_2}{(W/P)_1} = \frac{0.7(1.1A)K^{0.3}L^{-0.3}}{0.7AK^{0.3}L^{-0.3}}$$

$$= 1.1.$$

2. a. The marginal product of labor MPL is found by differentiating the production function with respect to labor:

$$MPL = \frac{dY}{dL}$$

$$= \frac{1}{3}K^{1/3}H^{1/3}L^{-2/3}.$$

This equation is increasing in human capital because more human capital makes all the existing labor more productive.

b. The marginal product of human capital MPH is found by differentiating the production function with respect to human capital:

$$MPH = \frac{dY}{dH}$$

$$= \frac{1}{3}K^{1/3}L^{1/3}H^{-2/3}.$$

This equation is decreasing in human capital because there are diminishing returns.

c. The labor share of output is the proportion of output that goes to labor. The total amount of output that goes to labor is the real wage (which, under perfect competition, equals the marginal product of labor) times the quantity of labor. This quantity is divided by the total amount of output to compute the labor share:

$$\text{Labor Share} = \frac{(\frac{1}{3}K^{1/3}H^{1/3}L^{-2/3})L}{K^{1/3}H^{1/3}L^{1/3}}$$

$$= \frac{1}{3}.$$

We can use the same logic to find the human capital share:

$$\text{Human Capital Share} = \frac{\left(\frac{1}{3}K^{1/3}L^{1/3}H^{-2/3}\right)H}{K^{1/3}H^{1/3}L^{1/3}}$$

$$= \frac{1}{3},$$

so labor gets one-third of the output, and human capital gets one-third of the output. Since workers own their human capital (we hope!), it will appear that labor gets two-thirds of output.

d. The ratio of the skilled wage to the unskilled wage is:

$$\frac{W_{\text{skilled}}}{W_{\text{unskilled}}} = \frac{MPL + MPH}{MPL}$$

$$= \frac{\frac{1}{3}K^{1/3}L^{-2/3}H^{1/3} + \frac{1}{3}K^{1/3}L^{1/3}H^{-2/3}}{\frac{1}{3}K^{1/3}L^{-2/3}H^{1/3}}$$

$$= 1 + \frac{L}{H}.$$

Notice that the ratio is always greater than 1 because skilled workers get paid more than unskilled workers. Also, when H increases this ratio falls because the diminishing returns to human capital lower its return, while at the same time increasing the marginal product of unskilled workers.

e. If more college scholarships increase H, then it does lead to a more egalitarian society. The policy lowers the returns to education, decreasing the gap between the wages of more and less educated workers. More importantly, the policy even raises the absolute wage of unskilled workers because their marginal product rises when the number of skilled workers rises.

CHAPTER 4 Money and Inflation

Questions for Review

1. Money has three functions: it is a store of value, a unit of account, and a medium of exchange. As a store of value, money provides a way to transfer purchasing power from the present to the future. As a unit of account, money provides the terms in which prices are quoted and debts are recorded. As a medium of exchange, money is what we use to buy goods and services.
2. Fiat money is established as money by the government but has no intrinsic value. For example, a U.S. dollar bill is fiat money. Commodity money is money that is based on a commodity with some intrinsic value. Gold, when used as money, is an example of commodity money.
3. In many countries, a central bank controls the money supply. In the United States, the central bank is the Federal Reserve—often called the Fed. The control of the money supply is called *monetary policy*.

   The primary way that the Fed controls the money supply is through open-market operations, which involve the purchase or sale of government bonds. To increase the money supply, the Fed uses dollars to buy government bonds from the public, putting more dollars into the hands of the public. To decrease the money supply, the Fed sells some of its government bonds, taking dollars out of the hands of the public.
4. The quantity equation is an identity that expresses the link between the number of transactions that people make and how much money they hold. We write it as

   $$\text{Money} \times \text{Velocity} = \text{Price} \times \text{Transactions}$$
   $$M \times V = P \times T.$$

   The right-hand side of the quantity equation tells us about the total number of transactions that occur during a given period of time, say, a year. T represents the total number of times that any two individuals exchange goods or services for money. P represents the price of a typical transaction. Hence, the product $P \times T$ represents the number of dollars exchanged in a year.

   The left-hand side of the quantity equation tells us about the money used to make these transactions. M represents the quantity of money in the economy. V represents the transactions velocity of money—the rate at which money circulates in the economy.

   Because the number of transactions is difficult to measure, economists usually use a slightly different version of the quantity equation, in which the total output of the economy Y replaces the number of transactions T:

   $$\text{Money} \times \text{Velocity} = \text{Price} \times \text{Output}$$
   $$M \times V = P \times Y.$$

   P now represents the price of one unit of output, so that $P \times Y$ is the dollar value of output—nominal GDP. V represents the income velocity of money—the number of times a dollar bill becomes a part of someone's income.
5. If we assume that velocity in the quantity equation is constant, then we can view the quantity equation as a theory of nominal GDP. The quantity equation with fixed velocity states that

   $$MV = PY.$$

   If velocity V is constant, then a change in the quantity of money (M) causes a proportionate change in nominal GDP (PY). If we assume further that output is fixed by the factors of production and the production technology, then we can conclude that the quantity of money determines the price level. This is called the *quantity theory c money*.

6. The holders of money pay the inflation tax. As prices rise, the real value of the mone that people hold falls—that is, a given amount of money buys fewer goods and service since prices are higher.

7. The Fisher equation expresses the relationship between nominal and real interes rates. It says that the nominal interest rate i equals the real interest rate r plus th inflation rate π:

$$i = r + \pi.$$

This tells us that the nominal interest rate can change either because the real interes rate changes or the inflation rate changes. The real interest rate is assumed to be unaf fected by inflation; as discussed in Chapter 3, it adjusts to equilibrate saving an investment. There is thus a one-to-one relationship between the inflation rate and th nominal interest rate: if inflation increases by 1 percent, then the nominal interest rat also increases by 1 percent. This one-to-one relationship is called the **Fisher effect**.

If inflation increases from 6 to 8 percent, then the Fisher effect implies that th nominal interest rate increases by 2 percentage points, while the real interest rat remains constant.

8. The costs of expected inflation include the following:
   a. **Shoeleather costs.** Higher inflation means higher nominal interest rates, whicl mean that people want to hold lower real money balances. If people hold lowe money balances, they must make more frequent trips to the bank to withdrav money. This is inconvenient (and it causes shoes to wear out more quickly).
   b. **Menu costs.** Higher inflation induces firms to change their posted prices mor often. This may be costly if they must reprint their menus and catalogs.
   c. **Greater variability in relative prices**. If firms change their prices infrequently then inflation causes greater variability in relative prices. Since free-marke economies rely on relative prices to allocate resources efficiently, inflation leads t microeconomic inefficiencies.
   d. **Altered tax liabilities.** Many provisions of the tax code do not take into account th effect of inflation. Hence, inflation can alter individuals' and firms' tax liabilitie often in ways that lawmakers did not intend.
   e. **The inconvenience of a changing price level.** It is inconvenient to live in a worl with a changing price level. Money is the yardstick with which we measure eco nomic transactions. Money is a less useful measure when its value is alway changing.

   There is an additional cost to unexpected inflation:

   f. **Arbitrary redistributions of wealth.** Unexpected inflation arbitrarily redistribute wealth among individuals. For example, if inflation is higher than expected debtors gain and creditors lose. Also, people with fixed pensions are hurt becaus their dollars buy fewer goods.

9. A hyperinflation always reflects monetary policy. That is, the price level cannot grov rapidly unless the supply of money also grows rapidly; and hyperinflations do not en unless the government drastically reduces money growth. This explanation, however begs a central question: Why does the government start and then stop printing lots c money? The answer almost always lies in fiscal policy: When the government has large budget deficit (possibly due to a recent war or some other major event) that it can not fund by borrowing, it resorts to printing money to pay its bills. And only when thi fiscal problem is alleviated—by reducing government spending and collecting mor taxes—can the government hope to slow its rate of money growth.

10. A *real variable* is one that is measured in units that are constant over time—for exam ple, they might be measured in "constant dollars." That is, the units are adjusted fo

inflation. A *nominal variable* is one that is measured in current dollars; the value of the variable is not adjusted for inflation. For example, a real variable could be a Hershey's candy bar; the nominal variable is the current-price value of the Hershey's candy bar—5 cents in 1960, say, and 75 cents in 1999. The interest rate you are quoted by your bank—8 percent, say—is a nominal rate, since it is not adjusted for inflation. If inflation is, say, 3 percent, then the real interest rate, which measures your purchasing power, is 5 percent.

Problems and Applications

1. Money functions as a store of value, a medium of exchange, and a unit of account.
   a. A credit card can serve as a medium of exchange because it is accepted in exchange for goods and services. A credit card is, arguably, a (negative) store of value because you can accumulate debt with it. A credit card is not a unit of account—a car, for example, does not cost 5 VISA cards.
   b. A Rembrandt painting is a store of value only.
   c. A subway token, within the subway system, satisfies all three functions of money. Yet outside the subway system, it is not widely used as a unit of account or a medium of exchange, so it is not a form of money.
2. The real interest rate is the difference between the nominal interest rate and the inflation rate. The nominal interest rate is 11 percent, but we need to solve for the inflation rate. We do this with the quantity identity expressed in percentage-change form:

   $$\%\text{ Change in } M + \%\text{ Change in } V = \%\text{ Change in } P + \%\text{ Change in } Y.$$

   Rearranging this equation tells us that the inflation rate is given by:

   $$\%\text{ Change in } P + \%\text{ Change in } M + \%\text{ Change in } V - \%\text{ Change in } Y.$$

   Substituting the numbers given in the problem, we thus find:

   $$\begin{aligned}\%\text{ Change in } P &= 14\% + 0\% - 5\% \\ &= 9\%.\end{aligned}$$

   Thus, the real interest rate is 2 percent: the nominal interest rate of 11 percent minus the inflation rate of 9 percent.
3. a. Legislators wish to ensure that the real value of Social Security and other benefits stays constant over time. This is achieved by indexing benefits to the cost of living as measured by the consumer price index. With indexing, nominal benefits change at the same rate as prices.
   b. Assuming the inflation is measured correctly (see Chapter 2 for more on this issue), senior citizens are unaffected by the lower rate of inflation. Although they get less money from the government, the goods they purchase are cheaper; their purchasing power is exactly the same as it was with the higher inflation rate.
4. The major benefit of having a national money is seigniorage—the ability of the government to raise revenue by printing money. The major cost is the possibility of inflation, or even hyperinflation, if the government relies too heavily on seigniorage. The benefits and costs of using a foreign money are exactly the reverse: the benefit of foreign money is that inflation is no longer under domestic political control, but the cost is that the domestic government loses its ability to raise revenue through seigniorage. (There is also a subjective cost to having pictures of foreign leaders on your currency.)

   The foreign country's political stability is a key factor. The primary reason for using another nation's money is to gain stability. If the foreign country is unstable, then the home country is definitely better off using its own currency—the home economy remains more stable, and it keeps the seigniorage.
5. A paper weapon might have been effective for all the reasons that a hyperinflation is bad. For example, it increases shoeleather and menu costs; it makes relative prices more variable; it alters tax liabilities in arbitrary ways; it increases variability in rela-

tive prices; it makes the unit of account less useful; and finally, it increases uncertaint and causes arbitrary redistributions of wealth. If the hyperinflation is sufficientl extreme, it can undermine the public's confidence in the economy and economic policy.

Note that if foreign airplanes dropped the money, then the government would no receive seigniorage revenue from the resulting inflation, so this benefit usually associ ated with inflation is lost.

6. One way to understand Coolidge's statement is to think of a government that is a ne debtor in nominal terms to the private sector. Let B denote the government's outstand ing debt measured in U.S. dollars. The debt in real terms equals B/P, where P is th price level. By increasing inflation, the government raises the price level and reduces i real terms the value of its outstanding debt. In this sense we can say that the govern ment repudiates the debt. This only matters, however, when inflation is unexpected. I inflation is expected, people demand a higher nominal interest rate. Repudiation stil occurs (i.e., the real value of the debt still falls when the price level rises), but it is no at the expense of the holders of the debt, since they are compensated with a highe nominal interest rate.
7. A deflation means a fall in the general price level, which is the same as a rise in th value of money. Under a gold standard, a rise in the value of money is a rise in th value of gold because money and gold are in a fixed ratio. Therefore, after a deflation an ounce of gold buys more goods and services. This creates an incentive to look for new gold deposits and, thus, more gold is found after a deflation.
8. An increase in the rate of money growth leads to an increase in the rate of inflation Inflation, in turn, causes the nominal interest rate to rise, which means that the oppor tunity cost of holding money increases. As a result, real money balances fall. Sinc money is part of wealth, real wealth also falls. A fall in wealth reduces consumption and, therefore, increases saving. The increase in saving leads to an outward shift of th saving schedule, as in Figure 4–1. This leads to a lower real interest rate.

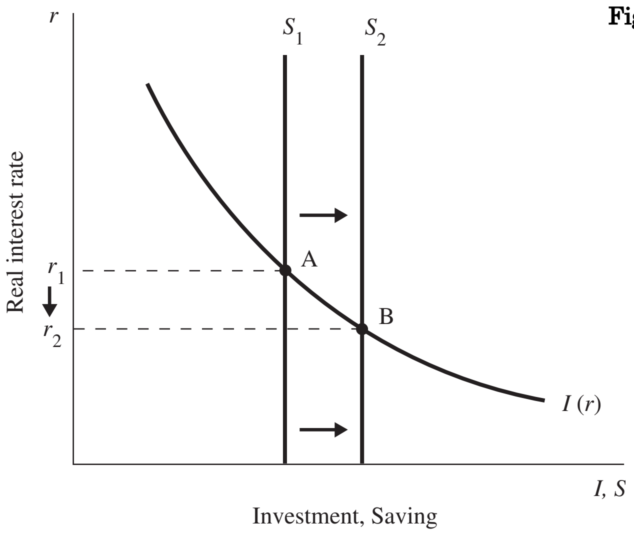


Figure 4–1

The classical dichotomy states that a change in a nominal variable such as infla tion does not affect real variables. In this case, the classical dichotomy does not hold the increase in the rate of inflation leads to a decrease in the real interest rate. Th Fisher effect states that $i = r + \pi$. In this case, since the real interest rate r falls, a 1 percent increase in inflation increases the nominal interest rate i by less than 1 per cent.

Most economists believe that this Mundell–Tobin effect is not important because real money balances are a small fraction of wealth. Hence, the impact on saving as illustrated in Figure 4–1 is small.

9. The *Economist* (www.economist.com) is a useful site for recent data. [Note: unfortunately, as of this writing (February 2002), you need a paid subscription to get access to many of the tables online.] Alternatively, the International Monetary Fund has links to country data sources (www.imf.org; follow the links to standards and codes and then to data dissemination).

   For example, in the twelve months ending in November 2001, consumer prices in Turkey rose 69 percent from a year earlier, M1 rose 55 percent while M2 rose 52 percent, and short-term interest rates were 54 percent. By contrast, in the United States in the twelve months ending in December 2001, consumer prices rose about 2 percent, M1 rose 8 percent, M2 rose 14 percent; and short-term interest rates were a little under 2 percent. These data are consistent with the theories in the chapter, in that high-inflation countries have higher rates of money growth and also higher nominal interest rates.

More Problems and Applications to Chapter 4

1. With constant money growth at rate μ, the question tells us that the Cagan model implies that $p_t = m_t + \gamma\mu$. This question draws out the implications of this equation.

   a. One way to interpret this result is to rearrange to find:

   $$m_t - p_t = -\gamma\mu.$$

   That is, real balances depend on the money growth rate. As the growth rate of money rises, real balances fall. This makes sense in terms of the model in this chapter, since faster money growth implies faster inflation, which makes it less desirable to hold money balances.

   b. With unchanged growth in the money supply, the increase in the level of the money supply m_t increases the price level p_t one-for-one.

   c. With unchanged current money supply m_t, a change in the growth rate of money μ changes the price level in the same direction.

   d. When the central bank reduces the rate of money growth μ, the price level will immediately fall. To offset this decline in the price level, the central bank can increase the current level of the money supply m_t, as we found in part (b). These answers assume that at each point in time, private agents expect the growth rate of money to remain unchanged, so that the change in policy takes them by surprise—but once it happens, it is completely credible. A practical problem is that the private sector might not find it credible that an *increase* in the current money supply signals a *decrease* in future money growth rates.

   e. If money demand does not depend on the expected rate of inflation, then the price level changes only when the money supply itself changes. That is, changes in the growth rate of money μ do not affect the price level. In part (d), the central bank can keep the current price level p_t constant simply by keeping the current money supply m_t constant.

CHAPTER 5 The Open Economy

Questions for Review

1. By rewriting the national income accounts identity, we show in the text that

$$S - I = NX.$$

This form of the national income accounts identity shows the relationship between the international flow of funds for capital accumulation, $S - I$, and the international flow of goods and services, NX.

Net foreign investment refers to the ($S - I$) part of this identity: it is the excess of domestic saving over domestic investment. In an open economy, domestic saving need not equal domestic investment, because investors can borrow and lend in world financial markets. The trade balance refers to the (NX) part of the identity: it is the difference between what we export and what we import.

Thus, the national accounts identity shows that the international flow of funds to finance capital accumulation and the international flow of goods and services are two sides of the same coin.

2. The *nominal exchange rate* is the relative price of the *currency* of two countries. The *real exchange rate*, sometimes called the *terms of trade*, is the relative price of the *goods* of two countries. It tells us the rate at which we can trade the goods of one country for the goods of another.

3. A cut in defense spending increases government saving and, hence, increases national saving. Investment depends on the world rate and is unaffected. Hence, the increase in saving causes the ($S - I$) schedule to shift to the right, as in Figure 5–1. The trade balance rises, and the real exchange rate falls.

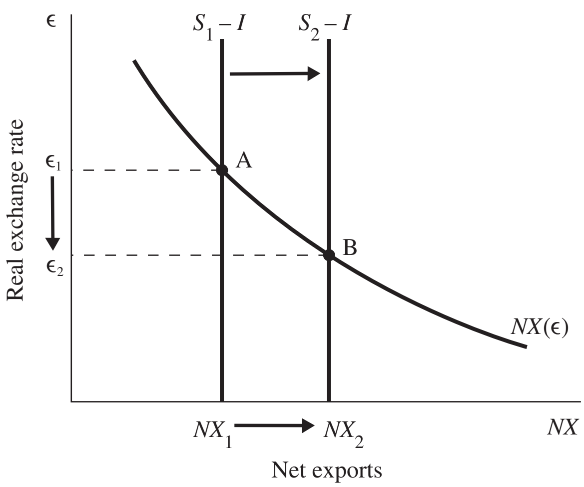


Figure 5–1

4. If a small open economy bans the import of Japanese VCRs, then for any given real exchange rate, imports are lower, so that net exports are higher. Hence, the net export schedule shifts out, as in Figure 5–2.

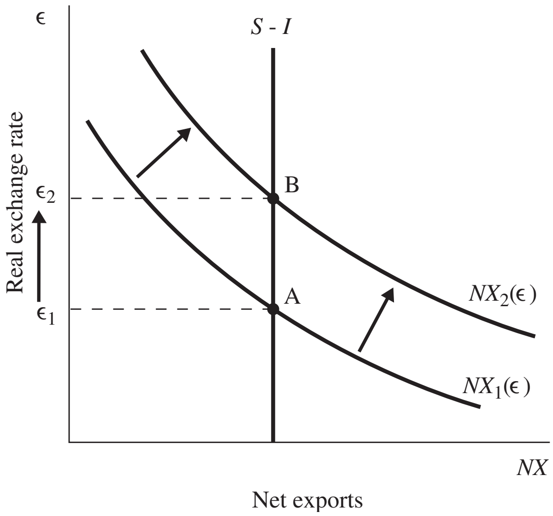


Figure 5–2

The protectionist policy of banning VCRs does not affect saving, investment, or the world interest rate, so the $S - I$ schedule does not change. Because protectionist policies do not alter either saving or investment in the model of this chapter, they cannot alter the trade balance. Instead, a protectionist policy drives the real exchange rate higher.

5. We can relate the real and nominal exchange rates by the expression

Nominal Exchange Rate		Real Exchange Rate		Ratio of Price Levels
e	=	ϵ	×	(P^*/P).

Let P^* be the Italian price level and P be the German price level. The nominal exchange rate e is the number of Italian lira per German mark (this is as if we take Germany to be the "domestic" country). We can express this in terms of percentage changes over time as

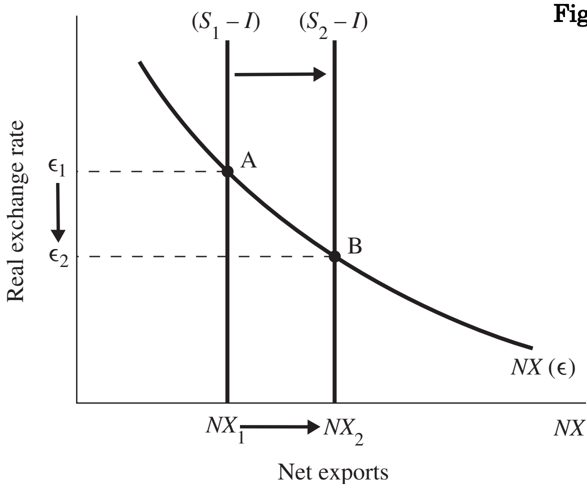
$$\%\text{ Change in } e = \%\text{ Change in } \epsilon + (\pi^* - \pi),$$

where π^* is the Italian inflation rate and π is the German inflation rate. If Italian inflation is higher than German inflation, then this equation tells us that a mark buys an increasing amount of lira over time: the mark rises relative to the lira. Alternatively, viewed from the Italian perspective, the exchange rate in terms of marks per lira falls.

Problems and Applications

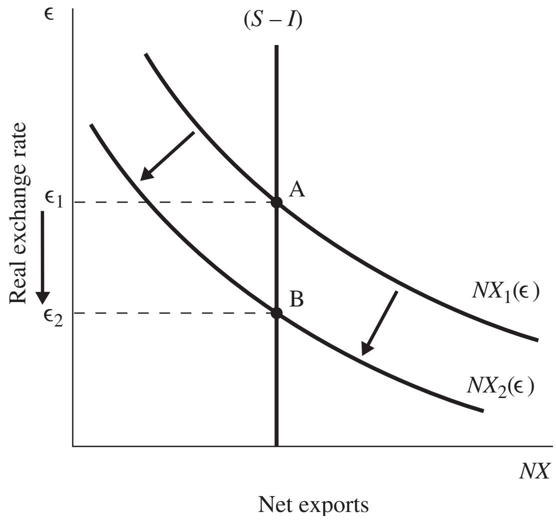
1. a. An increase in saving shifts the $(S - I)$ schedule to the right, increasing the supply of dollars available to be invested abroad, as in Figure 5–3. The increased supply of dollars causes the equilibrium real exchange rate to fall from ϵ_1 to ϵ_2. Because the dollar becomes less valuable, domestic goods become less expensive relative to foreign goods, so exports rise and imports fall. This means that the trade balance increases. The nominal exchange rate falls following the movement of the real exchange rate, because prices do not change in response to this shock.

Figure 5–3



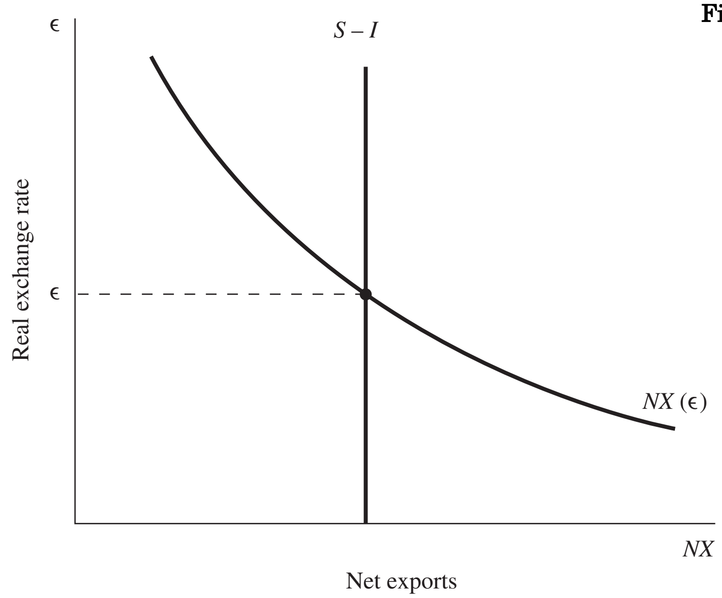
b. The introduction of a stylish line of Toyotas that makes some consumers prefer foreign cars over domestic cars has no effect on saving or investment, but it shifts the $NX(\epsilon)$ schedule inward, as in Figure 5–4. The trade balance does not change, but the real exchange rate falls from ϵ_1 to ϵ_2. Because prices are not affected, the nominal exchange rate follows the real exchange rate.

Figure 5–4



c. In the model we considered in this chapter, the introduction of ATMs has no effect on any real variables. The amounts of capital and labor determine output $\overline{Y}$. The world interest rate r^* determines investment $I(r^*)$. The difference between domestic saving and domestic investment $(S - I)$ determines net exports. Finally, the intersection of the $NX(\epsilon)$ schedule and the $(S - I)$ schedule determines the real exchange rate, as in Figure 5–5.

Figure 5–5



The introduction of ATMs, by reducing money demand, does affect the nominal exchange rate through its effect on the domestic price level. The price level adjusts to equilibrate the demand and supply of real balances, so that

$$M/P = (M/P)^d.$$

If M is fixed, then a fall in $(M/P)^d$ causes an increase in the price level: this reduces the supply of real balances M/P and restores equilibrium in the money market.

Now recall the formula for the nominal exchange rate:

$$e = \epsilon \times (P^*/P).$$

We know that the real exchange rate ϵ remains constant, and we assume that the foreign price level P^* is fixed. When the domestic price level P increases, the nominal exchange rate e depreciates.

2. a. National saving is the amount of output that is not purchased for current consumption by households or the government. We know output and government spending, and the consumption function allows us to solve for consumption. Hence, national saving is given by:

$$\begin{aligned} S &= Y - C - G \\ &= 5{,}000 - (250 + 0.75(5{,}000 - 1{,}000)) - 1{,}000 \\ &= 750. \end{aligned}$$

Investment depends negatively on the interest rate, which equals the world rate r^* of 5. Thus,

$$\begin{aligned} I &= 1{,}000 - 50 \times 5 \\ &= 750. \end{aligned}$$

Net exports equals the difference between saving and investment. Thus,

$$\begin{aligned} NX &= S - I \\ &= 750 - 750 \\ &= 0. \end{aligned}$$

Having solved for net exports, we can now find the exchange rate that clears the foreign-exchange market:

$$\begin{aligned} NX &= 500 - 500 \times \varepsilon \\ 0 &= 500 - 500 \times \varepsilon \\ \varepsilon &= 1. \end{aligned}$$

b. Doing the same analysis with the new value of government spending we find:

$$\begin{aligned} S &= Y - C - G \\ &= 5{,}000 - (250 + 0.75(5{,}000 - 1{,}000)) - 1{,}250 \\ &= 500 \end{aligned}$$

$$\begin{aligned} I &= 1{,}000 - 50 \times 5 \\ &= 750 \end{aligned}$$

$$\begin{aligned} NX &= S - I \\ &= 500 - 750 \\ &= -250 \end{aligned}$$

$$NX = 500 - 500 \times \varepsilon$$

$$-250 = 500 - 500 \times \varepsilon$$

$$\varepsilon = 1.5.$$

The increase in government spending reduces national saving, but with an unchanged world real interest rate, investment remains the same. Therefore, domestic investment now exceeds domestic saving, so some of this investment must be financed by borrowing from abroad. This capital inflow is accomplished by reducing net exports, which requires that the currency appreciate.

c. Repeating the same steps with the new interest rate,

$$\begin{aligned} S &= Y - C - G \\ &= 5{,}000 - (250 + 0.75(5{,}000 - 1{,}000)) - 1{,}000 \\ &= 750 \end{aligned}$$

$$\begin{aligned} I &= 1{,}000 - 50 \times 10 \\ &= 500 \end{aligned}$$

$$\begin{aligned} NX &= S - I \\ &= 750 - 500 \\ &= 250 \end{aligned}$$

$$NX = 500 - 500 \times \varepsilon$$

$$250 = 500 - 500 \times \varepsilon$$

$$\varepsilon = 0.5.$$

Saving is unchanged from part (a), but the higher world interest rate lowers investment. This capital outflow is accomplished by running a trade surplus, which requires that the currency depreciate.

3. a. When Leverett's exports become less popular, its domestic saving $Y - C - G$ does not change. This is because we assume that Y is determined by the amount of capital and labor, consumption depends only on disposable income, and government spending is a fixed exogenous variable. Investment also does not change, since investment depends on the interest rate, and Leverett is a small open economy that takes the world interest rate as given. Because neither saving nor investment changes, net exports, which equal $S - I$, do not change either. This is shown in Figure 5–6 as the unmoving $S - I$ curve.

The decreased popularity of Leverett's exports leads to a shift inward of the net exports curve, as shown in Figure 5–6. At the new equilibrium, net exports are unchanged but the currency has depreciated.

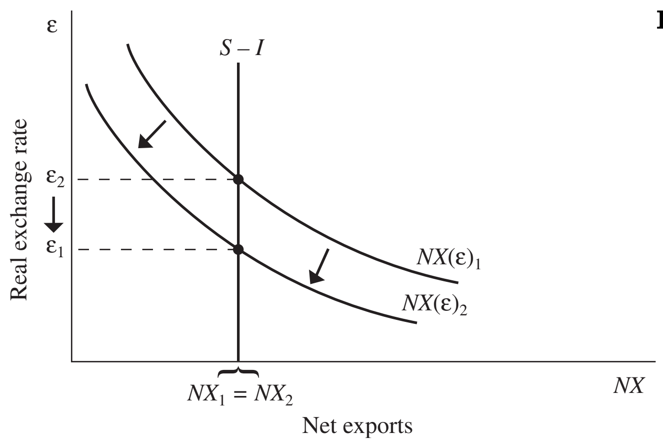


Figure 5–6

Even though Leverett's exports are less popular, its trade balance has remained the same. The reason for this is that the depreciated currency provides a stimulus to net exports, which overcomes the unpopularity of its exports by making them cheaper.

b. Leverett's currency now buys less foreign currency, so traveling abroad is more expensive. This is an example of the fact that imports (including foreign travel) have become more expensive—as required to keep net exports unchanged in the face of decreased demand for exports.

c. If the government reduces taxes, then disposable income and consumption rise. Hence, saving falls so that net exports also fall. This fall in net exports puts upward pressure on the exchange rate that offsets the decreased world demand. Investment and the interest rate would be unaffected by this policy since Leverett takes the world interest rate as given.

4. The increase in government spending decreases government saving and, thus, decreases national saving; this shifts the saving schedule to the left, as in Figure 5–7. Given the world interest rate r^*, the decrease in domestic saving causes the trade balance to fall.

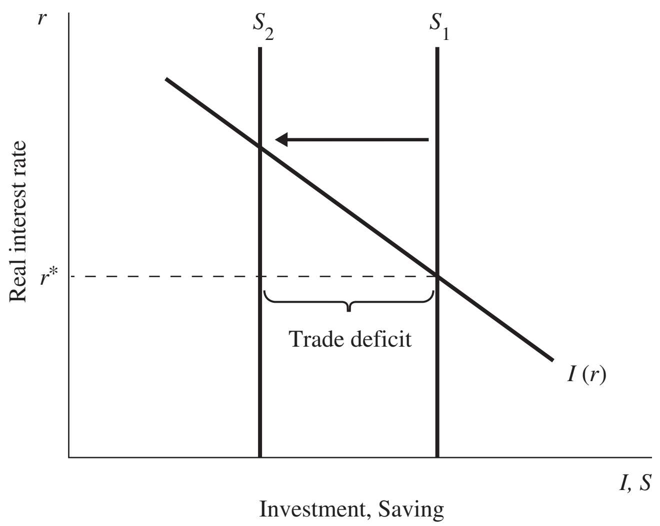


Figure 5–7

Figure 5–8 shows the impact of this increase in government purchases on the real exchange rate. The decrease in national saving causes the $(S - I)$ schedule to shift to the left, lowering the supply of dollars to be invested abroad. The lower supply of dollars causes the equilibrium real exchange rate to rise. As a result, domestic goods become more expensive relative to foreign goods, which causes exports to fall and imports to rise. In other words, as we determined in Figure 5–7, the trade balance falls.

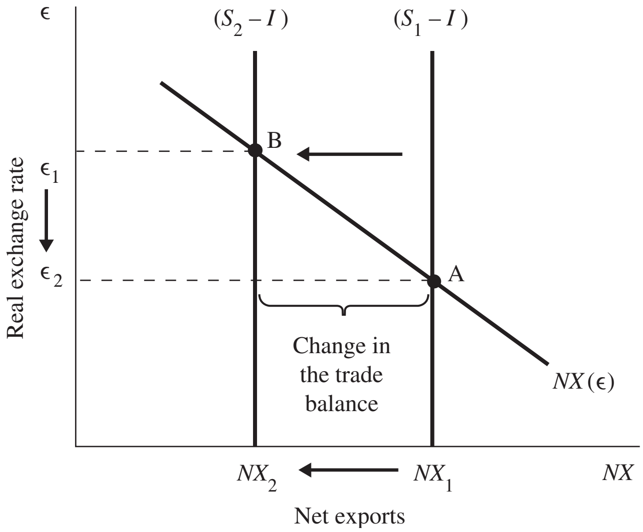


Figure 5–8

The answer to this question does depend on whether this is a local war or a world war. A world war causes many governments to increase expenditures; this increases the world interest rate r^*. The effect on a country's external accounts depends on the size of the change in the world interest rate relative to the size of the decrease in saving. For example, an increase in the world interest rate could cause a country to have a trade deficit, as in Figure 5–9, or a trade surplus, as in Figure 5–10.

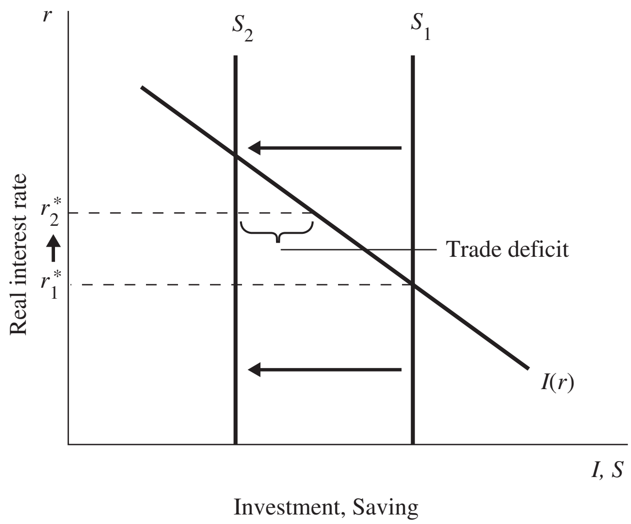


Figure 5–9

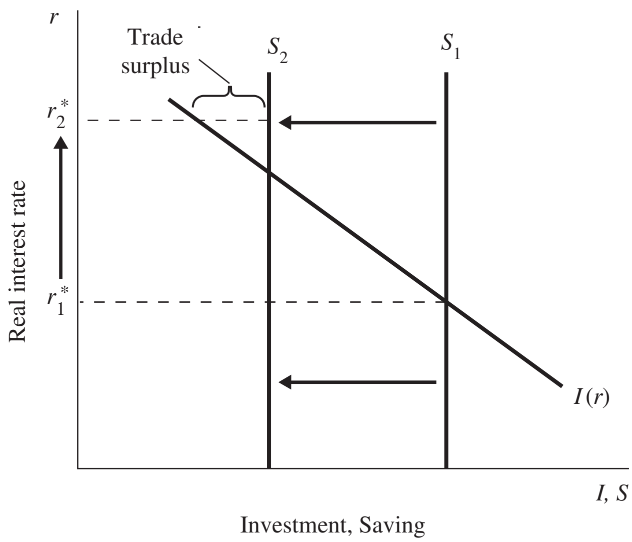


Figure 5–10

5. Clinton's policy would not affect net exports because it does not affect national saving (because it would not affect Y, C, or G) or investment. It would, however, shift the NX curve by decreasing U.S. demand for Japanese auto imports. This shift of the curve, shown in Figure 5–11, would raise the exchange rate. Although net exports would not change, the volume of both imports and exports would fall by the same amount.

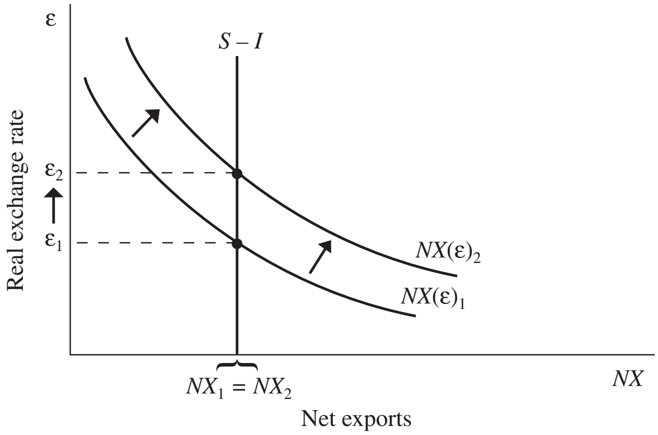


Figure 5–11

There are also important compositional effects of this policy. On the production side, the higher exchange rate increases imports and puts pressure on the sales of American companies with the exception of American luxury car production, which is shielded by the tariff. Also American exporters will be hurt by the higher exchange rate, which makes their goods more expensive to foreign countries. Consumers of Japanese luxury cars will be hurt by the tariffs while all other consumers will benefit from the appreciated dollar, which allows them to purchase goods more cheaply. In sum, the policy would shift demand to American luxury car producers at the expense of the rest of American production and also shift consumption from Japanese luxury cars to all other imports.

6. a. If the countries that institute an investment tax credit are large enough to shift the world investment demand schedule, then the tax credits shift the world investment demand schedule upward, as in Figure 5–12.

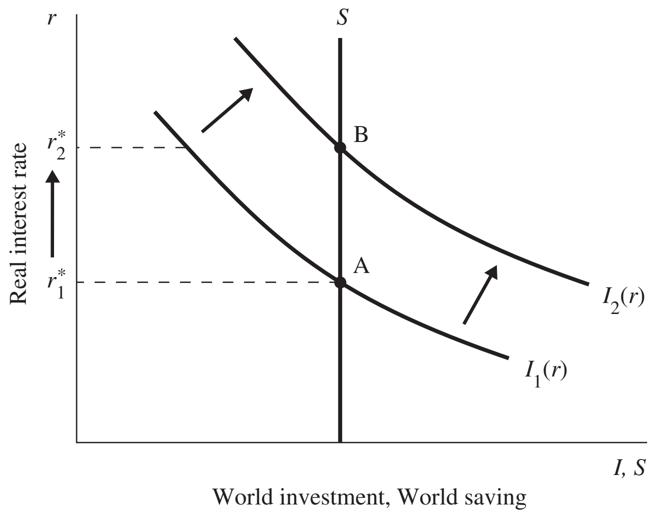


Figure 5–12

b. The world interest rate increases from r_1^* to r_2^* because of the increase in world investment demand; this is shown in Figure 5–12. (Remember that the world is a closed economy.)

c. The increase in the world interest rate increases the required rate of return on investments in our country. Because the investment schedule slopes downward, we know that a higher world interest rate means lower investment, as in Figure 5–13.

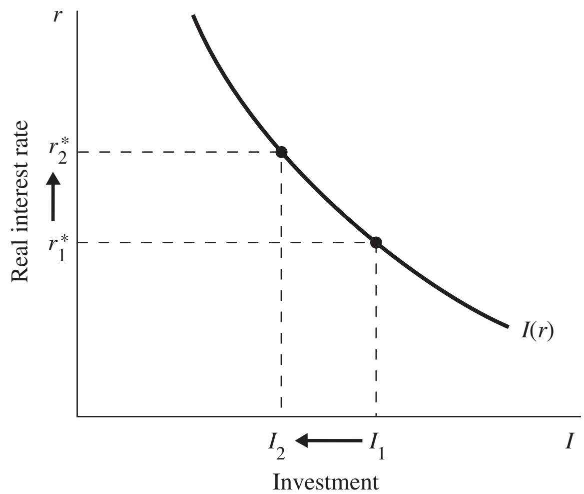


Figure 5–13

d. Given that our saving has not changed, the higher world interest rate means that our trade balance increases, as in Figure 5–14.

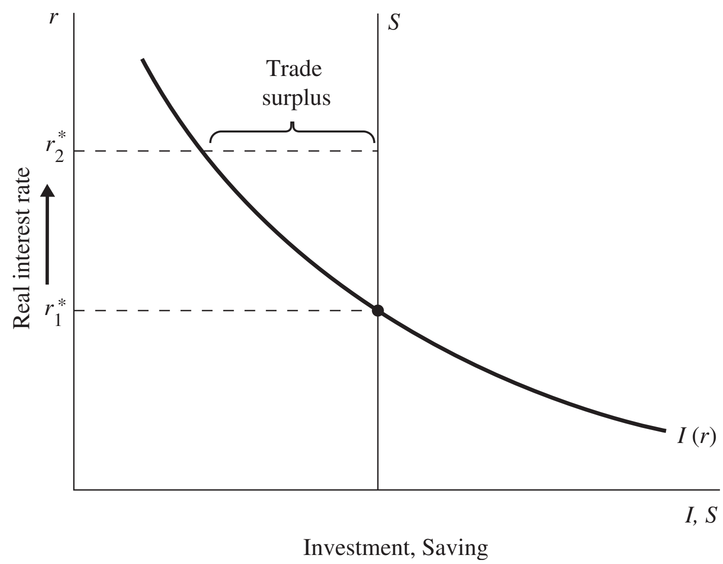


Figure 5–14

e. To bring about the required increase in the trade balance, the real exchange rate must fall. Our goods become less expensive relative to foreign goods, so that exports increase and imports decrease, as in Figure 5–15.

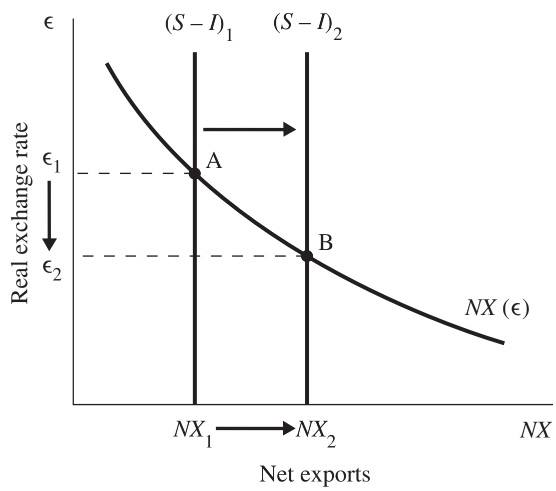


Figure 5–15

7. The easiest way to tell if your friend is right or wrong is to consider an example. Suppose that ten years ago, a cup of American coffee cost $1, while a cup of Italian espresso cost 1,000 lira. Since $1 bought 1,000 lira ten years ago, it cost the same amount of money to buy a cup of coffee in both countries. Since total U.S. inflation has been 25 percent, the American cup of coffee now costs $1.25. Total Italian inflation has been 100 percent, so the Italian cup of espresso now costs 2,000 lira. This year, $1 buys 1,500 lira, so that the cup of espresso costs 2,000 lira/[1,500 lira/dollar] = $1.33. This means that it is now more expensive to purchase espresso in Italy than coffee in the United States.

Thus, your friend is simply wrong to conclude that it is cheaper to travel in Italy. Even though the dollar buys more lira than it used to, the relatively rapid inflation in Italy means that lira buy fewer goods than they used to—it is more expensive now for an American to travel there.

8. a. The Fisher equation says that

$$i = r + \pi^e$$

where

i = the nominal interest rate
r = the real interest rate (same in both countries)
π^e = the expected inflation rate.

Plugging in the values given in the question for the nominal interest rates for each country, we find:

$$12 = r + \pi^e_{Can*}$$
$$8 = r + \pi^e_{US*}$$

This implies that

€€€€€€€€€€€€€ $\pi^e_{Can} - \pi^e_{US} = 4.$

Because we know that the real interest rate r is the same in both countries, we conclude that expected inflation in Canada is four percentage points higher than in the United States.

b. As in the text, we can express the nominal exchange rate as

$$e = \varepsilon \times (P_{Can}/P_{US}),$$

where

ε = the real exchange rate
P_{Can} = the price level in Canada
P_{US} = the price level in the United States.

The change in the nominal exchange rate can be written as:

$$\%\text{ change in } e = \%\text{ change in } \varepsilon + (\pi_{Can} - \pi_{US}).$$

We know that if purchasing-power parity holds, than a dollar must have the same purchasing power in every country. This implies that the percent change in the real exchange rate ε is zero because purchasing-power parity implies that the real exchange rate is fixed. Thus, changes in the nominal exchange rate result from differences in the inflaction rates in the United States and Canada. In equation form this says

$$\%\text{ change in } e = (\pi_{Can} - \pi_{US}).$$

Because economic agents know that purchasing-power parity holds, they expect this relationship to hold. In other words, the expected change in the nominal exchange rate equals the expected inflation rate in Canada minus the expected inflation rate in the United States. That is,

$$\text{Expected }\%\text{ change in } e = \pi^e_{Can} - \pi^e_{US*}$$

In part (a), we found that the difference in expected inflation rates is 4 percent. Therefore, the expected change in the nominal exchange rate e is 4 percent.

c. The problem with your friend's scheme is that it does not take into account the change in the nominal exchange rate e between the U.S. and Canadian dollars. Given that the real interest rate is fixed and identical in the United States and Canada, and given purchasing-power parity, we know that the difference in nominal interest rates accounts for the expected change in the nominal exchange rate between U.S. and Canadian dollars. In this example, the Canadian nominal interest rate is 12 percent, while the U.S. nominal interest rate is 8 percent. We conclude from this that the expected change in the nominal exchange rate is 4 percent. Therefore,

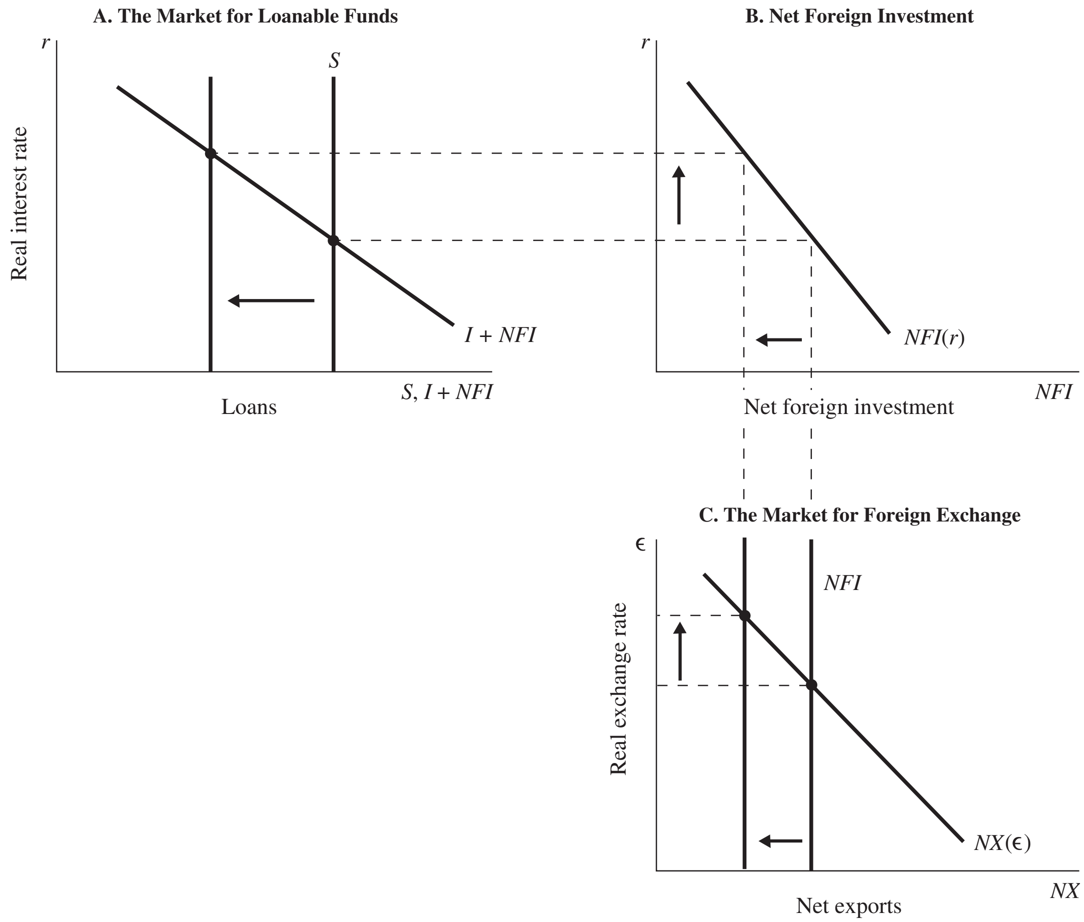
$$e \text{ this year} = 1 \text{ C\$/US\$}.$$
$$e \text{ next year} = 1.04 \text{ C\$/US\$}.$$

Assume that your friend borrows 1 U.S. dollar from an American bank at 8 percent, exchanges it for 1 Canadian dollar, and puts it in a Canadian Bank. At the end of the year your friend will have $1.12 in Canadian dollars. But to repay the American bank, the Canadian dollars must be converted back into U.S. dollars. The $1.12 (Canadian) becomes $1.08 (American), which is the amount owed to the U.S. bank. So in the end, your friend breaks even. In fact, after paying for transaction costs, your friend loses money.

More Problems and Applications to Chapter 5

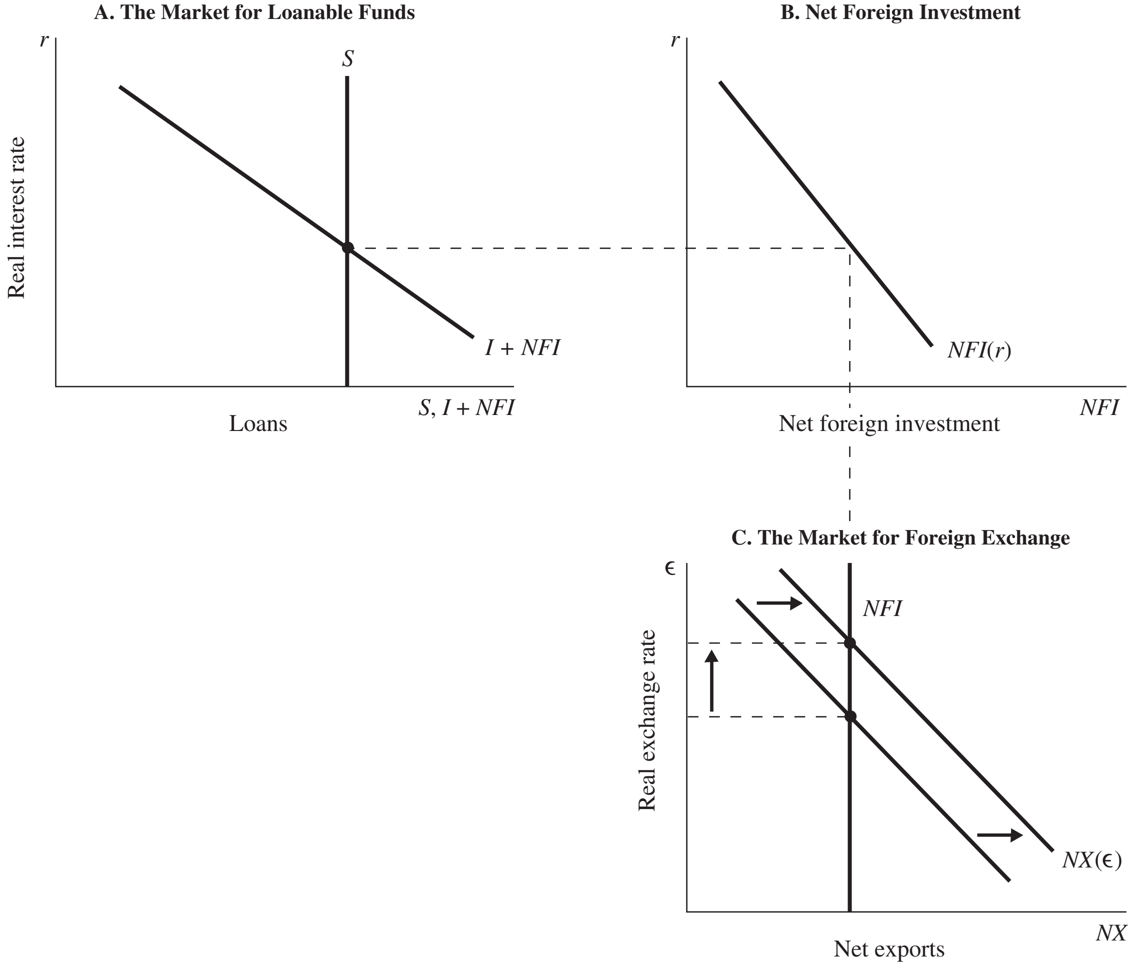
1. a. As shown in Figure 5–16, an increase in government purchases reduces national saving. This reduces the supply of loans and raises the equilibrium interest rate. This causes both domestic investment and net foreign investment to fall. The fall in net foreign investment reduces the supply of dollars to be exchanged into foreign currency, so the exchange rate appreciates and the trade balance falls.

Figure 5–16



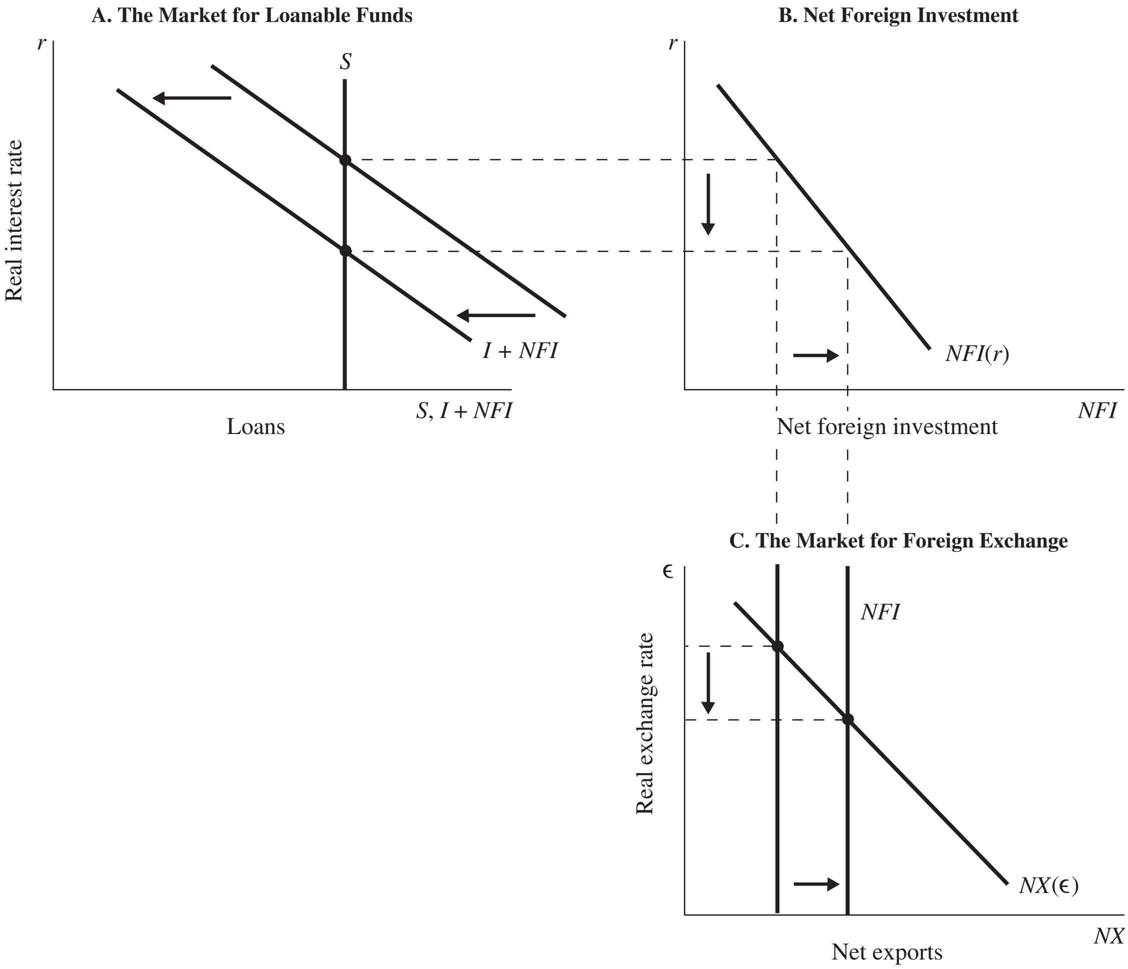
b. As shown in Figure 5–17, the increase in demand for exports shifts the net exports schedule outward. Since nothing has changed in the market for loanable funds, the interest rate remains the same, which in turn implies that net foreign investment remains the same. The shift in the net exports schedule causes the exchange rate to appreciate. The rise in the exchange rate makes U.S. goods more expensive relative to foreign goods, which depresses exports and stimulates imports. In the end, the increase in demand for American goods does not affect the trade balance.

Figure 5–17



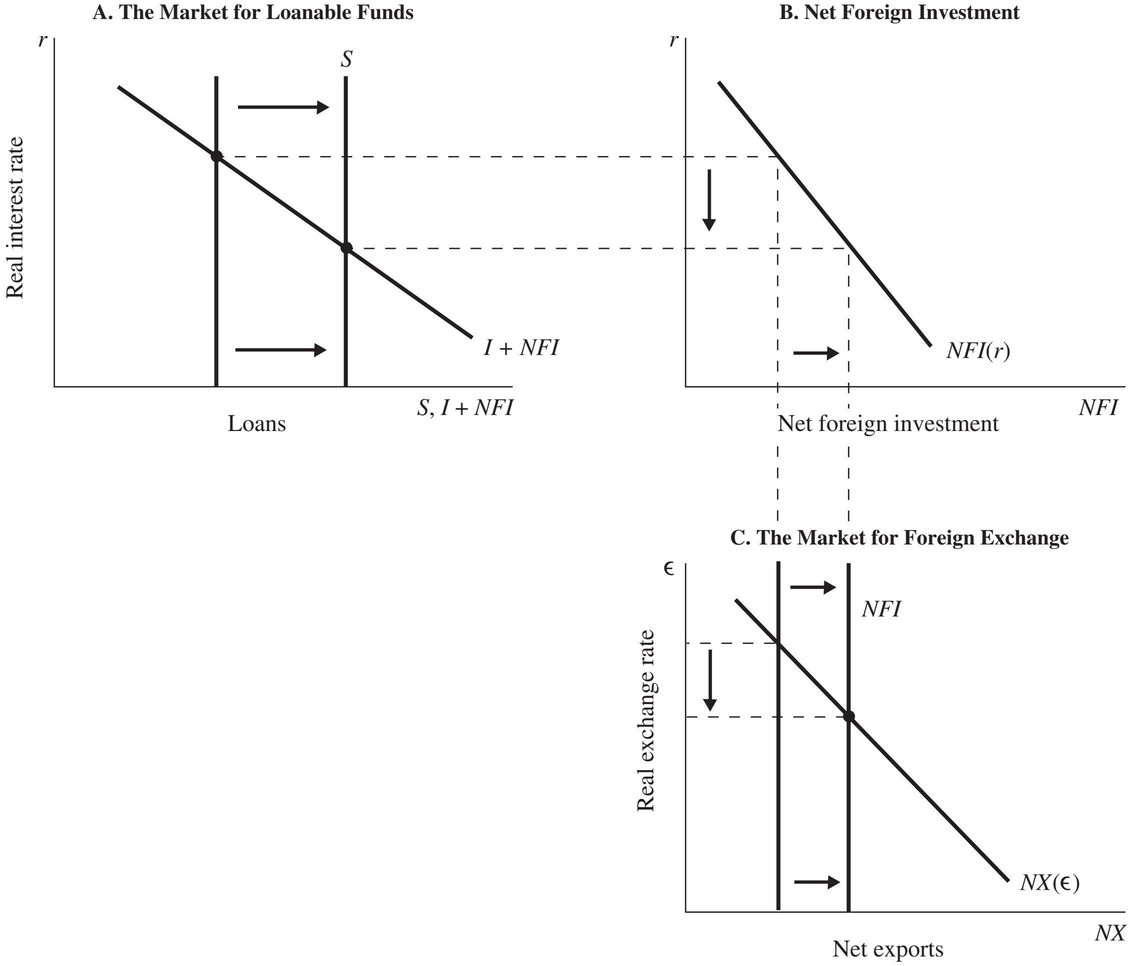
c. As shown in Figure 5–18, the U.S. investment demand schedule shifts inward. The demand for loans falls, so the equilibrium interest rate falls. The lower interest rate increases net foreign investment. Despite the fall in the interest rate, domestic investment falls; we know this because $I + NFI$ does not change, and NFI rises. The rise in net foreign investment increases the supply of dollars in the market for foreign exchange. The exchange rate depreciates, and net exports rise.

Figure 5–18



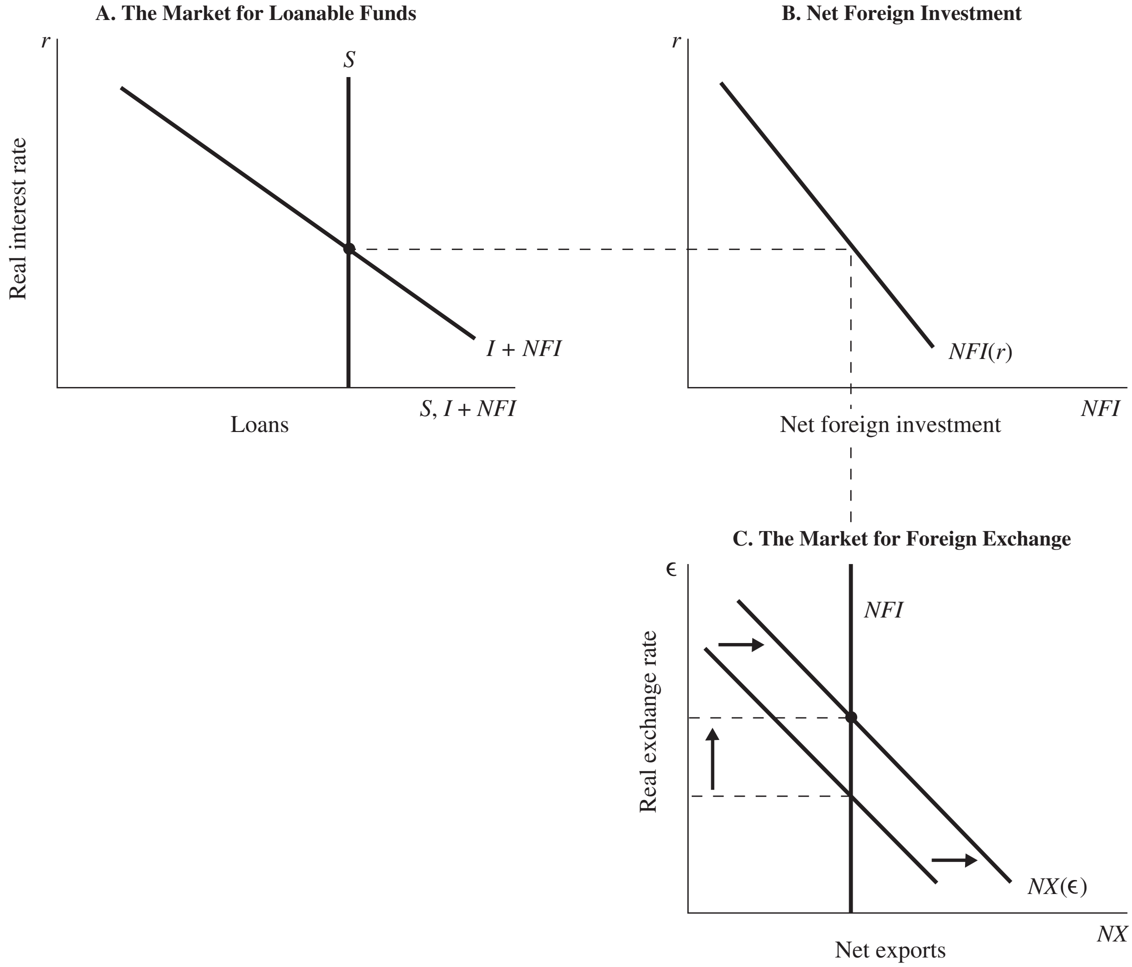
d. As shown in Figure 5–19, the increase in saving increases the supply of loans and lowers the equilibrium interest rate. This causes both domestic investment and net foreign investment to rise. The increase in net foreign investment increases the supply of dollars to be exchanged into foreign currency, so the exchange rate depreciates and the trade balance rises.

Figure 5–19



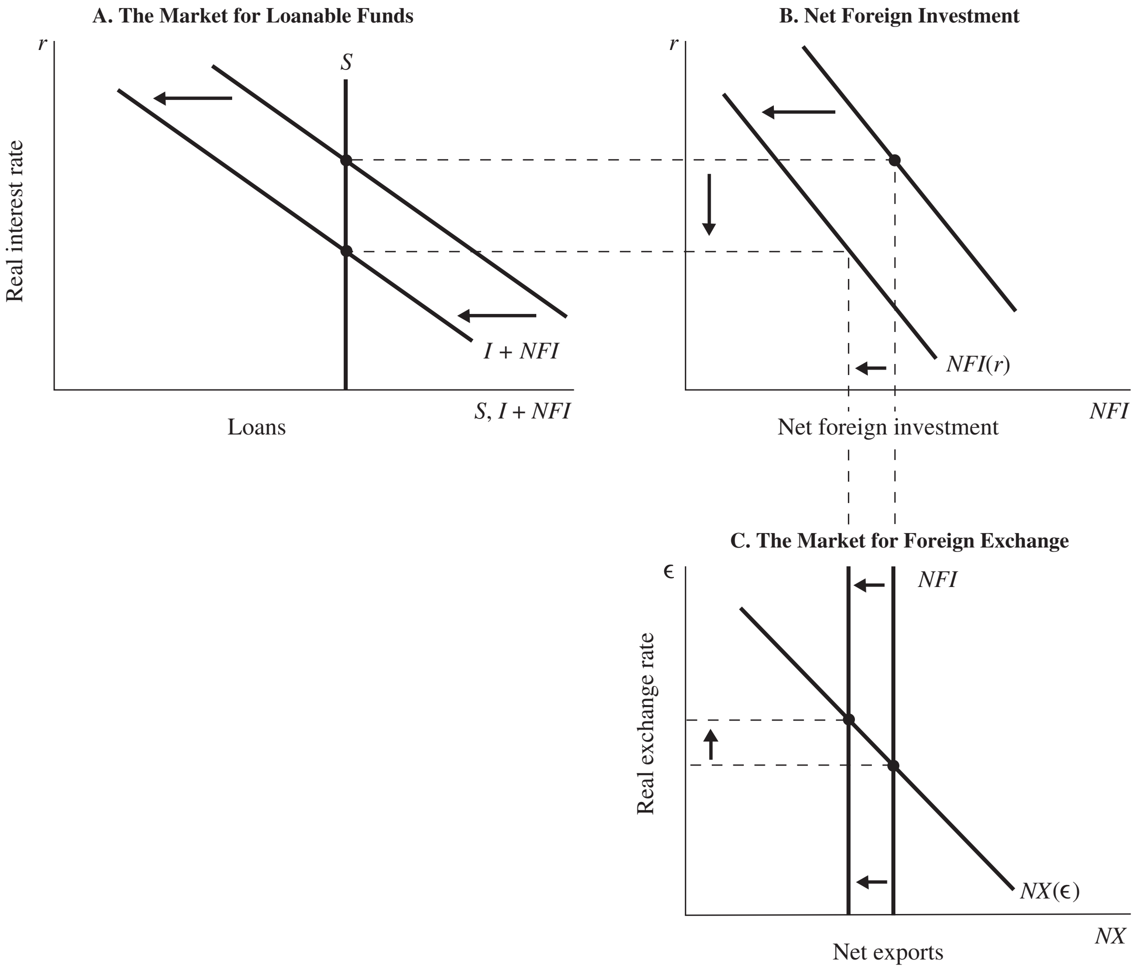
e. The reduction in the willingness of Americans to travel abroad reduces imports, since foreign travel counts as an import. As shown in Figure 5–20, this shifts the net exports schedule outward. Since nothing has changed in the market for loanable funds, the interest rate remains the same, which in turn implies that net foreign investment remains the same. The shift in the net exports schedule causes the exchange rate to appreciate. The rise in the exchange rate makes U.S. goods more expensive relative to foreign goods, which depresses exports and stimulates imports. In the end, the fall in Americans' desire to travel abroad does not affect the trade balance.

Figure 5–20



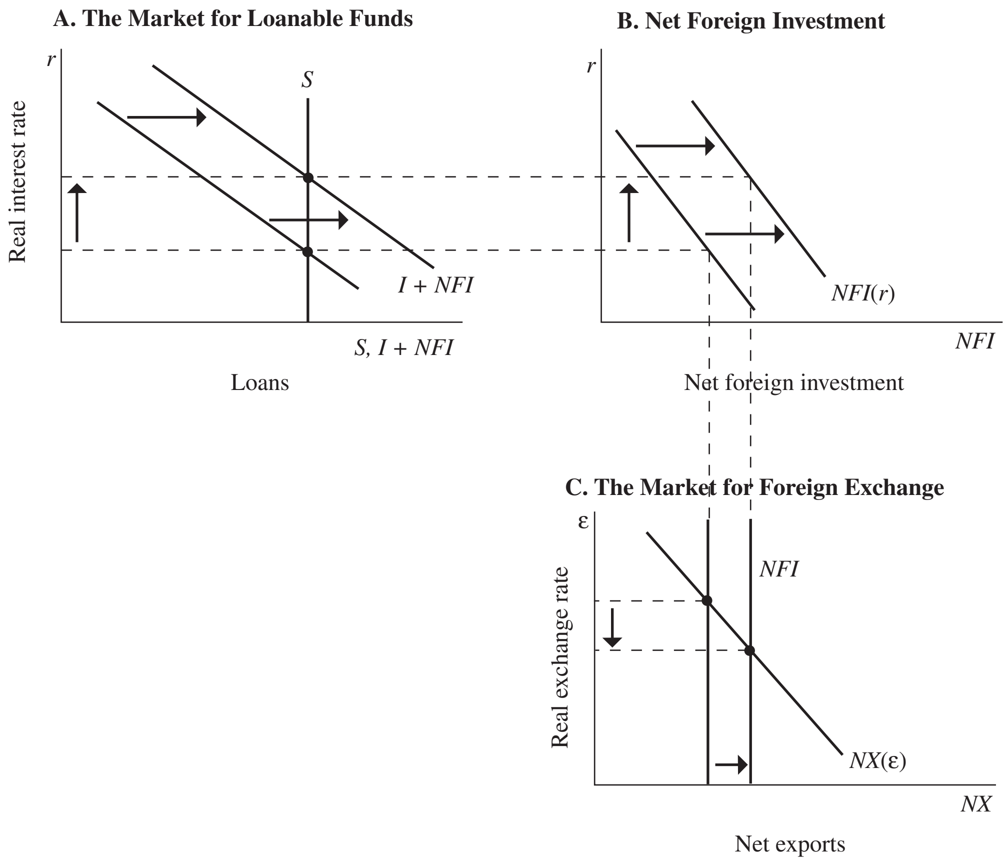
f. As shown in Figure 5–21, the net foreign investment schedule shifts in. This reduces demand for loans, so the equilibrium interest rate falls and investment rises. Net foreign investment falls, despite the fall in the interest rate; we know this because $I + NFI$ is unchanged and investment rises. The fall in net foreign investment reduces the supply of dollars to be exchanged into foreign currency, so the exchange rate appreciates and the trade balance falls.

Figure 5–21



2. Gingrich's statement has no immediate effect on any of the "fundamentals" in the economy: consumption, government purchases, taxes, and output are all unchanged. International investors, however, will be more reluctant to invest in the American economy, particularly to purchase U.S. government debt, because of the default risk. As both Americans and foreigners move their money out of the United States, the *NFI* curve shifts outward (there is more foreign investment), as shown in Figure 5–22(B). This raises the interest rate in order to keep $I + NFI$ equal to the unchanged S, shown in Figure 5–22(A). The increase in *NFI* raises the supply in the market for foreign exchange, which lowers the equilibrium exchange rate as shown in Figure 5–22(C).

Figure 5–22



Questions for Review

1. The rates of job separation and job finding determine the natural rate of unemployment. The rate of job separation is the fraction of people who lose their job each month. The higher the rate of job separation, the higher the natural rate of unemployment. The rate of job finding is the fraction of unemployed people who find a job each month. The higher the rate of job finding, the lower the natural rate of unemployment.
2. Frictional unemployment is the unemployment caused by the time it takes to match workers and jobs. Finding an appropriate job takes time because the flow of information about job candidates and job vacancies is not instantaneous. Because different jobs require different skills and pay different wages, unemployed workers may not accept the first job offer they receive.

   In contrast, wait unemployment is the unemployment resulting from wage rigidity and job rationing. These workers are unemployed not because they are actively searching for a job that best suits their skills (as in the case of frictional unemployment), but because at the prevailing real wage the supply of labor exceeds the demand. If the wage does not adjust to clear the labor market, then these workers must "wait" for jobs to become available. Wait unemployment thus arises because firms fail to reduce wages despite an excess supply of labor.
3. The real wage may remain above the level that equilibrates labor supply and labor demand because of minimum wage laws, the monopoly power of unions, and efficiency wages.

   Minimum-wage laws cause wage rigidity when they prevent wages from falling to equilibrium levels. Although most workers are paid a wage above the minimum level, for some workers, especially the unskilled and inexperienced, the minimum wage raises their wage above the equilibrium level. It therefore reduces the quantity of their labor that firms demand, and an excess supply of workers—that is, unemployment—results.

   The monopoly power of unions causes wage rigidity because the wages of unionized workers are determined not by the equilibrium of supply and demand but by collective bargaining between union leaders and firm management. The wage agreement often raises the wage above the equilibrium level and allows the firm to decide how many workers to employ. These high wages cause firms to hire fewer workers than at the market-clearing wage, so wait unemployment increases.

   Efficiency-wage theories suggest that high wages make workers more productive. The influence of wages on worker efficiency may explain why firms do not cut wages despite an excess supply of labor. Even though a wage reduction decreases the firm's wage bill, it may also lower worker productivity and therefore the firm's profits.
4. Depending on how one looks at the data, most unemployment can appear to be *either* short term or long term. Most spells of unemployment are short; that is, most of those who became unemployed find jobs quickly. On the other hand, most weeks of unemployment are attributable to the small number of long-term unemployed. By definition, the long-term unemployed do not find jobs quickly, so they appear on unemployment rolls for many weeks or months.
5. Economists have proposed at least two major hypotheses to explain the increase in the natural rate of unemployment in the 1970s and 1980s, and the decrease in the natural rate in the 1990s. The first is the changing demographic composition of the labor force. Because of the post–World-War-II baby boom, the number of young workers rose in the

1970s. Young workers have higher rates of unemployment, so this demographic shift should tend to increase unemployment. In the 1990s, the baby-boom workers aged and the average age of the labor force increased, thus lowering the average unemployment rate.

The second hypothesis is based on changes in the prevalence of sectoral shifts. The greater the amount of sectoral reallocation of workers, the greater the rate of job separation and the higher the level of frictional unemployment. The volatility of oil prices in the 1970s and 1980s is a possible source of increased sectoral shifts; in the 1990s, oil prices have been more stable.

The proposed explanations are plausible, but neither seems conclusive on its own.

Problems and Applications

1. a. In the example that follows, we assume that during the school year you look for a part-time job, and that on average it takes 2 weeks to find one. We also assume that the typical job lasts 1 semester, or 12 weeks.

   If it takes 2 weeks to find a job, then the rate of job finding in weeks is:

$$f = (1 \text{ job}/2 \text{ weeks}) = 0.5 \text{ jobs/weeks}.$$

   b. If the job lasts for 12 weeks, then the rate of job separation in weeks is:

$$s = (1 \text{ job}/12 \text{ weeks}) = 0.083 \text{ jobs/week}.$$

   c. From the text, we know that the formula for the natural rate of unemployment is

$$(U/L) = (s/(s+f)),$$

   where U is the number of people unemployed and L is the number of people in the labor force.

   Plugging in the values for f and s that were calculated in part (b), we find:

$$(U/L) = (0.083/(0.083 + 0.5)) = 0.14.$$

   Thus, if on average it takes 2 weeks to find a job that lasts 12 weeks, the natural rate of unemployment for this population of college students seeking part-time employment is 14 percent.

2. To show that the unemployment rate evolves over time to the steady-state rate, let's begin by defining how the number of people unemployed changes over time. The change in the number of unemployed equals the number of people losing jobs (sE) minus the number finding jobs (fU). In equation form, we can express this as:

$$U_{t+1} - U_t = \Delta U_{t+1} = sE_t - fU_t.$$

Recall from the text that $L = E_t + U_t$, or $E_t = L - U_t$, where L is the total labor force (we will assume that L is constant). Substituting for E_t in the above equation, we find:

$$\Delta U_{t+1} = s(L - U_t) - fU_t.$$

Dividing by L, we get an expression for the change in the unemployment rate from t to $t + 1$:

$$\Delta U_{t+1}/L = (U_{t+1}/L) - (U_t/L) = \Delta[U/L]_{t+1} = s(1 - U_t/L) - fU_t/L.$$

Rearranging terms on the right-hand side, we find:

$$\begin{aligned}\Delta[U/L]_{t+1} &= s - (s+f)U_t/L \\ &= (s+f)[s/(s+f) - U_t/L].\end{aligned}$$

The first point to note about this equation is that in steady state, when the unemployment rate equals its natural rate, the left-hand side of this expression equals zero. This tells us that, as we found in the text, the natural rate of unemployment $(U/L)^n$ equals $s/(s + f)$. We can now rewrite the above expression, substituting $(U/L)^n$ for $s/(s + f)$, to get an equation that is easier to interpret:

$$\Delta[U/L]_{t+1} = (s + f)[(U/L)^n - U_t/L].$$

This expression shows the following:

- If $U_t/L > (U/L)^n$ (that is, the unemployment rate is above its natural rate), then $\Delta[U/L]_{t+1}$ is negative: the unemployment rate falls.
- If $U_t/L < (U/L)^n$ (that is, the unemployment rate is below its natural rate), then $\Delta[U/L]_{t+1}$ is positive: the unemployment rate rises.

This process continues until the unemployment rate U/L reaches the steady-state rate $(U/L)^n$.

3. Call the number of residents of the dorm who are involved I, the number who are uninvolved U, and the total number of students $T = I + U$. In steady state the total number of involved students is constant. For this to happen we need the number of newly uninvolved students, $(0.10)I$, to be equal to the number of students who just became involved, $(0.05)U$. Following a few substitutions:

$$\begin{aligned}(0.05)U &= (0.10)I \\ &= (0.10)(T - U),\end{aligned}$$

so

$$\begin{aligned}\frac{U}{T} &= \frac{0.10}{0.10 + 0.05} \\ &= \frac{2}{3}.\end{aligned}$$

We find that two-thirds of the students are uninvolved.

4. Consider the formula for the natural rate of unemployment,

$$\frac{U}{L} = \frac{s}{s + f}.$$

If the new law lowers the chance of separation s, but has no effect on the rate of job finding f, then the natural rate of unemployment falls.

For several reasons, however, the new law might tend to reduce f. First, raising the cost of firing might make firms more careful about hiring workers, since firms have a harder time firing workers who turn out to be a poor match. Second, if searchers think that the new legislation will lead them to spend a longer period of time on a particular job, then they might weigh more carefully whether or not to take that job. If the reduction in f is large enough, then the new policy may even increase the natural rate of unemployment.

5. a. The demand for labor is determined by the amount of labor that a profit-maximizing firm wants to hire at a given real wage. The profit-maximizing condition is that the firm hire labor until the marginal product of labor equals the real wage,

$$MPL = \frac{W}{P}.$$

The marginal product of labor is found by differentiating the production function with respect to labor (see the appendix to Chapter 3 for more discussion),

$$\begin{aligned} MPL &= \frac{dY}{dL}. \\ &= \frac{d(K^{1/3}L^{2/3})}{dL} \\ &= \frac{2}{3}K^{1/3}L^{-1/3}. \end{aligned}$$

In order to solve for labor demand, we set the *MPL* equal to the real wage and solve for *L*:

$$\begin{aligned} \frac{2}{3}K^{1/3}L^{-1/3} &= \frac{W}{P} \\ L &= \frac{8}{27}K\left(\frac{W}{P}\right)^{-3}. \end{aligned}$$

Notice that this expression has the intuitively desirable feature that increases in the real wage reduce the demand for labor.

b. We asume that the 1,000 units of capital and the 1,000 units of labor are supplied inelastically (i.e., they will work at any price). In this case we know that all 1,000 units of each will be used in equilibrium, so we can substitute them into the above labor demand function and solve for $\frac{W}{P}$.

$$\begin{aligned} 1{,}000 &= \frac{8}{27}1{,}000\left(\frac{W}{P}\right)^{-3} \\ \frac{W}{P} &= \frac{2}{3}. \end{aligned}$$

In equilibrium, employment will be 1,000, and multiplying this by 2/3 we find that the workers earn 667 units of output. The total output is given by the production function:

$$\begin{aligned} Y &= K^{1/3}L^{2/3} \\ &= 1{,}000^{1/3}1{,}000^{2/3} \\ &= 1{,}000. \end{aligned}$$

Notice that workers get two-thirds of output, which is consistent with what we know about the Cobb–Douglas production function from the appendix to Chapter 3.

c. The congressionally mandated wage of 1 unit of output is above the equilibrium wage of 2/3 units of output.

d. Firms will use their labor demand function to decide how many workers to hire at the given real wage of 1 and capital stock of 1,000:

$$\begin{aligned} L &= \frac{8}{27}1{,}000(1)^{-3} \\ &= 296, \end{aligned}$$

so 296 workers will be hired for a total compensation of 296 units of output.

e. The policy redistributes output from the 704 workers who become involuntarily unemployed to the 296 workers who get paid more than before. The lucky workers benefit less than the losers lose as the total compensation to the working class falls from 667 to 296 units of output.

f. This problem does focus the analysis of minimum-wage laws on the two effects of these laws: they raise the wage for some workers while downward-sloping labor demand reduces the total number of jobs. Note, however, that if labor demand is less elastic than in this example, then the loss of employment may be smaller, and the change in worker income might be positive.

6. a. The labor demand curve is given by the marginal product of labor schedule faced by firms. If a country experiences a reduction in productivity, then the labor demand curve shifts downward as in Figure 6–1. If labor becomes less productive, then at any given real wage, firms demand less labor.

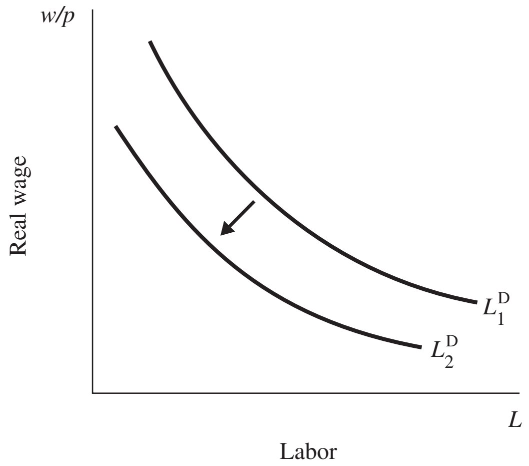


Figure 6–1

b. If the labor market is always in equilibrium, then, assuming a fixed labor supply, an adverse productivity shock causes a decrease in the real wage but has no effect on employment or unemployment, as in Figure 6–2.

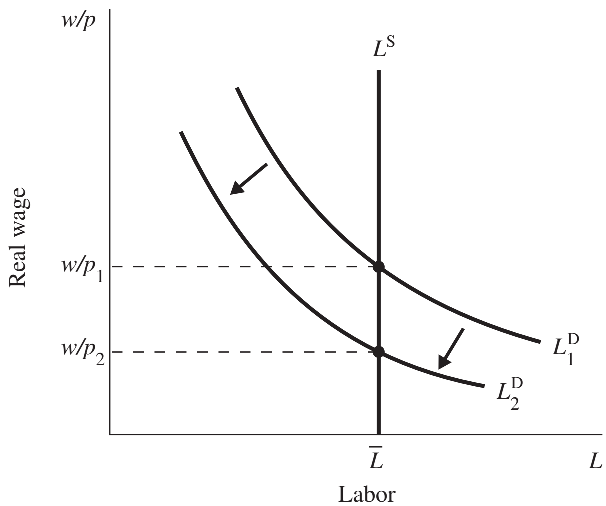


Figure 6–2

c. If unions constrain real wages to remain unaltered, then as illustrated in Figure 6–3, employment falls to L_1 and unemployment equals $L - L_1$.

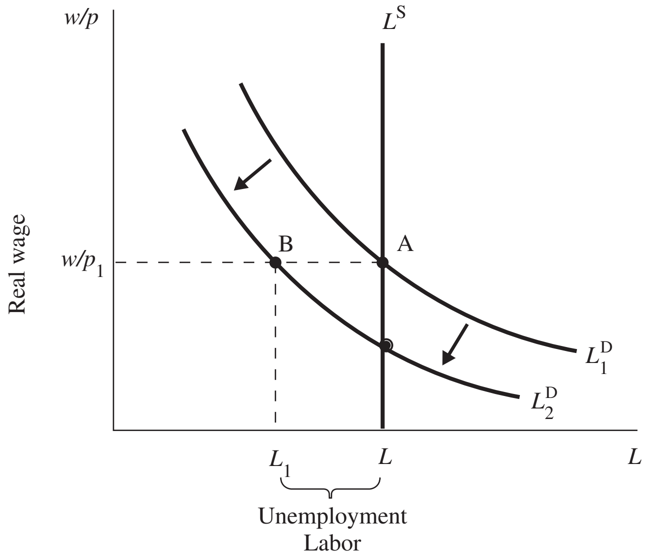


Figure 6–3

This example shows that the effect of a productivity shock on an economy depends on the role of unions and the response of collective bargaining to such a change.

7. The vacant office space problem is similar to the unemployment problem; we can apply the same concepts we used in analyzing unemployed labor to analyze why vacant office space exists. There is a rate of office separation: firms that occupy offices leave, either to move to different offices or because they go out of business. There is a rate of office finding: firms that need office space (either to start up or expand) find empty offices. It takes time to match firms with available space. Different types of firms require spaces with different attributes depending on what their specific needs are. Also, because demand for different goods fluctuates, there are "sectoral shifts"—changes in the composition of demand among industries and regions—that affect the profitability and office needs of different firms.

CHAPTER 7 Economic Growth I

Questions for Review

1. In the Solow growth model, a high saving rate leads to a large steady-state capital stock and a high level of steady-state output. A low saving rate leads to a small steady-state capital stock and a low level of steady-state output. Higher saving leads to faster economic growth only in the short run. An increase in the saving rate raises growth until the economy reaches the new steady state. That is, if the economy maintains a high saving rate, it will also maintain a large capital stock and a high level of output, but it will *not* maintain a high rate of growth forever.

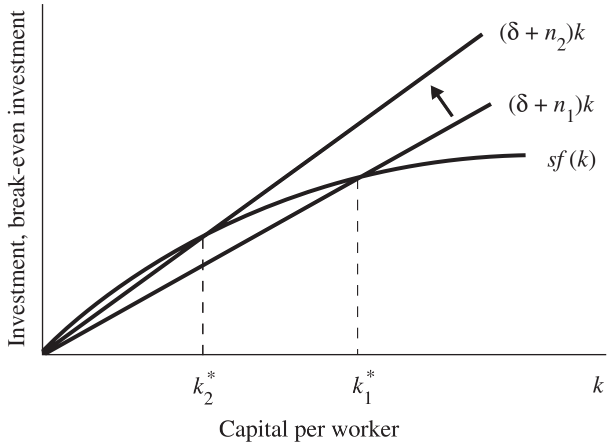
2. It is reasonable to assume that the objective of an economic policymaker is to maximize the economic well-being of the individual members of society. Since economic well-being depends on the amount of consumption, the policymaker should choose the steady state with the highest level of consumption. The Golden Rule level of capital represents the level that maximizes consumption in the steady state.

   Suppose, for example, that there is no population growth or technological change. If the steady-state capital stock increases by one unit, then output increases by the marginal product of capital *MPK*; depreciation, however, increases by an amount δ, so that the net amount of extra output available for consumption is $MPK - \delta$. The Golden Rule capital stock is the level at which $MPK = \delta$, so that the marginal product of capital equals the depreciation rate.

3. When the economy begins above the Golden Rule level of capital, reaching the Golden Rule level leads to higher consumption at all points in time. Therefore, the policymaker would always want to choose the Golden Rule level, because consumption is increased for all periods of time. On the other hand, when the economy begins below the Golden Rule level of capital, reaching the Golden Rule level means reducing consumption today to increase consumption in the future. In this case, the policymaker's decision is not as clear. If the policymaker cares more about current generations than about future generations, he or she may decide *not* to pursue policies to reach the Golden Rule steady state. If the policymaker cares equally about all generations, then he or she chooses to reach the Golden Rule. Even though the current generation will have to consume less, an infinite number of future generations will benefit from increased consumption by moving to the Golden Rule.

4. The higher the population growth rate is, the lower the steady-state level of capital per worker is, and therefore there is a lower level of steady-state income. For example, Figure 7–1 shows the steady state for two levels of population growth, a low level n_1 and a higher level n_2. The higher population growth n_2 means that the line representing population growth and depreciation is higher, so the steady-state level of capital per worker is lower.

Figure 7–1



The steady-state growth rate of total income is $n + g$: the higher the population growth rate n is, the higher the growth rate of total income is. Income per worker, however, grows at rate g in steady state and, thus, is not affected by population growth.

Problems and Applications

1. a. A production function has constant returns to scale if increasing all factors of production by an equal percentage causes output to increase by the same percentage. Mathematically, a production function has constant returns to scale if $zY = F(zK, zL)$ for any positive number z. That is, if we multiply both the amount of capital and the amount of labor by some amount z, then the amount of output is multiplied by z. For example, if we double the amounts of capital and labor we use (setting $z = 2$), then output also doubles.

   To see if the production function $Y = F(K, L) = K^{1/2}L^{1/2}$ has constant returns to scale, we write:

$$F(zK, zL) = (zK)^{1/2}(zL)^{1/2} = zK^{1/2}L^{1/2} = zY.$$

   Therefore, the production function $Y = K^{1/2}L^{1/2}$ has constant returns to scale.

   b. To find the per-worker production function, divide the production function $Y = K^{1/2}L^{1/2}$ by L:

$$\frac{Y}{L} = \frac{K^{1/2}L^{1/2}}{L}.$$

   If we define $y = Y/L$, we can rewrite the above expression as:

$$y = K^{1/2}/L^{1/2}.$$

   Defining $k = K/L$, we can rewrite the above expression as:

$$y = k^{1/2}.$$

c. We know the following facts about countries A and B:

δ = depreciation rate = 0.05,
s_a = saving rate of country A = 0.1,
s_b = saving rate of country B = 0.2, and
$y = k^{1/2}$ is the per-worker production function derived in part (b) for countries A and B.

The growth of the capital stock Δk equals the amount of investment $sf(k)$, less the amount of depreciation δk. That is, $\Delta k = sf(k) - \delta k$. In steady state, the capital stock does not grow, so we can write this as $sf(k) = \delta k$.

To find the steady-state level of capital per worker, plug the per-worker production function into the steady-state investment condition, and solve for k^*:

$$sk^{1/2} = \delta k.$$

Rewriting this:

$$k^{1/2} = s/\delta$$
$$k = (s/\delta)^2.$$

To find the steady-state level of capital per worker k^*, plug the saving rate for each country into the above formula:

$$\text{Country A:} \quad k_a^* = (s_a/\delta)^2 = (0.1/0.05)^2 = 4.$$

$$\text{Country B:} \quad k_b^* = (s_b/\delta)^2 = (0.2/0.05)^2 = 16.$$

Now that we have found k^* for each country, we can calculate the steady-state levels of income per worker for countries A and B because we know that $y = k^{1/2}$:

$$y_a^* = (4)^{1/2} = 2.$$
$$y_b^* = (16)^{1/2} = 4.$$

We know that out of each dollar of income, workers save a fraction s and consume a fraction $(1 - s)$. That is, the consumption function is $c = (1 - s)y$. Since we know the steady-state levels of income in the two countries, we find

$$\text{Country A:} \quad c_a^* = (1 - s_a)y_a^* = (1 - 0.1)(2) = 1.8.$$

$$\text{Country B:} \quad c_b^* = (1 - s_b)y_b^* = (1 - 0.2)(4) = 3.2.$$

d. Using the following facts and equations, we calculate income per worker y, consumption per worker c, and capital per worker k:

$$s_a = 0.1.$$
$$s_b = 0.2.$$
$$\delta = 0.05.$$
$$k_o = 2 \text{ for both countries.}$$
$$y = k^{1/2}.$$
$$c = (1 - s)y.$$

Country A						
Year	k	$y = k^{1/2}$	$c = (1 - s_a)y$	$i = s_a y$	δk	$\Delta k = i - \delta k$
1	2	1.414	1.273	0.141	0.100	0.041
2	2.041	1.429	1.286	0.143	0.102	0.041
3	2.082	1.443	1.299	0.144	0.104	0.040
4	2.122	1.457	1.311	0.146	0.106	0.040
5	2.102	1.470	1.323	0.147	0.108	0.039

Country B						
Year	k	$y = k^{1/2}$	$c = (1 - s_a)y$	$i = s_a y$	δk	$\Delta k = i - \delta k$
1	2	1.414	1.131	0.283	0.100	0.183
2	2.183	1.477	1.182	0.295	0.109	0.186
3	2.369	1.539	1.231	0.308	0.118	0.190
4	2.559	1.600	1.280	0.320	0.128	0.192
5	2.751	1.659	1.327	0.332	0.138	0.194

Note that it will take five years before consumption in country B is higher than consumption in country A.

2. a. The production function in the Solow growth model is $Y = F(K, L)$, or expressed terms of output per worker, $y = f(k)$. If a war reduces the labor force through casualties, then L falls but $k = K/L$ rises. The production function tells us that total output falls because there are fewer workers. Output per worker increases, however, since each worker has more capital.

b. The reduction in the labor force means that the capital stock per worker is higher after the war. Therefore, if the economy were in a steady state prior to the war, then after the war the economy has a capital stock that is higher than the steady-state level. This is shown in Figure 7–2 as an increase in capital per worker from k^* to k_1. As the economy returns to the steady state, the capital stock per worker falls from k_1 back to k^*, so output per worker also falls.

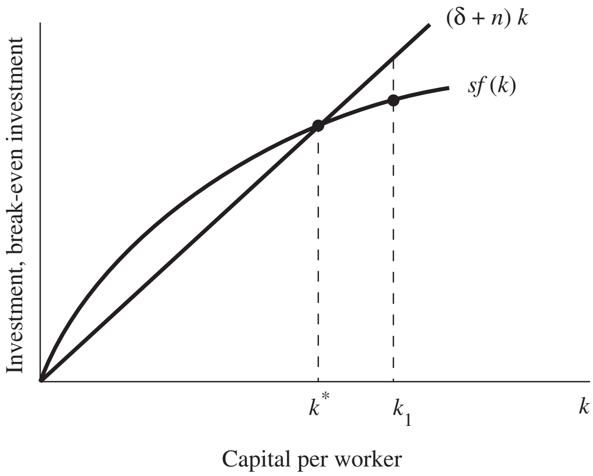


Figure 7–2

Hence, in the transition to the new steady state, output growth is slower. In the steady state, we know that technological progress determines the growth rate of output per worker. Once the economy returns to the steady state, output per worker equals the rate of technological progress—as it was before the war.

3. a. We follow Section 7-1, "Approaching the Steady State: A Numerical Example." The production function is $Y = K^{0.3}L^{0.7}$. To derive the per-worker production function $f(k)$, divide both sides of the production function by the labor force L:

$$\frac{Y}{L} = \frac{K^{0.3}L^{0.7}}{L}.$$

Rearrange to obtain:

$$\frac{Y}{L} = \left(\frac{K}{L}\right)^{0.3}.$$

Because $y = Y/L$ and $k = K/L$, this becomes:

$$y = k^{0.3}.$$

b. Recall that

$$\Delta k = sf(k) - \delta k.$$

The steady-state value of capital k^* is defined as the value of k at which capital stock is constant, so $\Delta k = 0$. It follows that in steady state

$$0 = sf(k) - \delta k,$$

or, equivalently,

$$\frac{k*}{f(k*)} = \frac{s}{\delta}.$$

For the production function in this problem, it follows that:

$$\frac{k*}{(k*)^{0.3}} = \frac{s}{\delta}.$$

Rearranging:

$$(k*)^{0.7} = \frac{s}{\delta},$$

or

$$k* = \left(\frac{s}{\delta}\right)^{1/0.7}$$

Substituting this equation for steady-state capital per worker into the per-worker production function from part (a) gives:

$$y* = \left(\frac{s}{\delta}\right)^{0.3/0.7}$$

Consumption is the amount of output that is not invested. Since investment in the steady state equals δk^*, it follows that

$$c* = f(k*) - \delta k* = \left(\frac{s}{\delta}\right)^{0.3/0.7} - \delta\left(\frac{s}{\delta}\right)^{1/0.7}$$

(*Note:* An alternative approach to the problem is to note that consumption also equals the amount of output that is not saved:

$$c^* = (1-s)f(k^*) = (1-s)(k^*)^{0.3} = (1-s)\left(\frac{s}{\delta}\right)^{0.3/0.7}$$

Some algebraic manipulation shows that this equation is equal to the equation above.)

c. The table below shows k^*, y^*, and c^* for the saving rate in the left column, using the equations from part (b). We assume a depreciation rate of 10 percent (i.e., 0.1). (The last column shows the marginal product of capital, derived in part (d) below).

	k^*	y^*	c^*	*MPK*
0	0.00	0.00	0.00	
0.1	1.00	1.00	0.90	0.30
0.2	2.69	1.35	1.08	0.15
0.3	4.80	1.60	1.12	0.10
0.4	7.25	1.81	1.09	0.08
0.5	9.97	1.99	1.00	0.06
0.6	12.93	2.16	0.86	0.05
0.7	16.12	2.30	0.69	0.04
0.8	19.50	2.44	0.49	0.04
0.9	23.08	2.56	0.26	0.03
1	26.83	2.68	0.00	0.03

Note that a saving rate of 100 percent (s = 1.0) maximizes output per worker. In that case, of course, nothing is ever consumed, so c^* =0. Consumption per worker is maximized at a rate of saving of 0.3 percent—that is, where s equals capital's share in output. This is the Golden Rule level of s.

d. We can differentiate the production function $Y = K^{0.3}L^{0.7}$ with respect to K to find the marginal product of capital. This gives:

$$MPK = 0.3\frac{K^{0.3}L^{0.7}}{K} = 0.3\frac{Y}{K} = 0.3\frac{y}{k}.$$

The table in part (c) shows the marginal product of capital for each value of the saving rate. (Note that the appendix to Chapter 3 derived the *MPK* for the general Cobb–Douglas production function. The equation above corresponds to the special case where α equals 0.3.)

4. Suppose the economy begins with an initial steady-state capital stock below the Golden Rule level. The immediate effect of devoting a larger share of national output to investment is that the economy devotes a smaller share to consumption; that is, "living standards" as measured by consumption fall. The higher investment rate means that the capital stock increases more quickly, so the growth rates of output and output per worker rise. The productivity of workers is the average amount produced by each worker—that is, output per worker. So productivity growth rises. Hence, the immediate effect is that living standards fall but productivity growth rises.

In the new steady state, output grows at rate $n + g$, while output per worker grows at rate g. This means that in the steady state, productivity growth is independent of the rate of investment. Since we begin with an initial steady-state capital stock below the Golden Rule level, the higher investment rate means that the new steady state has a higher level of consumption, so living standards are higher.

Thus, an increase in the investment rate increases the productivity growth rate in the short run but has no effect in the long run. Living standards, on the other hand, fall immediately and only rise over time. That is, the quotation emphasizes growth, but not the sacrifice required to achieve it.

5. As in the text, let $k = K/L$ stand for capital per unit of labor. The equation for the evolution of k is

$$\Delta k = \text{Saving} - (\delta + n)k.$$

If all capital income is saved and if capital earns its marginal product, then saving equals $MPK \times k$. We can substitute this into the above equation to find

$$\Delta k = MPK \times k - (\delta + n)k.$$

In the steady state, capital per efficiency unit of capital does not change, so $\Delta k = 0$. From the above equation, this tells us that

$$MPK \times k = (\delta + n)k,$$

or

$$MPK = (\delta + n).$$

Equivalently,

$$MPK - \delta = n.$$

In this economy's steady state, the net marginal product of capital, $MPK - \delta$, equals the rate of growth of output, n. But this condition describes the Golden Rule steady state. Hence, we conclude that this economy reaches the Golden Rule level of capital accumulation.

6. First, consider steady states. In Figure 7–3, the slower population growth rate shifts the line representing population growth and depreciation downward. The new steady state has a higher level of capital per worker, k_2^*, and hence a higher level of output per worker.

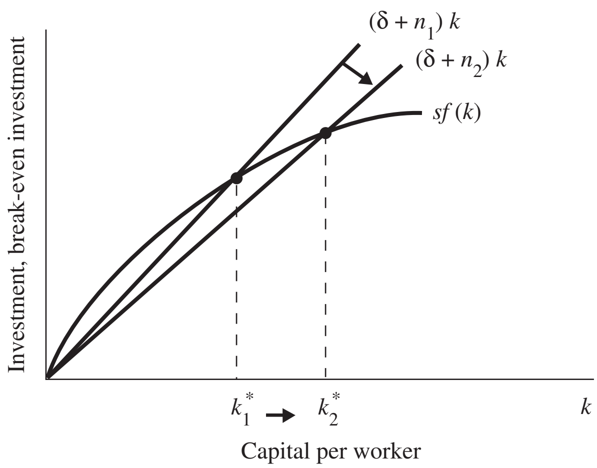


Figure 7–3

What about steady-state growth rates? In steady state, total output grows at rate $n + g$, whereas output per-person grows at rate g. Hence, slower population growth will lower *total* output growth, but *per-person* output growth will be the same.

Now consider the transition. We know that the steady-state level of output per person is higher with low population growth. Hence, during the transition to the new steady state, output per person must grow at a rate faster than g for a while. In the decades after the fall in population growth, growth in total output will fall while growth in output per person will rise.

7. If there are decreasing returns to labor and capital, then increasing both capital and labor by the same proportion increases output by less than this proportion. For example, if we double the amounts of capital and labor, then output less than doubles. This may happen if there is a fixed factor such as land in the production function, and it becomes scarce as the economy grows larger. Then population growth will increase total output but decrease output per worker, since each worker has less of the fixed factor to work with.

   If there are increasing returns to scale, then doubling inputs of capital and labor more than doubles output. This may happen if specialization of labor becomes greater as population grows. Then population growth increases total output and also increases output per worker, since the economy is able to take advantage of the scale economy more quickly.

8. a. To find output per capita y we divide total output by the number of workers:

$$y = \frac{k^{\alpha}\left[(1-u^{*})L\right]^{-\alpha}}{L}$$

$$= \left(\frac{K}{L}\right)^{\alpha}(1-u^{*})^{1-\alpha}$$

$$= k^{\alpha}(1-u^{*})^{1-\alpha},$$

where the final step uses the definition $k = \frac{K}{L}$. Notice that unemployment reduces the amount of per capita output for any given capital–person ratio because some of the people are not producing anything.

The steady state is the level of capital per person at which the increase in capital per capita from investment equals its decrease from depreciation and population growth (see Chapter 4 for more details).

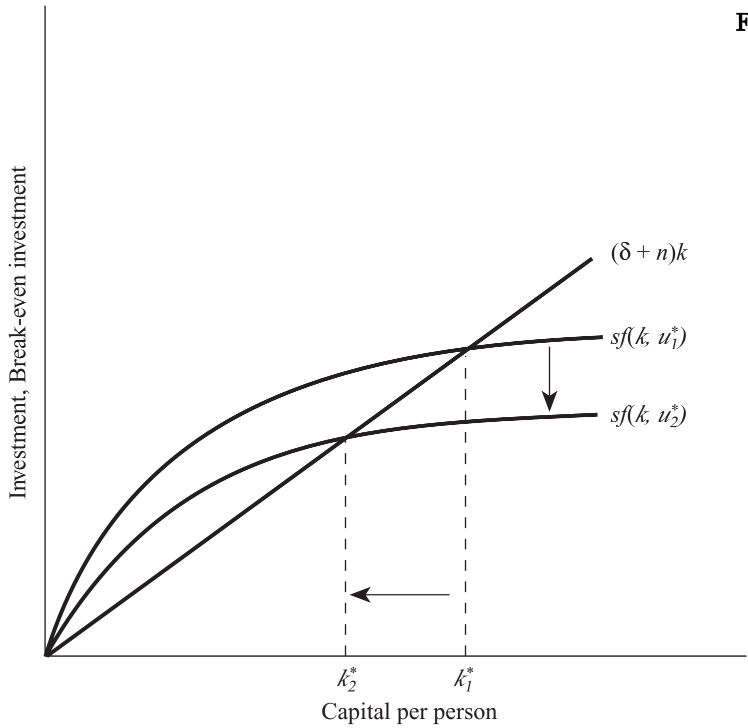
$$sy^{*} = (\delta + n)k^{*}$$

$$sk^{*\alpha}(1-u)^{1-\alpha} = (\delta + n)k^{*}$$

$$k^{*} = (1-u^{*})\left(\frac{s}{\delta + n}\right)^{\frac{1}{1-\alpha}}$$

Unemployment lowers the marginal product of capital and, hence, acts like a negative technological shock that reduces the amount of capital the economy can reproduce in steady state. Figure 7–4 shows this graphically: an increase in unemployment lowers the $sf(k)$ line and the steady-state level of capital per person.

Figure 7–4



Finally, to get steady-state output plug the steady-state level of capital into the production function:

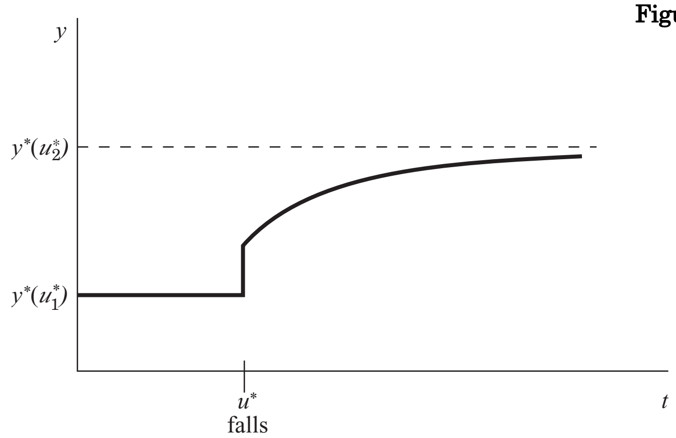
$$y^* = \left((1-u^*)\left(\frac{s}{\delta+n}\right)^{\frac{1}{1-\alpha}} \right)^{\alpha} (1-u^*)^{1-\alpha}$$

$$= (1-u^*)\left(\frac{s}{\delta+n}\right)^{\frac{\alpha}{1-\alpha}}$$

Unemployment lowers output for two reasons: for a given k, unemployment lowers y, and unemployment also lowers the steady-state value k^*.

b. Figure 7–5 below shows the pattern of output over time. As soon as unemployment falls from u_1 to u_2, output jumps up from its initial steady-state value of $y*(u_1)$. The economy has the same amount of capital (since it takes time to adjust the capital stock), but this capital is combined with more workers. At that moment the economy is out of steady state: it has less capital than it wants to match the increased number of workers in the economy. The economy begins its transition by accumulating more capital, raising output even further than the original jump. Eventually the capital stock and output converge to their new, higher steady-state levels.

Figure 7–5



9. There is no unique way to find the data to answer this question. For example, from the World Bank web site, I followed links to "Data and Statistics." I then followed a link to "Quick Reference Tables" (http://www.worldbank.org/data/databytopic/GNPPC.pdf) to find a summary table of income per capita across countries. (Note that there are some subtle issues in converting currency values across countries that are beyond the scope of this book. The data in Table 7–1 use what are called “purchasing power parity.”)

   As an example, I chose to compare the United States (income per person of \$31,900 in 1999) and Pakistan (\$1,860), with a 17-fold difference in income per person. How can we decide what factors are most important? As the text notes, differences in income must come from differences in capital, labor, and/or technology. The Solow growth model gives us a framework for thinking about the importance of these factors.

   One clear difference across countries is in educational attainment. One can think about differences in educational attainment as reflecting differences in broad “human capital” (analogous to physical capital) or as differences in the level of technology (e.g., if your work force is more educated, then you can implement better technologies). For our purposes, we will think of education as reflecting “technology,” in that it allows more output per worker for any given level of physical capital per worker.

   From the World Bank web site (country tables) I found the following data (downloaded February 2002):

	Labor Force Growth (1994–2000)	Investment/GDP (1990) (percent)	Illiteracy (percent of population 15+)
United States	1.5	18	0
Pakistan	3.0	19	54

   How can we decide which factor explains the most? It seems unlikely that the small difference in investment/GDP explains the large difference in per capital income, leaving labor-force growth and illiteracy (or, more generally, technology) as the likely culprits. But we can be more formal about this using the Solow model.

   We follow Section 7-1, “Approaching the Steady State: A Numerical Example.” For the moment, we assume the two countries have the same production technology: $Y=K^{0.5}L^{0.5}$. (This will allow us to decide whether differences in saving and population growth can explain the differences in income per capita; if not, then differences in technology will remain as the likely explanation.) As in the text, we can express this equation in terms of the per-worker production function $f(k)$:

$$y = k^{0.5}.$$

In steady-state, we know that

$$\Delta k = sf(k) - (n + \delta)k.$$

The steady-state value of capital k^* is defined as the value of k at which capital stock is constant, so $\Delta k = 0$. It follows that in steady state

$$0 = sf(k) - (n + \delta)k,$$

or, equivalently,

$$\frac{k^*}{f(k^*)} = \frac{s}{n + \delta}.$$

For the production function in this problem, it follows that:

$$\frac{k^*}{(k^*)^{0.5}} = \frac{s}{n + \delta},$$

Rearranging:

$$(k^*)^{0.5} = \frac{s}{n + \delta},$$

or

$$k^* = \left(\frac{s}{n+\delta}\right)^2.$$

Substituting this equation for steady-state capital per worker into the per-worker production function gives:

$$y^* = \left(\frac{s}{n + \delta}\right).$$

If we assume that the United States and Pakistan are in steady state and have the same rates of depreciation—say, 5 percent—then the ratio of income per capita in the two countries is:

$$\frac{y_{\text{US}}}{y_{\text{Parkistan}}} = \left[\frac{s_{\text{US}}}{s_{\text{Pakistan}}}\right]\left[\frac{n_{\text{Pakistan}} + 0.05}{n_{\text{US}} + 0.05}\right]$$

This equation tells us that if, say, the U.S. saving rate had been twice Pakistan's saving rate, then U.S. income per worker would be twice Pakistan's level (other things equal). Clearly, given that the U.S. has 17-times higher income per worker but very similar levels of investment relative to GDP, this variable is not a major factor in the comparison. Even population growth can only explain a factor of 1.2 (0.08/0.065) difference in levels of output per worker.

The remaining culprit is technology, and the high level of illiteracy in Pakistan is consistent with this conclusion.

CHAPTER 8 Economic Growth II

Questions for Review

1. In the Solow model, we find that only technological progress can affect the steady-state rate of growth in income per worker. Growth in the capital stock (through high saving) has no effect on the steady-state growth rate of income per worker; neither does population growth. But technological progress can lead to sustained growth.
2. To decide whether an economy has more or less capital than the Golden Rule, we need to compare the marginal product of capital net of depreciation ($MPK - \delta$) with the growth rate of total output ($n + g$). The growth rate of GDP is readily available. Estimating the net marginal product of capital requires a little more work but, as shown in the text, can be backed out of available data on the capital stock relative to GDP, the total amount of depreciation relative to GDP, and capital's share in GDP.
3. Economic policy can influence the saving rate by either increasing public saving or providing incentives to stimulate private saving. Public saving is the difference between government revenue and government spending. If spending exceeds revenue, the government runs a budget deficit, which is negative saving. Policies that decrease the deficit (such as reductions in government purchases or increases in taxes) increase public saving, whereas policies that increase the deficit decrease saving. A variety of government policies affect private saving. The decision by a household to save may depend on the rate of return; the greater the return to saving, the more attractive saving becomes. Tax incentives such as tax-exempt retirement accounts for individuals and investment tax credits for corporations increase the rate of return and encourage private saving.
4. The rate of growth of output per person slowed worldwide after 1972. This slowdown appears to reflect a slowdown in productivity growth—the rate at which the production function is improving over time. Various explanations have been proposed, but the slowdown remains a mystery. In the second half of the 1990s, productivity grew more quickly again in the United States and, it appears, a few other countries. Many commentators attribute the productivity revival to the effects of information technology.
5. Endogenous growth theories attempt to explain the rate of technological progress by explaining the decisions that determine the creation of knowledge through research and development. By contrast, the Solow model simply took this rate as exogenous. In the Solow model, the saving rate affects growth temporarily, but diminishing returns to capital eventually force the economy to approach a steady state in which growth depends only on exogenous technological progress. By contrast, many endogenous growth models in essence assume that there are constant (rather than diminishing) returns to capital, interpreted to include knowledge. Hence, changes in the saving rate can lead to persistent growth.

Problems and Applications

1. a. To solve for the steady-state value of y as a function of s, n, g, and δ, we begin with the equation for the change in the capital stock in the steady state:

$$\Delta k = sf(k) - (\delta + n + g)k = 0.$$

The production function $y = \sqrt{k}$ can also be rewritten as $y^2 = k$. Plugging this production function into the equation for the change in the capital stock, we find that in the steady state:

$$sy - (\delta + n + g)y^2 = 0.$$

Solving this, we find the steady-state value of y:

$$y^* = s/(\delta + n + g).$$

b. The question provides us with the following information about each country:

Developed country:	$s = 0.28$	Less-developed country:	$s = 0.10$
	$n = 0.01$		$n = 0.04$
	$g = 0.02$		$g = 0.02$
	$\delta = 0.04$		$\delta = 0.04$

Using the equation for y^* that we derived in part (a), we can calculate the steady-state values of y for each country.

Developed country: $y^* = 0.28/(0.04 + 0.01 + 0.02) = 4.$

Less-developed country: $y^* = 0.10/(0.04 + 0.04 + 0.02) = 1.$

c. The equation for y^* that we derived in part (a) shows that the less-developed country could raise its level of income by reducing its population growth rate n or by increasing its saving rate s. Policies that reduce population growth include introducing methods of birth control and implementing disincentives for having children. Policies that increase the saving rate include increasing public saving by reducing the budget deficit and introducing private saving incentives such as I.R.A.'s and other tax concessions that increase the return to saving.

2. To solve this problem, it is useful to establish what we know about the U.S. economy:

A Cobb–Douglas production function has the form $y = k^{\alpha}$, where α is capital's share of income. The question tells us that $\alpha = 0.3$, so we know that the production function is $y = k^{0.3}$.

In the steady state, we know that the growth rate of output equals 3 percent, so we know that $(n + g) = 0.03$.

The depreciation rate $\delta = 0.04$.

The capital–output ratio $K/Y = 2.5$. Because $k/y = [K/(L \times E)]/[Y/(L \times E)] = K/Y$, we also know that $k/y = 2.5$. (That is, the capital–output ratio is the same in terms of effective workers as it is in levels.)

a. Begin with the steady-state condition, $sy = (\delta + n + g)k$. Rewriting this equation leads to a formula for saving in the steady state:

$$s = (\delta + n + g)(k/y).$$

Plugging in the values established above:

$$s = (0.04 + 0.03)(2.5) = 0.175.$$

The initial saving rate is 17.5 percent.

b. We know from Chapter 3 that with a Cobb–Douglas production function, capital's share of income $\alpha = MPK(K/Y)$. Rewriting, we have:

$$MPK = \alpha/(K/Y).$$

Plugging in the values established above, we find:

$$MPK = 0.3/2.5 = 0.12.$$

c. We know that at the Golden Rule steady state:

$$MPK = (n + g + \delta).$$

Plugging in the values established above:

$$MPK = (0.03 + 0.04) = 0.07.$$

At the Golden Rule steady state, the marginal product of capital is 7 percent, whereas it is 12 percent in the initial steady state. Hence, from the initial steady state we need to increase k to achieve the Golden Rule steady state.

d. We know from Chapter 3 that for a Cobb–Douglas production function, $MPK = \alpha (Y/K)$. Solving this for the capital–output ratio, we find:

$$K/Y = \alpha/MPK.$$

We can solve for the Golden Rule capital–output ratio using this equation. If we plug in the value 0.07 for the Golden Rule steady-state marginal product of capital, and the value 0.3 for α, we find:

$$K/Y = 0.3/0.07 = 4.29.$$

In the Golden Rule steady state, the capital–output ratio equals 4.29, compared to the current capital–output ratio of 2.5.

e. We know from part (a) that in the steady state

$$s = (\delta + n + g)(k/y),$$

where k/y is the steady-state capital–output ratio. In the introduction to this answer, we showed that $k/y = K/Y$, and in part (d) we found that the Golden Rule $K/Y = 4.29$. Plugging in this value and those established above:

$$s = (0.04 + 0.03)(4.29) = 0.30.$$

To reach the Golden Rule steady state, the saving rate must rise from 17.5 to 30 percent.

3. a. In the steady state, we know that $sy = (\delta + n + g)k$. This implies that

$$k/y = s/(\delta + n + g).$$

Since s, δ, n, and g are constant, this means that the ratio k/y is also constant. Since $k/y = [K/(L \times E)]/[Y/(L \times E)] = K/Y$, we can conclude that in the steady state, the capital–output ratio is constant.

b. We know that capital's share of income $= MPK \times (K/Y)$. In the steady state, we know from part (a) that the capital–output ratio K/Y is constant. We also know from the hint that the MPK is a function of k, which is constant in the steady state; therefore the MPK itself must be constant. Thus, capital's share of income is constant. Labor's share of income is 1 – [capital's share]. Hence, if capital's share is constant, we see that labor's share of income is also constant.

c. We know that in the steady state, total income grows at $n + g$—the rate of population growth plus the rate of technological change. In part (b) we showed that labor's and capital's share of income is constant. If the shares are constant, and total income grows at the rate $n + g$, then labor income and capital income must also grow at the rate $n + g$.

d. Define the real rental price of capital R as:

$$\begin{aligned} R &= \text{Total Capital Income/Capital Stock} \\ &= (MPK \times K)/K \\ &= MPK. \end{aligned}$$

We know that in the steady state, the MPK is constant because capital per effective worker k is constant. Therefore, we can conclude that the real rental price of capital is constant in the steady state.

To show that the real wage w grows at the rate of technological progress g, define:

$$TLI = \text{Total Labor Income.}$$
$$L = \text{Labor Force.}$$

Using the hint that the real wage equals total labor income divided by the labor force:

$$w = TLI/L.$$

Equivalently,

$$wL = TLI.$$

In terms of percentage changes, we can write this as

$$\Delta w/w + \Delta L/L = \Delta TLI/TLI.$$

This equation says that the growth rate of the real wage plus the growth rate of the labor force equals the growth rate of total labor income. We know that the labor force grows at rate n, and from part (c) we know that total labor income grows at rate $n + g$. We therefore conclude that the real wage grows at rate g.

4. How do differences in education across countries affect the Solow model? Education is one factor affecting the *efficiency of labor*, which we denoted by E. (Other factors affecting the efficiency of labor include levels of health, skill, and knowledge.) Since country 1 has a more highly educated labor force than country 2, each worker in country 1 is more efficient. That is, $E_1 > E_2$. We will assume that both countries are in steady state.
   a. In the Solow growth model, the rate of growth of total income is equal to $n + g$, which is independent of the work force's *level* of education. The two countries will, thus, have the same rate of growth of total income because they have the same rate of population growth and the same rate of technological progress.
   b. Because both countries have the same saving rate, the same population growth rate, and the same rate of technological progress, we know that the two countries will converge to the same steady-state level of capital per efficiency unit of labor k^*. This is shown in Figure 8–1.

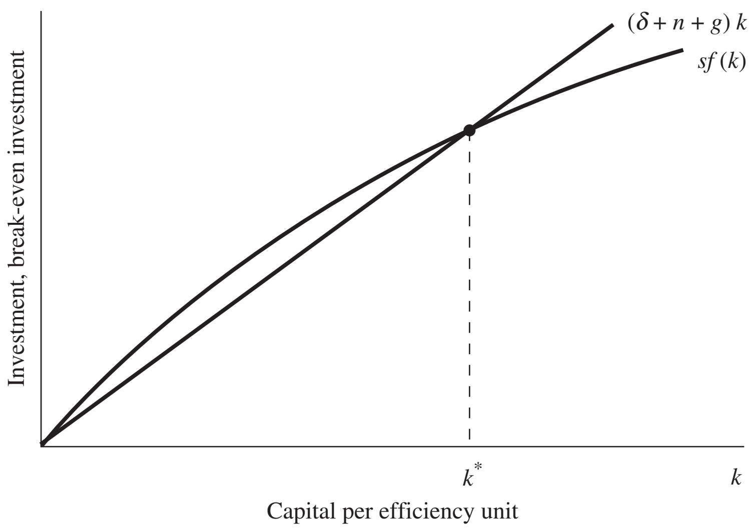


Figure 8–1

Hence, output per efficiency unit of labor in the steady state, which is $y^* = f(k^*)$, is the same in both countries. But $y^* = Y/(L \times E)$ or $Y/L = y^* E$. We know that y^* will be the same in both countries, but that $E_1 > E_2$. Therefore, $y^*E_1 > y^*E_2$. This implies that $(Y/L)_1 > (Y/L)_2$. Thus, the level of income per worker will be higher in the country with the more educated labor force.

c. We know that the real rental price of capital R equals the marginal product of capital (MPK). But the MPK depends on the capital stock per efficiency unit of labor. In the steady state, both countries have $k_1^* = k_2^* = k^*$ because both countries have the same saving rate, the same population growth rate, and the same rate of technological progress. Therefore, it must be true that $R_1 = R_2 = MPK$. Thus, the real rental price of capital is identical in both countries.

d. Output is divided between capital income and labor income. Therefore, the wage per efficiency unit of labor can be expressed as:

$$w = f(k) - MPK \bullet k.$$

As discussed in parts (b) and (c), both countries have the same steady-state capital stock k and the same MPK. Therefore, the wage per efficiency unit in the two countries is equal.

Workers, however, care about the wage per unit of labor, not the wage per efficiency unit. Also, we can observe the wage per unit of labor but not the wage per efficiency unit. The wage per unit of labor is related to the wage per efficiency unit of labor by the equation

$$\text{Wage per Unit of } L = wE.$$

Thus, the wage per unit of labor is higher in the country with the more educated labor force.

5. a. In the two-sector endogenous growth model in the text, the production function for manufactured goods is

$$Y = F(K,(1-u)\,EL).$$

We assumed in this model that this function has constant returns to scale. As in Section 3-1, constant returns means that for any positive number z, $zY = F(zK, z(1-u)\,EL)$. Setting $z = 1/EL$, we obtain:

$$\frac{Y}{EL} = F\left(\frac{K}{EL},(1-u)\right).$$

Using our standard definitions of y as output per effective worker and k as capital per effective worker, we can write this as

$$y = F(k,(1-u)).$$

b. To begin, note that from the production function in research universities, the growth rate of labor efficiency, $\Delta E / E$, equals $g(u)$. We can now follow the logic of Section 8-1, substituting the function $g(u)$ for the constant growth rate g. In order to keep capital per effective worker (K/EL) constant, break-even investment includes three terms: δk is needed to replace depreciating capital, nk is needed to provide capital for new workers, and $g(u)$ is needed to provide capital for the greater stock of knowledge E created by research universities. That is, break-even investment is $(\delta + n + g(u))k$.

c. Again following the logic of Section 8-1, the growth of capital per effective worker is the difference between saving per effective worker and break-even investment per effective worker. We now substitute the per-effective-worker production function from part (a), and the function $g(u)$ for the constant growth rate g, to obtain:

$$\Delta k = sF(k,(1-u)) - (\delta + n + g(u))k.$$

In the steady state, $\Delta k = 0$, so we can rewrite the equation above as:

$$sF(k,(1-u)) = (\delta + n + g(u))k$$

As in our analysis of the Solow model, for a given value of u we can plot the left- and right-hand sides of this equation:

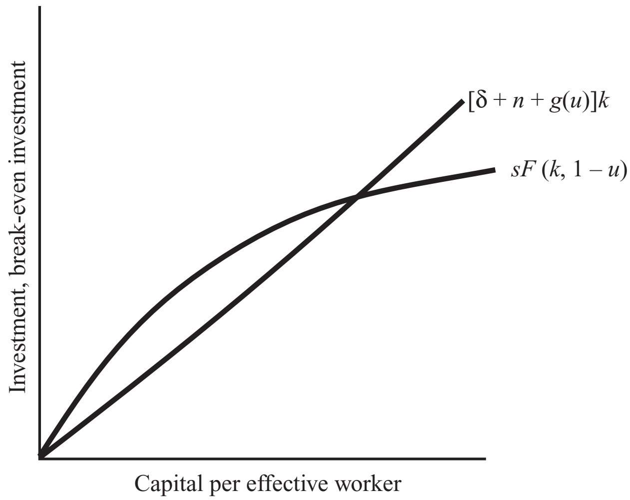


Figure 8–2

The steady state is given by the intersection of the two curves.

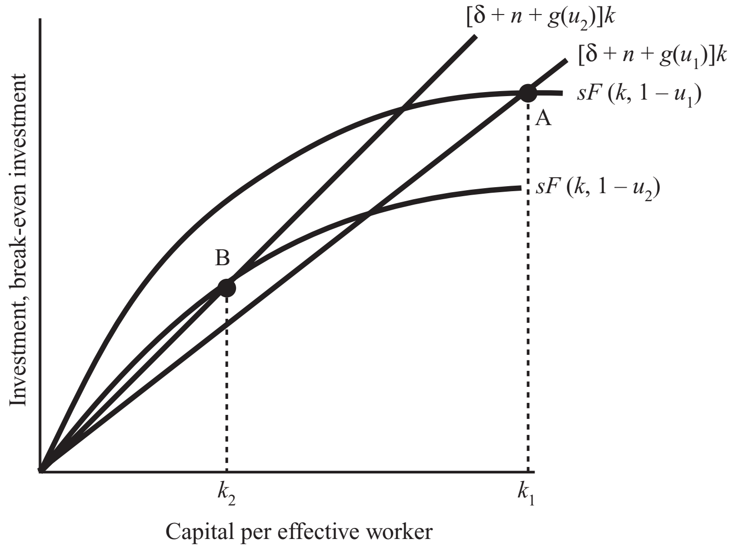
d. The steady state has constant capital per effective worker k as given by Figure 8–2 above. We also assume that in the steady state, there is a constant share of time spent in research universities, so u is constant. (After all, if u were not constant, it wouldn't be a "steady" state!). Hence, output per effective worker y is also constant. Output per worker equals yE, and E grows at rate $g(u)$. Therefore, output per worker grows at rate $g(u)$. The saving rate does not affect this growth rate. However, the amount of time spent in research universities does affect this rate: as more time is spent in research universities, the steady-state growth rate rises.

e. An increase in u shifts both lines in our figure. Output per effective worker falls for any given level of capital per effective worker, since less of each worker's time is spent producing manufactured goods. This is the immediate effect of the change, since at the time u rises, the capital stock K and the efficiency of each worker E are constant. Since output per effective worker falls, the curve showing saving per effective worker shifts down.

At the same time, the increase in time spent in research universities increases the growth rate of labor efficiency $g(u)$. Hence, break-even investment [which we found above in part (b)] rises at any given level of k, so the line showing break-even investment also shifts up.

Figure 8–3 below shows these shifts:

Figure 8–3



In the new steady state, capital per effective worker falls from k_1 to k_2. Output per effective worker also falls.

f. In the short run, the increase in u unambiguously decreases consumption. After all, we argued in part (e) that the immediate effect is to decrease output, since workers spend less time producing manufacturing goods and more time in research universities expanding the stock of knowledge. For a given saving rate, the decrease in output implies a decrease in consumption.

The long-run steady-state effect is more subtle. We found in part (e) that output per effective worker falls in the steady state. But welfare depends on output (and consumption) per *worker*, not per effective worker. The increase in time spent in research universities implies that E grows faster. That is, output per worker equals yE. Although steady-state y falls, in the long run the faster growth rate of E necessarily dominates. That is, in the long run, consumption unambiguously rises.

Nevertheless, because of the initial decline in consumption, the increase in u is not unambiguously a good thing. That is, a policymaker who cares more about current generations than about future generations may decide not to pursue a policy of increasing u. (This is analogous to the question considered in Chapter 7 of whether a policymaker should try to reach the Golden Rule level of capital per effective worker if k is currently below the Golden Rule level.)

More Problems and Applications to Chapter 8

1. a. The growth in total output (Y) depends on the growth rates of labor (L), capital (K), and total factor productivity (A), as summarized by the equation:

$$\Delta Y/Y = \alpha \Delta K/K + (1 - \alpha)\Delta L/L + \Delta A/A,$$

where α is capital's share of output. We can look at the effect on output of a 5-percent increase in labor by setting $\Delta K/K = \Delta A/A = 0$. Since $\alpha = 2/3$, this gives us

$$\begin{aligned}\Delta Y/Y &= (1/3)\,(5\%)\\ &= 1.67\%.\end{aligned}$$

A 5-percent increase in labor input increases output by 1.67 percent.

Labor productivity is Y/L. We can write the growth rate in labor productivity as

$$\frac{\Delta(Y/L)}{Y/L} = \frac{\Delta Y}{Y} - \frac{\Delta L}{L}.$$

Substituting for the growth in output and the growth in labor, we find

$$\begin{aligned}\Delta(Y/L)/(Y/L) &= 1.67\% - 5.0\%\\ &= -3.34\%.\end{aligned}$$

Labor productivity falls by 3.34 percent.

To find the change in total factor productivity, we use the equation

$$\Delta A/A = \Delta Y/Y - \alpha \Delta K/K - (1 - \alpha)\Delta L/L.$$

For this problem, we find

$$\begin{aligned}\Delta A/A &= 1.67\% - 0 - (1/3)\,(5\%)\\ &= 0.\end{aligned}$$

Total factor productivity is the amount of output growth that remains after we have accounted for the determinants of growth that we can measure. In this case, there is no change in technology, so all of the output growth is attributable to measured input growth. That is, total factor productivity growth is zero, as expected.

b. Between years 1 and 2, the capital stock grows by 1/6, labor input grows by 1/3, and output grows by 1/6. We know that the growth in total factor productivity is given by

$$\Delta A/A = \Delta Y/Y - \alpha \Delta K/K - (1 - \alpha)\Delta L/L.$$

Substituting the numbers above, and setting $\alpha = 2/3$, we find

$$\begin{aligned}\Delta A/A &= (1/6) - (2/3)(1/6) - (1/3)(1/3)\\ &= 3/18 - 2/18 - 2/18\\ &= -\,1/18\\ &= -\,.056.\end{aligned}$$

Total factor productivity falls by 1/18, or approximately 5.6 percent.

2. By definition, output Y equals labor productivity Y/L multiplied by the labor force L:

$$Y = (Y/L)L.$$

Using the mathematical trick in the hint, we can rewrite this as

$$\frac{\Delta Y}{Y} = \frac{\Delta(Y/L)}{Y/L} + \frac{\Delta L}{L}.$$

We can rearrange this as

$$\frac{\Delta(Y/L)}{Y/L} = \frac{\Delta Y}{Y} - \frac{\Delta L}{L}.$$

Substituting for $\Delta Y/Y$ from the text, we find

$$\begin{aligned}
\frac{\Delta(Y/L)}{Y/L} &= \frac{\Delta A}{A} + \frac{\alpha \Delta K}{K} + (1-\alpha)\frac{\Delta L}{L} - \frac{\Delta L}{L} \\
&= \frac{\Delta A}{A} + \frac{\alpha \Delta K}{K} - \frac{\alpha \Delta L}{L} \\
&= \frac{\Delta A}{A} + \alpha\left[\frac{\Delta K}{K} - \frac{\Delta L}{L}\right].
\end{aligned}$$

Using the same trick we used above, we can express the term in brackets as

$$\Delta K/K - \Delta L/L = \Delta(K/L)/(K/L).$$

Making this substitution in the equation for labor productivity growth, we conclude that

$$\frac{\Delta(Y/L)}{Y/L} = \frac{\Delta A}{A} + \frac{\alpha \Delta(K/L)}{K/L}.$$

3. We know the following:

$$\begin{aligned}
\Delta Y/Y &= n + g = 3\% \\
\Delta K/K &= n + g = 3\% \\
\Delta L/L &= n = 1\% \\
\text{Capital's share} &= \alpha = 0.3 \\
\text{Labor's share} &= 1 - \alpha = 0.7.
\end{aligned}$$

Using these facts, we can easily find the contributions of each of the factors, and then find the contribution of total factor productivity growth, using the following equations:

Output Growth		Capital's Contribution		Labor's Contribution		Total Factor Productivity
$\frac{\Delta Y}{Y}$	=	$\frac{\alpha \Delta K}{K}$	+	$\frac{(1-\alpha)\Delta L}{L}$	+	$\frac{\Delta A}{A}$
3.0%	=	(0.3)(3%)	+	(0.7)(1%)	+	$\Delta A/A$

We can easily solve this for $\Delta A/A$, to find that

3.0%	=	0.9%	+	0.7%	+	1.4%.

We conclude that the contribution of capital is 0.9% per year, the contribution of labor is 0.7% per year, and the contribution of total factor productivity growth is 1.4% per year. These numbers are qualitatively similar to the ones in Table 8–3 in the text for the United States although in Table 8–3, capital and labor contribute more and TFP contributed less from 1950–1999.

Questions for Review

1. The price of a magazine is an example of a price that is sticky in the short run and flexible in the long run. Economists do not have a definitive answer as to why magazine prices are sticky in the short run. Perhaps customers would find it inconvenient if the price of a magazine they purchase changed every month.
2. Aggregate demand is the relation between the quantity of output demanded and the aggregate price level. To understand why the aggregate demand curve slopes downward, we need to develop a theory of aggregate demand. One simple theory of aggregate demand is based on the quantity theory of money. Write the quantity equation in terms of the supply and demand for real money balances as

$$M/P = (M/P)^{d} = kY,$$

where $k = 1/V$. This equation tells us that for any fixed money supply M, a negative relationship exists between the price level P and output Y, assuming that velocity V is fixed: the higher the price level, the lower the level of real balances and, therefore, the lower the quantity of goods and services demanded Y. In other words, the aggregate demand curve slopes downward, as in Figure 9–1.

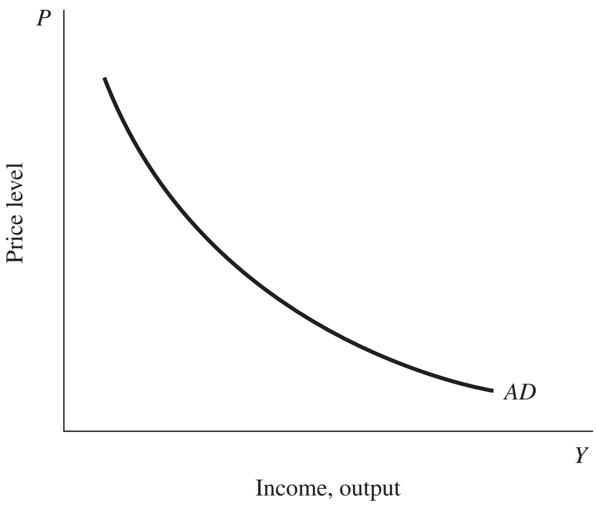


Figure 9–1

One way to understand this negative relationship between the price level and output is to note the link between money and transactions. If we assume that V is constant, then the money supply determines the dollar value of all transactions:

$$MV = PY.$$

An increase in the price level implies that each transaction requires more dollars. For the above identity to hold with constant velocity, the quantity of transactions and thus the quantity of goods and services purchased Y must fall.

3. If the Fed increases the money supply, then the aggregate demand curve shifts outward, as in Figure 9–2. In the short run, prices are sticky, so the economy moves along

the short-run aggregate supply curve from point A to point B. Output rises above its natural rate level $\bar{Y}$: the economy is in a boom. The high demand, however, eventually causes wages and prices to increase. This gradual increase in prices moves the economy along the new aggregate demand curve AD_2 to point C. At the new long-run equilibrium, output is at its natural-rate level, but prices are higher than they were in the initial equilibrium at point A.

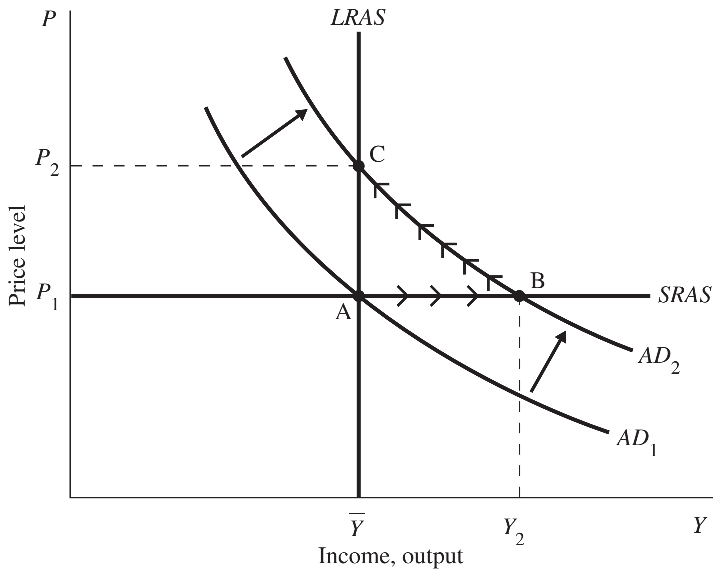


Figure 9–2

4. It is easier for the Fed to deal with demand shocks than with supply shocks because the Fed can reduce or even eliminate the impact of demand shocks on output by controlling the money supply. In the case of a supply shock, however, there is no way for the Fed to adjust aggregate demand to maintain both full employment and a stable price level.

   To understand why this is true, consider the policy options available to the Fed in each case. Suppose that a demand shock (such as the introduction of automatic teller machines, which reduce money demand) shifts the aggregate demand curve outward, as in Figure 9–3. Output increases in the short run to Y_2. In the long run output returns to the natural-rate level, but at a higher price level P_2. The Fed can offset this increase in velocity, however, by reducing the money supply; this returns the aggregate

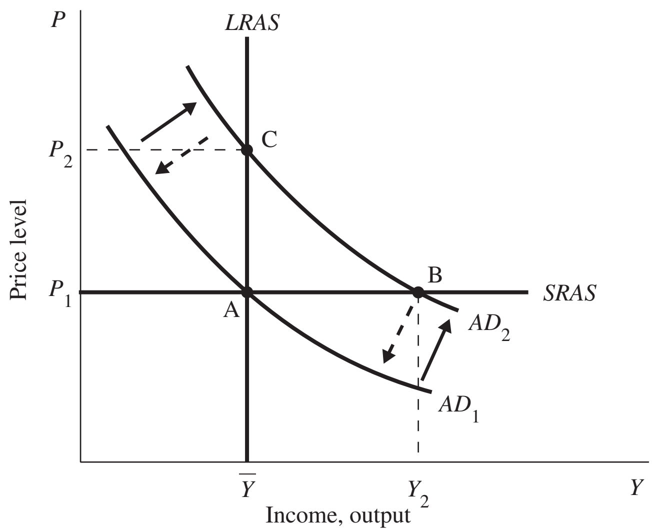


Figure 9–3

demand curve to its initial position, AD_1. To the extent that the Fed can control the money supply, it can reduce or even eliminate the impact of demand shocks on output.

Now consider how an adverse supply shock (such as a crop failure or an increase in union aggressiveness) affects the economy. As shown in Figure 9–4, the short-run aggregate supply curve shifts up, and the economy moves from point A to point B.

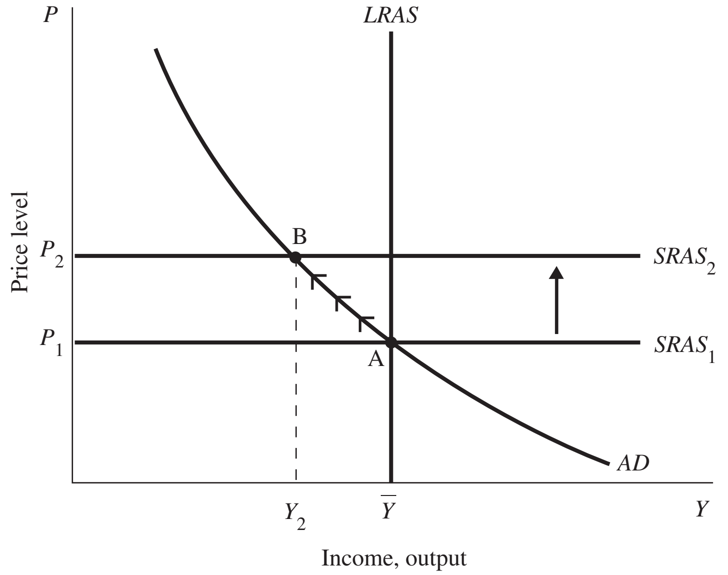


Figure 9–4

Output falls below the natural rate and prices rise. The Fed has two options. Its first option is to hold aggregate demand constant, in which case output falls below its natural rate. Eventually prices fall and restore full employment, but the cost is a painful

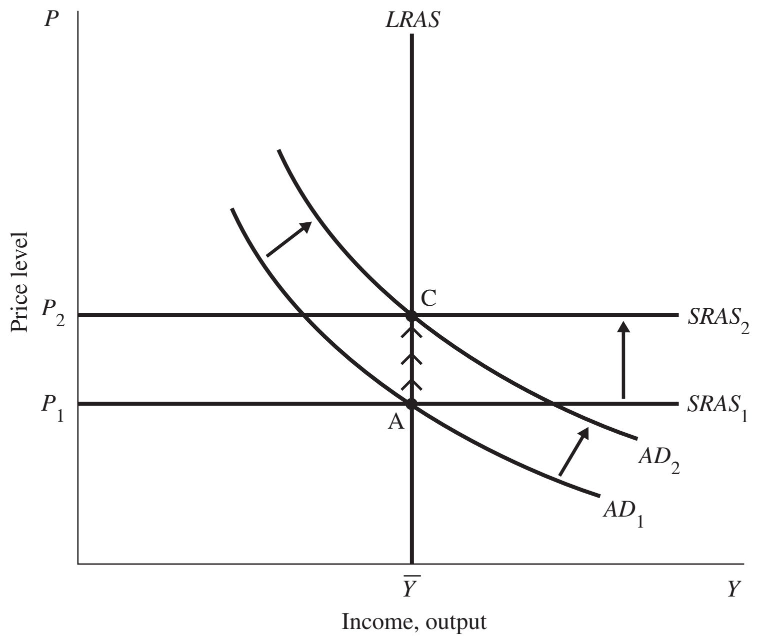


Figure 9–5

recession. Its second option is to increase aggregate demand by increasing the money supply, bringing the economy back toward the natural rate of output, as in Figure 9–5.

This policy leads to a permanently higher price level at the new equilibrium, point C. Thus, in the case of a supply shock, there is no way to adjust aggregate demand to maintain both full employment and a stable price level.

Problems and Applications

1. a. Interest-bearing checking accounts make holding money more attractive. This increases the demand for money.

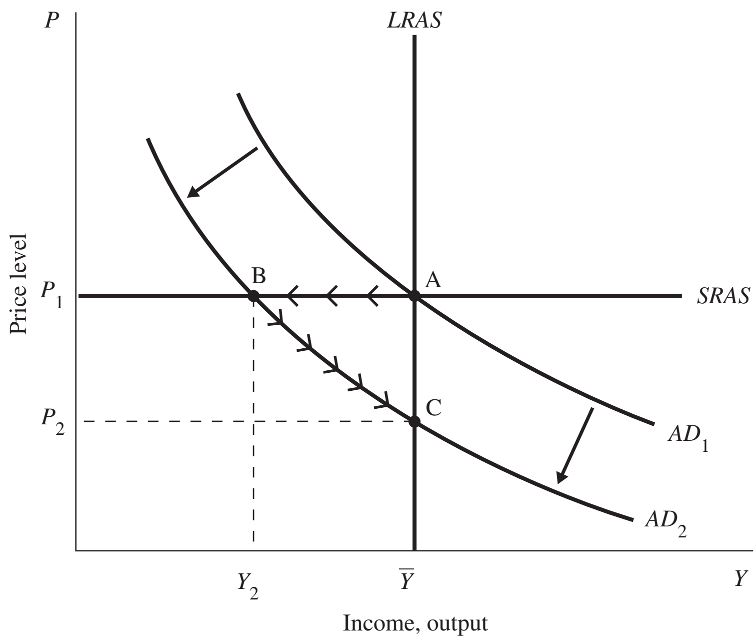
   b. The increase in money demand is equivalent to a decrease in the velocity of money. Recall the quantity equation

$$M/P = kY,$$

   where $k = 1/V$. For this equation to hold, an increase in real money balances for a given amount of output means that k must increase; that is, velocity falls. Because interest on checking accounts encourages people to hold money, dollars circulate less frequently.

   c. If the Fed keeps the money supply the same, the decrease in velocity shifts the aggregate demand curve downward, as in Figure 9–6. In the short run when prices are sticky, the economy moves from the initial equilibrium, point A, to the short-run equilibrium, point B. The drop in aggregate demand reduces the output of the economy below the natural rate.

Figure 9–6



Over time, the low level of aggregate demand causes prices and wages to fall. As prices fall, output gradually rises until it reaches the natural-rate level of output at point C.

d. The decrease in velocity causes the aggregate demand curve to shift downward. The Fed could increase the money supply to offset this decrease and thereby return the economy to its original equilibrium at point A, as in Figure 9–7.

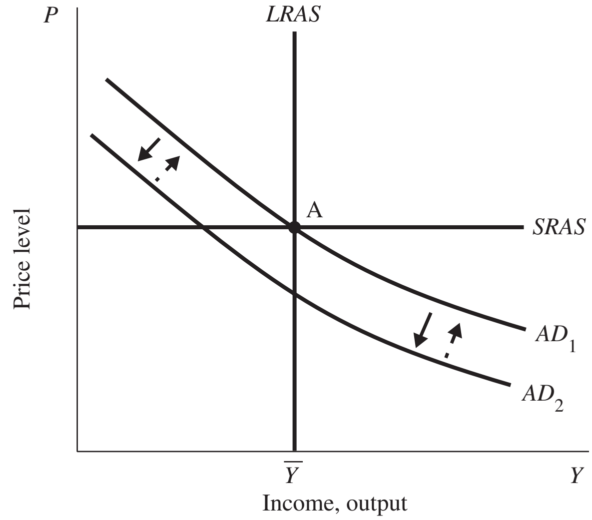


Figure 9–7

To the extent that the Fed can accurately measure changes in velocity, it has the ability to reduce or even eliminate the impact of such a demand shock on output. In particular, when a regulatory change causes money demand to change in a predictable way, the Fed should make the money supply respond to that change in order to prevent it from disrupting the economy.

2. a. If the Fed reduces the money supply, then the aggregate demand curve shifts down, as in Figure 9–8. This result is based on the quantity equation $MV = PY$, which tells us that a decrease in money M leads to a proportionate decrease in nominal output PY (assuming that velocity V is fixed). For any given price level P, the level of output Y is lower, and for any given Y, P is lower.

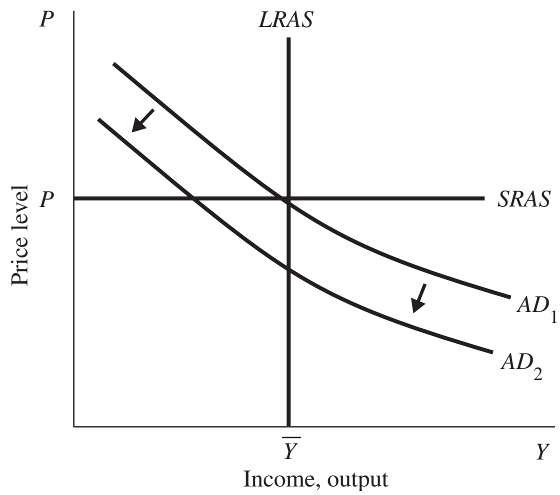


Figure 9–8

b. Recall from Chapter 4 that we can express the quantity equation in terms of percentage changes:

$$\%\Delta \text{ in } M + \%\Delta \text{ in } V = \%\Delta \text{ in } P + \%\Delta \text{ in } Y.$$

If we assume that velocity is constant, then the $\%\Delta$ in $V = 0$. Therefore,

$$\%\Delta \text{ in } M = \%\Delta \text{ in } P + \%\Delta \text{ in } Y.$$

We know that in the short run, the price level is fixed. This implies that the $\%\Delta$ in $P = 0$. Therefore,

$$\%\Delta \text{ in } M = \%\Delta \text{ in } Y.$$

Based on this equation, we conclude that in the short run a 5-percent reduction in the money supply leads to a 5-percent reduction in output. This is shown in Figure 9–9.

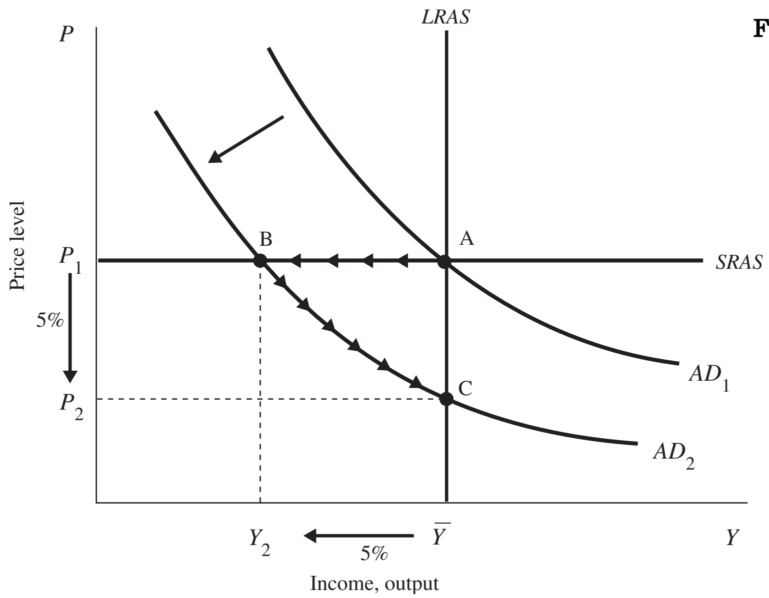


Figure 9–9

In the long run we know that prices are flexible and the economy returns to its natural rate of output. This implies that in the long run, the $\%\Delta$ in $Y = 0$. Therefore,

$$\%\Delta \text{ in } M = \%\Delta \text{ in } P.$$

Based on this equation, we conclude that in the long run a 5-percent reduction in the money supply leads to a 5-percent reduction in the price level, as shown in Figure 9–9.

c. Okun's law refers to the negative relationship that exists between unemployment and real GDP. Okun's law can be summarized by the equation:

$$\%\Delta \text{ in Real GDP} = 3\% - 2 \times [\Delta \text{ in Unemployment Rate}].$$

That is, output moves in the opposite direction from unemployment, with a ratio of 2 to 1. In the short run, when Y falls 5 percent, unemployment increases 2-1/2 percent. In the long run, both output and unemployment return to their natural rate levels. Thus, there is no long-run change in unemployment.

d. The national income accounts identity tells us that saving $S = Y - C - G$. Thus, when Y falls, S falls. Figure 9–10 shows that this causes the real interest rate to rise. When Y returns to its original equilibrium level, so does the real interest rate.

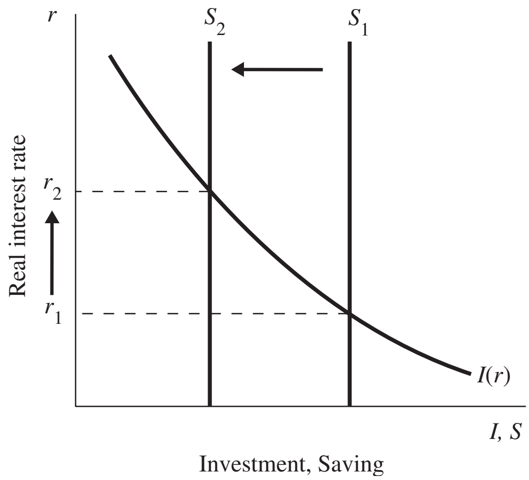


Figure 9–10

3. a. An exogenous decrease in the velocity of money causes the aggregate demand curve to shift downward, as in Figure 9–11. In the short run, prices are fixed, so output falls.

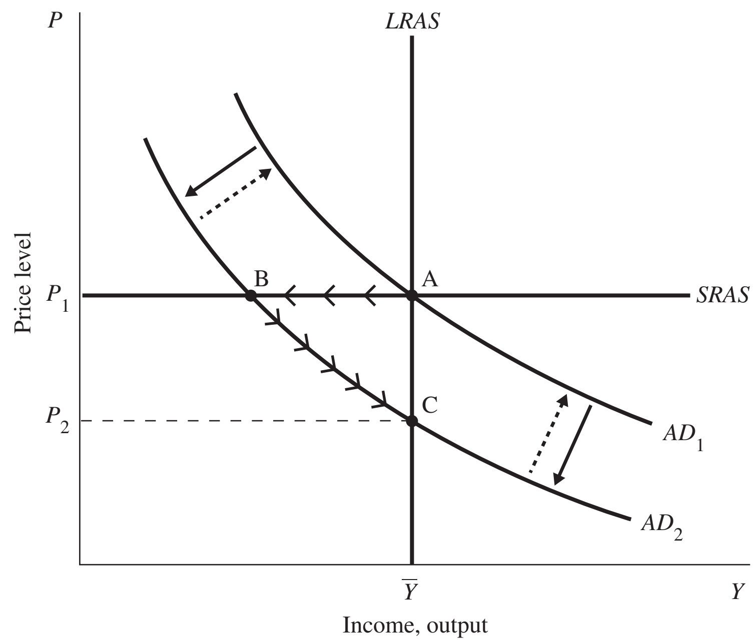


Figure 9–11

If the Fed wants to keep output and employment at their natural-rate levels, it must increase aggregate demand to offset the decrease in velocity. By increasing the money supply, the Fed can shift the aggregate demand curve upward, restoring the economy to its original equilibrium at point A. Both the price level and output remain constant.

If the Fed wants to keep prices stable, then it wants to avoid the long-run adjustment to a lower price level at point C in Figure 9–11. Therefore, it should increase the money supply and shift the aggregate demand curve upward, again restoring the original equilibrium at point A.

Thus, both Feds make the same choice of policy in response to this demand shock.

b. An exogenous increase in the price of oil is an adverse supply shock that causes the short-run aggregate supply curve to shift upward, as in Figure 9–12.

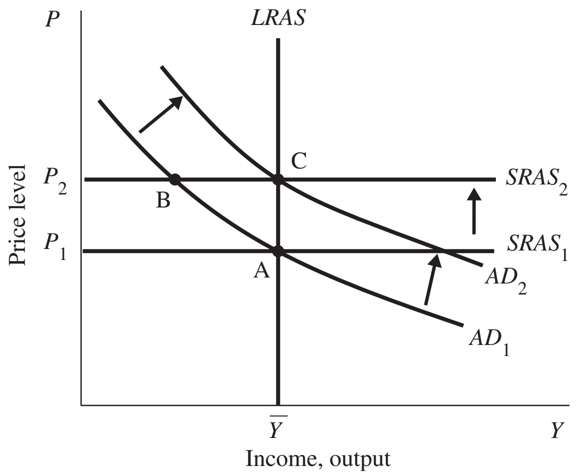


Figure 9–12

If the Fed cares about keeping output and employment at their natural-rate levels, then it should increase aggregate demand by increasing the money supply. This policy response shifts the aggregate demand curve upwards, as shown in the shift from AD_1 to AD_2 in Figure 9–12. In this case, the economy immediately reaches a new equilibrium at point C. The price level at point C is permanently higher, but there is no loss in output associated with the adverse supply shock.

If the Fed cares about keeping prices stable, then there is no policy response it can implement. In the short run, the price level stays at the higher level P_2. If the Fed increases aggregate demand, then the economy ends up with a permanently higher price level. Hence, the Fed must simply wait, holding aggregate demand constant. Eventually, prices fall to restore full employment at the old price level P_1. But the cost of this process is a prolonged recession.

Thus, the two Feds make a different policy choice in response to a supply shock.

4. From the main NBER web page (www.nber.org), I followed the link to Business Cycle Dates (http://www.nber.org/cycles.html, downloaded February 10, 2002). As of this writing, the latest turning point was in March 2001, when the economy switched from expansion to contraction.

Previous recessions (contractions) over the past three decades were July 1990 to March 1991; July 1981 to November 1982; January 1980 to July 1980; and November 1973 to March 1975. (Note that in the NBER table, the beginning date of a recession is shown as the “peak” (second column shown) of one expansion, and the end of the recession is shown as the “trough” (first column shown) of the next expansion.)

Questions for Review

1. The Keynesian cross tells us that fiscal policy has a multiplied effect on income. The reason is that according to the consumption function, higher income causes higher consumption. For example, an increase in government purchases of ΔG raises expenditure and, therefore, income by ΔG. This increase in income causes consumption to rise by $MPC \times \Delta G$, where MPC is the marginal propensity to consume. This increase in consumption raises expenditure and income even further. This feedback from consumption to income continues indefinitely. Therefore, in the Keynesian-cross model, increasing government spending by one dollar causes an increase in income that is greater than one dollar: it increases by $\Delta G/(1 - MPC)$.
2. The theory of liquidity preference explains how the supply and demand for real money balances determine the interest rate. A simple version of this theory assumes that there is a fixed supply of money, which the Fed chooses. The price level P is also fixed in this model, so that the supply of real balances is fixed. The demand for real money balances depends on the interest rate, which is the opportunity cost of holding money. At a high interest rate, people hold less money because the opportunity cost is high. By holding money, they forgo the interest on interest-bearing deposits. In contrast, at a low interest rate, people hold more money because the opportunity cost is low. Figure 10–1 graphs the supply and demand for real money balances. Based on this theory of liquidity preference, the interest rate adjusts to equilibrate the supply and demand for real money balances.

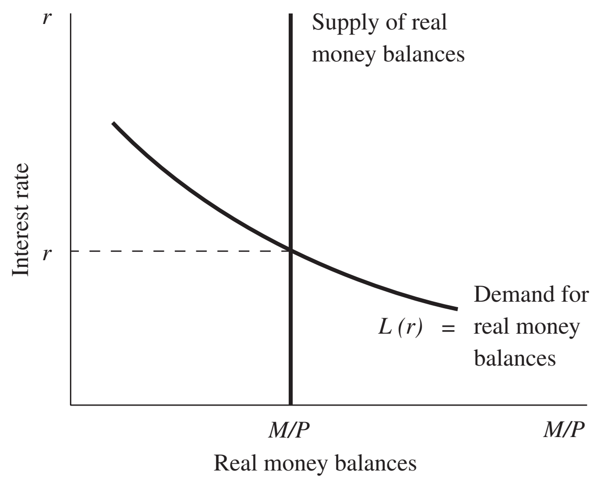


Figure 10–1

Why does an increase in the money supply lower the interest rate? Consider what happens when the Fed increases the money supply from M_1 to M_2. Because the price level P is fixed, this increase in the money supply shifts the supply of real money balances M/P to the right, as in Figure 10–2.

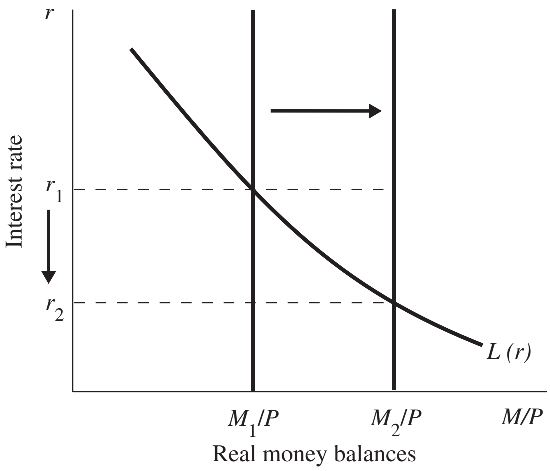


Figure 10–2

The interest rate must adjust to equilibrate supply and demand. At the old interest rate r_1, supply exceeds demand. People holding the excess supply of money try to convert some of it into interest-bearing bank deposits or bonds. Banks and bond issuers, who prefer to pay lower interest rates, respond to this excess supply of money by lowering the interest rate. The interest rate falls until a new equilibrium is reached at r_2.

3. The *IS* curve summarizes the relationship between the interest rate and the level of income that arises from equilibrium in the market for goods and services. Investment is negatively related to the interest rate. As illustrated in Figure 10–3, if the interest rate rises from r_1 to r_2, the level of planned investment falls from I_1 to I_2.

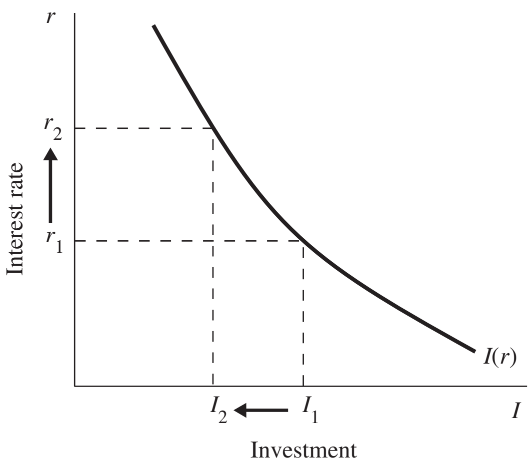


Figure 10–3

The Keynesian cross tells us that a reduction in planned investment shifts the expenditure function downward and reduces national income, as in Figure 10–4(A).

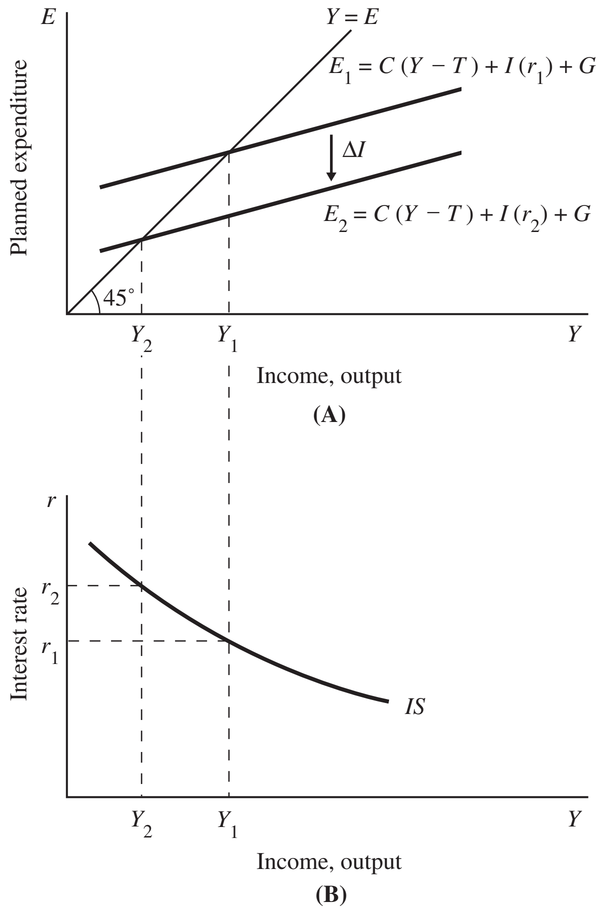
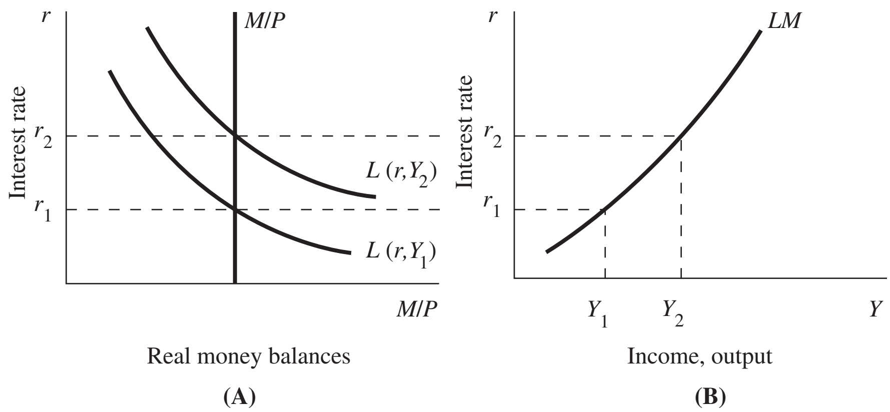


Figure 10–4

Thus, as shown in Figure 10–4(B), a higher interest rate results in a lower level of national income: the *IS* curve slopes downward.

4. The LM curve summarizes the relationship between the level of income and the interest rate that arises from equilibrium in the market for real money balances. It tells us the interest rate that equilibrates the money market for any given level of income. The theory of liquidity preference explains why the LM curve slopes upward. This theory assumes that the demand for real money balances $L(r, Y)$ depends negatively on the interest rate (because the interest rate is the opportunity cost of holding money) and positively on the level of income. The price level is fixed in the short run, so the Fed determines the fixed supply of real money balances M/P. As illustrated in Figure 10–5(A), the interest rate equilibrates the supply and demand for real money balances for a given level of income.

Figure 10–5



Now consider what happens to the interest rate when the level of income increases from Y_1 to Y_2. The increase in income shifts the money demand curve upward. At the old interest rate r_1, the demand for real money balances now exceeds the supply. The interest rate must rise to equilibrate supply and demand. Therefore, as shown in Figure 10–5(B), a higher level of income leads to a higher interest rate: The LM curve slopes upward.

Problems and Applications

1. a. The Keynesian cross graphs an economy's planned expenditure function, $E = C(Y - T) + I + G$, and the equilibrium condition that actual expenditure equals planned expenditure, $Y = E$, as shown in Figure 10–6.

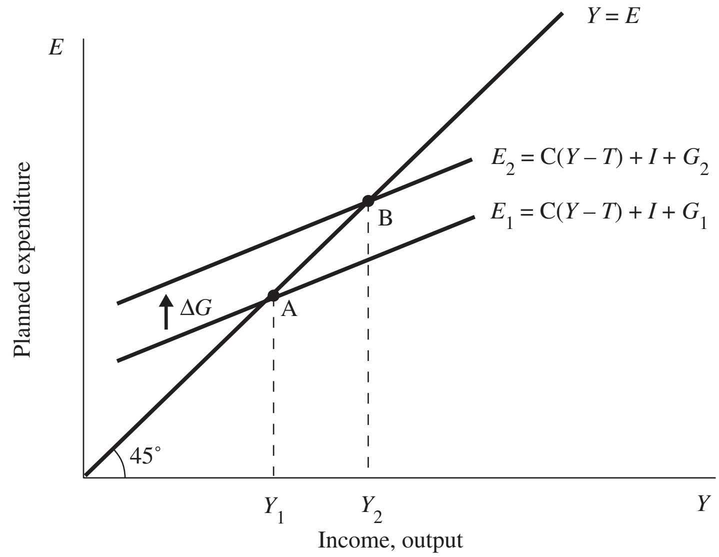


Figure 10–6

An increase in government purchases from G_1 to G_2 shifts the planned expenditure function upward. The new equilibrium is at point B. The change in Y equals the product of the government-purchases multiplier and the change in government spending: $\Delta Y = [1/(1 - MPC)]\Delta G$. Because we know that the marginal propensity to consume MPC is less than one, this expression tells us that a one-dollar increase in G leads to an increase in Y that is greater than one dollar.

b. An increase in taxes ΔT reduces disposable income $Y - T$ by ΔT and, therefore, reduces consumption by $MPC \times \Delta T$. For any given level of income Y, planned expenditure falls. In the Keynesian cross, the tax increase shifts the planned-expenditure function down by $MPC \times \Delta T$, as in Figure 10–7.

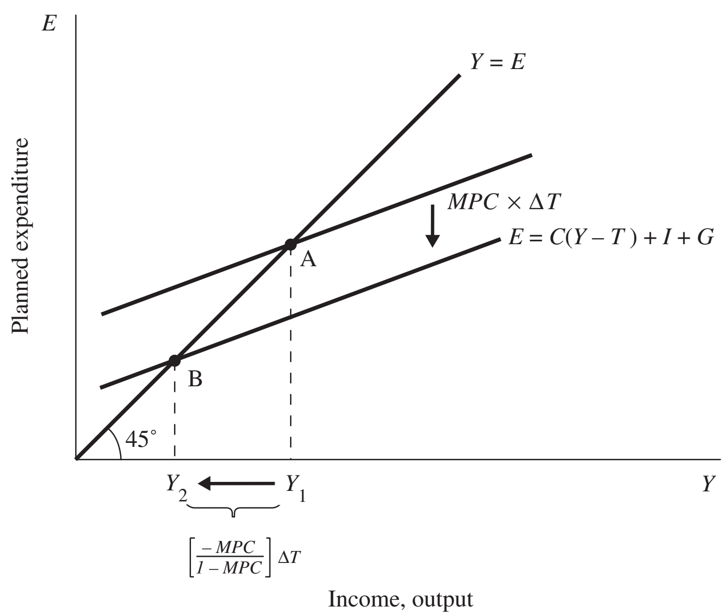


Figure 10–7

The amount by which Y falls is given by the product of the tax multiplier and the increase in taxes:

$$\Delta Y = [-MPC/(1 - MPC)]\Delta T.$$

c. We can calculate the effect of an equal increase in government expenditure and taxes by adding the two multiplier effects that we used in parts (a) and (b):

$$\Delta Y = \underbrace{[(1/(1 - MPC))\Delta G]}_{\substack{\text{Government}\\ \text{Spending}\\ \text{Multiplier}}} - \underbrace{[(MPC/(1 - MPC))\Delta T]}_{\substack{\text{Tax}\\ \text{Multiplier}}}.$$

Because government purchases and taxes increase by the same amount, we know that $\Delta G = \Delta T$. Therefore, we can rewrite the above equation as:

$$\begin{aligned}\Delta Y &= [(1/(1 - MPC)) - (MPC/(1 - MPC))]\Delta G\\ &= \Delta G.\end{aligned}$$

This expression tells us that an equal increase in government purchases and taxes increases Y by the amount that G increases. That is, the balanced-budget multiplier is exactly 1.

2. a. Total planned expenditure is

$$E = C(Y - T) + I + G.$$

Plugging in the consumption function and the values for investment I, government purchases G, and taxes T given in the question, total planned expenditure E is

$$\begin{aligned}E &= 200 + 0.75(Y - 100) + 100 + 100\\ &= 0.75Y + 325.\end{aligned}$$

This equation is graphed in Figure 10–8.

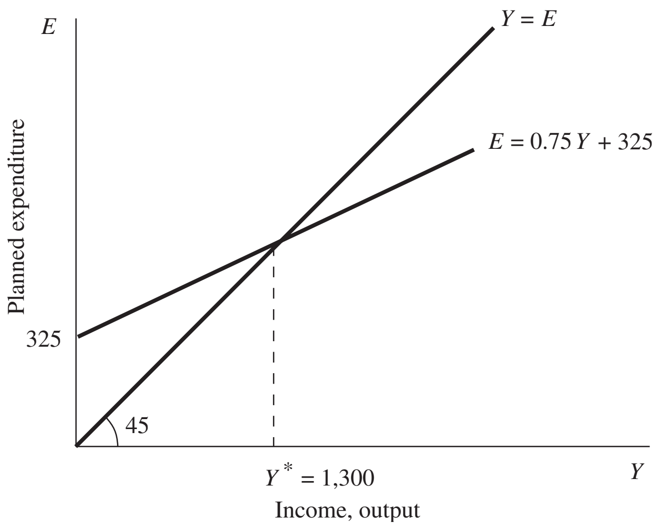


Figure 10–8

b. To find the equilibrium level of income, combine the planned-expenditure equation derived in part (a) with the equilibrium condition $Y = E$:

$$\begin{aligned}\overline{Y} &= 0.75Y + 325\\ Y &= 1{,}300.\end{aligned}$$

The equilibrium level of income is 1,300, as indicated in Figure 10–8.

c. If government purchases increase to 125, then planned expenditure changes to $E = 0.75Y + 350$. Equilibrium income increases to $Y = 1{,}400$. Therefore, an increase in government purchases of 25 (i.e., 125 – 100 = 25) increases income by 100. This is what we expect to find, because the government-purchases multiplier is $1/(1 - MPC)$: because the MPC is 0.75, the government-purchases multiplier is 4.

d. A level of income of 1,600 represents an increase of 300 over the original level of income. The government-purchases multiplier is $1/(1 - MPC)$: the MPC in this example equals 0.75, so the government-purchases multiplier is 4. This means that government purchases must increase by 75 (to a level of 175) for income to increase by 300.

3\. a. When taxes do not depend on income, a one-dollar increase in income means that disposable income increases by one dollar. Consumption increases by the marginal propensity to consume MPC. When taxes do depend on income, a one-dollar increase in income means that disposable income increases by only $(1 - t)$ dollars. Consumption increases by the product of the MPC and the change in disposable income, or $(1 - t)MPC$. This is less than the MPC. The key point is that disposable income changes by less than total income, so the effect on consumption is smaller.

b. When taxes are fixed, we know that $\Delta Y/\Delta G = 1/(1 - MPC)$. We found this by considering an increase in government purchases of ΔG; the initial effect of this change is to increase income by ΔG. This in turn increases consumption by an amount equal to the marginal propensity to consume times the change in income, $MPC \times \Delta G$. This increase in consumption raises expenditure and income even further. The process continues indefinitely, and we derive the multiplier above.

When taxes depend on income, we know that the increase of ΔG increases total income by ΔG; disposable income, however, increases by only $(1 - t)\Delta G$—less than dollar for dollar. Consumption then increases by an amount $(1 - t) MPC \times \Delta G$. Expenditure and income increase by this amount, which in turn causes consumption to increase even more. The process continues, and the total change in output is

$$\begin{aligned}\Delta Y &= \Delta G\,\{1 + (1 - t)MPC + [(1 - t)MPC]^2 + [(1 - t)MPC]^3 + \ldots.\}\\ &= \Delta G\,[1/(1 - (1 - t)MPC)].\end{aligned}$$

Thus, the government-purchases multiplier becomes $1/(1 - (1 - t)MPC)$ rather than $1/(1 - MPC)$. This means a much smaller multiplier. For example, if the marginal propensity to consume MPC is 3/4 and the tax rate t is 1/3, then the multiplier falls from $1/(1 - 3/4)$, or 4, to $1/(1 - (1 - 1/3)(3/4))$, or 2.

c. In this chapter, we derived the IS curve algebraically and used it to gain insight into the relationship between the interest rate and output. To determine how this tax system alters the slope of the IS curve, we can derive the IS curve for the case in which taxes depend on income. Begin with the national income accounts identity:

$$Y = C + I + G.$$

The consumption function is

$$C = a + b(Y - \overline{T} - tY).$$

Note that in this consumption function taxes are a function of income. The investment function is the same as in the chapter:

$$I = c - dr.$$

Substitute the consumption and investment functions into the national income accounts identity to obtain:

$$Y = [a + b(Y - T - tY)] + c - dr + G.$$

Solving for Y:

$$Y = \frac{a + c}{1 - b(1 - t)} + \frac{1}{1 - b(1 - t)}G + \frac{-b}{1 - b(1 - t)}\overline{T} + \frac{-d}{1 - b(1 - t)}r.$$

This IS equation is analogous to the one derived in the text except that each term is divided by $1 - b(1 - t)$ rather than by $(1 - b)$. We know that t is a tax rate, which is less than 1. Therefore, we conclude that this IS curve is steeper than the one in which taxes are a fixed amount.

4. a. If society becomes more thrifty—meaning that for any given level of income people save more and consume less—then the planned-expenditure function shifts downward, as in Figure 10–9 (note that $\overline{C}_2 < \overline{C}_1$). Equilibrium income falls from Y_1 to Y_2.

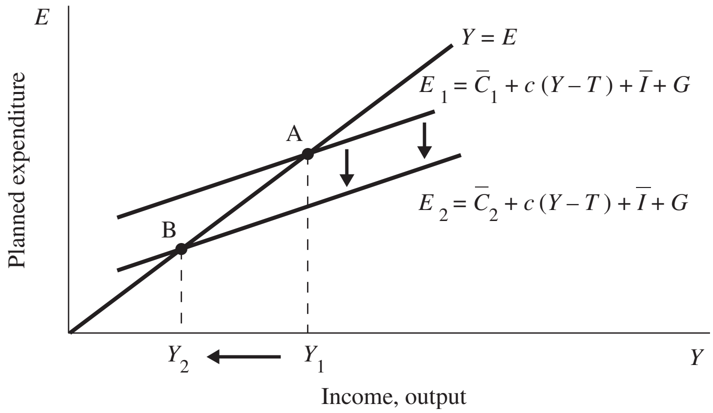


Figure 10–9

b. Equilibrium saving remains unchanged. The national accounts identity tells us that saving equals investment, or $S = I$. In the Keynesian-cross model, we assumed that desired investment is fixed. This assumption implies that investment is the same in the new equilibrium as it was in the old. We can conclude that saving is exactly the same in both equilibria.

c. The paradox of thrift is that even though thriftiness increases, saving is unaffected. Increased thriftiness leads only to a fall in income. For an individual, we usually consider thriftiness a virtue. From the perspective of the Keynesian cross, however, thriftiness is a vice.

d. In the classical model of Chapter 3, the paradox of thrift does not arise. In that model, output is fixed by the factors of production and the production technology, and the interest rate adjusts to equilibrate saving and investment, where investment depends on the interest rate. An increase in thriftiness decreases consumption and increases saving for any level of output; since output is fixed, the saving schedule shifts to the right, as in Figure 10–10. At the new equilibrium, the interest rate is lower, and investment and saving are higher.

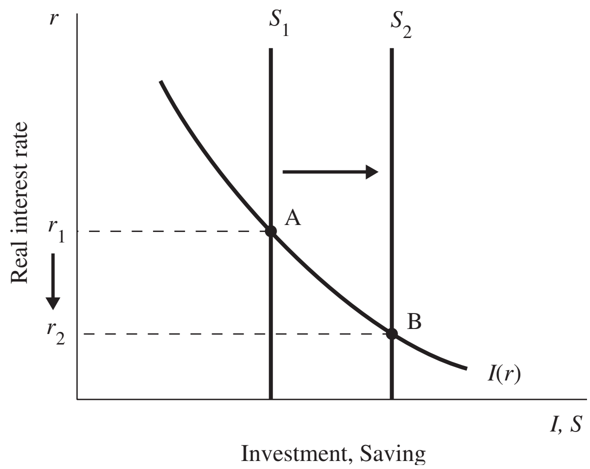


Figure 10–10

Thus, in the classical model, the paradox of thrift does not exist.

5. a. The downward sloping line in Figure 10–11 represents the money demand function $(M/P)^d = 1{,}000 - 100r$. With $M = 1{,}000$ and $P = 2$, the real money supply $(M/P)^s = 500$. The real money supply is independent of the interest rate and is, therefore, represented by the vertical line in Figure 10–11.

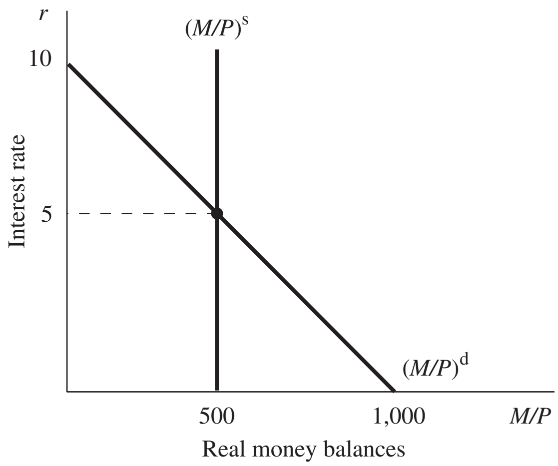


Figure 10–11

b. We can solve for the equilibrium interest rate by setting the supply and demand for real balances equal to each other:

$$500 = 1{,}000 - 100r$$
$$r = 5.$$

Therefore, the equilibrium real interest rate equals 5 percent.

c. If the price level remains fixed at 2 and the supply of money is raised from 1,000 to 1,200, then the new supply of real balances $(M/P)^s$ equals 600. We can solve for the new equilibrium interest rate by setting the new $(M/P)^s$ equal to $(M/P)^d$:

$$600 = 1{,}000 - 100r$$
$$100r = 400$$
$$r = 4.$$

Thus, increasing the money supply from 1,000 to 1,200 causes the equilibrium interest rate to fall from 5 percent to 4 percent.

d. To determine at what level the Fed should set the money supply to raise the interest rate to 7 percent, set $(M/P)^s$ equal to $(M/P)^d$:

$$M/P = 1{,}000 - 100r.$$

Setting the price level at 2 and substituting $r = 7$, we find:

$$M/2 = 1{,}000 - 100 \times 7$$
$$M = 600.$$

For the Fed to raise the interest rate from 5 percent to 7 percent, it must reduce the nominal money supply from 1,000 to 600.

CHAPTER 11 Aggregate Demand II

Questions for Review

1. The aggregate demand curve represents the negative relationship between the price level and the level of national income. In Chapter 9, we looked at a simplified theory of aggregate demand based on the quantity theory. In this chapter, we explore how the *IS–LM* model provides a more complete theory of aggregate demand. We can see why the aggregate demand curve slopes downward by considering what happens in the *IS–LM* model when the price level changes. As Figure 11–1(A) illustrates, for a given money supply, an increase in the price level from P_1 to P_2 shifts the *LM* curve upward because real balances decline; this reduces income from Y_1 to Y_2. The aggregate demand curve in Figure 11–1(B) summarizes this relationship between the price level and income that results from the *IS–LM* model.

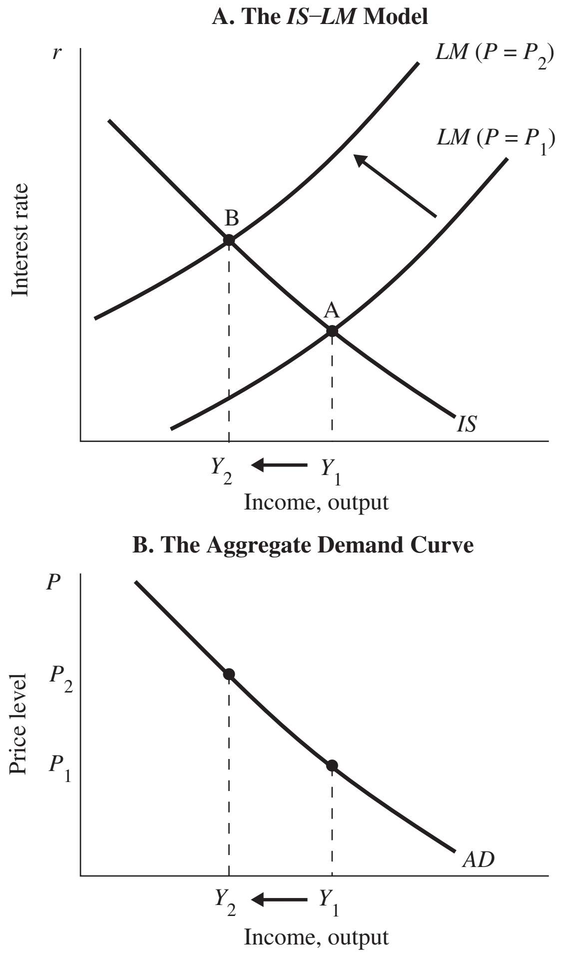


Figure 11–1

2. The tax multiplier in the Keynesian-cross model tells us that, for any given interest rate, the tax increase causes income to fall by $\Delta T \times [-MPC/(1 - MPC)]$. This *IS* curve shifts to the left by this amount, as in Figure 11–2. The equilibrium of the economy moves from point A to point B. The tax increase reduces the interest rate from r_1 to r_2 and reduces national income from Y_1 to Y_2. Consumption falls because disposable income falls; investment rises because the interest rate falls.

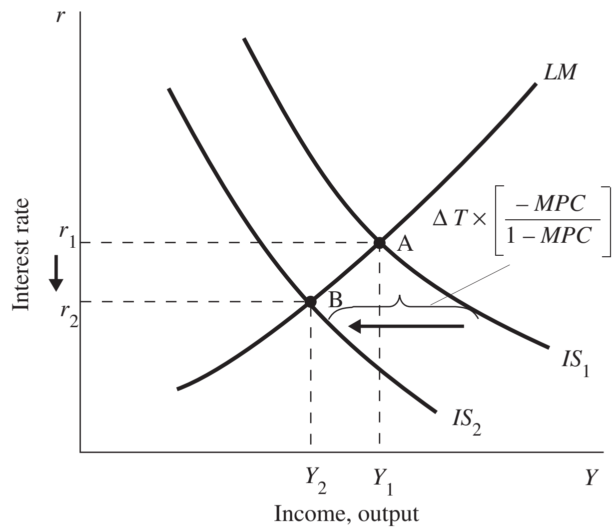


Figure 11–2

Note that the decrease in income in the *IS–LM* model is smaller than in the Keynesian cross, because the *IS–LM* model takes into account the fact that investment rises when the interest rate falls.

3. Given a fixed price level, a decrease in the nominal money supply decreases real money balances. The theory of liquidity preference shows that, for any given level of income, a decrease in real money balances leads to a higher interest rate. Thus, the *LM* curve shifts upward, as in Figure 11–3. The equilibrium moves from point A to point B. The decrease in the money supply reduces income and raises the interest rate. Consumption falls because disposable income falls, whereas investment falls because the interest rate rises.

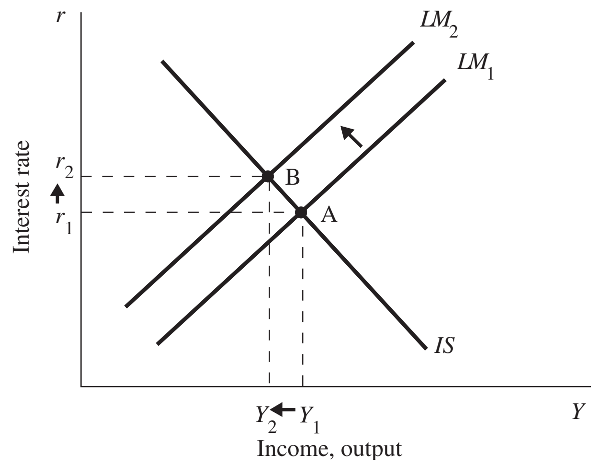


Figure 11–3

4. Falling prices can either increase or decrease equilibrium income. There are two ways in which falling prices can increase income. First, an increase in real money balances shifts the *LM* curve downward, thereby increasing income. Second, the *IS* curve shifts to the right because of the Pigou effect: real money balances are part of household wealth, so an increase in real money balances makes consumers feel wealthier and buy more. This shifts the *IS* curve to the right, also increasing income.

   There are two ways in which falling prices can reduce income. The first is the debt-deflation theory. An unexpected decrease in the price level redistributes wealth from debtors to creditors. If debtors have a higher propensity to consume than creditors, then this redistribution causes debtors to decrease their spending by more than creditors increase theirs. As a result, aggregate consumption falls, shifting the *IS* curve to the left and reducing income. The second way in which falling prices can reduce income is through the effects of expected deflation. Recall that the real interest rate r equals the nominal interest rate i minus the expected inflation rate π^e: $r = i - \pi^e$. If everyone expects the price level to fall in the future (i.e., π^e is negative), then for any given nominal interest rate, the real interest rate is higher. A higher real interest rate depresses investment and shifts the *IS* curve to the left, reducing income.

Problems and Applications

1. a. If the central bank increases the money supply, then the *LM* curve shifts downward, as shown in Figure 11–4. Income increases and the interest rate falls. The increase in disposable income causes consumption to rise; the fall in the interest rate causes investment to rise as well.

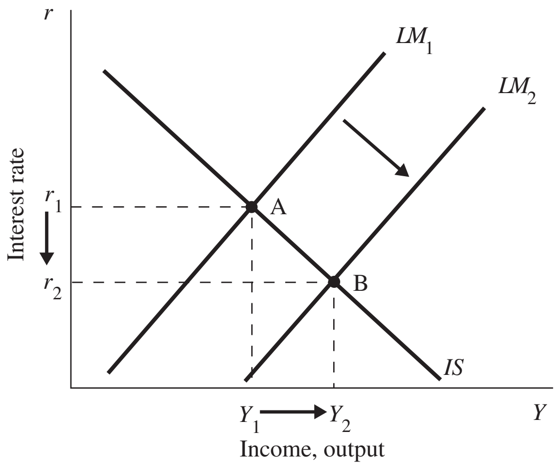


Figure 11–4

b. If government purchases increase, then the government-purchases multiplier tells us that the *IS* curve shifts to the right by an amount equal to $[1/(1 - MPC)]\Delta G$. This is shown in Figure 11–5. Income and the interest rate both increase. The increase in disposable income causes consumption to rise, while the increase in the interest rate causes investment to fall.

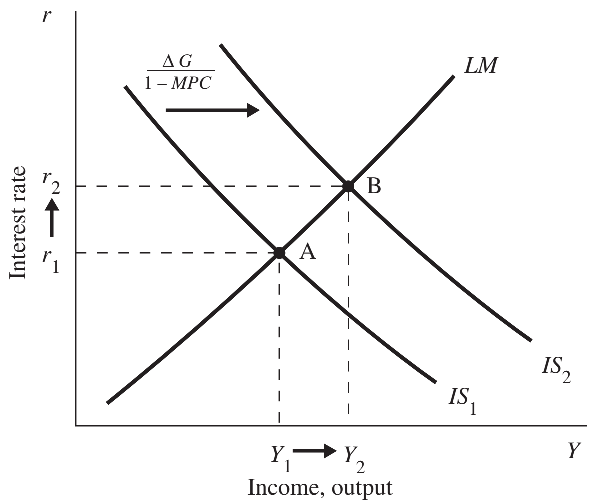


Figure 11–5

c. If the government increases taxes, then the tax multiplier tells us that the *IS* curve shifts to the left by an amount equal to $[-MPC/(1 - MPC)]\Delta T$. This is shown in Figure 11–6. Income and the interest rate both fall. Disposable income falls because income is lower and taxes are higher; this causes consumption to fall. The fall in the interest rate causes investment to rise.

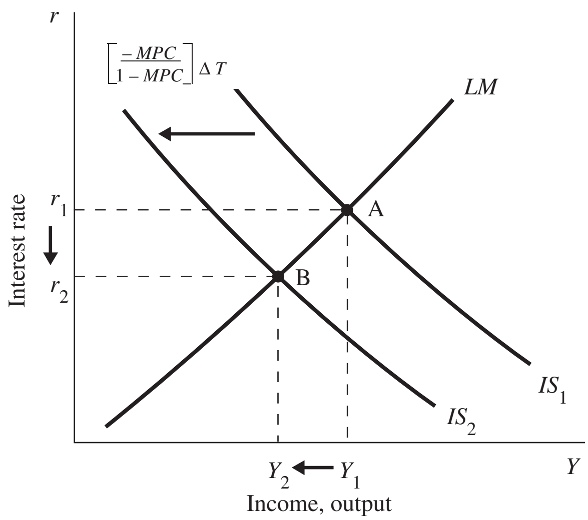


Figure 11–6

d. We can figure out how much the *IS* curve shifts in response to an equal increase in government purchases and taxes by adding together the two multiplier effects that we used in parts (b) and (c):

$$\Delta Y = [(1/(1 - MPC))]\Delta G] - [(MPC/(1 - MPC))\Delta T]$$

Because government purchases and taxes increase by the same amount, we know that $\Delta G = \Delta T$. Therefore, we can rewrite the above equation as:

$$\Delta Y = [(1/(1 - MPC)) - (MPC/(1 - MPC))]\Delta G$$

$$\Delta Y = \Delta G.$$

This expression tells us how output changes, holding the interest rate constant. It says that an equal increase in government purchases and taxes shifts the *IS* curve to the right by the amount that *G* increases.

This shift is shown in Figure 11–7. Output increases, but by less than the amount that *G* and *T* increase; this means that disposable income $Y - T$ falls. As a result, consumption also falls. The interest rate rises, causing investment to fall.

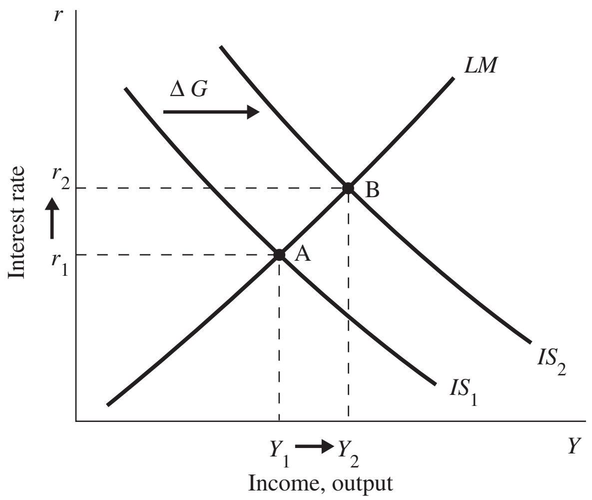


Figure 11–7

2. a. The invention of the new high-speed chip increases investment demand, which shifts the *IS* curve out. That is, at every interest rate, firms want to invest more. The increase in the demand for investment goods shifts the *IS* curve out, raising income and employment. Figure 11–8 shows the effect graphically.

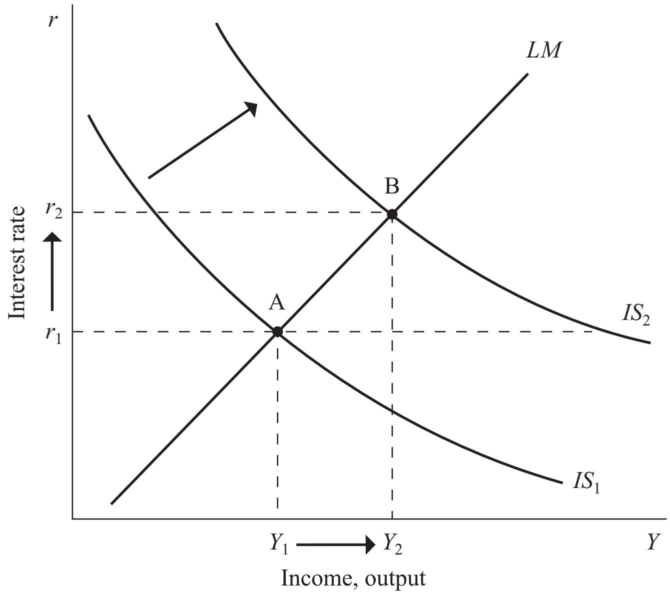


Figure 11–8

The increase in income from the higher investment demand also raises interest rates. This happens because the higher income raises demand for money; since the supply of money does not change, the interest rate must rise in order to restore equilibrium in the money market. The rise in interest rates partially offsets the increase in investment demand, so that output does not rise by the full amount of the rightward shift in the *IS* curve.

Overall, income, interest rates, consumption, and investment all rise.

b. The increased demand for cash shifts the *LM* curve up. This happens because at any given level of income and money supply, the interest rate necessary to equilibrate the money market is higher. Figure 11–9 shows the effect of this *LM* shift graphically.

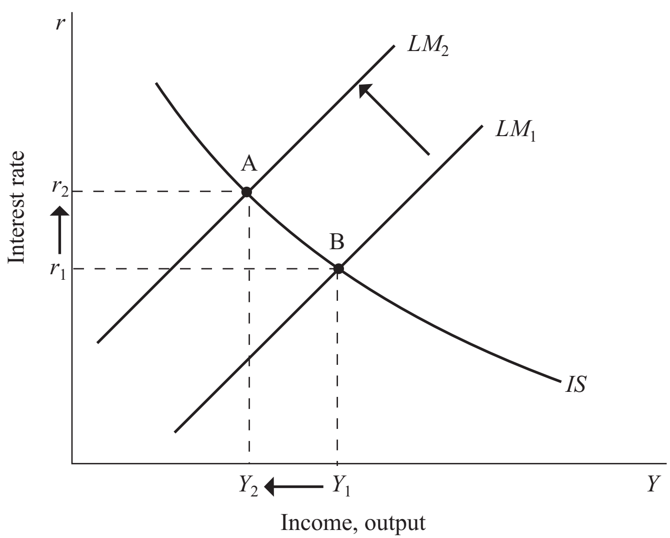


Figure 11–9

The upward shift in the *LM* curve lowers income and raises the interest rate. Consumption falls because income falls, and investment falls because the interest rate rises.

c. At any given level of income, consumers now wish to save more and consume less. Because of this downward shift in the consumption function, the *IS* curve shifts inward. Figure 11–10 shows the effect of this *IS* shift graphically.

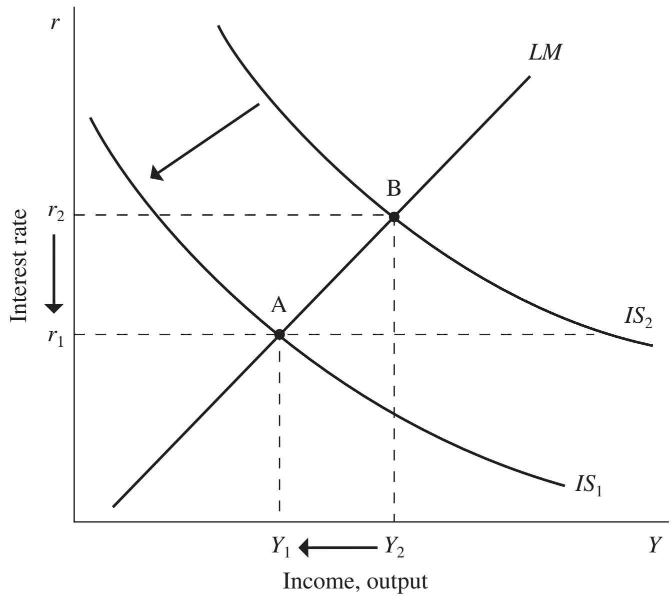


Figure 11–10

Income, interest rates, and consumption all fall, while investment rises. Income falls because at every level of the interest rate, planned expenditure falls. The interest rate falls because the fall in income reduces demand for money; since the supply of money is unchanged, the interest rate must fall to restore money-market equilibrium. Consumption falls both because of the shift in the consumption function and because income falls. Investment rises because of the lower interest rates and partially offsets the effect on output of the fall in consumption.

3\. a. The *IS* curve is given by:

$$Y = C(Y - T) + I(r) + G.$$

We can plug in the consumption and investment functions and values for G and T as given in the question and then rearrange to solve for the *IS* curve for this economy:

$$\begin{aligned} Y &= 200 + 0.75(Y - 100) + 200 - 25r + 100 \\ Y - 0.75Y &= 425 - 25r \\ (1 - 0.75)Y &= 425 - 25r \\ Y &= (1/0.25)\,(425 - 25r) \\ Y &= 1{,}700 - 100r. \end{aligned}$$

This *IS* equation is graphed in Figure 11–11 for r ranging from 0 to 8.

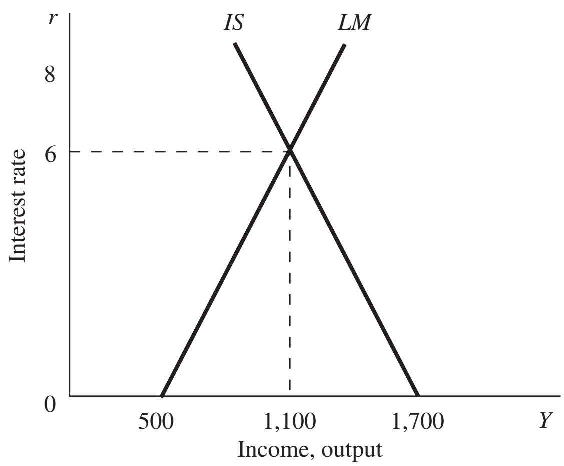


Figure 11–11

b. The *LM* curve is determined by equating the demand for and supply of real money balances. The supply of real balances is 1,000/2 = 500. Setting this equal to money demand, we find:

$$500 = Y - 100r.$$

$$Y = 500 + 100r.$$

This *LM* curve is graphed in Figure 11–11 for r ranging from 0 to 8.

c. If we take the price level as given, then the *IS* and the *LM* equations give us two equations in two unknowns, Y and r. We found the following equations in parts (a) and (b):

$$IS\text{: } Y = 1{,}700 - 100r.$$

$$LM\text{: } Y = 500 + 100r.$$

Equating these, we can solve for r:

$$\begin{aligned} 1{,}700 - 100r &= 500 + 100r \\ 1{,}200 &= 200r \\ r &= 6. \end{aligned}$$

Now that we know r, we can solve for Y by substituting it into either the *IS* or the *LM* equation. We find

$$Y = 1{,}100.$$

Therefore, the equilibrium interest rate is 6 percent and the equilibrium level of output is 1,100, as depicted in Figure 11–11.

d. If government purchases increase from 100 to 150, then the *IS* equation becomes:

$$Y = 200 + 0.75(Y - 100) + 200 - 25r + 150.$$

Simplifying, we find:

$$Y = 1{,}900 - 100r.$$

This *IS* curve is graphed as IS_2 in Figure 11–12. We see that the *IS* curve shifts to the right by 200.

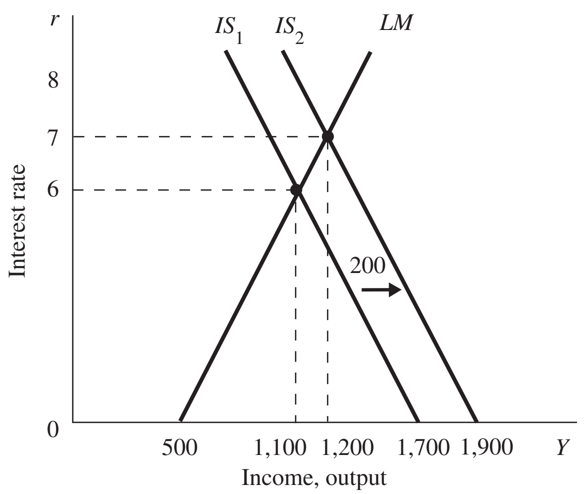


Figure 11–12

By equating the new *IS* curve with the *LM* curve derived in part (b), we can solve for the new equilibrium interest rate:

$$1{,}900 - 100r = 500 + 100r$$
$$1{,}400 = 200r$$
$$7 = r.$$

We can now substitute r into either the *IS* or the *LM* equation to find the new level of output. We find

$$Y = 1{,}200.$$

Therefore, the increase in government purchases causes the equilibrium interest rate to rise from 6 percent to 7 percent, while output increases from 1,100 to 1,200. This is depicted in Figure 11–12.

e. If the money supply increases from 1,000 to 1,200, then the LM equation becomes:

$$(1{,}200/2) = Y - 100r,$$

or

$$Y = 600 + 100r.$$

This LM curve is graphed as LM_2 in Figure 11–13. We see that the LM curve shifts to the right by 100 because of the increase in real money balances.

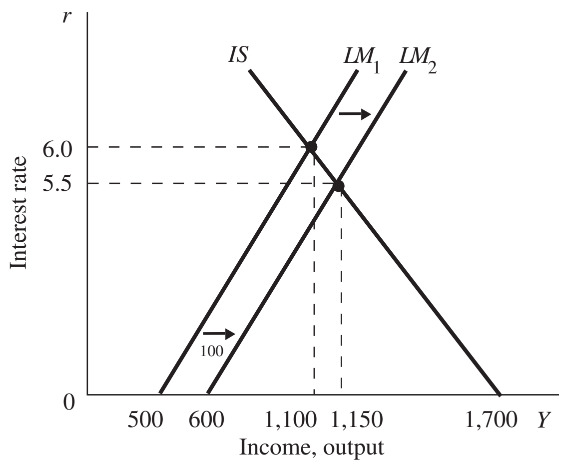


Figure 11–13

To determine the new equilibrium interest rate and level of output, equate the IS curve from part (a) with the new LM curve derived above:

$$1{,}700 - 100r = 600 + 100r$$
$$1{,}100 = 200r$$
$$5.5 = r.$$

Substituting this into either the IS or the LM equation, we find

$$Y = 1{,}150.$$

Therefore, the increase in the money supply causes the interest rate to fall from 6 percent to 5.5 percent, while output increases from 1,100 to 1,150. This is depicted in Figure 11–13.

f. If the price level rises from 2 to 4, then real money balances fall from 500 to 1,000/4 = 250. The LM equation becomes:

$$Y = 250 + 100r.$$

As shown in Figure 11–14, the *LM* curve shifts to the left by 250 because the increase in the price level reduces real money balances.

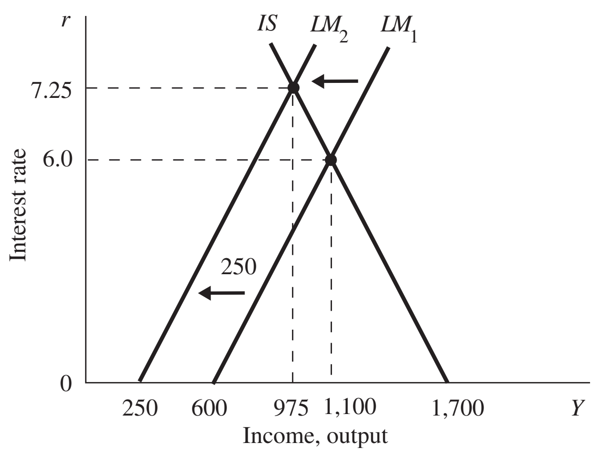


Figure 11–14

To determine the new equilibrium interest rate, equate the *IS* curve from part (a) with the new *LM* curve from above:

$$1{,}700 - 100r = 250 + 100r$$
$$1{,}450 = 200r$$
$$7.25 = r.$$

Substituting this interest rate into either the *IS* or the *LM* equation, we find

$$Y = 975.$$

Therefore, the new equilibrium interest rate is 7.25, and the new equilibrium level of output is 975, as depicted in Figure 11–14.

g. The aggregate demand curve is a relationship between the price level and the level of income. To derive the aggregate demand curve, we want to solve the *IS* and the *LM* equations for Y as a function of P. That is, we want to substitute out for the interest rate. We can do this by solving the *IS* and the *LM* equations for the interest rate:

$$IS: \quad Y = 1{,}700 - 100r$$
$$100r = 1{,}700 - Y.$$
$$LM: \quad (M/P) = Y - 100r$$
$$100r = Y - (M/P).$$

Combining these two equations, we find

$$1{,}700 - Y = Y - (M/P)$$
$$2Y = 1{,}700 + M/P$$
$$Y = 850 + M/2P.$$

Since the nominal money supply M equals 1,000, this becomes

$$Y = 850 + 500/P.$$

This aggregate demand equation is graphed in Figure 11–15.

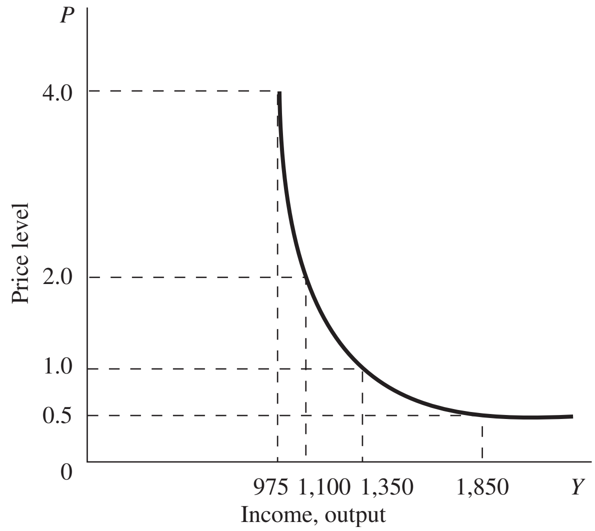


Figure 11–15

How does the increase in fiscal policy of part (d) affect the aggregate demand curve? We can see this by deriving the aggregate demand curve using the *IS* equation from part (d) and the *LM* curve from part (b):

$$IS: \quad Y = 1{,}900 - 100r$$
$$100r = 1{,}900 - Y.$$
$$LM: \quad (1{,}000/P) = Y - 100r$$
$$100r = Y - (1{,}000/P).$$

Combining and solving for Y:

$$1{,}900 - Y = Y - (1{,}000/P),$$

or

$$Y = 950 + 500/P.$$

By comparing this new aggregate demand equation to the one previously derived, we can see that the increase in government purchases by 50 shifts the aggregate demand curve to the right by 100.

How does the increase in the money supply of part (e) affect the aggregate demand curve? Because the *AD* curve is $Y = 850 + M/2P$, the increase in the money supply from 1,000 to 1,200 causes it to become

$$Y = 850 + 600/P.$$

By comparing this new aggregate demand curve to the one originally derived, we see that the increase in the money supply shifts the aggregate demand curve to the right.

4. a. The *IS* curve represents the relationship between the interest rate and the level of income that arises from equilibrium in the market for goods and services. That is, it describes the combinations of income and the interest rate that satisfy the equation

$$Y = C(Y - T) + I(r) + G.$$

If investment does not depend on the interest rate, then *nothing* in the *IS* equation depends on the interest rate; income must adjust to ensure that the quantity of goods produced, Y, equals the quantity of goods demanded, $C + I + G$. Thus, the *IS* curve is vertical at this level, as shown in Figure 11–16.

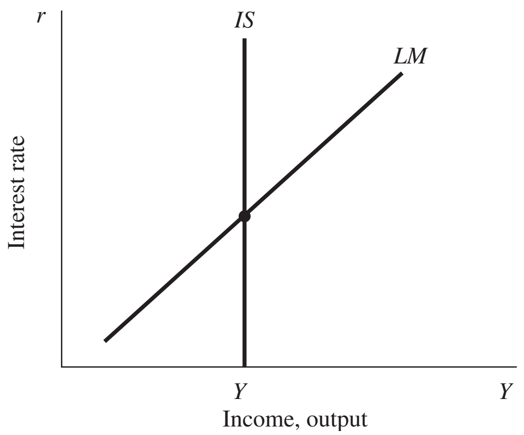


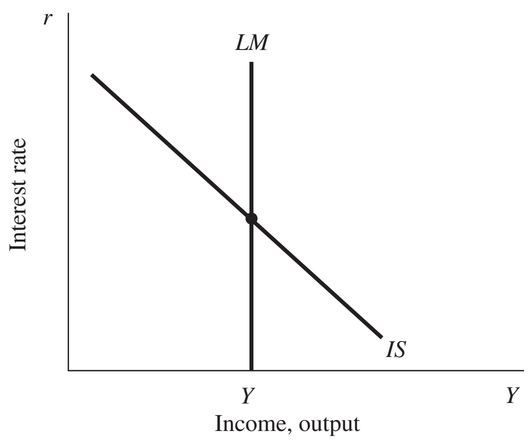
Figure 11–16

Monetary policy has no effect on output, because the *IS* curve determines Y. Monetary policy can affect only the interest rate. In contrast, fiscal policy is effective: output increases by the full amount that the *IS* curve shifts.

b. The *LM* curve represents the combinations of income and the interest rate at which the money market is in equilibrium. If money demand does not depend on the interest rate, then we can write the *LM* equation as

$$M/P = L(Y).$$

For any given level of real balances M/P, there is only one level of income at which the money market is in equilibrium. Thus, the *LM* curve is vertical, as shown in Figure 11–17.



Fiscal policy now has no effect on output; it can affect only the interest rate. Monetary policy is effective: a shift in the *LM* curve increases output by the full amount of the shift.

c. If money demand does not depend on income, then we can write the *LM* equation as

$$M/P = L(r).$$

For any given level of real balances M/P, there is only one level of the interest rate at which the money market is in equilibrium. Hence, the LM curve is horizontal, as shown in Figure 11–18.

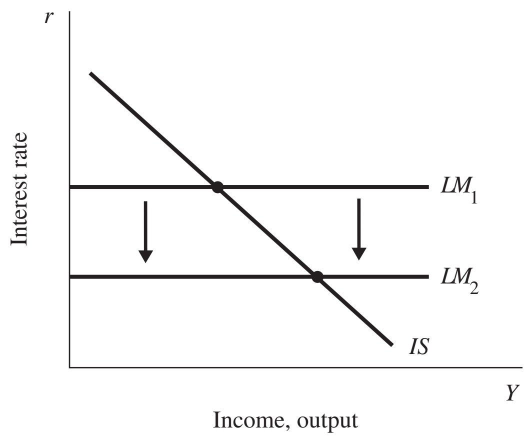


Figure 11–18

Fiscal policy is very effective: output increases by the full amount that the *IS* curve shifts. Monetary policy is also effective: an increase in the money supply causes the interest rate to fall, so the *LM* curve shifts down, as shown in Figure 11–18.

d. The *LM* curve gives the combinations of income and the interest rate at which the supply and demand for real balances are equal, so that the money market is in equilibrium. The general form of the *LM* equation is

$$M/P = L(r, Y).$$

Suppose income Y increases by \$1. How much must the interest rate change to keep the money market in equilibrium? The increase in Y increases money demand. If money demand is extremely sensitive to the interest rate, then it takes a *very* small increase in the interest rate to reduce money demand and restore equilibrium in the money market. Hence, the *LM* curve is (nearly) horizontal, as shown in Figure 11–19.

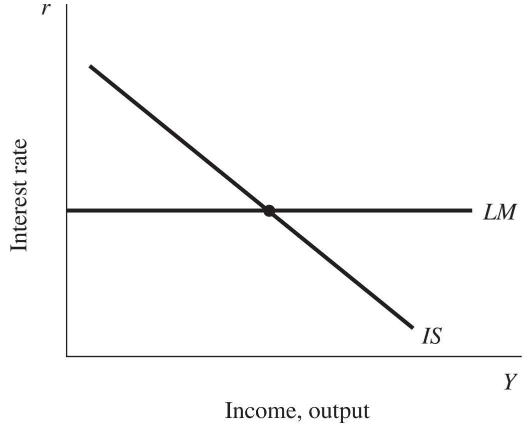


Figure 11–19

An example may make this clearer. Consider a linear version of the *LM* equation:

$$M/P = eY - fr.$$

Note that as f gets larger, money demand becomes increasingly sensitive to the interest rate. Rearranging this equation to solve for r, we find

$$r = (e/f)Y - (1/f)(M/P).$$

We want to focus on how changes in each of the variables are related to changes in the other variables. Hence, it is convenient to write this equation in terms of changes:

$$\Delta r = (e/f)\Delta Y - (1/f)\Delta(M/P).$$

The slope of the *LM* equation tells us how much r changes when Y changes, holding M fixed. If $\Delta(M/P) = 0$, then the slope is $\Delta r/\Delta Y = (e/f)$. As f gets very large, this slope gets closer and closer to zero.

If money demand is very sensitive to the interest rate, then fiscal policy is very effective: with a horizontal *LM* curve, output increases by the full amount that the *IS* curve shifts. Monetary policy is now completely ineffective: an increase in the money supply does not shift the *LM* curve at all. We see this in our example by considering what happens if M increases. For any given Y (so that we set $\Delta Y = 0$), $\Delta r/\Delta(M/P) = (-1/f)$; this tells us how much the *LM* curve shifts down. As f gets larger, this shift gets smaller and approaches zero. (This is in contrast to the horizontal *LM* curve in part (c), which does shift down.)

5. To raise investment while keeping output constant, the government should adopt a loose monetary policy and a tight fiscal policy, as shown in Figure 11–20. In the new equilibrium at point B, the interest rate is lower, so that investment is higher. The tight fiscal policy—reducing government purchases, for example—offsets the effect of this increase in investment on output.

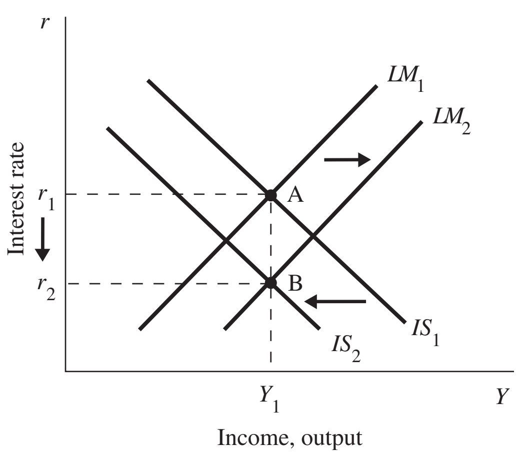


Figure 11–20

The policy mix in the early 1980s did exactly the opposite. Fiscal policy was expansionary, while monetary policy was contractionary. Such a policy mix shifts the *IS* curve to the right and the *LM* curve to the left, as in Figure 11–21. The real interest rate rises and investment falls.

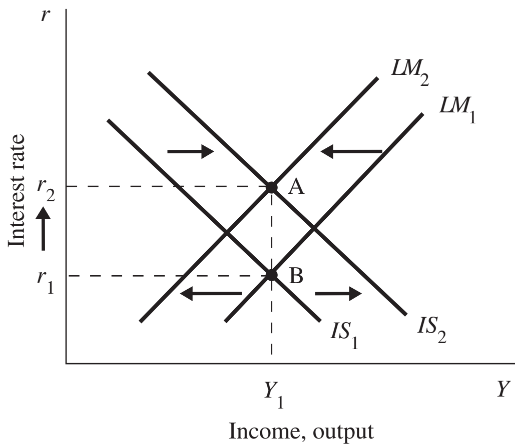


Figure 11–21

6. a. An increase in the money supply shifts the *LM* curve to the right in the short run. This moves the economy from point A to point B in Figure 11–22: the interest rate falls from r_1 to r_2, and output rises from $\overline{Y}$ to Y_2. The increase in output occurs because the lower interest rate stimulates investment, which increases output.

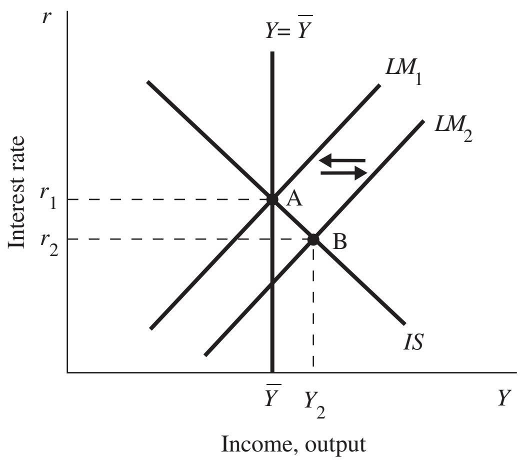
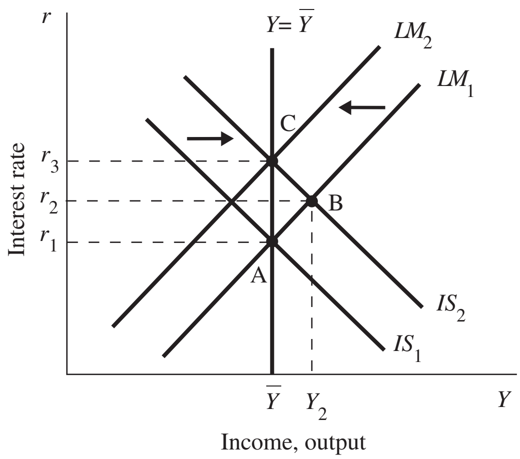


Figure 11–22

Since the level of output is now above its long-run level, prices begin to rise. A rising price level lowers real balances, which raises the interest rate. As indicated in Figure 11–22, the *LM* curve shifts back to the left. Prices continue to rise until the economy returns to its original position at point A. The interest rate returns to r_1, and investment returns to its original level. Thus, in the long run, there is no impact on real variables from an increase in the money supply. (This is what we called *monetary neutrality* in Chapter 4.)

b. An increase in government purchases shifts the *IS* curve to the right, and the economy moves from point A to point B, as shown in Figure 11–23. In the short run, output increases from $\overline{Y}$ to Y_2, and the interest rate increases from r_1 to r_2.

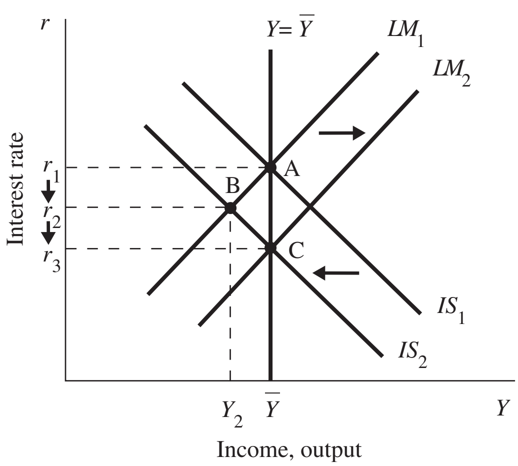
Figure 11–23



The increase in the interest rate reduces investment and "crowds out" part of the expansionary effect of the increase in government purchases. Initially, the *LM* curve is not affected because government spending does not enter the *LM* equation. After the increase, output is above its long-run equilibrium level, so prices begin to rise. The rise in prices reduces real balances, which shifts the *LM* curve to the left. The interest rate rises even more than in the short run. This process continues until the long-run level of output is again reached. At the new equilibrium, point C, interest rates have risen to r_3, and the price level is permanently higher. Note that, like monetary policy, fiscal policy cannot change the long-run level of output. Unlike monetary policy, however, it can change the *composition* of output. For example, the level of investment at point C is lower than it is at point A.

c. An increase in taxes reduces disposable income for consumers, shifting the *IS* curve to the left, as shown in Figure 11–24. In the short run, output and the interest rate decline to Y_2 to r_2 as the economy moves from point A to point B.

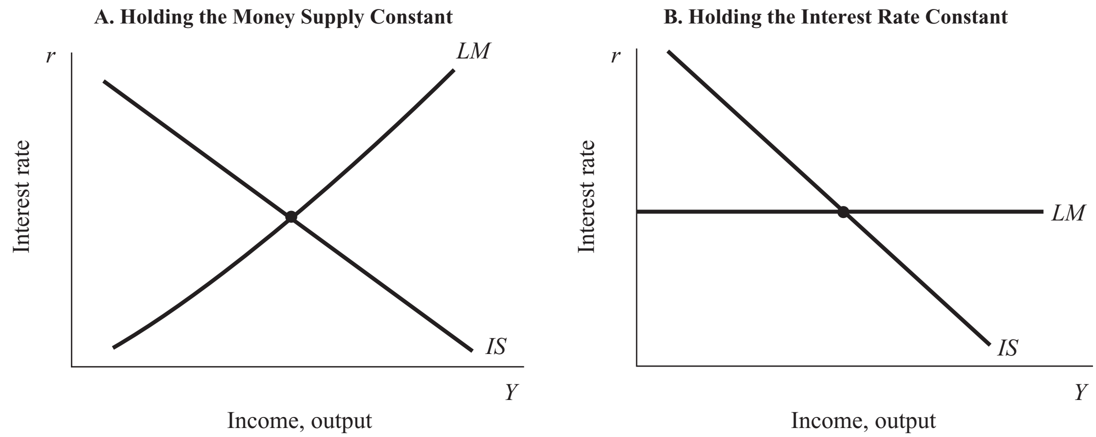
Figure 11–24



Initially, the *LM* curve is not affected. In the longer run, prices begin to decline because output is below its long-run equilibrium level, and the *LM* curve then shifts to the right because of the increase in real money balances. Interest rates fall even further to r_3 and, thus, further stimulate investment and increase income. In the long run, the economy moves to point C. Output returns to $\overline{Y}$, the price level and the interest rate are lower, and the decrease in consumption has been offset by an equal increases in investment.

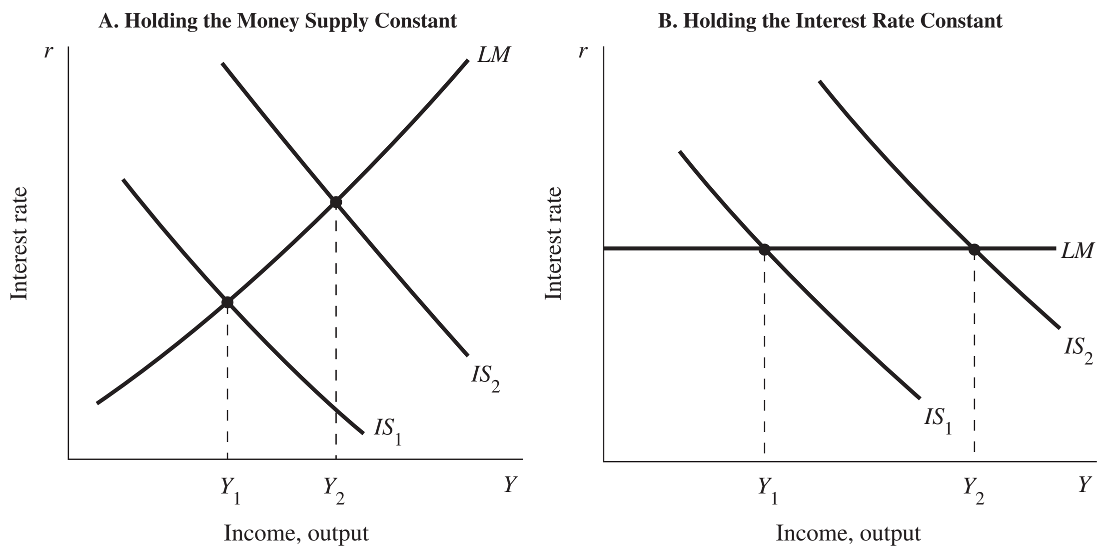
7. Figure 11–25(A) shows what the *IS–LM* model looks like for the case in which the Fed holds the money supply constant. Figure 11–25(B) shows what the model looks like if the Fed adjusts the money supply to hold the interest rate constant; this policy makes the effective *LM* curve horizontal.

Figure 11–25



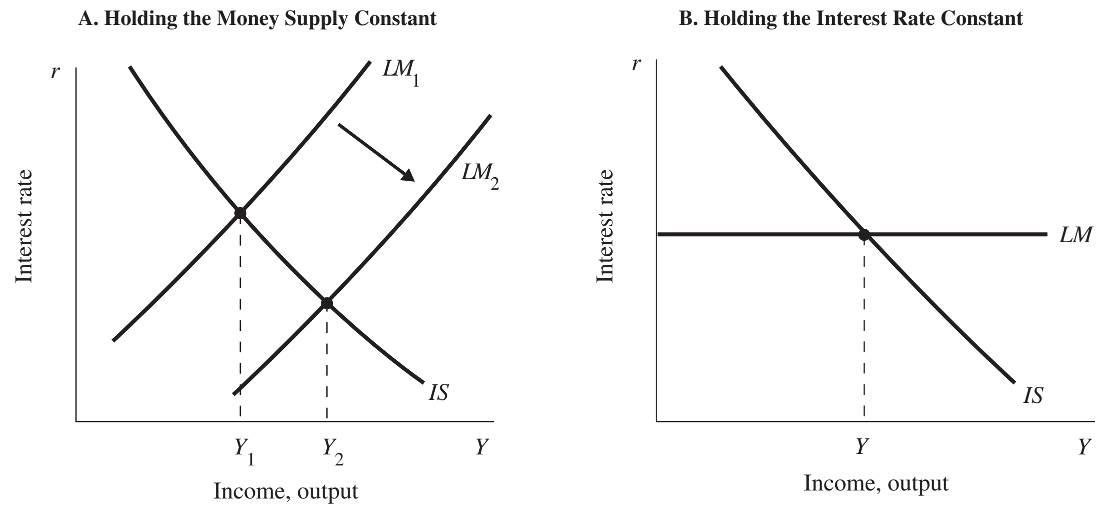
a. If all shocks to the economy arise from exogenous changes in the demand for goods and services, this means that all shocks are to the *IS* curve. Suppose a shock causes the *IS* curve to shift from IS_1 to IS_2. Figures 11–26(A) and (B) show what effect this has on output under the two policies. It is clear that output fluctuates less if the Fed follows a policy of keeping the money supply constant. Thus, if all shocks are to the *IS* curve, then the Fed should follow a policy of keeping the money supply constant.

Figure 11–26



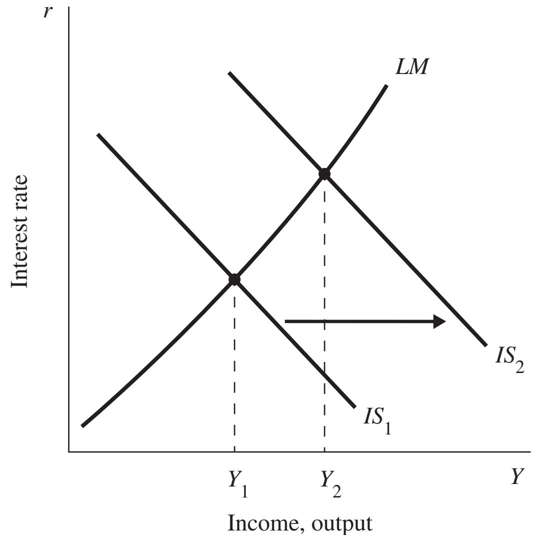
b. If all shocks in the economy arise from exogenous changes in the demand for money, this means that all shocks are to the *LM* curve. If the Fed follows a policy of adjusting the money supply to keep the interest rate constant, then the *LM* curve does not shift in response to these shocks—the Fed immediately adjusts the money supply to keep the money market in equilibrium. Figures 11–27(A) and (B) show the effects of the two policies. It is clear that output fluctuates less if the Fed holds the interest rate constant, as in Figure 11–27(B). If the Fed holds the interest rate constant and offsets shocks to money demand by changing the money supply, then all variability in output is eliminated. Thus, if all shocks are to the *LM* curve, then the Fed should adjust the money supply to hold the interest rate constant, thereby stabilizing output.

Figure 11–27



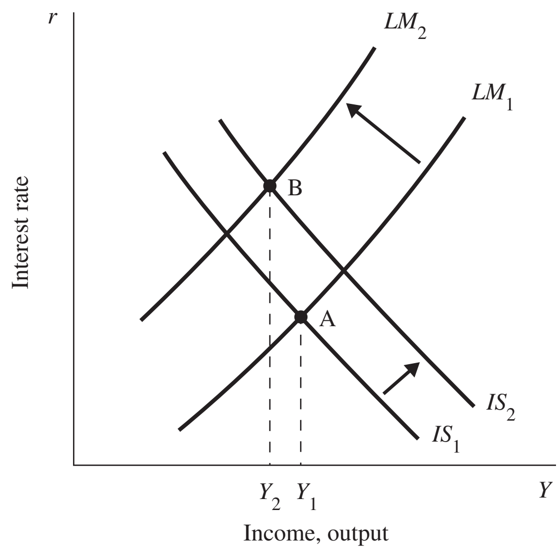
8. a. The analysis of changes in government purchases is unaffected by making money demand dependent on disposable income instead of total expenditure. An increase in government purchases shifts the *IS* curve to the right, as in the standard case. The *LM* curve is unaffected by this increase. Thus, the analysis is the same as it was before; this is shown in Figure 11–28.

Figure 11–28



b. A tax cut causes disposable income $Y - T$ to increase at every level of income Y. This increases consumption for any given level of income as well, so the *IS* curve shifts to the right, as in the standard case. This is shown in Figure 11–29. If money demand depends on disposable income, however, then the tax cut increases money demand, so the *LM* curve shifts upward, as shown in the figure.
Thus, the analysis of a change in taxes is altered drastically by making money demand dependent on disposable income. As shown in the figure, it is possible for a tax cut to be contractionary.

Figure 11–29



CHAPTER 12 Aggregate Demand in the Open Economy

Questions for Review

1. In the Mundell–Fleming model, an increase in taxes shifts the IS^* curve to the left. If the exchange rate floats freely, then the LM^* curve is unaffected. As shown in Figure 12–1, the exchange rate falls while aggregate income remains unchanged. The fall in the exchange rate causes the trade balance to increase.

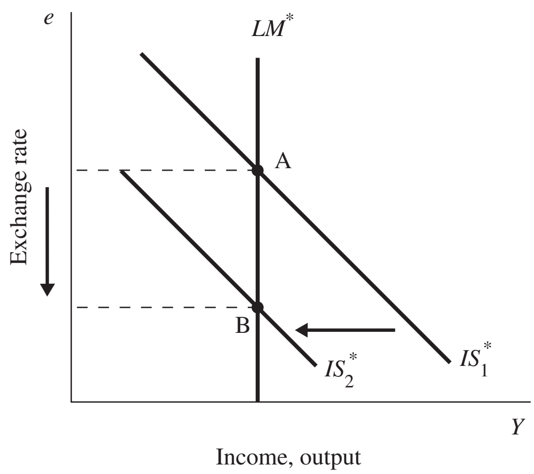


Figure 12–1

Now suppose there are fixed exchange rates. When the IS^* curve shifts to the left in Figure 12–2, the money supply has to fall to keep the exchange rate constant, shifting the LM^* curve from LM^*_1 to LM^*_2. As shown in the figure, output falls while the exchange rate remains fixed.

Net exports can only change if the exchange rate changes or the net exports schedule shifts. Neither occurs here, so net exports do not change.

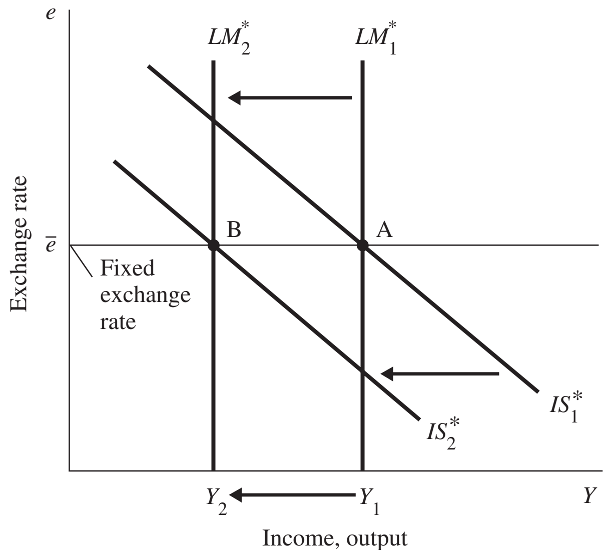


Figure 12–2

We conclude that in an open economy, fiscal policy is effective at influencing output under fixed exchange rates but ineffective under floating exchange rates.

2. In the Mundell–Fleming model with floating exchange rates, a reduction in the money supply reduces real balances M/P, causing the LM^* curve to shift to the left. As shown in Figure 12–3, this leads to a new equilibrium with lower income and a higher exchange rate. The increase in the exchange rate reduces the trade balance.

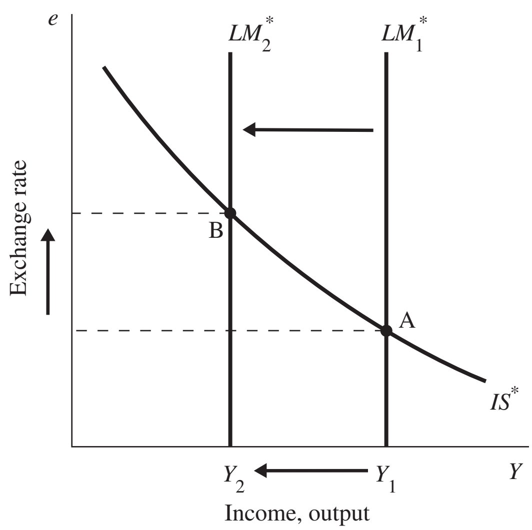


Figure 12–3

If exchange rates are fixed, then the upward pressure on the exchange rate forces the Fed to sell dollars and buy foreign exchange. This increases the money supply M and shifts the LM^* curve back to the right until it reaches LM^*_1 again, as shown in Figure 12–4.

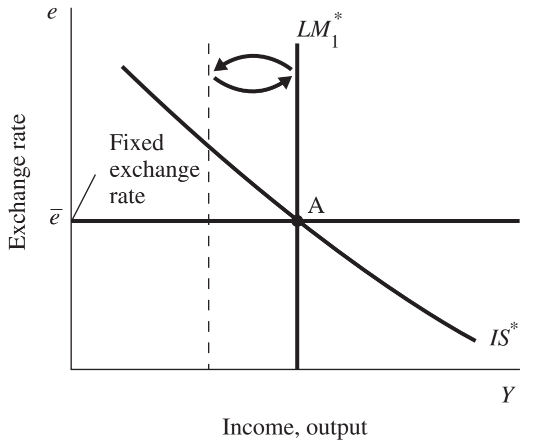


Figure 12–4

In equilibrium, income, the exchange rate, and the trade balance are unchanged.

We conclude that in an open economy, monetary policy is effective at influencing output under floating exchange rates but impossible under fixed exchange rates.

3. In the Mundell–Fleming model under floating exchange rates, removing a quota on imported cars shifts the net exports schedule inward, as shown in Figure 12–5. As in the figure, for any given exchange rate, such as $\bar{e}$, net exports fall. This is because it now becomes possible for Americans to buy more Toyotas, Volkswagens, and other foreign cars than they could when there was a quota.

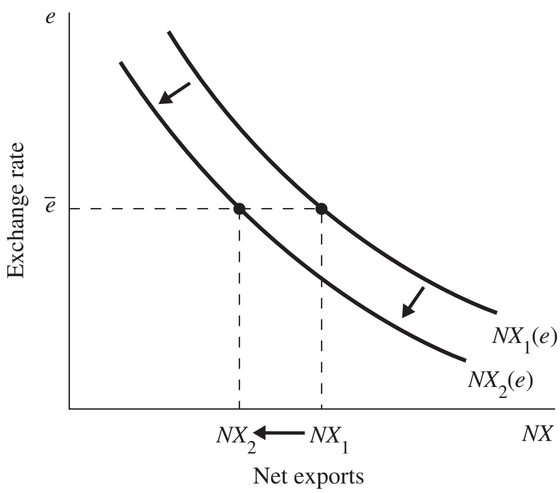


Figure 12–5

This inward shift in the net-exports schedule causes the IS^* schedule to shift inward as well, as shown in Figure 12–6.

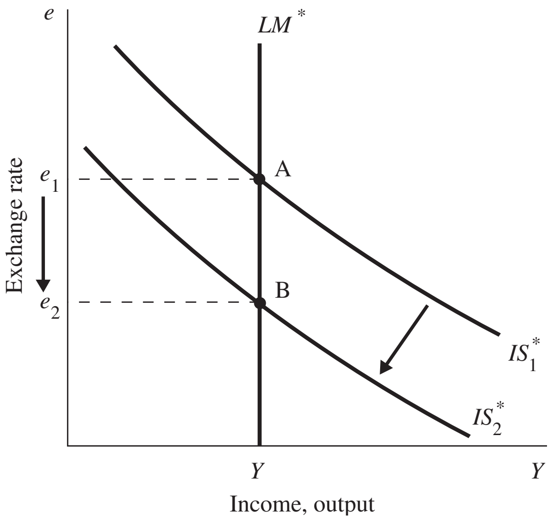


Figure 12–6

The exchange rate falls while income remains unchanged. The trade balance is also unchanged. We know this since

$$NX(e) = Y - C(Y - T) - I(r) - G.$$

Removing the quota has no effect on Y, C, I, or G, so it also has no effect on the trade balance.

If there are fixed exchange rates, then the shift in the IS^* curve puts downward pressure on the exchange rate, as above. In order to keep the exchange rate fixed, the Fed is forced to buy dollars and sell foreign exchange. This shifts the LM^* curve to the left, as shown in Figure 12–7.

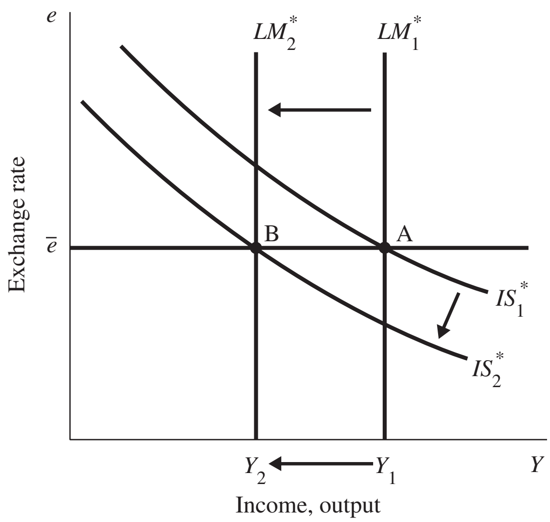


Figure 12–7

In equilibrium, income is lower and the exchange rate is unchanged. The trade balance falls; we know this because net exports are lower at any level of the exchange rate.

4. The following table lists some of the advantages and disadvantages of floating versus fixed exchange rates.

Table 12–1

Floating Exchange Rates	
Advantages:	Allows monetary policy to pursue goals other than just exchange-rate stabilization, for example, the stability of prices and employment.
Disadvantages:	Exchange-rate uncertainty is higher, and this might make international trade more difficult.
Fixed Exchange Rates	
Advantages:	Makes international trade easier by reducing exchange rate uncertainty. It disciplines the monetary authority, preventing excessive growth in M. As a monetary rule, it is easy to implement.
Disadvantages:	Monetary policy cannot be used to pursue policy goals other than maintaining the exchange rate. As a way to discipline the monetary authority, it may lead to greater instability in income and employment.

Problems and Applications

1. The following three equations describe the Mundell–Fleming model:

$$Y = C(Y - T) + I(r) + G + NX(e). \qquad (IS)$$
$$M/P = L(r, Y). \qquad (LM)$$
$$r = r^*.$$

In addition, we assume that the price level is fixed in the short run, both at home and abroad. This means that the nominal exchange rate e equals the real exchange rate ϵ.

a. If consumers decide to spend less and save more, then the IS^* curve shifts to the left. Figure 12–8 shows the case of floating exchange rates. Since the money supply does not adjust, the LM^* curve does not shift. Since the LM^* curve is unchanged, output Y is also unchanged. The exchange rate falls (depreciates), which causes an increase in the trade balance equal to the fall in consumption.

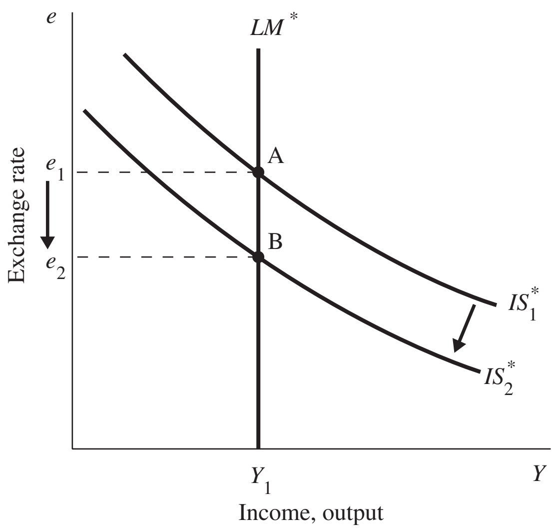


Figure 12–8

Figure 12–9 shows the case of fixed exchange rates. The IS^* curve shifts to the left, but the exchange rate cannot fall. Instead, output falls. Since the exchange rate does not change, we know that the trade balance does not change either.

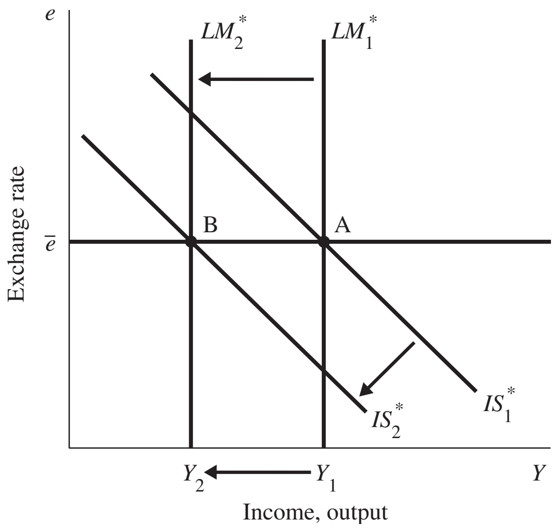


Figure 12–9

In essence, the fall in desired spending puts downward pressure on the interest rate and, hence, on the exchange rate. If there are fixed exchange rates, then the central bank buys the domestic currency that investors seek to exchange, and provides foreign currency. As a result, the exchange rate does not change, so the trade balance does not change. Hence, there is nothing to offset the fall in consumption, and output falls.

b. If some consumers decide they prefer stylish Toyotas to Fords and Chryslers, then the net-exports schedule, shown in Figure 12–10, shifts to the left. That is, at any level of the exchange rate, net exports are lower than they were before.

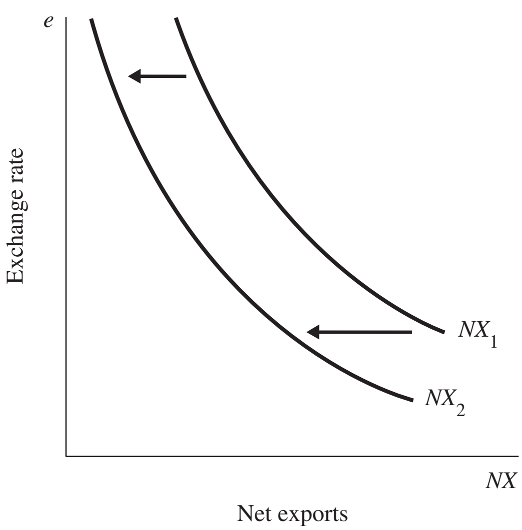


Figure 12–10

This shifts the IS^* curve to the left as well, as shown in Figure 12–11 for the case of floating exchange rates. Since the LM^* curve is fixed, output does not change, while the exchange rate falls (depreciates).

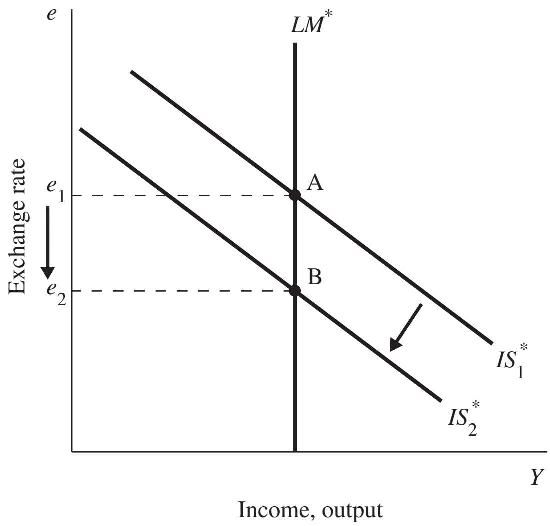
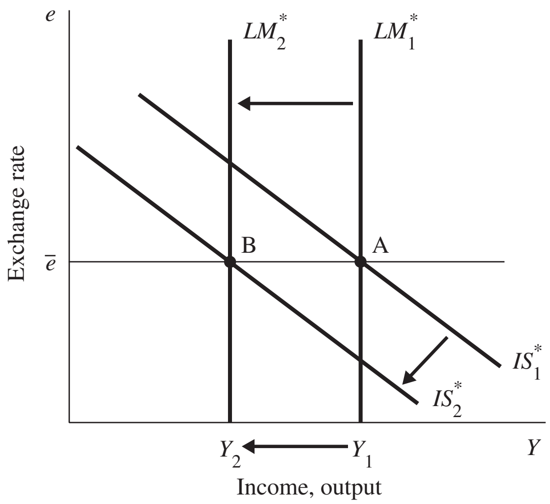


Figure 12–11

The trade balance does not change either, despite the fall in the exchange rate. We know this since $NX = S - I$, and both saving and investment remain unchanged.

Figure 12–12 shows the case of fixed exchange rates. The leftward shift in the IS^* curve puts downward pressure on the exchange rate. The central bank buys dollars and sells foreign exchange to keep e fixed: this reduces M and shifts the LM^* curve to the left. As a result, output falls.

Figure 12–12



The trade balance falls, because the shift in the net exports schedule means that net exports are lower for any given level of the exchange rate.

c. The introduction of ATM machines reduces the demand for money. We know that equilibrium in the money market requires that the supply of real balances M/P must equal demand:

$$M/P = L(r^*, Y).$$

A fall in money demand means that for unchanged income and interest rates, the right-hand side of this equation falls. Since M and P are both fixed, we know that the left-hand side of this equation cannot adjust to restore equilibrium. We also know that the interest rate is fixed at the level of the world interest rate. This means that income—the only variable that can adjust—must rise in order to increase the demand for money. That is, the LM^* curve shifts to the right.

Figure 12–13 shows the case with floating exchange rates. Income rises, the exchange rate falls (depreciates), and the trade balance rises.

Figure 12–13

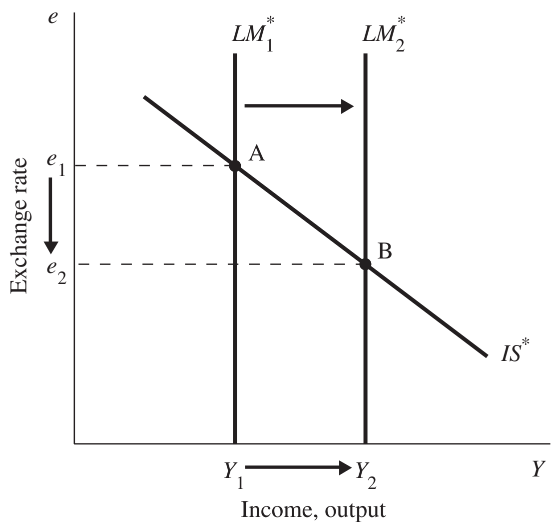
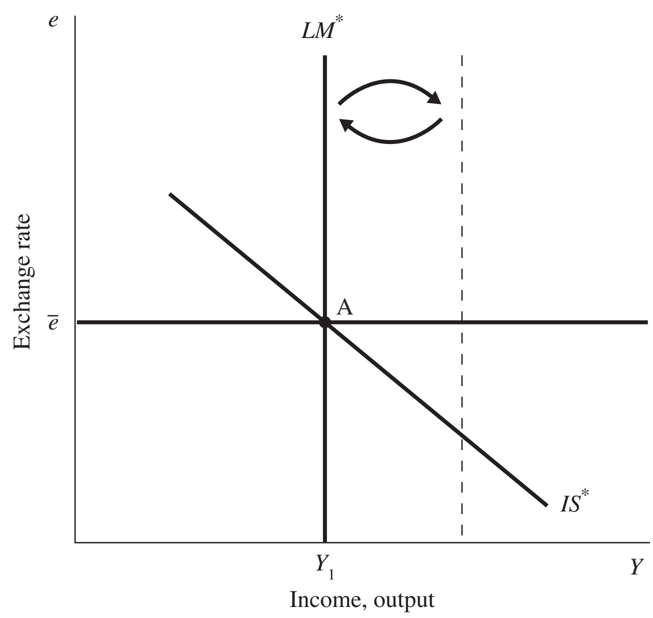


Figure 12–14 shows the case of fixed exchange rates. The LM^* schedule shifts to the right; as before, this tends to push domestic interest rates down and cause the currency to depreciate. However, the central bank buys dollars and sells foreign currency in order to keep the exchange rate from falling. This reduces the money supply and shifts the LM^* schedule back to the left. The LM^* curve continues to shift back until the original equilibrium is restored.

Figure 12–14



In the end, income, the exchange rate, and the trade balance are unchanged.

2. a. The Mundell–Fleming model takes the world interest rate r^* as an exogenous variable. However, there is no reason to expect the world interest rate to be constant. In the closed-economy model of Chapter 3, the equilibrium of saving and investment determines the real interest rate. In an open economy in the long run, the world real interest rate is the rate that equilibrates world saving and world investment demand. Anything that reduces world saving or increases world investment demand increases the world interest rate. In addition, in the short run with fixed prices, anything that increases the worldwide demand for goods or reduces the worldwide supply of money causes the world interest rate to rise.

b. Figure 12–15 shows the effect of an increase in the world interest rate under floating exchange rates. Both the IS^* and the LM^* curves shift. The IS^* curve shifts to the left, because the higher interest rate causes investment $I(r^*)$ to fall. The LM^* curve shifts to the right because the higher interest rate reduces money demand. Since the supply of real balances M/P is fixed, the higher interest rate leads to an excess supply of real balances. To restore equilibrium in the money market, income must rise; this increases the demand for money until there is no longer an excess supply.

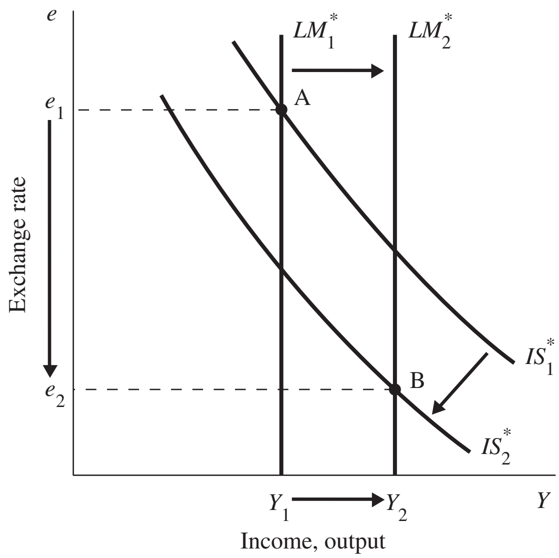


Figure 12–15

We see from the figure that output rises and the exchange rate falls (depreciates). Hence, the trade balance increases.

c. Figure 12–16 shows the effect of an increase in the world interest rate if exchange rates are fixed. Both the IS^* and LM^* curves shift. As in part (b), the IS^* curve shifts to the left since the higher interest rate causes investment demand to fall. The LM^* schedule, however, shifts to the left instead of to the right. This is because the downward pressure on the exchange rate causes the central bank to buy dollars and sell foreign exchange. This reduces the supply of money M and shifts the LM^* schedule to the left. The LM^* curve must shift all the way back to LM^*_2 in the figure, where the fixed-exchange-rate line crosses the new IS^* curve.

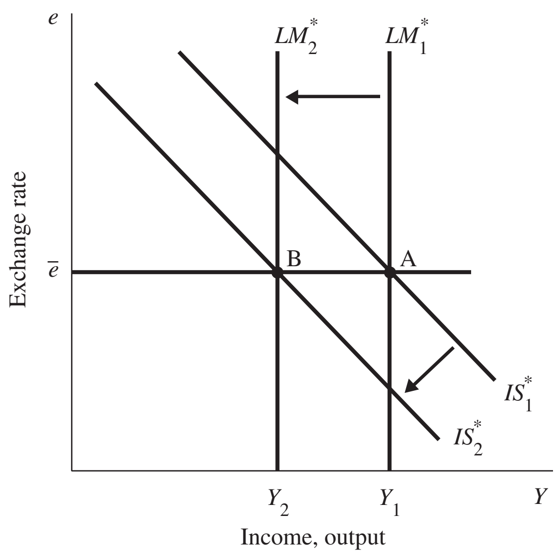


Figure 12–16

In equilibrium, output falls while the exchange rate remains unchanged. Since the exchange rate does not change, neither does the trade balance.

3. a. A depreciation of the currency makes American goods more competitive. This is because a depreciation means that the same price in dollars translates into fewer units of foreign currency. That is, in terms of foreign currency, American goods become cheaper so that foreigners buy more of them. For example, suppose the exchange rate between yen and dollars falls from 200 yen/dollar to 100 yen/dollar. If an American can of tennis balls costs \$2.50, its price in yen falls from 500 yen to 250 yen. This fall in price increases the quantity of American-made tennis balls demanded in Japan. That is, American tennis balls are more competitive.

b. Consider first the case of floating exchange rates. We know that the position of the LM^* curve determines output. Hence, we know that we want to keep the money supply fixed. As shown in Figure 12–17, we want to use fiscal policy to shift the IS^* curve to the left to cause the exchange rate to fall (depreciate). We can do this by reducing government spending or increasing taxes.

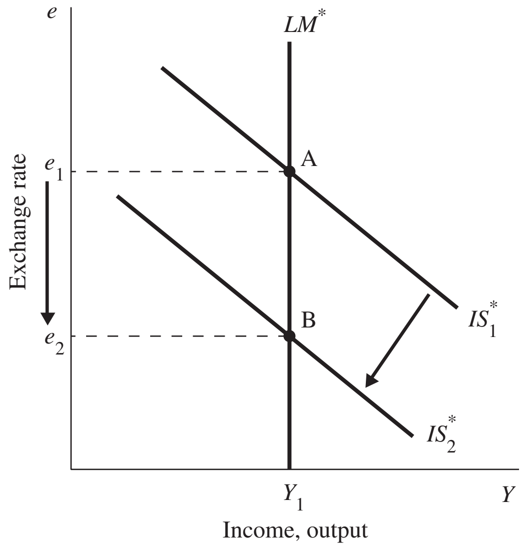


Figure 12–17

Now suppose that the exchange rate is fixed at some level. If we want to increase competitiveness, we need to reduce the exchange rate; that is, we need to fix it at a lower level. The first step is to devalue the dollar, fixing the exchange rate at the desired lower level. This increases net exports and tends to increase output, as shown in Figure 12–18. We can offset this rise in output with contractionary fiscal policy that shifts the IS^* curve to the left, as shown in the figure.

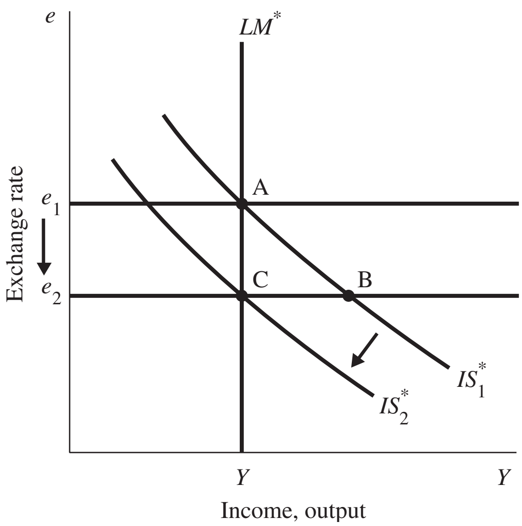


Figure 12–18

4. In the text, we assumed that net exports depend only on the exchange rate. This is analogous to the usual story in microeconomics in which the demand for any good (in this case, net exports) depends on the price of that good. The "price" of net exports is the exchange rate. However, we also expect that the demand for any good depends on income, and this may be true here as well: as income rises, we want to buy more of all goods, both domestic and imported. Hence, as income rises, imports increase, so net exports fall. Thus, we can write net exports as a function of both the exchange rate and income:

$$NX = NX(e, Y).$$

Figure 12–19 shows the net exports schedule as a function of the exchange rate. As before, the net exports schedule is downward sloping, so an increase in the exchange rate reduces net exports. We have drawn this schedule for a given level of income. If income increases from Y_1 to Y_2, the net exports schedule shifts inward from $NX(Y_1)$ to $NX(Y_2)$.

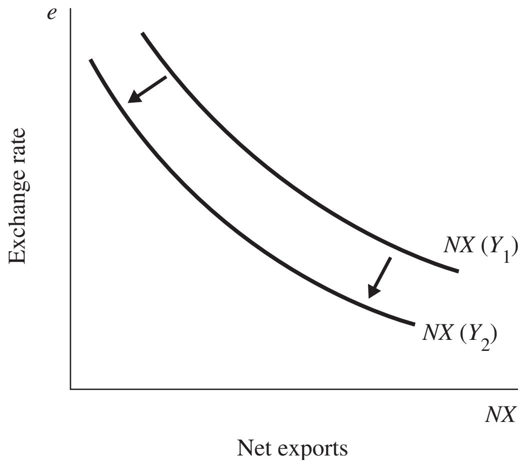


Figure 12–19

a. Figure 12–20 shows the effect of a fiscal expansion under floating exchange rates. The fiscal expansion (an increase in government expenditure or a cut in taxes) shifts the IS^* schedule to the right. But with floating exchange rates, if the LM^* curve does not change, neither does income. Since income does not change, the net-exports schedule remains at its original level $NX(Y_1)$.

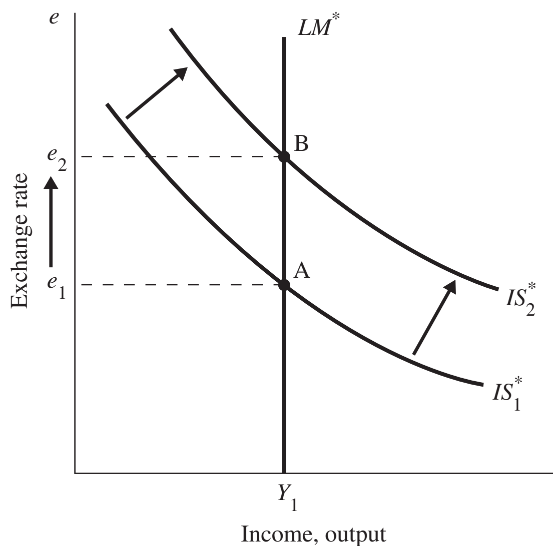


Figure 12–20

The final result is that income does not change, and the exchange rate appreciates from e_1 to e_2. Net exports fall because of the appreciation of the currency.

Thus, our answer is the same as that given in Table 12–1.

b. Figure 12–21 shows the effect of a fiscal expansion under fixed exchange rates. The fiscal expansion shifts the IS^* curve to the right, from IS^*_1 to IS^*_2. As in part (a), for unchanged real balances, this tends to push the exchange rate up. To prevent this appreciation, however, the central bank intervenes in currency markets, selling dollars and buying foreign exchange. This increases the money supply and shifts the LM^* curve to the right, from LM^*_1 to LM^*_2.

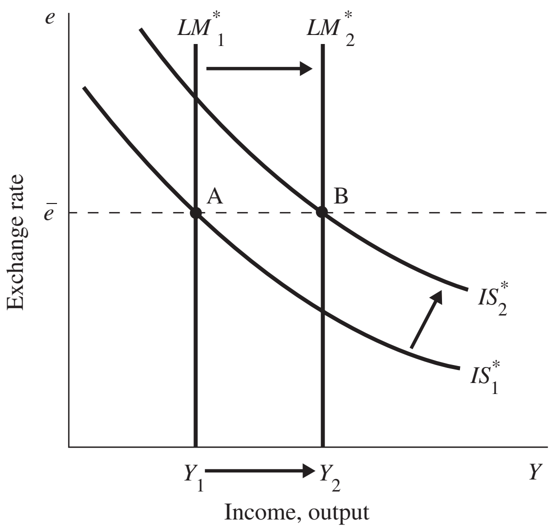


Figure 12–21

Output rises while the exchange rate remains fixed. Despite the unchanged exchange rate, the higher level of income reduces net exports because the net-exports schedule shifts inward.

Thus, our answer differs from the answer in Table 12–1 only in that under fixed exchange rates, a fiscal expansion reduces the trade balance.

5. [Note the similarity to question 7 in Chapter 11.] We want to consider the effects of a tax cut when the LM^* curve depends on disposable income instead of income:

$$M/P = L[r, Y - T].$$

A tax cut now shifts both the IS^* and the LM^* curves. Figure 12–22 shows the case of floating exchange rates. The IS^* curve shifts to the right, from IS^*_1 to IS^*_2. The LM^* curve shifts to the left, however, from LM^*_1 to LM^*_2.

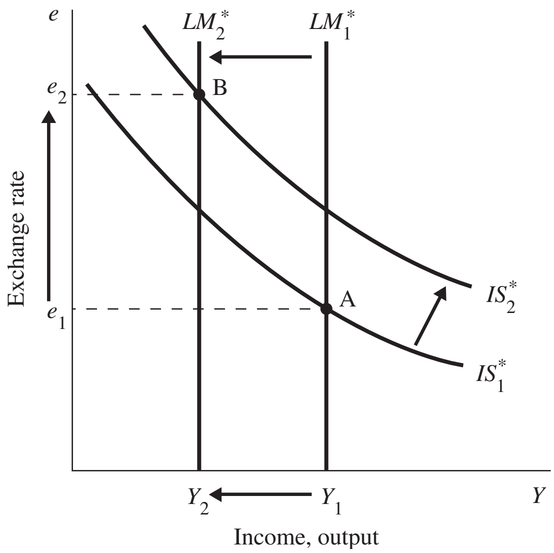


Figure 12–22

We know that real balances M/P are fixed in the short run, while the interest rate is fixed at the level of the world interest rate r^*. Disposable income is the only variable that can adjust to bring the money market into equilibrium: hence, the LM^* equation determines the level of disposable income. If taxes T fall, then income Y must also fall to keep disposable income fixed.

In Figure 12–22, we move from an original equilibrium at point A to a new equilibrium at point B. Income falls by the amount of the tax cut, and the exchange rate appreciates.

If there are fixed exchange rates, the IS^* curve still shifts to the right; but the initial shift in the LM^* curve no longer matters. That is, the upward pressure on the exchange rate causes the central bank to sell dollars and buy foreign exchange; this increases the money supply and shifts the LM^* curve to the *right*, as shown in Figure 12–23.

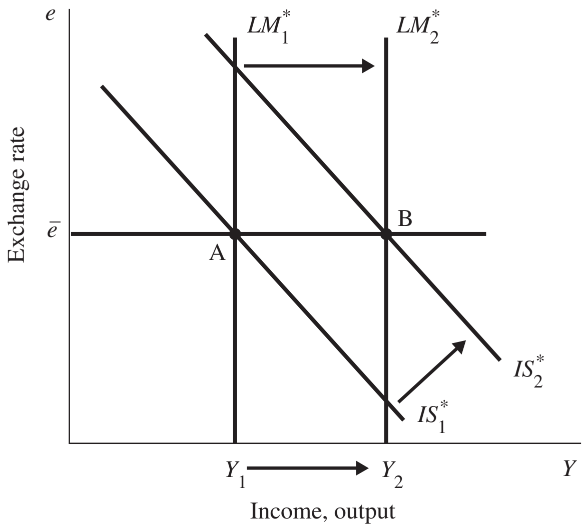


Figure 12–23

The new equilibrium, at point B, is at the intersection of the new IS^* curve, IS^*_2, and the horizontal line at the level of the fixed exchange rate. There is no difference between this case and the standard case where money demand depends on income.

6. Since people demand money balances in order to buy goods and services, it makes sense to think that the price level that is relevant is the price level of the goods and services they buy. This includes both domestic and foreign goods. But the dollar price of foreign goods depends on the exchange rate. For example, if the dollar rises from 100 yen/dollar to 150 yen/dollar, then a Japanese good that costs 300 yen falls in price from \$3 to \$2. Hence, we can write the condition for equilibrium in the money market as

$$M/P = L(r, Y),$$

where

$$P = \lambda P_d + (1 - \lambda)P_f/e.$$

a. A higher exchange rate makes foreign goods cheaper. To the extent that people consume foreign goods (a fraction $1 - \lambda$), this lowers the price level P that is relevant for the money market. This lower price level increases the supply of real balances M/P. To keep the money market in equilibrium, we require income to rise to increase money demand as well.

Hence, the LM^* curve is upward sloping.

b. In the standard Mundell–Fleming model, expansionary fiscal policy has no effect on output under floating exchange rates. As shown in Figure 12–24, this is no longer true here. A cut in taxes or an increase in government spending shifts the IS^* curve to the right, from IS^*_1 to IS^*_2. Since the LM^* curve is upward sloping, the result is an increase in output.

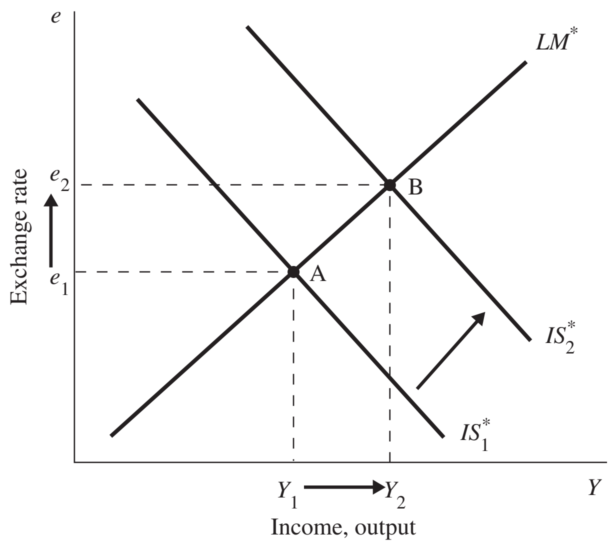


Figure 12–24

c. A central assumption in this chapter is that the price level is fixed in the short run. That is, we assumed that the short-run aggregate supply curve is horizontal at $P = \overline{P}$, as shown in Figure 12–25.

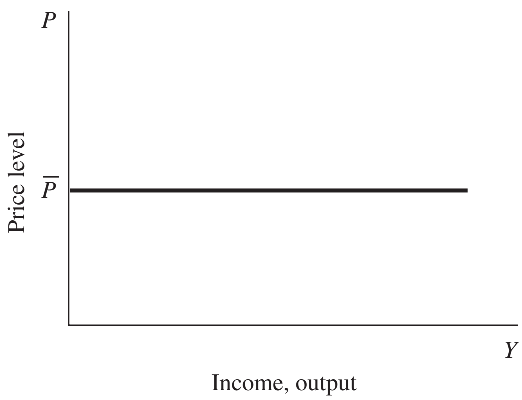


Figure 12–25

A supply shock is something that shifts the AS curve. If the price level P depends on the exchange rate, then as shown in Figure 12–26, an appreciation of the exchange rate e causes the price level P to fall—that is, the aggregate supply curve shifts down from AS_1 to AS_2. In other words, it looks exactly like a supply shock, except that the "shock" is endogenous, not exogenous.

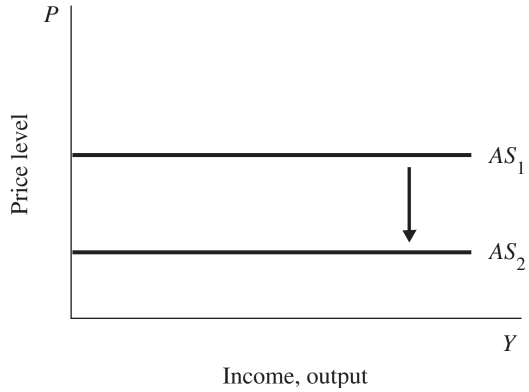


Figure 12–26

7. a. California is a small open economy, and we assume that it can print dollar bills. Its exchange rate, however, is fixed with the rest of the United States: one dollar can be exchanged for one dollar. In the Mundell–Fleming model with fixed exchange rates, California cannot use monetary policy to affect output, because this policy is already used to control the exchange rate. Hence, if California wishes to stimulate employment, it should use fiscal policy.

b. In the short run, the import prohibition shifts the IS^* curve out. This increases demand for Californian goods and puts upward pressure on the exchange rate. To counteract this, the Californian money supply increases, so the LM^* curve shifts out as well. The new short-run equilibrium is at point K in Figures 12–27(A) and (B).

Assuming that we started with the economy producing at its natural rate, the increase in demand for Californian goods tends to raise their prices. This rise in the price level lowers real money balances, shifting the short-run AS curve upward and the LM^* curve inward. Eventually, the Californian economy ends up at point C, with no change in output or the trade balance, but with a higher real exchange rate relative to Washington.

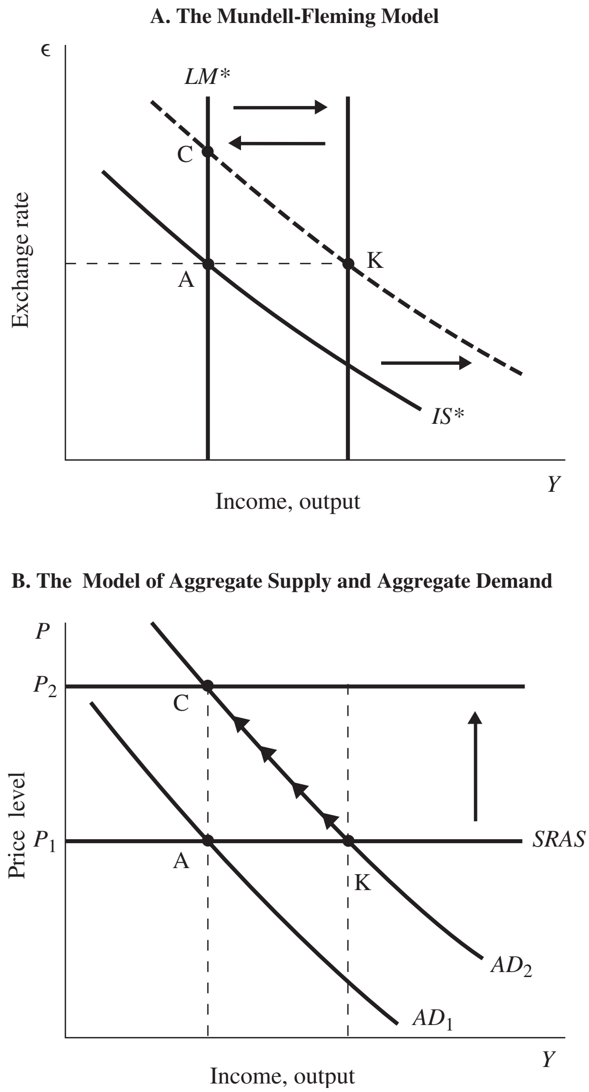
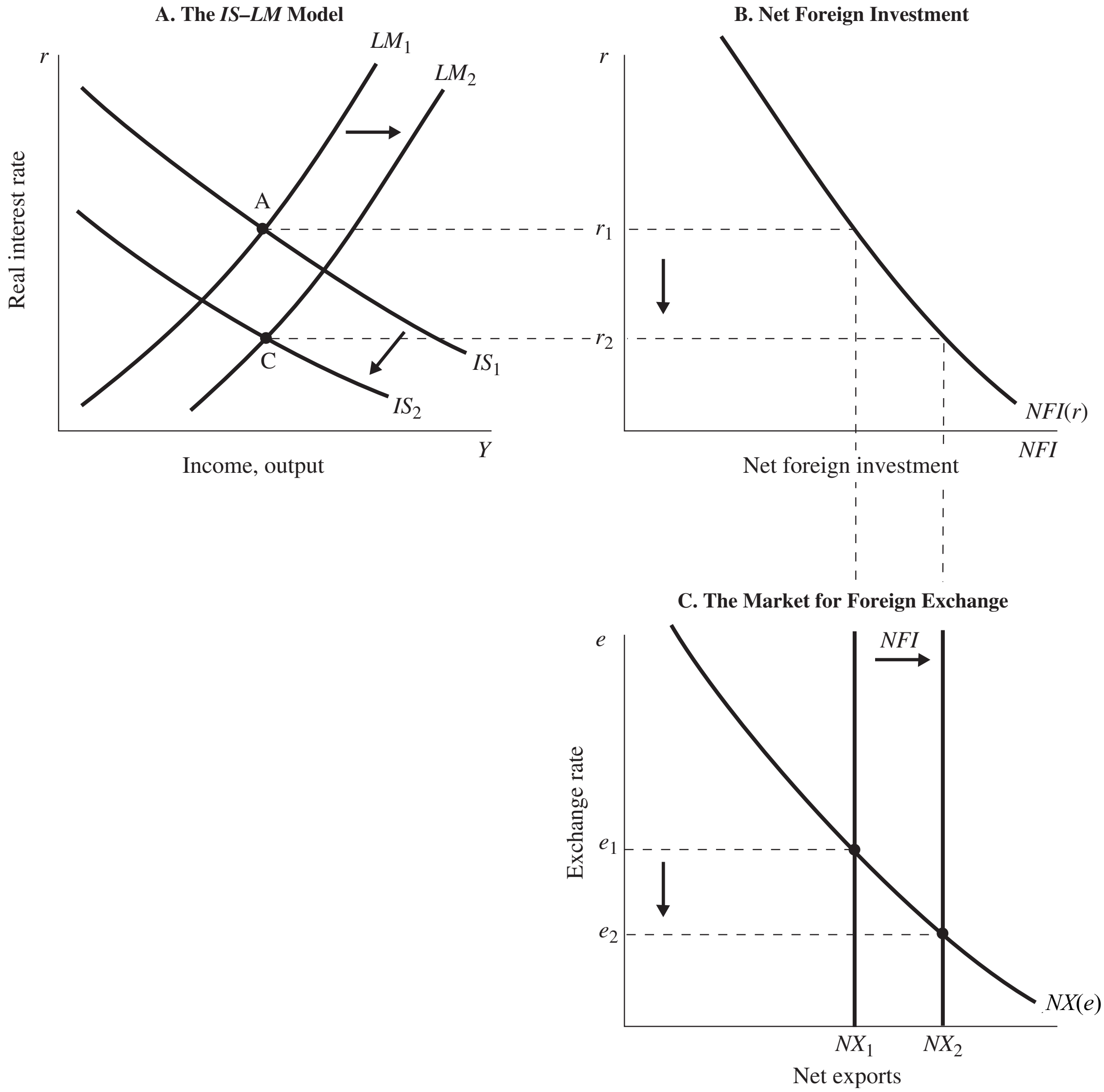


Figure 12–27

More Problems and Applications to Chapter 12

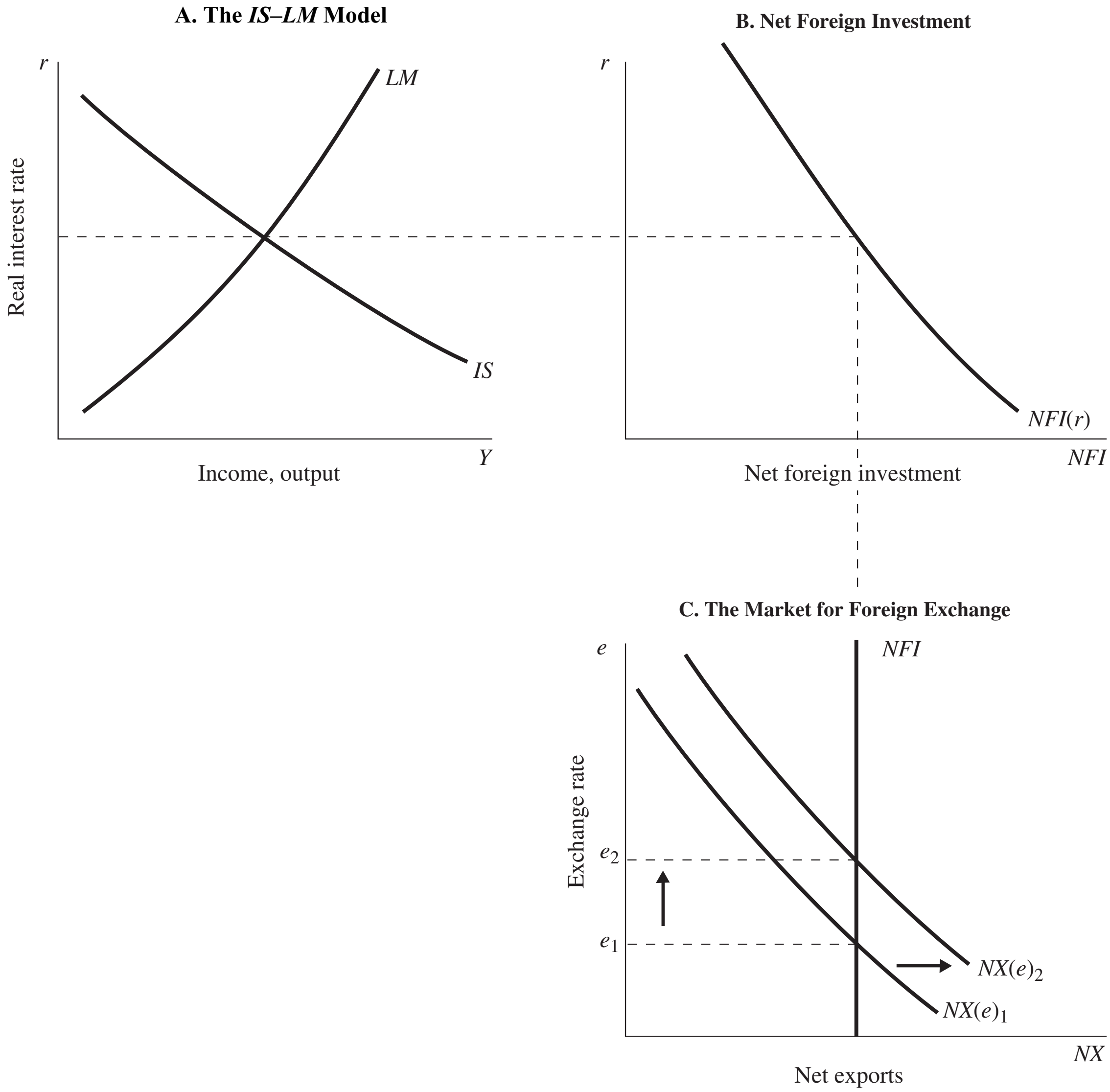
1. a. Higher taxes shift the *IS* curve inward. To keep output unchanged, the central bank must increase the money supply, shifting the *LM* curve to the right. At the new equilibrium (point C in Figure 12–28), the interest rate is lower, the exchange rate has depreciated, and the trade balance has risen.

Figure 12–28



b. Restricting the import of foreign cars shifts the *NX*(*e*) schedule outward [see panel (C)]. This has no effect on either the *IS* curve or the *LM* curve, however, because the *NFI* schedule is unaffected. Hence, output doesn't change and there is no need for any change in monetary policy. As shown in Figure 12–29, interest rates and the trade balance don't change, but the exchange rate appreciates.

Figure 12–29



2. a. The *NFI* curve becomes flatter, because a small change in the interest rate now has a larger effect on capital flows.

   b. As argued in the text, a flatter *NFI* curve makes the *IS* curve flatter, as well.

   c. Figure 12–30 shows the effect of a shift in the *LM* curve for both a steep and a flat *IS* curve. It is clear that the flatter the *IS* curve is, the less effect any change in the money supply has on interest rates. Hence, the Fed has less control over the interest rate when investors are more willing to substitute foreign and domestic assets.

   d. It is clear from Figure 12–30 that the flatter the *IS* curve is, the greater effect any change in the money supply has on output. Hence, the Fed has more control over output.

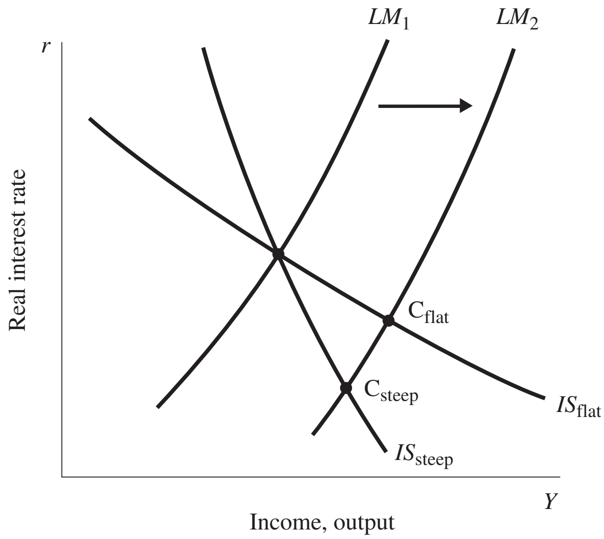
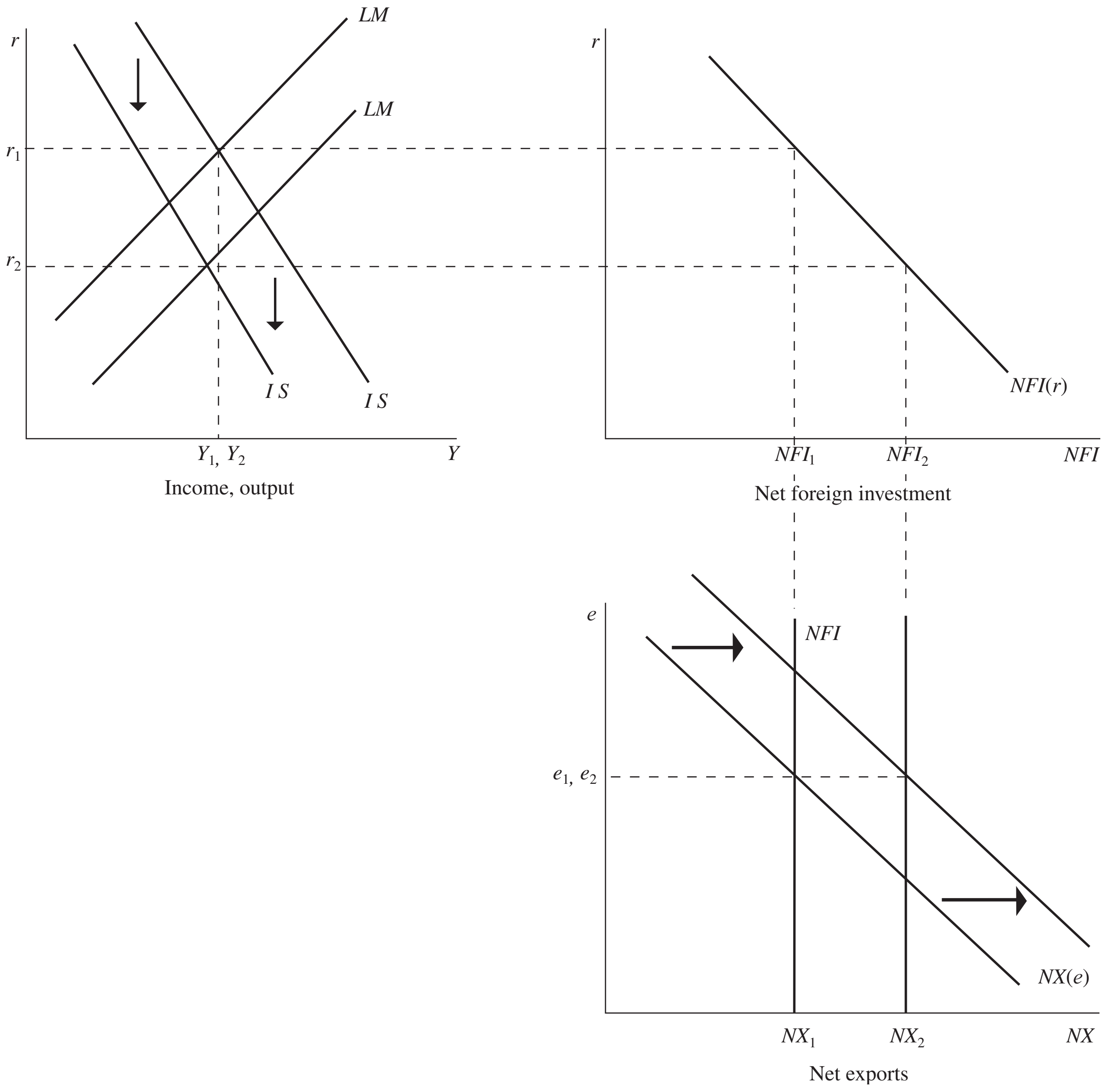


Figure 12–30

3. a. No. It is impossible to raise investment without affecting income or the exchange rate just by using monetary and fiscal policies. Investment can only be increased through a lower interest rate. Regardless of what policy is used to lower the interest rate (e.g., expansionary monetary policy and contractionary fiscal policy), net foreign investment will increase, lowering the exchange rate.

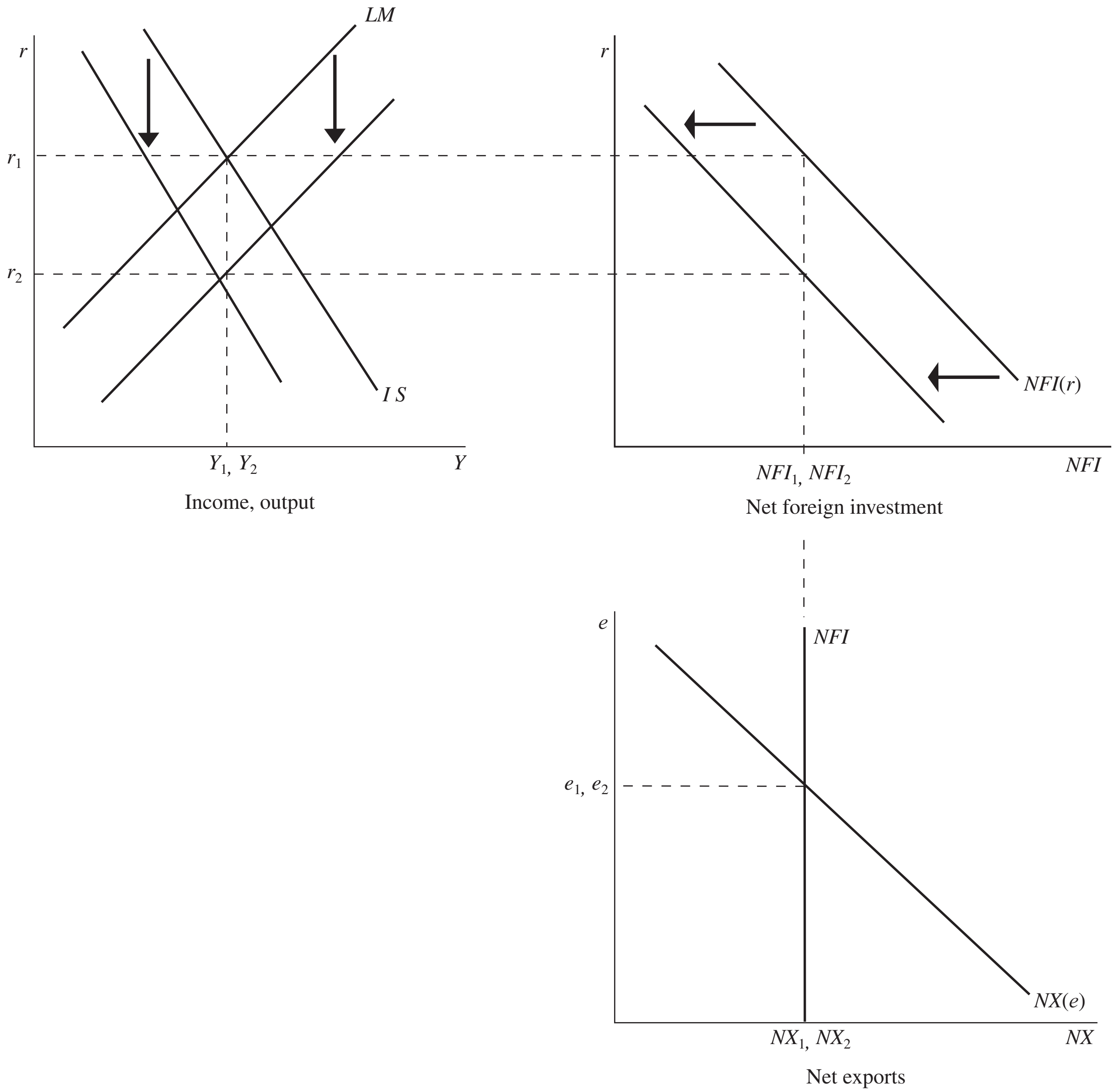
   b. Yes. Policymakers can raise investment without affecting income or the exchange rate with a combination of expansionary monetary policy and contractionary fiscal policy, and protection against imports can raise investment without affecting the other variables. Both the monetary expansion and the fiscal contraction would put downward pressure on interest rates and stimulate investment. It is necessary to combine these two policies so that their effects on income exactly offset each other. The lower interest rates will, as in part (a), increase net foreign investment, which would normally put downward pressure on the exchange rate. The protectionist policies, however, shift the net-exports curve out; this puts countervailing upward pressure on the exchange rate and offsets the effect of the fall in interest rates. Figure 12–31 shows this combination of policies.

Figure 12–31



c. Yes. Policymakers can raise investment without affecting income or the exchange rate through a home monetary expansion and fiscal contraction, combined with a lower foreign interest rate either through a foreign monetary expansion or fiscal contraction. The domestic policy lowers the interest rate, stimulating investment. The foreign policy shifts the *NFI* curve inward. Even with lower interest rates, the quantity of *NFI* would be unchanged and there would be no pressure on the exchange rate. This combination of policies is shown in Figure 12–32.

Figure 12–32

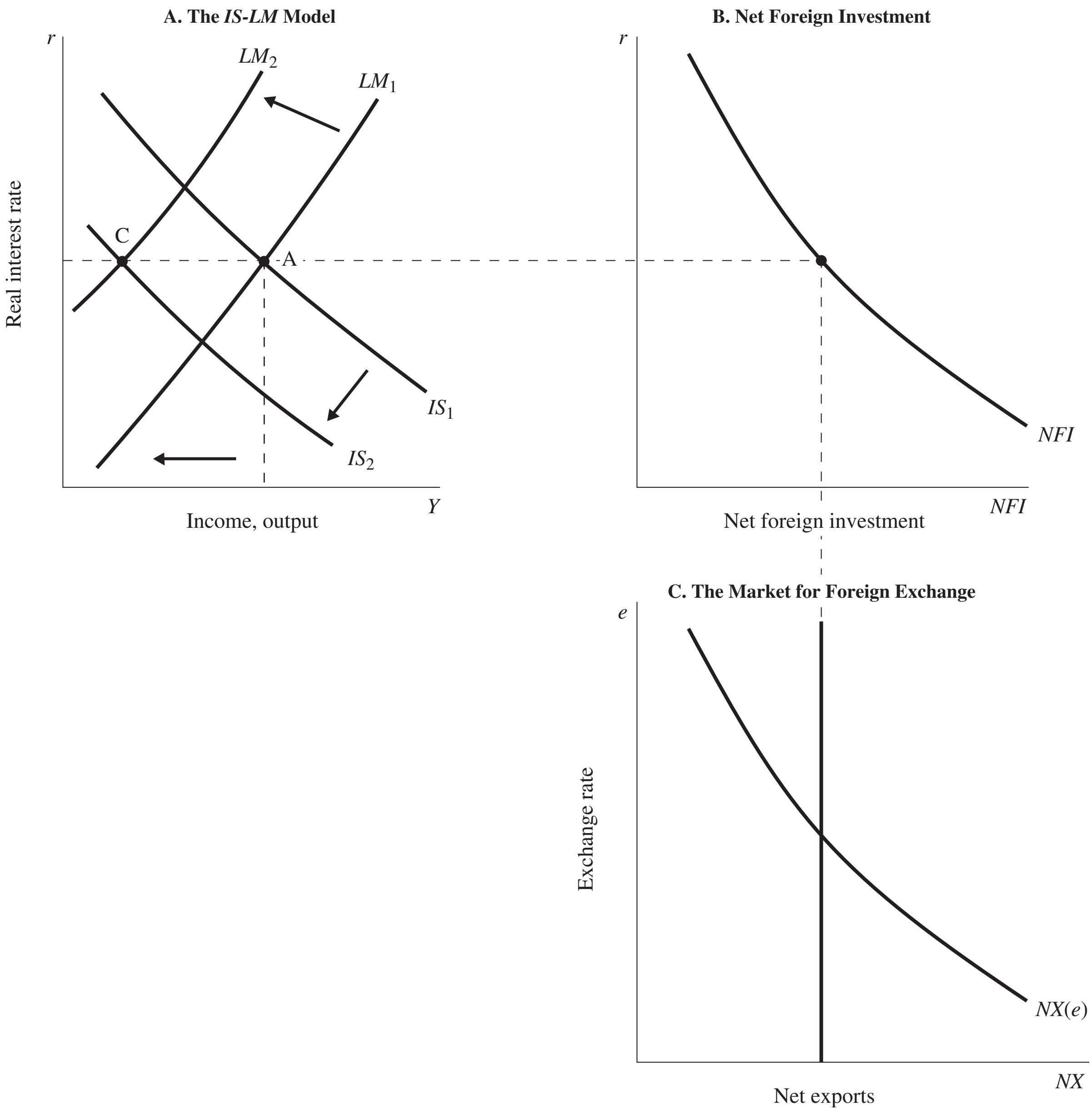


4. a. Figure 12–33 shows the effect of a fiscal contraction on a large open economy with a fixed exchange rate. The fiscal contraction shifts the *IS* curve to the left in panel

(A), which puts downward pressure on the interest rate. This tends to increase *NFI* and cause the exchange rate to depreciate [see panels (B) and (C)]. To avoid this, the central bank intervenes and buys dollars. This keeps the exchange rate from depreciating; it also shifts the *LM* curve to the left. The new equilibrium, at point C, has an unchanged interest rate and exchange rate, but lower output.

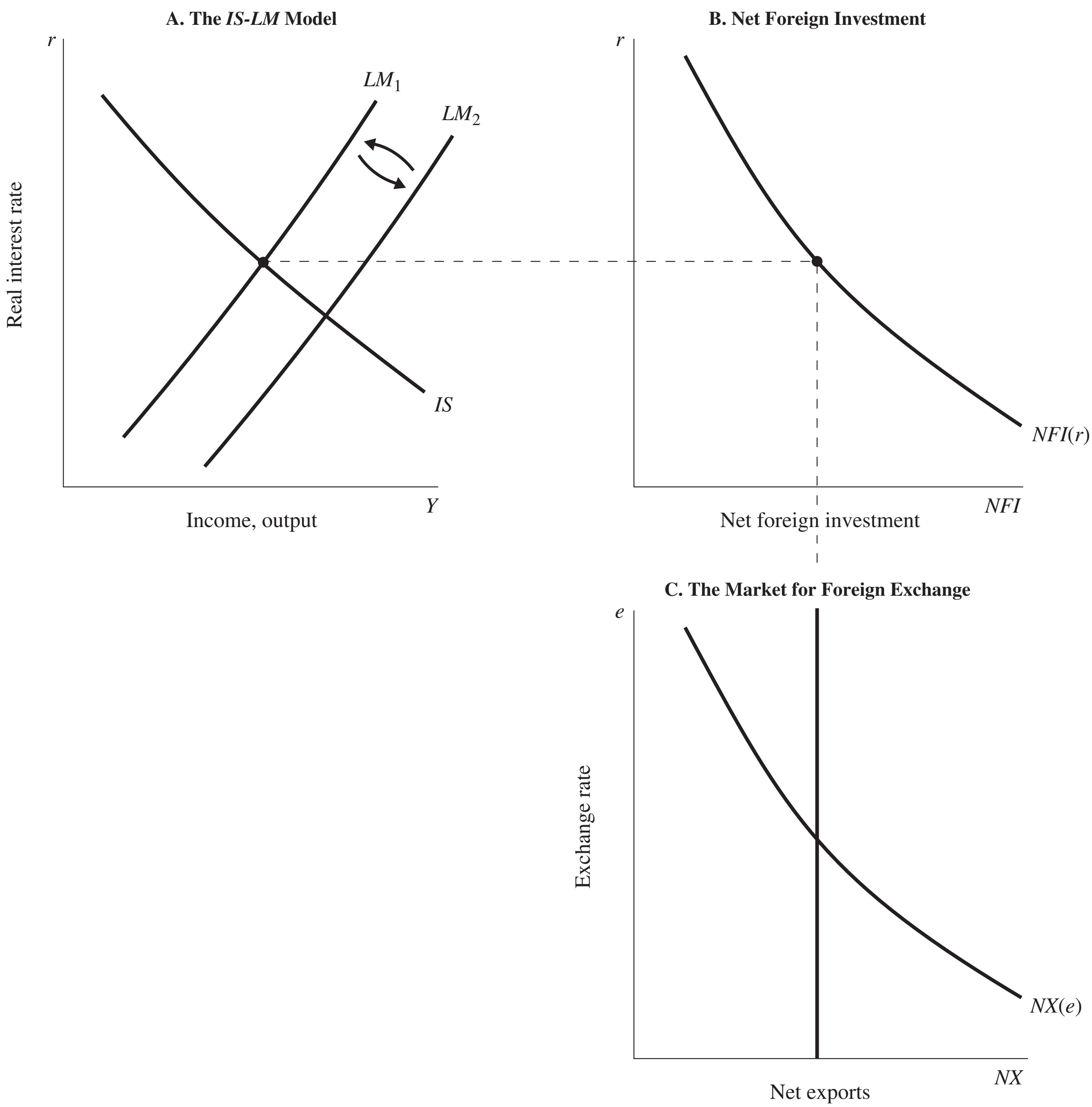
This effect is the same as in a small open economy.

Figure 12–33



b. A monetary expansion tends to shift the *LM* curve to the right, lowering the interest rate [panel (A) in Figure 12–34]. This tends to increase *NFI* and cause the exchange rate to depreciate [see panels (B) and (C)]. To avoid this depreciation, the central bank must buy its currency and sell foreign exchange. This reduces the money supply and shifts the *LM* curve back to its original position. As in the model of a small open economy, monetary policy is ineffectual under a fixed exchange rate.

Figure 12–34



CHAPTER 13 Aggregate Supply

Questions for Review

1. In this chapter we looked at three models of the short-run aggregate supply curve. All three models attempt to explain why, in the short run, output might deviate from its long-run "natural rate"—the level of output that is consistent with the full employment of labor and capital. All three models result in an aggregate supply function in which output deviates from its natural rate $\overline{Y}$ when the price level deviates from the expected price level:

$$Y = \overline{Y} + \alpha(P - P^e).$$

The first model is the sticky-wage model. The market failure is in the labor market, since nominal wages do not adjust immediately to changes in labor demand or supply—that is, the labor market does not clear instantaneously. Hence, an unexpected increase in the price level causes a fall in the real wage (W/P). The lower real wage induces firms to hire more labor, and this increases the amount of output they produce.

The second model is the imperfect-information model. As in the worker-misperception model, this model assumes that there is imperfect information about prices. Here, though, it is not workers in the labor market who are fooled: it is suppliers of goods who confuse changes in the price level with changes in relative prices. If a producer observes the nominal price of the firm's good rising, the producer attributes some of the rise to an increase in relative price, even if it is purely a general price increase. As a result, the producer increases production.

The third model is the sticky-price model. The market imperfection in this model is that prices in the goods market do not adjust immediately to changes in demand conditions—the goods market does not clear instantaneously. If the demand for a firm's goods falls, it responds by reducing output, not prices.

2. In this chapter, we argued that in the short run, the supply of output depends on the natural rate of output and on the difference between the price level and the expected price level. This relationship is expressed in the aggregate-supply equation:

$$Y = \overline{Y} + \alpha(P - P^e).$$

The Phillips curve is an alternative way to express aggregate supply. It provides a simple way to express the tradeoff between inflation and unemployment implied by the short-run aggregate supply curve. The Phillips curve posits that inflation π depends on the expected inflation rate π^e, on cyclical unemployment $u - u^n$, and on supply shocks ϵ:

$$\pi = \pi^e - \beta(u - u^n) + \epsilon.$$

Both equations tell us the same information in a different way: both imply a connection between real economic activity and *unexpected* changes in prices.

3. Inflation is inertial because of the way people form expectations. It is plausible to assume that people's expectations of inflation depend on recently observed inflation. These expectations then influence the wages and prices that people set. For example, if prices have been rising quickly, people will expect them to continue to rise quickly. These expectations will be built into the contracts people set, so that actual wages and prices will rise quickly.

4. *Demand-pull inflation* results from high aggregate demand: the increase in demand "pulls" prices and output up. *Cost-push inflation* comes from adverse supply shocks that push up the cost of production—for example, the increases in oil prices in the mid- and late-1970s.

   The Phillips curve tells us that inflation depends on expected inflation, the difference between unemployment and its natural rate, and a shock ϵ:

$$\pi = \pi^e - \beta(u - u^n) + \epsilon.$$

   The term "$-\beta(u - u^n)$" is the demand-pull inflation, since if unemployment is below its natural rate ($u < u^n$), inflation rises. The supply shock ϵ is the cost-push inflation.

5. The Phillips curve relates the inflation rate to the expected inflation rate and to the difference between unemployment and its natural rate. So one way to reduce inflation is to have a recession, raising unemployment above its natural rate. It is possible to bring inflation down without a recession, however, if we can costlessly reduce *expected* inflation.

   According to the rational-expectations approach, people optimally use all of the information available to them in forming their expectations. So to reduce expected inflation, we require, first, that the plan to reduce inflation be announced before people form expectations (e.g., before they form wage agreements and price contracts); and second, that those setting wages and prices believe that the announced plan will be carried out. If both requirements are met, then expected inflation will fall immediately and without cost, and this in turn will bring down actual inflation.

6. One way in which a recession might raise the natural rate of unemployment is by affecting the process of job search, increasing the amount of frictional unemployment. For example, workers who are unemployed lose valuable job skills. This reduces their ability to find jobs after the recession ends because they are less desirable to firms. Also, after a long period of unemployment, individuals may lose some of their desire to work, and hence search less hard.

   Second, a recession may affect the process that determines wages, increasing wait unemployment. Wage negotiations may give a greater voice to "insiders," those who actually have jobs. Those who become unemployed become "outsiders." If the smaller group of insiders cares more about high real wages and less about high employment, then the recession may permanently push real wages above the equilibrium level and raise the amount of wait unemployment.

   This permanent impact of a recession on the natural rate of unemployment is called *hysteresis*.

Problems and Applications

1. In the sticky-wage model, we assumed that the wage did not adjust immediately to changes in the labor market. This resulted in an upward-sloping aggregate supply curve with the form

$$Y = \overline{Y} + \alpha(P - P^e).$$

   In this problem, we consider the effect of allowing these contracts to be indexed for inflation.

   a. In the simple sticky-wage model, the nominal wage W equals the desired real wage ω times the expected price level P^e:

$$W = \omega P^e.$$

Full indexing, however, makes the nominal wage depend on the *actual* price level. That is, the contract specifies the desired real wage ω, and the nominal wage adjusts fully to changes in the price level. As a result,

$$W = \omega P,$$

or

$$W/P = \omega.$$

This means that unexpected price changes do not affect the real wage and, hence, do not affect the amount of labor used or the amount of output produced. The aggregate supply schedule is thus vertical at $Y = \overline{Y}$.

b. If there is partial indexing, then the aggregate supply curve will be steeper than it is without indexing, although it will not be vertical. In the sticky-wage model, an unexpected increase in the price level reduces the real wage W/P, since the nominal wage W is unaffected. With partial indexing, the increase in the price level causes an increase in the nominal wage. Since the indexing is only partial, the nominal wage increases by less than the price level does, so the real wage falls. This causes firms to use more labor and increase production. However, the real wage does not fall as much as it does without indexing, so output does not rise as much.

In effect, this is like making the parameter α smaller in the equation for aggregate supply. That is, output fluctuations become less responsive to surprises in the price level.

2. In this question, we examine two special cases of the sticky-price model developed in this chapter. In the sticky-price model, all firms have a desired price p that depends on the overall level of prices P as well as the level of aggregate demand $Y - \overline{Y}$. We wrote this as

$$p = P + a(Y - \overline{Y}).$$

There are two types of firms. A proportion $(1 - s)$ of the firms have flexible prices and set prices using the above equation. The remaining proportion s of the firms have sticky prices—they announce their prices in advance based on the economic conditions that they expect in the future. We assume that these firms expect output to be at its natural rate, so $(Y^e - \overline{Y}^e) = 0$. Hence, these firms set their prices equal to the expected price level:

$$p = P^e.$$

The overall price level is a weighted average of the prices set by the two types of firms:

$$P = sP^e + (1 - s)[P + a(Y - \overline{Y})].$$

Rearranging:

$$P = P^e + [a(1 - s)/s](Y - \overline{Y}).$$

a. If no firms have flexible prices, then $s = 1$. The above equation tells us that

$$P = P^e.$$

That is, the aggregate price level is fixed at the expected price level: the aggregate supply curve is horizontal in the short run, as assumed in Chapter 9.

b. If desired relative prices do not depend at all on the level of output, then $a = 0$ in the equation for the price level. Once again, we find $P = P^e$: the aggregate supply curve is horizontal in the short run, as assumed in Chapter 9.

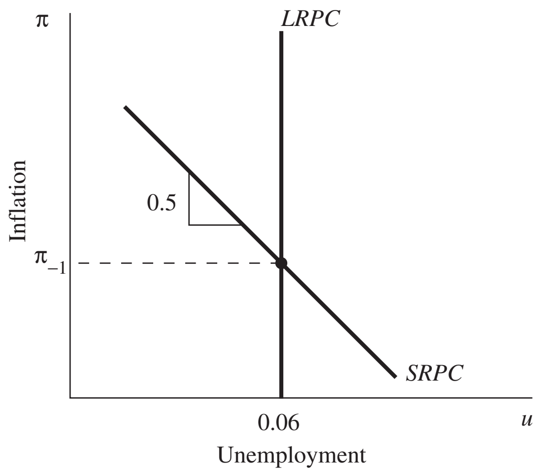
3. The economy has the Phillips curve:

$$\pi = \pi_{-1} - 0.5(u - 0.06).$$

a. The natural rate of unemployment is the rate at which the inflation rate does not deviate from the expected inflation rate. Here, the expected inflation rate is just last period's actual inflation rate. Setting the inflation rate equal to last period's inflation rate, that is, $\pi = \pi_{-1}$, we find that $u = 0.06$. Thus, the natural rate of unemployment is 6 percent.

b. In the short run (that is, in a single period) the expected inflation rate is fixed at the level of inflation in the previous period, π_{-1}. Hence, the short-run relationship between inflation and unemployment is just the graph of the Phillips curve: it has a slope of –0.5, and it passes through the point where $\pi = \pi_{-1}$ and $u = 0.06$. This is shown in Figure 13–1. In the long run, expected inflation equals actual inflation, so that $\pi = \pi_{-1}$, and output and unemployment equal their natural rates. The long-run Phillips curve thus is vertical at an unemployment rate of 6 percent.

Figure 13–1



c. To reduce inflation, the Phillips curve tells us that unemployment must be above its natural rate of 6 percent for some period of time. We can write the Phillips curve in the form

$$\pi - \pi_{-1} = 0.5(u - 0.06).$$

Since we want inflation to fall by 5 percentage points, we want $\pi - \pi_{-1} = -0.05$. Plugging this into the left-hand side of the above equation, we find

$$-0.05 = -0.5(u - 0.06).$$

We can now solve this for u:

$$u = 0.16.$$

Hence, we need 10 percentage point-years of cyclical unemployment above the natural rate of 6 percent.

Okun's law says that a change of 1 percentage point in unemployment translates into a change of 2 percentage points in GDP. Hence, an increase in unemployment of 10 percentage points corresponds to a fall in output of 20 percentage points. The sacrifice ratio is the percentage of a year's GDP that must be forgone to reduce inflation by 1 percentage point. Dividing the 20 percentage-point decrease in GDP by the 5 percentage-point decrease in inflation, we find that the sacrifice ratio is 20/5 = 4.

d. One scenario is to have very high unemployment for a short period of time. For example, we could have 16 percent unemployment for a single year. Alternatively, we could have a small amount of cyclical unemployment spread out over a long period of time. For example, we could have 8 percent unemployment for 5 years. Both of these plans would bring the inflation rate down from 10 percent to 5 percent, although at different speeds.

4. The cost of reducing inflation comes from the cost of changing people's expectations about inflation. If expectations can be changed costlessly, then reducing inflation is also costless. Algebraically, the Phillips curve tells us that

$$\pi = \pi^e - \beta(u - u^n).$$

If the government can lower expected inflation π^e to the desired level of inflation, then there is no need for unemployment to rise above its natural rate.

According to the rational-expectations approach, people form expectations about inflation using all of the information that is available to them. This includes information about current policies in effect. If everyone *believes* that the government is committed to reducing inflation, then expected inflation will immediately fall. In terms of the Phillips curve, π^e falls immediately with little or no cost to the economy. That is, the sacrifice ratio will be very small.

On the other hand, if people *do not* believe that the government will carry out its intentions, then π^e remains high. Expectations will not adjust because people are skeptical that the government will follow through on its plans.

Thus, according to the rational-expectations approach, the cost of reducing inflation depends on how resolute and credible the government is. An important issue is how the government can make its commitment to reducing inflation more credible. One possibility, for example, is to appoint people who have a reputation as inflation fighters. A second possibility is to have Congress pass a law requiring the Federal Reserve to lower inflation. Of course, people might expect the Fed to ignore this law, or expect Congress to change the law later. A third possibility is to pass a constitutional amendment limiting monetary growth. People might rationally believe that a constitutional amendment is relatively difficult to change.

5. In this question we consider several implications of rational expectations—the assumption that people optimally use all of the information available to them in forming their expectations—for the models of sticky wages and sticky prices that we considered in this chapter. Both of these models imply an aggregate supply curve in which output varies from its natural rate only if the price level varies from its expected level:

$$Y = \overline{Y} + \alpha(P - P^e).$$

This aggregate supply curve means that monetary policy can affect real GDP only by affecting $(P - P^e)$—that is, causing an unexpected change in the price level.

a. Only unanticipated changes in the money supply can affect real GDP. Since people take into account all of the information available to them, they already take into account the effects of anticipated changes in money when they form their expectations of the price level P^e. For example, if people expect the money supply to increase by 10 percent and it actually does increase by 10 percent, then there is no effect on output since there is no price surprise—$(P - P^e) = 0$. On the other hand, suppose the Fed increases the money supply more than expected, so that prices increase by 15 percent when people expect them to increase by only 10 percent. Since $P > P^e$, output rises. But it is only the unanticipated part of money growth that increases output.

b. The Fed often tries to stabilize the economy by offsetting shocks to output and unemployment. For example, it might increase the money supply during recessions in an attempt to stimulate the economy, and it might reduce the money supply during booms in an attempt to slow it down. The Fed can only do this by surprising people about the price level: during a recession, they want prices to be higher than expected, and during booms, they want prices to be lower than expected. If people have rational expectations, however, they will *expect* the Fed to respond this way. So if the economy is in a boom, people expect the Fed to reduce the money supply; in a recession, people expect the Fed to increase the money supply. In either case, it is impossible for the Fed to cause $(P - P^e)$ to vary systematically from zero. Since people take into account the systematic, anticipated movements in money, the effect on output of systematic, active policy is exactly the same as a policy of keeping the money supply constant.

c. If the Fed sets the money supply after people set wages and prices, then the Fed can use monetary policy systematically to stabilize output. The assumption of rational expectations means that people use all of the information available to them in forming expectations about the price level. This includes information about the state of the economy and information about how the Fed will respond to this state. This does not mean that people *know* what the state of the economy will be, nor do they know exactly how the Fed will act: they simply make their best guess.

   As time passes, the Fed learns information about the economy that was unknown to those setting wages and prices. At this point, since contracts have already set these wages and prices, people are stuck with their expectations P^e. The Fed can then use monetary policy to affect the actual price level P, and hence can affect output systematically.

6. In this model, the natural rate of unemployment is an average of the unemployment rates in the past two years. Hence, if a recession raises the unemployment rate in some year, then the natural rate of unemployment rises as well. This means that the model exhibits hysteresis: short-term cyclical unemployment affects the long-term natural rate of unemployment.

a. The natural rate of unemployment might depend on recent unemployment for at least two reasons, suggested by theories of hysteresis. First, recent unemployment rates might affect the level of frictional unemployment. Unemployed workers lose job skills and find it harder to get jobs; also, unemployed workers might lose some of their desire to work, and hence search less hard for a job. Second, recent unemployment rates might affect the level of wait unemployment. If labor negotiations give a greater voice to "insiders" than "outsiders," then the insiders might push for high wages at the expense of jobs. This will be especially true in industries in which negotiations take place between firms and unions.

b. If the Fed seeks to reduce inflation permanently by 1 percentage point, then the Phillips curve tells us that in the first period we require

$$\pi_1 - \pi_0 = -1 = -0.5(u_1 - u_1^n),$$

or

$$(u_1 - u_1^n) = 2.$$

That is, we require an unemployment rate 2 percentage points above the original natural rate u_1^n. Next period, however, the natural rate will rise as a result of the cyclical unemployment. The new natural rate u_2^n will be

$$\begin{aligned} u_2^n &= 0.5[u_1 + u_0] \\ &= 0.5[(u_1^n + 2) + u_1^n] \\ &= u_1^n + 1. \end{aligned}$$

Hence, the natural rate of unemployment rises by 1 percentage point. If the Fed wants to keep inflation at its new level, then unemployment in period 2 must equal the new natural rate u_2^n. Hence,

$$u_2 = u_1^n + 1.$$

In every subsequent period, it remains true that the unemployment rate must equal the natural rate. This natural rate never returns to its original level: we can show this by deriving the sequence of unemployment rates:

$$u_3 = (1/2)u_2 + (1/2)u_1 = u_1^n + 1\text{-}1/2$$

$$u_4 = (1/2)u_3 + (1/2)u_2 = u_1^n + 1\text{-}1/4$$

$$u_5 = (1/2)u_4 + (1/2)u_3 = u_1^n + 1\text{-}3/8.$$

Unemployment always remains above its original natural rate. In fact, we can show that it is always *at least* 1 percent above its original natural rate. Thus, to reduce inflation by 1 percentage point, unemployment rises above its original level by 2 percentage points in the first year, and by 1 or more percentage points in every year after that.

c. Because unemployment is always higher than it started, output is always lower than it would have been. Hence, the sacrifice ratio is infinite.

d. Without hysteresis, we found that there was a short-run tradeoff but no long-run tradeoff between inflation and unemployment. With hysteresis, we find that there *is* a long-run tradeoff between inflation and unemployment: to reduce inflation, unemployment must rise permanently.

7. a. The natural rate of output is determined by the production function, $\overline{Y} = F(\overline{K}, \overline{L})$. If a tax cut raises work effort, it increases $\overline{L}$ and, thus, increases the natural rate of output.

b. The tax cut shifts the aggregate demand curve outward for the normal reason that disposable income and, hence, consumption rise. It shifts the long-run aggregate supply curve outward because the natural rate of output rises.

The effect of the tax cut on the short-run aggregate supply (*SRAS*) curve depends on which model you use. The labor supply curve shifts outward because workers are willing to supply more labor at any given real wage while the labor demand curve is unchanged. In the sticky-wage or sticky-price models the quantity of labor is demand-determined, so the *SRAS* curve does not move. By contrast, the imperfect-information model assumes that the labor market is always in equilibrium, so the greater supply of labor leads to higher employment immediately: the *SRAS* shifts out.

c. If you are using the sticky-wage or sticky-price model, the short-run analysis is the same as the conventional model without the labor-supply effect. That is, output and prices both rise because aggregate demand rises while short-run aggregate supply is unchanged. If you use the imperfect-information model, short-run aggregate supply shifts outward, so that the tax cut is more expansionary and less inflationary than the conventional model. Figure 13–2 shows the effects in both models. Point A is the original equilibrium, point SW is the new equilibrium in the sticky-wage model, and point II is the new equilibrium in the imperfect-information model.

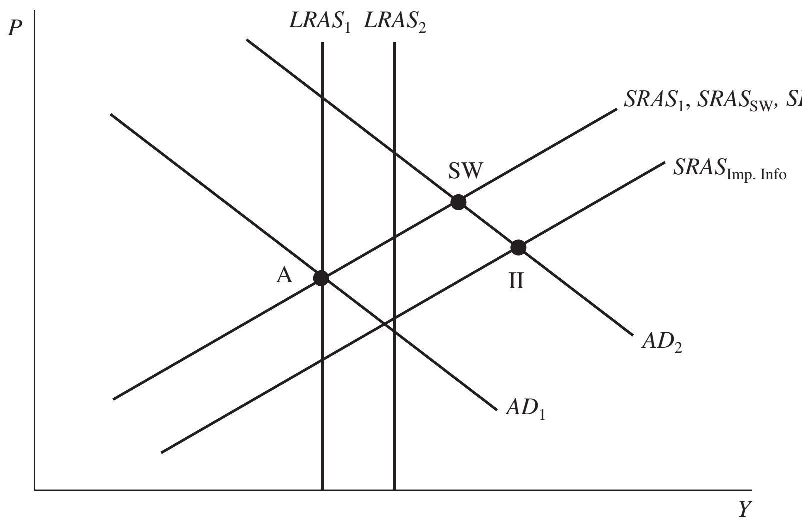
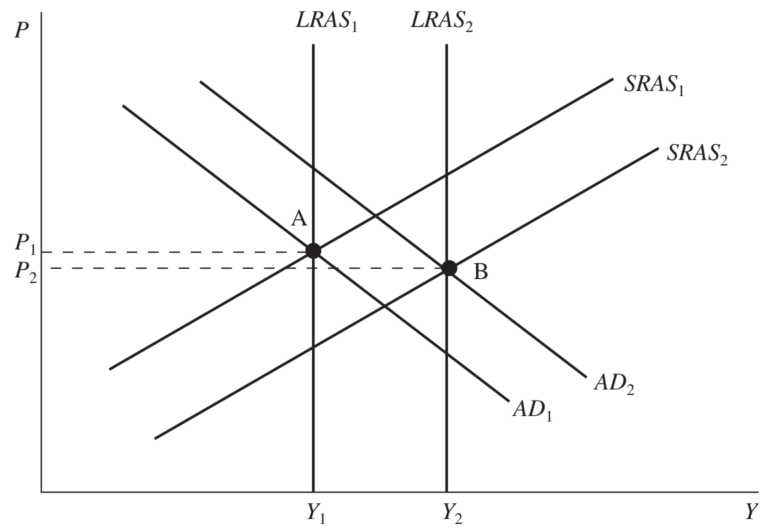


Figure 13–2

d. In contrast to the normal model, the tax cut raises long-run output by increasing the supply of labor. The policy's long-run effect on price is indeterminate, depending, in part on whether *SRAS* does, in fact, shift out. The change in the long-run equilibrium is shown in Figure 13–3.

Figure 13–3



8. In this quote, Alan Blinder argues that in low-inflation countries like the United States, the benefits of disinflation are small whereas the costs are large. That is, menu costs, shoeleather costs, and tax distortions simply do not add up to much, so eliminating inflation offers only small benefits. By contrast, the costs in terms of unemployment and lost output that are associated with lowering inflation are easily quantifiable and very large.

   The basic policy implication of these beliefs about the relative benefits and costs of disinflation is that policymakers should not tighten policy in order to lower inflation rates that are already relatively low. The statement leaves two other issues ambiguous. First, should policymakers concern themselves with rising inflation? Second, should policymakers concern themselves with making inflation more predictable around the level it has inherited? Blinder may feel that these issues should have little weight relative to output stabilization.

9. From the BLS web site (www.bls.gov), there are various ways to get the CPI data. The approach I took (in February 2002) was to follow the links to the Consumer Price Index, then I followed the links to the most recent (current) economic news release. This led me to a table of contents, and I followed the first link to Consumer Price Index Summary (the direct web address for that link was http://www.bls.gov/news.release/cpi.nr0.htm). Midway through that release was a table showing the "percentage change [for the] 12 months ending in December" for recent years. For the years 1996–2001, the table shows:

Year	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Overall CPI	3.3	1.7	1.6	2.7	3.4	1.6
CPI excluding food and energy	2.6	2.2	2.4	1.9	2.6	2.7

The overall CPI was clearly more volatile than the CPI excluding food and energy. For example, the overall CPI rose sharply from 1998 to 1999, and fell sharply from 2000 to 2001 (patterns that were not evident in the CPI excluding food and energy). The difference reflects shocks to the price of food and energy-especially energy prices, which are highly variable.

When energy prices, say, go down, the total CPI will rise less than the CPI excluding food and energy. This represents a supply shock, which shifts the aggregate supply curve and Phillips curve downward. In 1997 and 1998, for example, when the overall CPI rose less than the CPI excluding food and energy, we would expect that the decline in inflation did not necessarily require unemployment to rise above its natural rate. Indeed, unemployment was falling over that period.

More Problems and Applications to Chapter 13

1. a. The classical large open economy model (from the Appendix to Chapter 5) is similar to special case 2 in the text, except that it allows the interest rate to deviate from the world interest rate. That is, this is the special case where $P^e=P$, $L(i,Y)=(1/V)Y$, and CF=CF(r-r^*), with a non-infinitely elastic international capital flow. Because capital flows do not respond overwhelmingly to any differences between the domestic and world interest rates, these rates can, in fact, vary in this case.

   b. The Keynesian cross model of Chapter 10 is the special case where (i) the economy is closed, so that CF(r-r^*)=0 ; (ii) $I(r) = I$, so that investment is given exogenously; and (iii) α is infinite, so that the short-run aggregate-supply curve is horizontal. In this special case, output depends solely on the demand for goods and services.

   c. The IS-LM model for the large open economy (from the appendix to Chapter 12) is the special case where α is infinite and CF=CF(r-r^*) is not infinitely elastic. In this case, the short-run aggregate supply curve is horizontal, and capital flows do not respond too much to differences between the domestic and world interest rates.

CHAPTER 14 Stabilization Policy

Questions for Review

1. The inside lag is the time it takes for policymakers to recognize that a shock has hit the economy and to put the appropriate policies into effect. Once a policy is in place, the outside lag is the amount of time it takes for the policy action to influence the economy. This lag arises because it takes time for spending, income, and employment to respond to the change in policy.

   Fiscal policy has a long inside lag—for example, it can take years from the time a tax change is proposed until it becomes law. Monetary policy has a relatively short inside lag. Once the Fed decides a policy change is needed, it can make the change in days or weeks.

   Monetary policy, however, has a long outside lag. An increase in the money supply affects the economy by lowering interest rates, which, in turn, increases investment. But many firms make investment plans far in advance. Thus, from the time the Fed acts, it takes about six months before the effects show up in real GDP.

2. Both monetary and fiscal policy work with long lags. As a result, in deciding whether policy should expand or contract aggregate demand, we must predict what the state of the economy will be six months to a year in the future.

   One way economists try to forecast developments in the economy is with the index of leading indicators. It comprises 11 data series that often fluctuate in advance of the economy, such as stock prices, the number of building permits issued, the value of orders for new plants and equipment, and the money supply.

   A second way forecasters look ahead is with models of the economy. These large-scale computer models have many equations, each representing a part of the economy. Once we make assumptions about the path of the exogenous variables—taxes, government spending, the money supply, the price of oil, and so forth—the models yield predictions about the paths of unemployment, inflation, output, and other endogenous variables.

3. The way people respond to economic policies depends on their expectations about the future. These expectations depend on many things, including the economic policies that the government pursues. The Lucas critique of economic policy argues that traditional methods of policy evaluation do not adequately take account of the way policy affects expectations.

   For example, the sacrifice ratio—the number of percentage points of GDP that must be forgone to reduce inflation by 1 percentage point—depends on individuals' expectations of inflation. We cannot simply assume that these expectations will remain constant, or will adjust only slowly, no matter what policies the government pursues; instead, these expectations will depend on what the Fed does.

4. A person's view of macroeconomic history affects his or her view of whether macroeconomic policy should play an active role or a passive role. If one believes that the economy has experienced many large shocks to aggregate supply and aggregate demand, and if policy has successfully insulated the economy from these shocks, then the case for active policy is clear. Conversely, if one believes that the economy has experienced few large shocks, and if the fluctuations we observe can be traced to inept economic policy, then the case for passive policy is clear.

5. The problem of time inconsistency arises because expectations of future policies affect how people act today. As a result, policymakers may want to announce today the policy they intend to follow in the future, in order to influence the expectations held by private decisionmakers. Once these private decisionmakers have acted on their expectations, the policymakers may be tempted to renege on their announcement.

   For example, your professor has an incentive to announce that there will be a final exam in your course, so that you study and learn the material. On the morning of the exam, when you have already studied and learned all the material, the professor might be tempted to cancel the exam so that he or she does not have to grade it.

   Similarly, the government has an incentive to announce that it will not negotiate with terrorists. If terrorists believe that they have nothing to gain by kidnapping hostages, then they will not do so. However, once hostages are kidnapped, the government faces a strong temptation to negotiate and make concessions.

   In monetary policy, suppose the Fed announces a policy of low inflation, and everyone believes the announcement. The Fed then has an incentive to raise inflation, because it faces a favorable tradeoff between inflation and unemployment.

   The problem with situations in which time inconsistency arises is that people are led to distrust policy announcements. Then students do not study for their exams, terrorists kidnap hostages, and the Fed faces an unfavorable tradeoff. In these situations, a rule that commits the policymaker to a particular policy can sometimes help the policymaker achieve his or her goals—students study, terrorists do not take hostages, and inflation remains low.

6. One policy rule that the Fed might follow is to allow the money supply to grow at a constant rate. Monetarist economists believe that most large fluctuations in the economy result from fluctuations in the money supply; hence, a rule of steady money growth would prevent these large fluctuations.

   A second policy rule is a nominal GDP target. Under this rule, the Fed would announce a planned path for nominal GDP. If nominal GDP were below this target, for example, the Fed would increase money growth to stimulate aggregate demand. An advantage of this policy rule is that it would allow monetary policy to adjust to changes in the velocity of money.

   A third policy rule is a target for the price level. The Fed would announce a planned path for the price level and adjust the money supply when the actual price level deviated from its target. This rule makes sense if one believes that price stability is the primary goal of monetary policy.

7. There are at least three objections to a balanced-budget rule for fiscal policy, that is, a rule preventing the government from spending more than it receives in tax revenue.

   First, budget deficits or surpluses can help to stabilize the economy. In a recession, for example, taxes automatically fall and transfers automatically rise. These tend both to stabilize the economy and to raise the budget into deficit.

   Second, budget deficits or surpluses allow the government to smooth tax rates across years, allowing the government to avoid large swings in tax rates from one year to the next. To keep tax rates smooth, the government should run deficits when income is unusually low, as in a recession, or when expenditures are unusually high, as in wartime.

   Third, budget deficits can be used to shift a tax burden from current to future generations. If the current generation fights a war to maintain freedom, future generations benefit. By running deficits to pay for the war, future generations then help pay for the war.

Problems and Applications

1. Suppose the economy has a Phillips curve

$$u = u^n - \alpha(\pi - \pi^e).$$

As usual, this implies that if inflation is lower than expected, then unemployment rises above its natural rate, and there is a recession. Similarly, if inflation is higher than expected, then unemployment falls below its natural rate, and there is a boom. Also, suppose that the Democratic party always follows a policy of high money growth and high inflation (call it π^D), whereas the Republican party always follows a policy of low money growth and low inflation (call it π^R).

a. The pattern of the political business cycle we observe depends on the inflation rate people expect at the beginning of each term. If expectations are perfectly rational and contracts can be adjusted immediately when a new party comes into power, then there will be no political business cycle pattern to unemployment. For example, if the Democrats win the coin flip, people immediately expect high inflation. Because $\pi = \pi^D = \pi^e$, the Democrats' monetary policy will have no effect on the real economy. We do observe a political business cycle pattern to inflation, in which Democrats have high inflation and Republicans have low inflation.

Now suppose that contracts are long enough that nominal wages and prices cannot be adjusted immediately. Before the result of the coin flip is known, there is a 50-percent chance that inflation will be high and a 50-percent chance that inflation will be low. Thus, at the beginning of each term, if people's expectations are rational, they expect an inflation rate of

$$\pi^e = 0.5\pi^D + 0.5\pi^R.$$

If Democrats win the coin toss, then $\pi > \pi^e$ initially, and unemployment falls below its natural rate. Hence, there is a boom at the beginning of Democratic terms. Over time, inflation rises to π^D, and unemployment returns to its natural rate.

If Republicans win, then inflation is lower than expected, and unemployment rises above its natural rate. Hence, there is a recession at the beginning of Republican terms. Over time, inflation falls to π^R, and unemployment returns to its natural rate.

b. If the two parties take turns, then there will be no political business cycle to unemployment, since everyone knows which party will be in office, so everyone knows whether inflation will be high or low. Even long-lasting contracts will take the actual inflation rate into account, since all future inflation rates are known with certainty. Inflation will alternate between a high level and a low level, depending on which party is in power.

2. There is a time-inconsistency problem with an announcement that new buildings will be exempt from rent-control laws. Before new housing is built, a city has an incentive to promise this exemption: landlords then expect to receive high rents from the new housing they provide. Once the new housing has been built, however, a city has an incentive to renege on its promise not to extend rent control. That way, many tenants gain while a few landlords lose. The problem is that builders might expect the city to renege on its promise; as a result, they may not build new buildings.

3. The Federal Reserve web site (www.federalreserve.gov) has many items that are relevant to a macroeconomics course. For example, following the links to "Monetary Policy" (http://www.federalreserve.gov/policy.htm) take you to material from the Federal Open Market Committee meetings and to testimony given by the Federal Reserve Chairman twice a year to Congress. Other links take you to speeches or testimony by the Chairman or members of the Board of Governors of the Federal Reserve System. Note that the web site also contains many items that are not related to macroeconomics. (For example, if you check the "Press Release" link on the web site, you are likely to find many items that concern regulatory matters, since the Federal Reserve plays an important role in regulating the banking system.)

More Problems and Applications to Chapter 14

1. a. In the model so far, nothing happens to the inflation rate when the natural rate of unemployment changes.

   b. The new loss function is

$$L(u, \pi) = u^2 + \gamma\pi^2.$$

The first step is to solve for the Fed's choice of inflation, for any given inflationary expectations. Substituting the Phillips curve into the loss function, we find:

$$L(u, \pi) = [u^{n} - \alpha(\pi - \pi^{e})]^2 + \gamma\pi^2.$$

We now differentiate with respect to inflation π, and set this first-order condition equal to zero:

$$dL/d\pi = 2\alpha^2(\pi - \pi^{e}) - 2\alpha u^{n} + 2\,\gamma\pi = 0$$

or,

$$\pi = (\alpha^2\pi^{e} + \alpha u^{n})/(\alpha^2 + \gamma).$$

Of course, rational agents understand that the Fed will choose this level of inflation. Expected inflation equals actual inflation, so the above equation simplifies to:

$$\pi = \alpha u^{n}/\gamma.$$

   c. When the natural rate of unemployment rises, the inflation rate also rises. Why? The Fed's dislike for a marginal increase in unemployment now rises as unemployment rises. Hence, private agents know that the Fed has a greater incentive to inflate when the natural rate is higher. Hence, the equilibrium inflation rate also rises.

   d. Appointing a conservative central banker means that γ rises. Hence, the equilibrium inflation rate falls. What happens to unemployment depends on how quickly inflationary expectations adjust. If they adjust immediately, then there is no change in unemployment, which remains at the natural rate. If expectations adjust slowly, however, then, from the Phillips curve, the fall in inflation causes unemployment to rise above the natural rate.

CHAPTER 15 Government Debt

Questions for Review

1. What is unusual about U.S. fiscal policy since 1980 is that government debt increased sharply during a period of peace and prosperity. Over the course of U.S. history, the indebtedness of the federal government relative to GDP has varied substantially. Historically, the debt–GDP ratio generally increases sharply during major wars and falls slowly during peacetime. The 1980s and 1990s are the only instance in U.S. history of a large increase in the debt–GDP ratio during peacetime.
2. Many economists project increasing budget deficits and government debt over the next several decades because of changes in the age profile of the population. Life expectancy has steadily increased, and birth rates have fallen. As a result, the elderly are becoming a larger share of the population. As more people become eligible for "entitlements" of Social Security and Medicare, government spending will rise automatically over time. Without changes in tax and expenditure policies, government debt will also rise sharply.
3. Standard measures of the budget deficit are imperfect measures of fiscal policy for at least four reasons. First, they do not correct for the effects of inflation. The measured deficit should equal the change in the government's real debt, not the change in the nominal debt. Second, such measures do not offset changes in government liabilities with changes in government assets. To measure the government's overall indebtedness, we should subtract government assets from government debt. Hence, the budget deficit should be measured as the change in debt minus the change in assets. Third, standard measures omit some liabilities altogether, such as the pensions of government workers and accumulated future Social Security benefits. Fourth, they do not correct for the effects of the business cycle.
4. Public saving is the difference between taxes and government purchases, so a debt-financed tax cut reduces public saving by the full amount that taxes fall. The tax cut also increases disposable income. According to the traditional view, since the marginal propensity to consume is between zero and one, both consumption and private saving increase. Because consumption rises, private saving increases by less than the amount of the tax cut. National saving is the sum of public and private saving; because public saving falls by more than private saving increases, national saving falls.
5. According to the Ricardian view, a debt-financed tax cut does not stimulate consumption because it does not raise permanent income—forward-looking consumers understand that government borrowing today means higher taxes in the future. Because the tax cut does not change consumption, households save the extra disposable income to pay for the future tax liability that the tax cut implies: private saving increases by the full amount of the tax cut. This increase in private saving exactly offsets the decrease in public saving associated with the tax cut. Therefore, the tax cut has no effect on national saving.
6. Which view of government debt you hold depends on how you think consumers behave. If you hold the traditional view, then you believe that a debt-financed tax cut stimulates consumer spending and lowers national saving. You might believe this for several reasons. First, consumers may be shortsighted or irrational, so that they think their permanent income has increased even though it has not. Second, consumers may face binding borrowing constraints, so that they are only able to consume their current income. Third, consumers may expect that the implied tax liability will fall on future

generations, and these consumers may not care enough about their children to leave them a bequest to offset this tax liability.

If you hold the Ricardian view, then you believe that the preceding objections are not important. In particular, you believe that consumers have the foresight to see that government borrowing today implies future taxes to be levied on them or their descendants. Hence, a debt-financed tax cut gives consumers transitory income that eventually will be taken back. As a result, consumers will save the extra income they receive in order to offset that future tax liability.

7. The level of government debt might affect the government's incentives regarding money creation because the government debt is specified in nominal terms. A higher price level reduces the real value of the government's debt. Hence, a high level of debt might encourage the government to print money in order to raise the price level and reduce the real value of its debt.

Problems and Applications

1. The budget deficit is defined as government purchases minus government revenues. Selling the Liberty Bell to Taco Bell would raise revenue for the U.S. government and, hence, reduce the deficit. A smaller budget deficit would lead the government to borrow less, and as a result the measured national debt would fall.

   If the United States adopted capital budgeting, the net national debt would be defined as the assets of the government (its schools, armies, parks, and so forth) minus the liabilities of the government (principally outstanding public debt). By selling the Liberty Bell the government would be reducing its assets by the value of the Liberty Bell and reducing its liabilities by its purchase price. Assuming Taco Bell paid a fair price, these reductions would be the same amount and the net national debt would be unchanged.

   Before you worry too much about the Taco Liberty Bell, you might want to notice that this ad appeared on April Fools Day.

2. Here is one possible letter:

   Dear Senator:

   In my previous letter, I assumed that a tax cut financed by government borrowing would stimulate consumer spending. Many economists make this assumption because it seems sensible that if people had more current income, then they would consume more. As a result of this increase in consumption, national saving would fall.

   Ricardian economists argue that the seemingly sensible assumption that I made is incorrect. Although a debt-financed tax cut would increase current disposable income, it would also imply that at some point in the future, the government must raise taxes to pay off the debt and accumulated interest. As a result, the tax cut would merely give consumers a transitory increase in income that would eventually be taken back. If consumers understand this, then they would know that their permanent, or lifetime, resources had not changed. Hence, the tax cut would have no effect on consumption, and households would save all of their extra disposable income to pay for the future tax liability. Because there would be no effect on consumption, there would also be no effect on national saving.

   If national saving did not change, then as pointed out by the prominent economist you heard from yesterday, the budget deficit would not have the effects I listed. In particular, output, employment, foreign debt, and interest rates would be unaffected in both the short run and the long run. The tax cut would have no effect on economic well-being.

   There are several reasons the Ricardian argument may fail. First, consumers might not be rational and forward-looking: they may not fully comprehend that the current tax cut means a future tax increase. Second, some people may face constraints on their borrowing: in essence, the tax cut would give these taxpayers a loan that they are unable to obtain now. Third, consumers may expect the implied future taxes to fall not on them, but on future generations whose consumption they do not care about.

Your committee must decide how you think consumers would behave in response to this debt-financed tax cut. In particular, would they consume more, or not?

Your faithful servant,
CBO Economist.

3. a. We will assume that the life-cycle model of Chapter 15 holds and that people want to keep consumption as smooth as possible. This implies that the effect on consumption of a temporary change in income will be spread out over a person's entire remaining life. We will also assume for simplicity that the interest rate is zero.

Consider a simple example. Let T be the amount of the one-time, temporary tax levied on the young, and let B be the amount of the one-time benefit paid to the old, where $B = T$. If a typical elderly person has 10 years left to live, then the temporary benefit increases the present consumption of the elderly by $B/10$. If a typical worker has 30 years left to live, then the increase in taxes decreases their present consumption by $T/30$. Aggregate consumption changes by an amount

$$\begin{aligned} \Delta C &= B/10 - T/30 \\ &= B/15. \end{aligned}$$

The transfer of wealth to the elderly causes a net increase in consumption and, therefore, a decrease in saving. This happens because the elderly increase consumption by more than the workers decrease it, because the elderly have fewer years left to live and thus have a higher marginal propensity to consume.

b. The answer to part (a) does depend on whether generations are altruistically linked. If generations are altruistically linked, then the elderly may not feel any better off because of the Social Security benefit, since the tax and benefit increase has no effect on a typical family's permanent income; it simply transfers resources from one generation of the family to another. If the elderly do not want to take advantage of this opportunity to consume at their children's expense, they may try to offset the effect of the tax increase on the young by giving them a gift or leaving a bequest. To the extent that this takes place, it mitigates the impact of the tax change on consumption and saving.

4. If generations are altruistically linked, generational accounting is not useful. Generational accounting looks at the lifetime income of different generations. If these generations are altruistically linked, however, what matters is the lifetime income of the entire family line, not the lifetime income of any particular generation. For example, an increase in the lifetime taxes of the young can be offset by an increase in bequests by the old.

If many consumers face binding borrowing constraints, then generational accounting can be useful, but it is incomplete. For example, consider the following two policies that help the young. First, cut current taxes, but keep future Social Security benefits unchanged. Second, keep current taxes unchanged, but raise future Social Security benefits. These two policies may be equivalent from the point of view of generational accounting, which looks at the combined effect of the policies on the generation. If the young face binding borrowing constraints, however, then the two policies are quite different. In particular, the first policy helps the young more than the second policy does.

5. A rule requiring a cyclically adjusted balanced budget has the potential to overcome, at least partially, the first two objections to a balanced-budget rule that were raised in this chapter. First, this rule allows the government to run countercyclical fiscal policy in order to stabilize the economy. That is, the government can run deficits during recessions, when taxes automatically fall and expenditures automatically rise. These automatic stabilizers affect the deficit but not the cyclically adjusted deficit. Second, this rule allows the government to smooth tax rates across years when

income is especially low or high—it is not necessary to raise tax rates in recessions or to cut them in booms.

On the other hand, this rule only partially overcomes these two objections, since the government can only run a deficit of a certain size, which might not be big enough. Also, a cyclically adjusted balanced budget does not allow the government to smooth tax rates across years when *expenditure* is especially high or low, as in times of war or peace. (We might take account of this by allowing an exemption from the balanced budget rule in special circumstances such as war.) This rule does not allow the government to overcome the third objection raised in the chapter, since the government cannot shift the burden of expenditure from one generation to another when this is warranted.

Finally, a serious problem with a rule requiring a balanced cyclically adjusted budget is that we do not directly *observe* this budget. That is, we need to estimate how far we are from full employment; then we need to estimate how expenditures and taxes would differ if we were at this full-employment level. None of these estimates can be made precisely.

6. The Congressional Budget Office (www.cbo.gov) regularly provides budget forecasts. For example, on February 10, 2002, the web site had prominent links to "The Budget and Economic Outlook" as well as related studies. Based on the testimony of the Director of the CBO (from a link off the CBO home page, which took me to http://www.cbo.gov/showdoc.cfm?index=3275&sequence=0&from=7), the debt held by the public is projected to decline from 32.7 percent of GDP in 2001 to 7.4 percent by the end of 2012.

   Several assumptions are notable. First, the CBO assumes that so-called *discretionary* government spending (items such as defense, administration, and the like, amounting to about 1/3 of federal spending) will grow at only the rate of inflation. Since the overall economy generally grows faster than inflation, this implies that the CBO builds in a steady decline in federal spending relative to GDP. Second, the CBO assumes that the taxes in the future will be whatever legislation currently says they will be (i.e., the CBO does not take a stand on what changes legislators might pass in the future). Third, the CBO makes an educated guess about future output growth, now projected at 3.2 percent over the next decade.

   The CBO Director justifies these assumptions by noting that "CBO's baseline projections are intended to serve as a neutral benchmark against which to measure the effects of possible changes in tax and spending policies. They are designed to project federal revenues and spending under the assumption that current laws and policies remain unchanged. Thus, these projections will almost certainly differ from actual budget totals: the economy may not follow the path that CBO projects, and lawmakers are likely to alter the nation's tax and spending policies."

   It is probably reasonable to assume that policymakers will increase real spending on discretionary programs as the economy itself grows over time. They may also change taxes, although the direction is harder to predict. If the United States experiences a productivity slowdown, this will reduce output growth and hence growth in tax revenue; future government debt will be larger than currently projected.

CHAPTER 16 Consumption

Questions for Review

1. First, Keynes conjectured that the marginal propensity to consume—the amount consumed out of an additional dollar of income—is between zero and one. This means that if an individual's income increases by a dollar, both consumption and saving increase.

   Second, Keynes conjectured that the ratio of consumption to income—called the *average propensity to consume*—falls as income rises. This implies that the rich save a higher proportion of their income than do the poor.

   Third, Keynes conjectured that income is the primary determinant of consumption. In particular, he believed that the interest rate does not have an important effect on consumption.

   A consumption function that satisfies these three conjectures is

$$C = \overline{C} + cY.$$

   $\overline{C}$ is a constant level of "autonomous consumption," and Y is disposable income; c is the marginal propensity to consume, and is between zero and one.

2. The evidence that was consistent with Keynes's conjectures came from studies of household data and short time-series. There were two observations from household data. First, households with higher income consumed more and saved more, implying that the marginal propensity to consume is between zero and one. Second, higher-income households saved a larger fraction of their income than lower-income households, implying that the average propensity to consume falls with income.

   There were three additional observations from short time-series. First, in years when aggregate income was low, both consumption and saving were low, implying that the marginal propensity to consume is between zero and one. Second, in years with low income, the ratio of consumption to income was high, implying that the average propensity to consume falls as income rises. Third, the correlation between income and consumption seemed so strong that no variables other than income seemed important in explaining consumption.

   The first piece of evidence against Keynes's three conjectures came from the failure of "secular stagnation" to occur after World War II. Based on the Keynesian consumption function, some economists expected that as income increased over time, the saving rate would also increase; they feared that there might not be enough profitable investment projects to absorb this saving, and the economy might enter a long depression of indefinite duration. This did not happen.

   The second piece of evidence against Keynes's conjectures came from studies of long time-series of consumption and income. Simon Kuznets found that the ratio of consumption to income was stable from decade to decade; that is, the average propensity to consume did not seem to be falling over time as income increased.

3. Both the life-cycle and permanent-income hypotheses emphasize that an individual's time horizon is longer than a single year. Thus, consumption is not simply a function of current income.

   The life-cycle hypothesis stresses that income varies over a person's life; saving allows consumers to move income from those times in life when income is high to those times when it is low. The life-cycle hypothesis predicts that consumption should depend on both wealth and income, since these determine a person's lifetime resources. Hence, we expect the consumption function to look like

$$C = \alpha W + \beta Y.$$

In the short run, with wealth fixed, we get a “conventional” Keynesian consumption function. In the long run, wealth increases, so the short-run consumption function shifts upward, as shown in Figure 16–1.

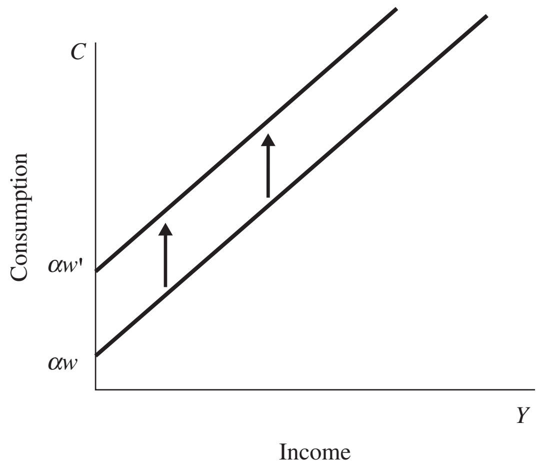


Figure 16–1

The permanent-income hypothesis also implies that people try to smooth consumption, though its emphasis is slightly different. Rather than focusing on the pattern of income over a lifetime, the permanent-income hypothesis emphasizes that people experience random and temporary changes in their income from year to year. The permanent-income hypothesis views current income as the sum of permanent income Y^p and transitory income Y^t. Milton Friedman hypothesized that consumption should depend primarily on permanent income:

$$C = \alpha Y^p.$$

The permanent-income hypothesis explains the consumption puzzle by suggesting that the standard Keynesian consumption function uses the wrong variable for income. For example, if a household has high transitory income, it will not have higher consumption; hence, if much of the variability in income is transitory, a researcher would find that high-income households had, on average, a lower average propensity to consume. This is also true in short time-series if much of the year-to-year variation in income is transitory. In long time-series, however, variations in income are largely permanent; therefore, consumers do not save any increases in income, but consume them instead.

4. Fisher's model of consumption looks at how a consumer who lives two periods will make consumption choices in order to be as well off as possible. Figure 16–2(A) shows the effect of an increase in second-period income if the consumer does not face a binding borrowing constraint. The budget constraint shifts outward, and the consumer increases consumption in both the first and the second period.

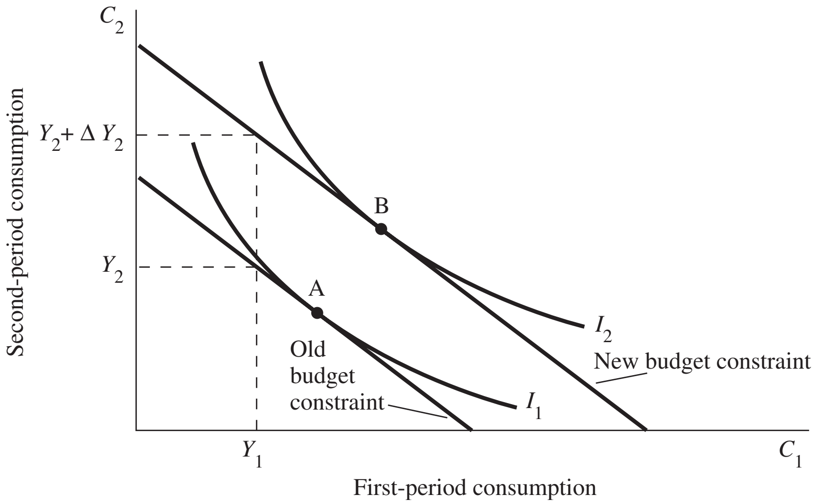


Figure 16–2A

Figure 16–2(B) shows what happens if there is a binding borrowing constraint. The consumer would like to borrow to increase first-period consumption but cannot. If income increases in the second period, the consumer is unable to increase first-period consumption. Therefore, the consumer continues to consume his or her entire income in each period. That is, for those consumers who would like to borrow but cannot, consumption depends only on current income.

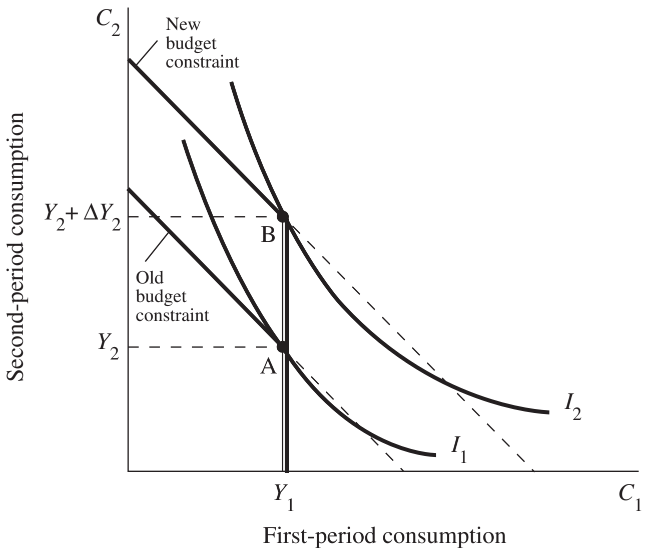


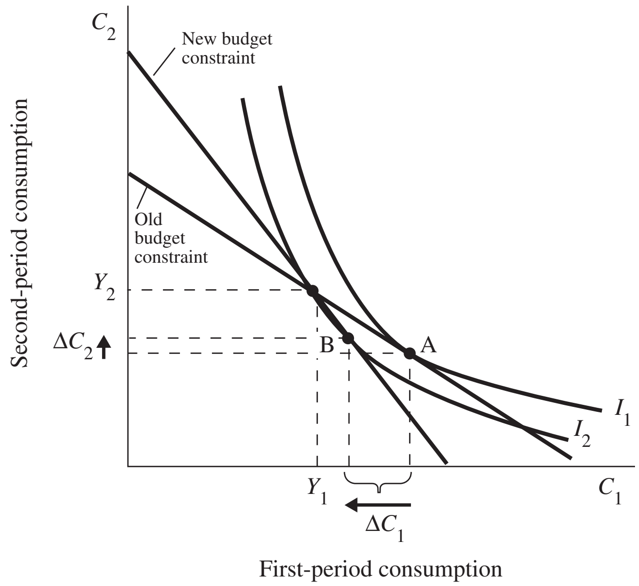
Figure 16–2B

5. The permanent-income hypothesis implies that consumers try to smooth consumption over time, so that current consumption is based on current expectations about lifetime income. It follows that changes in consumption reflect "surprises" about lifetime income. If consumers have rational expectations, then these surprises are unpredictable. Hence, consumption changes are also unpredictable.
6. Section 16.6 included several examples of time-inconsistent behavior, in which consumers alter their decisions simply because time passes. For example, a person may legitimately want to lose weight, but decide to eat a large dinner today and eat a small dinner tomorrow and thereafter. But the next day, they may once again make the same choice—eating a large dinner that day while promising to eat less on following days.

Problems and Applications

1. Figure 16–3 shows the effect of an increase in the interest rate on a consumer who borrows in the first period. The increase in the real interest rate causes the budget line to rotate around the point (Y_1, Y_2), becoming steeper.

Figure 16–3



We can break the effect on consumption from this change into an income and substitution effect. The income effect is the change in consumption that results from the movement to a different indifference curve. Because the consumer is a borrower, the increase in the interest rate makes the consumer worse off—that is, he or she cannot achieve as high an indifference curve. If consumption in each period is a normal good, this tends to reduce both C_1 and C_2.

The substitution effect is the change in consumption that results from the change in the relative price of consumption in the two periods. The increase in the interest rate makes second-period consumption relatively less expensive; this tends to make the consumer choose more consumption in the second period and less consumption in the first period.

On net, we find that for a borrower, first-period consumption falls unambiguously when the real interest rate rises, since both the income and substitution effects push in the same direction. Second-period consumption might rise or fall, depending on which effect is stronger. In Figure 16–3, we show the case in which the substitution effect is stronger than the income effect, so that C_2 increases.

2. a. We can use Jill's intertemporal budget constraint to solve for the interest rate:

$$C_1 + \frac{C_2}{1+r} = Y_1 + \frac{Y_2}{1+r}$$

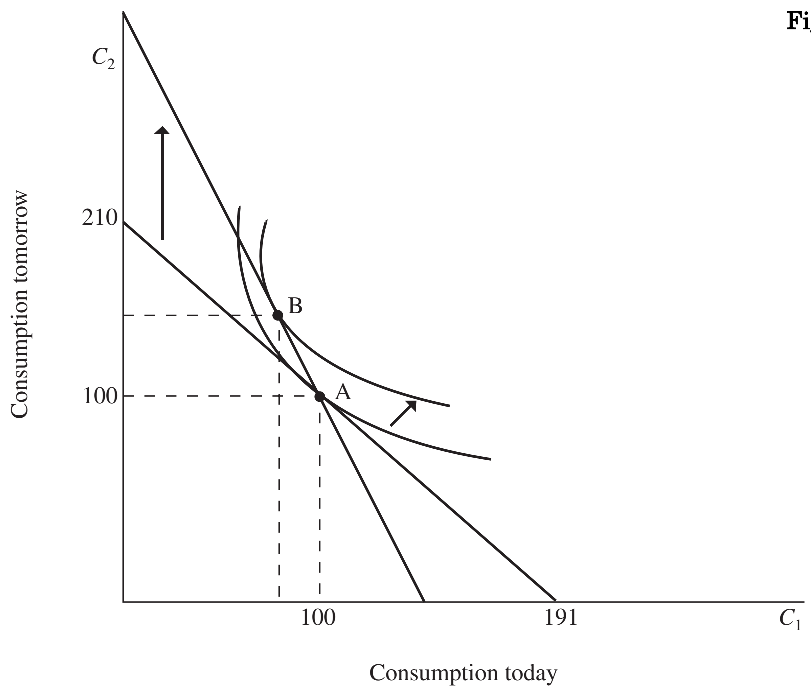
$$\$100 + \frac{\$100}{1+r} = \$0 + \frac{\$210}{1+r}$$

$$r = 10\%.$$

Jill borrowed \$100 for consumption in the first period and in the second period used her \$210 income to pay \$110 on the loan (principal plus interest) and \$100 for consumption.

b. The rise in interest rates leads Jack to consume less today and more tomorrow. This is because of the substitution effect: it costs him more to consume today than tomorrow, because of the higher opportunity cost in terms of forgone interest. This is shown in Figure 16–4.

Figure 16–4



By revealed preference we know Jack is better off: at the new interest rate he could still consume \$100 in each period, so the only reason he would change his consumption pattern is if the change makes him better off.

c. Jill consumes less today, while her consumption tomorrow can either rise or fall. She faces both a substitution effect and income effect. Because consumption today is more expensive, she substitutes out of it. Also, since all her income is in the second period, the higher interest rate raises her cost of borrowing and, thus, lowers her income. Assuming consumption in period one is a normal good, this provides an additional incentive for lowering it. Her new consumption choice is at point B in Figure 16–5.

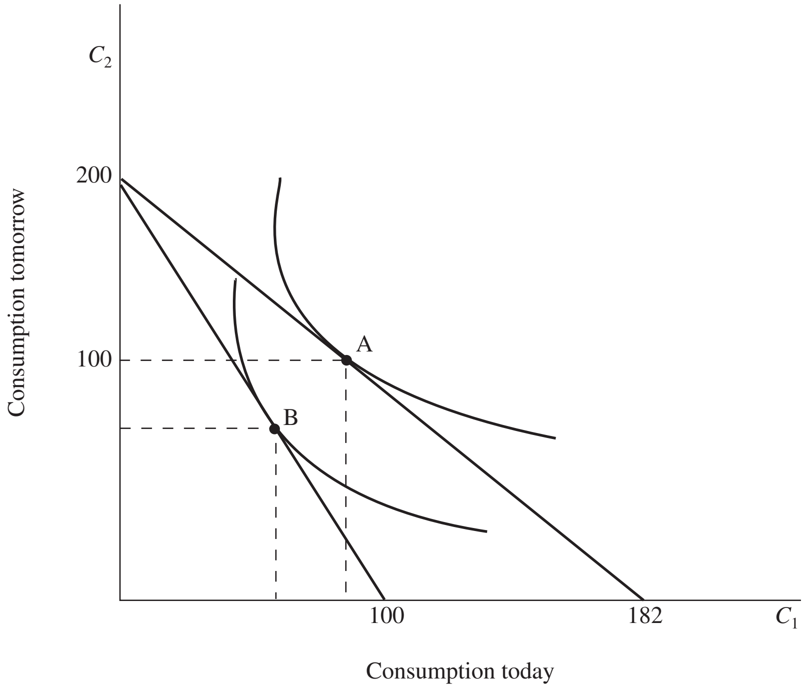


Figure 16–5

We know Jill is worse off with the higher interest rates because she could have consumed at point B before (by not spending all of her second-period money) but chose not to because point A had higher utility.

3. a. A consumer who consumes less than his income in period one is a saver and faces an interest rate r_s. His budget constraint is

$$C_1 + C_2/(1 + r_s) < Y_1 + Y_2/(1 + r_s).$$

b. A consumer who consumes more than income in period one is a borrower and faces an interest rate r_b. The budget constraint is

$$C_1 + C_2/(1 + r_b) < Y_1 + Y_2/(1 + r_b).$$

c. Figure 16–6 shows the two budget constraints; they intersect at the point (Y_1, Y_2), where the consumer is neither a borrower nor a lender. The shaded area represents the combinations of first-period and second-period consumption that the consumer can choose. To the left of the point (Y_1, Y_2), the interest rate is r_b.

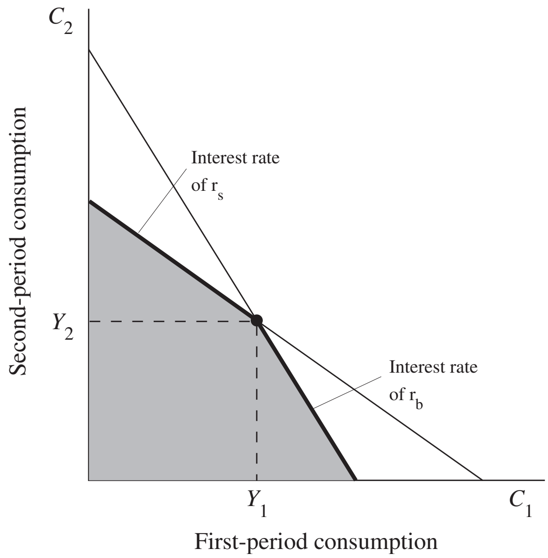


Figure 16–6

d. Figure 16–7 shows the three cases. Figure 16–7(A) shows the case of a saver for whom the indifference curve is tangent to the budget constraint along the line segment to the left of (Y_1, Y_2). Figure 16–7(B) shows the case of a borrower for whom the indifference curve is tangent to the budget constraint along the line segment to the right of (Y_1, Y_2). Finally, Figure 16–7(C) shows the case in which the consumer is neither a borrower nor a lender: the highest indifference curve the consumer can reach is the one that passes through the point (Y_1, Y_2).

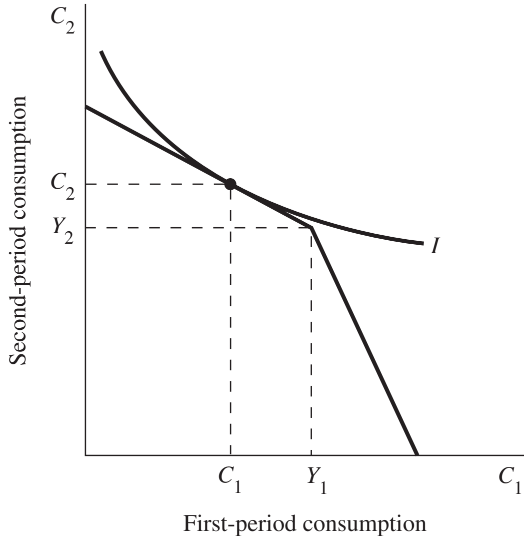


Figure 16–7A

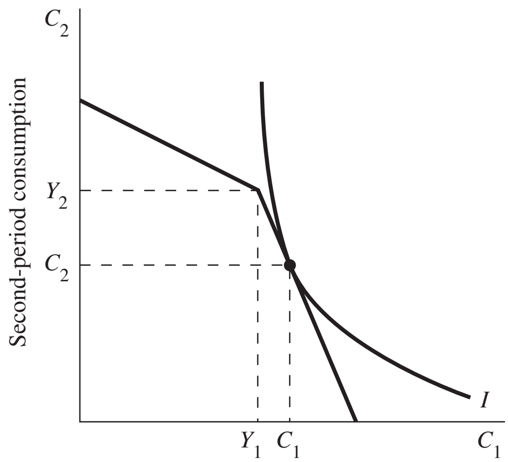


Figure 16–7B

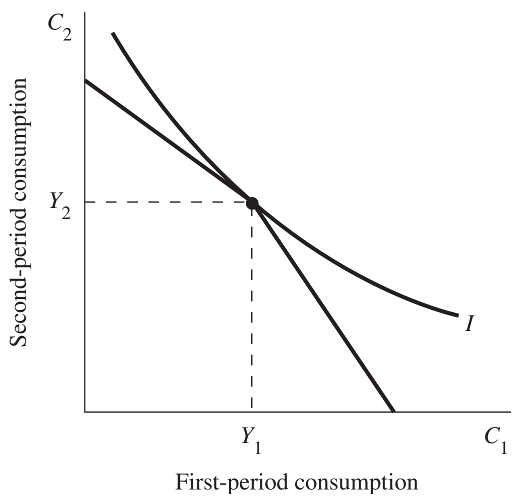


Figure 16–7C

e. If the consumer is a saver, then consumption in the first period depends on $[Y_1 + Y_2/(1 + r_s)]$—that is, income in both periods, Y_1 and Y_2, and the interest rate r_s. If the consumer is a borrower, then consumption in the first period depends on $[Y_1 + Y_2/(1 + r_b)]$—that is, income in both periods, Y_1 and Y_2, and the interest rate r_b. Note that borrowers discount future income more than savers.

If the consumer is neither a borrower nor a lender, then consumption in the first period depends just on Y_1.

4. The potency of fiscal policy to influence aggregate demand depends on the effect on consumption: if consumption changes a lot, then fiscal policy will have a large multiplier. If consumption changes only a little, then fiscal policy will have a small multiplier. That is, the fiscal-policy multipliers are higher if the marginal propensity to consume is higher.

a. Consider a two-period Fisher diagram. A temporary tax cut means an increase in first-period disposable income Y_1. Figure 16–8(A) shows the effect of this tax cut on a consumer who does not face a binding borrowing constraint, whereas Figure 16–8(B) shows the effect of this tax cut on a consumer who is constrained.

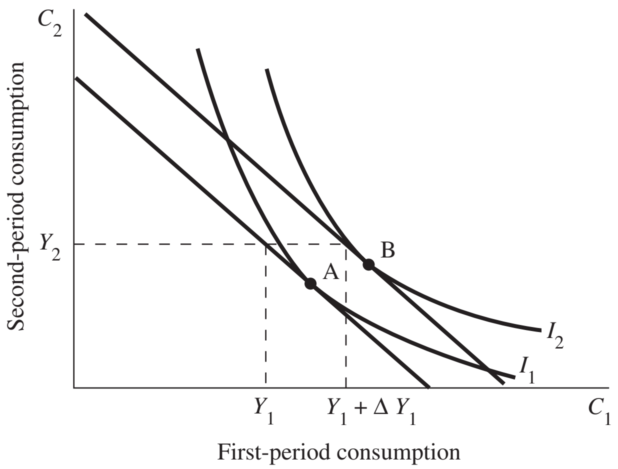


Figure 16–8A

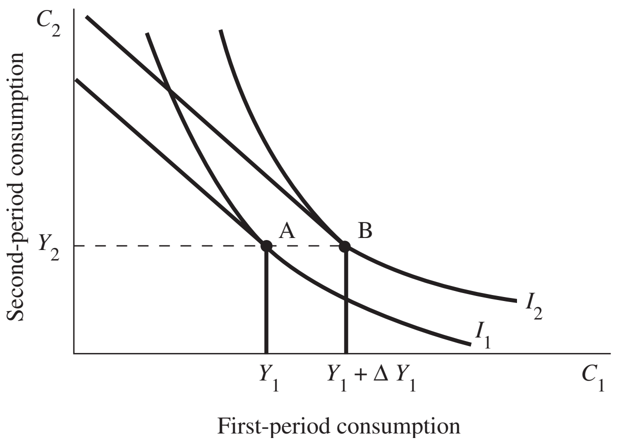


Figure 16–8B

The consumer with the constraint would have liked to get a loan to increase C_1, but could not. The temporary tax cut increases disposable income: as shown in the figure, the consumer's consumption rises by the full amount that taxes fall. The consumer who is constrained thus increases first-period consumption C_1 by more than the consumer who is not constrained—that is, the marginal propensity to consume is higher for a consumer who faces a borrowing constraint. Therefore, fiscal policy is more potent with binding borrowing constraints than it is without them.

b. Again, consider a two-period Fisher diagram. The announcement of a future tax cut increases Y_2. Figure 16–9(A) shows the effect of this tax cut on a consumer who does not face a binding borrowing constraint, whereas Figure 16–9(B) shows the effect of this tax cut on a consumer who is constrained.

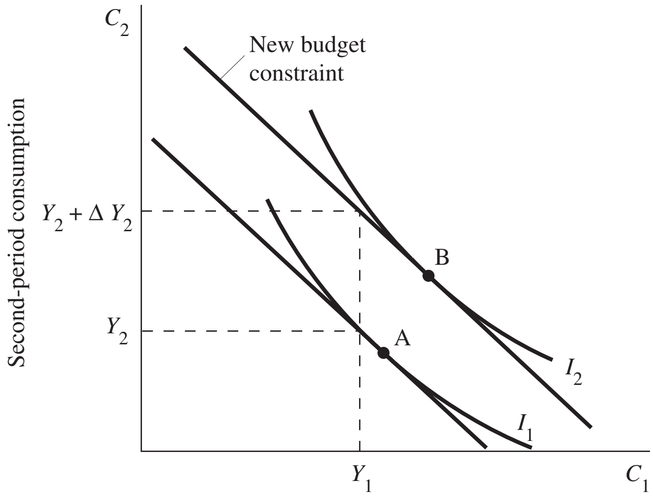


Figure 16–9A

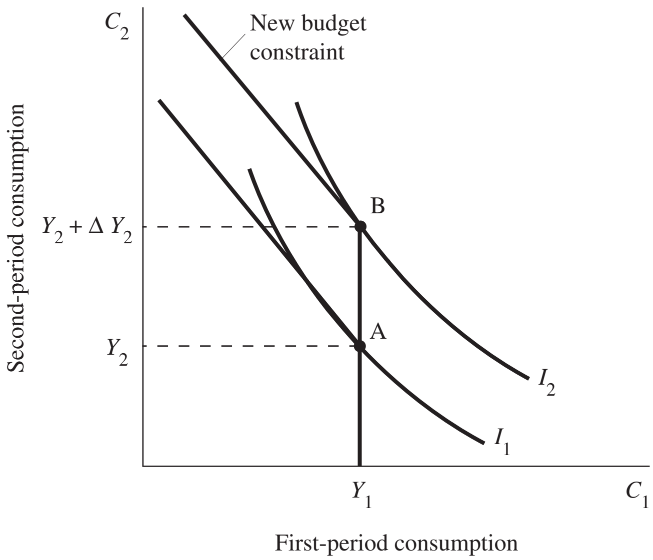


Figure 16–9B

The consumer who is not constrained immediately increases consumption C_1. The consumer who is constrained cannot increase C_1, because disposable income has not changed. Therefore, the announcement of a future tax cut has no effect on consumption or aggregate demand if consumers face binding borrowing constraints: fiscal policy is less potent.

5. In this question, we look at how income growth affects the pattern of consumption and wealth accumulation over a person's lifetime. For simplicity, we assume that the interest rate is zero and that the consumer wants as smooth a consumption path as possible.

a. Figure 16–10 shows the case in which the consumer can borrow. Income increases during the consumer's lifetime until retirement, when it falls to zero.

Desired consumption is level over the lifetime. Until year T_1, consumption is greater than income, so the consumer borrows. After T_1, consumption is less than income, so the consumer saves. This means that until T_1, wealth is negative and falling. After T_1, wealth begins to increase; after T_2, all borrowing is repaid, so wealth becomes positive. Wealth accumulation continues until retirement, when the consumer dissaves all wealth to finance consumption.

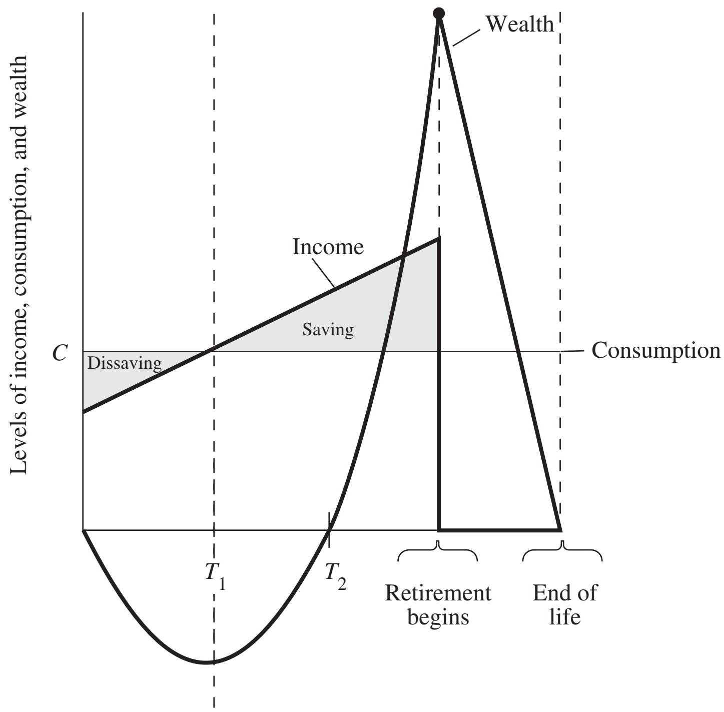


Figure 16–10

b. Figure 16–11 shows the case in which a borrowing constraint prevents the consumer from having negative wealth. Before T_1', the consumer would like to be borrowing, as in part (a), but cannot. Therefore, income is consumed and is neither saved nor borrowed. After T_1', the consumer begins to save for retirement, and lifetime consumption remains constant at C'.

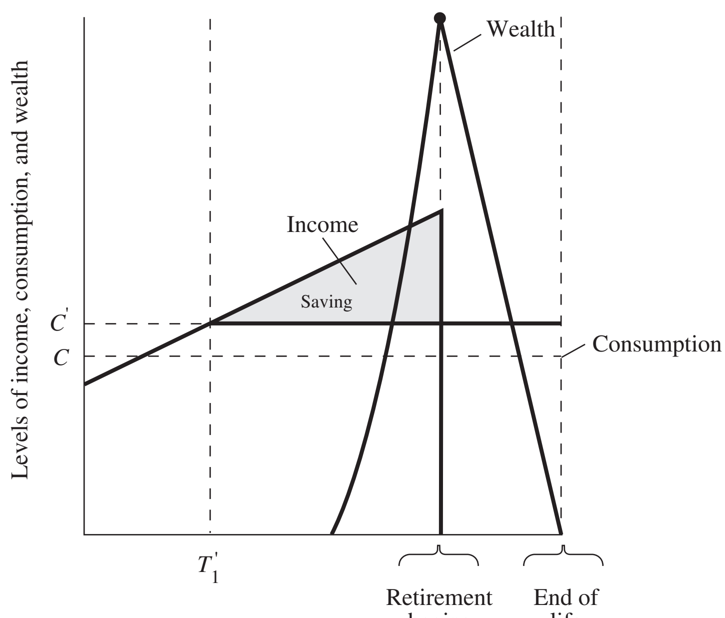


Figure 16–11

Note that C' is greater than C, and T_1' is greater than T_1, as shown. This is because in part (b), the consumer has lower consumption in the first part of life, so there are more resources left when there is no constraint—consumption will be higher.

6. The life-cycle model predicts that an important source of saving is that people save while they work to finance consumption after they retire. That is, the young save, and the old dissave. If the fraction of the population that is elderly will increase over the next 20 years, the life-cycle model predicts that as these elderly retire, they will begin to dissave their accumulated wealth in order to finance their retirement consumption: thus, the national saving rate should fall over the next 20 years.

7. In this chapter, we discussed two explanations for why the elderly do not dissave as rapidly as the life-cycle model predicts. First, because of the possibility of unpredictable and costly events, they may keep some precautionary saving as a buffer in case they live longer than expected or have large medical bills. Second, they may want to leave bequests to their children, relatives, or charities, so again, they do not dissave all of their wealth during retirement.

   If the elderly who do not have children dissave at the same rate as the elderly who do have children, this seems to imply that the reason for low dissaving is the precautionary motive; the bequest motive is presumably stronger for people who have children than for those who don't.

   An alternative interpretation is that perhaps having children does not increase desired saving. For example, having children raises the bequest motive, but it may also lower the precautionary motive: you can rely on your children in case of financial emergency. Perhaps the two effects on saving cancel each other.

8. If you are a fully rational and time-consistent consumer, you would certainly prefer the saving account that lets you take the money out on demand. After all, you get the same return on that account, but in unexpected circumstances (e.g., if you suffer an unexpected, temporary decline in income), you can use the funds in the account to finance your consumption. This is the kind of consumer in the intertemporal models of Irving Fisher, Franco Modigliani, and Milton Friedman.

   By contrast, if you face the "pull of instant gratification," you may prefer the account that requires a 30-day notification before withdrawals. In this way, you precommit yourself to not using the funds to satisfy a desire for instant gratification. This precommitment offers a way to overcome the time-inconsistency problem. That is, some people would like to save more, but at any particular moment, they face such a strong desire for instant gratification that they always choose to consume rather than save. This is the type of consumer in David Laibson's theory.

CHAPTER 17 Investment

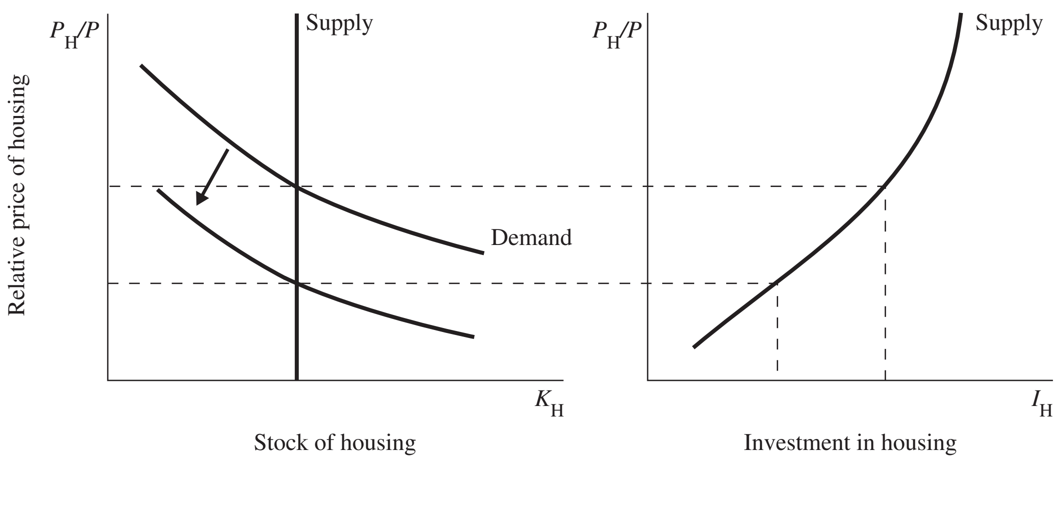
Questions for Review

1. In the neoclassical model of business fixed investment, firms will find it profitable to add to their capital stock if the real rental price of capital is greater than the cost of capital. The real rental price depends on the marginal product of capital, whereas the cost of capital depends on the real interest rate, the depreciation rate, and the relative price of capital goods.
2. Tobin's q is the ratio of the market value of installed capital to its replacement cost. Tobin reasoned that net investment should depend on whether q is greater or less than one. If q is greater than one, then the stock market values installed capital at more than it costs to replace. This creates an incentive to invest, because managers can raise the market value of their firms' stock by buying more capital. Conversely, if q is less than one, then the stock market values installed capital at less than its replacement cost. In this case, managers will not replace capital as it wears out.

   This theory provides an alternative way to express the neoclassical model of investment. If the marginal product of capital exceeds the cost of capital, for example, then installed capital earns profits. These profits make the firms desirable to own, which raises the market value of these firms' stock, implying a high value of q. Hence, Tobin's q captures the incentive to invest because it reflects the current and expected future profitability of capital.
3. An increase in the interest rate leads to a decrease in residential investment because it reduces housing demand. Many people take out mortgages to purchase their homes, and a rise in the interest rate increases the cost of the loan. Even for people who do not borrow to buy a home, the interest rate measures the opportunity cost of holding their wealth in housing rather than putting it in the bank.

   Figure 17–1 shows the effect of an increase in the interest rate on residential investment. The higher interest rate shifts the demand curve for housing down, as shown in Figure 17–1(A). This causes the relative price of housing to fall, and as shown in Figure 17–1(B), the lower relative price of housing decreases residential investment.

Figure 17–1



4. Reasons why firms might hold inventories include:
   a. **Production smoothing**. A firm may hold inventories to smooth the level of production over time. Rather than adjust production to match fluctuations in sales, it may be cheaper to produce goods at a constant rate. Hence, the firm increases inventories when sales are low and decreases them when sales are high.
   b. **Inventories as a factor of production**. Holding inventories may allow a firm to operate more efficiently. For example, a retail store may hold inventories so that it always has goods available to show customers. A manufacturing firm may hold inventories of spare parts to reduce the time an assembly line is shut down when a machine breaks.
   c. **Stock-out avoidance**. A firm may hold inventories to avoid running out of goods when sales are unexpectedly high. Firms often have to make production decisions before knowing how much customers will demand. If demand exceeds production and there are no inventories, the good will be out of stock for a period, and the firm will lose sales and profit.
   d. **Work in process**. Many goods require a number of steps in production and, therefore, take time to produce. When a product is not completely finished, its components are counted as part of a firm's inventory.

Problems and Applications

1. In answering parts (a) to (c), it is useful to recall the neoclassical investment function:

$$I = I_n[MPK - (P_K/P)(r + \delta)] + \delta K.$$

This equation tells us that business fixed investment depends on the marginal product of capital (MPK), the cost of capital $(P_K/P)(r + \delta)$, and the amount of depreciation of the capital stock (δK). Recall also that in equilibrium, the real rental price of capital equals the marginal product of capital.
   a. The rise in the real interest rate increases the cost of capital$(P_K/P)(r + \delta)$. Investment declines because firms no longer find it as profitable to add to their capital stock. Nothing happens immediately to the real rental price of capital, because the marginal product of capital does not change.
   b. If an earthquake destroys part of the capital stock, then the marginal product of capital rises because of diminishing marginal product. Hence, the real rental price of capital increases. Because the MPK rises relative to the cost of capital (which does not change), firms find it profitable to increase investment.
   c. If an immigration of foreign workers increases the size of the labor force, then the marginal product of capital and, hence, the real rental price of capital increase. Because the MPK rises relative to the cost of capital (which does not change), firms find it profitable to increase investment.

2. Recall the equation for business fixed investment:

$$I = I_n[MPK - (P_K/P)(r + \delta)] + \delta K.$$

This equation tells us that business fixed investment depends on the marginal product of capital, the cost of capital, and the amount of depreciation of the capital stock.

A one-time tax levied on oil reserves does not affect the MPK: the oil companies must pay the tax no matter how much capital they have. Because neither the benefit of owning capital (the MPK) nor the cost of capital are changed by the tax, investment does not change either.

If the firm faces financing constraints, however, then the amount it invests depends on the amount it currently earns. Because the tax reduces current earnings, it also reduces investment.

3. a. There are several reasons why investment might depend on national income. First, from the neoclassical model of business fixed investment we know that an

increase in employment increases the marginal product of capital. Hence, if national income is high because employment increases, then the *MPK* is high, and firms have an incentive to invest. Second, if firms face financing constraints, then an increase in current profits increases the amount that firms are able to invest. Third, increases in income raise housing demand, which increases the price of housing and, therefore, the level of residential investment. Fourth, the accelerator model of inventories implies that when output rises, firms wish to hold more inventories; this may be because inventories are a factor of production or because firms wish to avoid stock-outs.

b. In the Keynesian cross model of Chapter 10, we assumed that $I = \bar{I}$. We found the government-purchases multiplier by considering an increase in government expenditure of ΔG. The immediate effect is an increase in income of ΔG. This increase in income causes consumption to rise by $MPC \times \Delta G$. This increase in consumption increases expenditure and income once again. This process continues indefinitely, so the ultimate effect on income is

$$\begin{aligned}\Delta Y &= \Delta G[1 + mpc + mpc^2 + mpc^3 + \ldots] \\ &= (1/(1 - MPC))\Delta G.\end{aligned}$$

Hence, the government spending multiplier we found in Chapter 10 is

$$\Delta Y/\Delta G = 1/(1 - MPC).$$

Now suppose that investment also depends on income, so that $I = \bar{I} + aY$. As before, an increase in government expenditure by ΔG initially increases income by ${}^3G$. This initial increase in income causes consumption to rise $MPC \times \Delta G$; now, it also causes investment to increase by $a\Delta G$. This increase in consumption and investment increases expenditure and income once again. The process continues until

$$\begin{aligned}\Delta Y &= \Delta G[1 + (mpc + a) + (mpc + a)^2 + (mpc + a)^3 + \ldots] \\ &= (1/(1 - MPC - a))\Delta G.\end{aligned}$$

Hence, the government-purchases multiplier becomes

$$\Delta Y/\Delta G = 1/(1 - MPC - a).$$

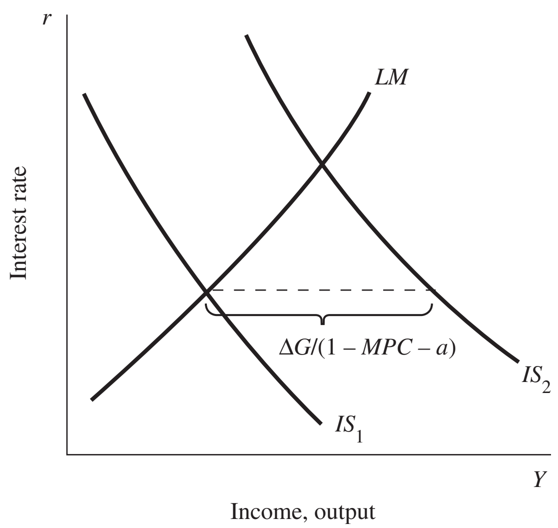
Proceeding the same way, we find that the tax multiplier becomes

$$\Delta Y/\Delta T = - MPC/(1 - MPC - a).$$

Note that the fiscal-policy multipliers are larger when investment depends on income.

c. The government-purchases multiplier in the Keynesian cross tells us how output responds to a change in government purchases, for a given interest rate. Therefore, it tells us how much the *IS* curve shifts out in response to a change in government purchases. If investment depends on both income and the interest rate, then we found in part (b) that the multiplier is larger, so that we know the *IS* curve shifts out farther than it does if investment depends on the interest rate alone. This is shown in Figure 17–2 by the shift from IS_1 to IS_2.

Figure 17–2



From the figure, it is clear that national income and the interest rate increase. Since income is higher, consumption is higher as well. We cannot tell whether investment rises or falls: the higher interest rate tends to make investment fall, whereas the higher national income tends to make investment rise.

In the standard model where investment depends only on the interest rate, an increase in government purchases unambiguously causes investment to fall. That is, government purchases "crowd out" investment. In this model, an increase in government purchases might instead increase investment in the short run through the temporary expansion in Y.

4. A stock market crash implies that the market value of installed capital falls. Tobin's q—the ratio of the market value of installed capital to its replacement cost—also falls. This causes investment and hence aggregate demand to fall.

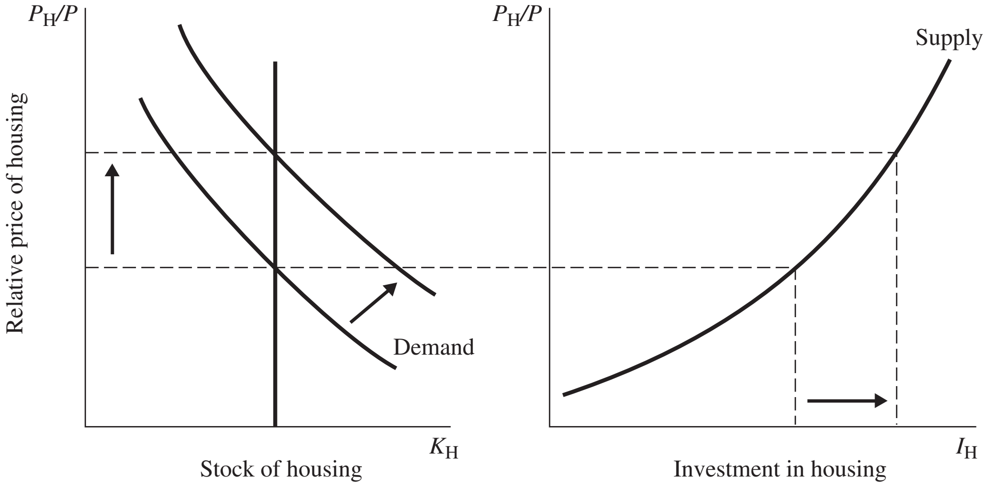
   If the Fed seeks to keep output unchanged, it can offset this aggregate-demand shock by running an expansionary monetary policy.

5. If managers think the opposition candidate might win, they may postpone some investments that they are considering. If they wait, and the opposition candidate is elected, then the investment tax credit reduces the cost of their investment. Hence, the campaign promise to implement an investment tax credit next year causes current investment to fall. This fall in investment reduces current aggregate demand and output: the recession deepens.

   Note that this deeper recession makes it more likely that voters vote for the opposition candidate instead of the incumbent, making it more likely that the opposition candidate wins.

6. a. In the 1970s, the baby-boom generation reached adulthood and started forming their own households. This implies that in our model of residential investment, demand for housing rose. As shown in Figure 17–3, this causes housing prices and residential investment to rise.

Figure 17–3

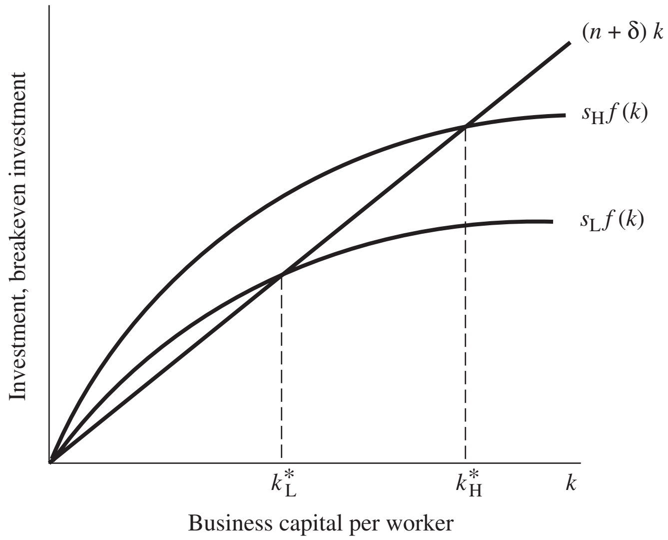


b. The *Economic Report of the President 1999* (Table B–7) reports that in 1970, the real price of housing—the ratio of the residential investment deflator to the GDP deflator—was 27.74/30.48, or 0.91. In 1980, this ratio had risen to 66.62/60.34, or 1.10. Thus, between 1970 and 1980 the real price of housing rose 21 percent. This finding is consistent with the prediction of our model.

7. Consider the Solow growth model from Chapters 4 and 5. The Solow model shows that the saving rate is a key determinant of the steady-state capital stock. If the tax laws encourage investment in housing but discourage investment in business capital, this implies that the fraction of output devoted to business investment is lower because of the tax consequences. Figure 17–4 shows the outcome of the Solow model for low and high saving rates. At the lower saving rate, business capital-per-worker and business output-per-worker is also lower. Thus, the tax system distorts the economy's choice of business output versus housing.

   An alternative way to see this effect is to think of the labor market. With less capital for each worker, the marginal product of labor is lower. Hence, in the long run, the real wage of workers is lower because of the distortions of the tax system.

Figure 17–4



CHAPTER 18 Money Supply and Money Demand

Questions for Review

1. In a system of fractional-reserve banking, banks create money because they ordinarily keep only a fraction of their deposits in reserve. They use the rest of their deposits to make loans. The easiest way to see how this creates money is to consider the balance sheets for three banks, as in Figure 18–1.

Figure 18–1

A. Balance Sheet — Firstbank Money Supply = $1,000

Assets		Liabilities	
Reserves	$1,000	Deposits	$1,000

B. Balance Sheet — Firstbank Money Supply = $1,800

Assets		Liabilities	
Reserves	$200	Deposits	$1,000
Loans	$800		

C. Balance Sheet — Secondbank Money Supply = $2440

Assets		Liabilities	
Reserves	$160	Deposits	$800
Loans	$640		

Suppose that people deposit the economy's supply of currency of $1,000 into Firstbank, as in Figure 18–1(A). Although the money supply is still $1,000, it is now in the form of demand deposits rather than currency. If the bank holds 100 percent of these deposits in reserve, then the bank has no influence on the money supply. Yet under a system of fractional-reserve banking, the bank need not keep all of its deposits in reserve; it must have enough reserves on hand so that reserves are available whenever depositors want to make withdrawals, but it makes loans with the rest of its deposits. If Firstbank has a reserve–deposit ratio of 20 percent, then it keeps $200 of the $1,000 in reserve and lends out the remaining $800. Figure 18–1(B) shows the balance sheet of Firstbank after $800 in loans have been made. By making these loans, Firstbank increases the money supply by $800. There are still $1,000 in demand deposits, but now borrowers also hold an additional $800 in currency. The total money supply equals $1,800.

Money creation does not stop with Firstbank. If the borrowers deposit their $800 of currency in Secondbank, then Secondbank can use these deposits to make loans. If Secondbank also has a reserve–deposit ratio of 20 percent, then it keeps $160 of the

\$800 in reserves and lends out the remaining \$640. By lending out this money, Secondbank increases the money supply by \$640, as in Figure 18–1(C). The total money supply is now \$2,440.

This process of money creation continues with each deposit and subsequent loans made. In the text, we demonstrated that each dollar of reserves generates ($\$1/rr$) of money, where rr is the reserve–deposit ratio. In this example, $rr = 0.20$, so the \$1,000 originally deposited in Firstbank generates \$5,000 of money.

2. The Fed influences the money supply through open-market operations, reserve requirements, and the discount rate. *Open-market operations* are the purchases and sales of government bonds by the Fed. If the Fed buys government bonds, the dollars it pays for the bonds increase the monetary base and, therefore, the money supply. If the Fed sells government bonds, the dollars it receives for the bonds reduce the monetary base and therefore the money supply. *Reserve requirements* are regulations imposed by the Fed that require banks to maintain a minimum reserve–deposit ratio. A decrease in the reserve requirements lowers the reserve–deposit ratio, which allows banks to make more loans on a given amount of deposits and, therefore, increases the money multiplier and the money supply. The *discount rate* is the interest rate that the Fed charges banks to borrow money. Banks borrow from the Fed if their reserves fall below the reserve requirements. A decrease in the discount rate makes it less expensive for banks to borrow reserves. Therefore, banks will be likely to borrow more from the Fed; this increases the monetary base and therefore the money supply.

3. To understand why a banking crisis might lead to a decrease in the money supply, first consider what determines the money supply. The model of the money supply we developed shows that

$$M = m \times B.$$

The money supply M depends on the money multiplier m and the monetary base B. The money multiplier can also be expressed in terms of the reserve–deposit ratio rr and the currency–deposit ratio cr. This expression becomes

$$M = \left[\frac{(cr + 1)}{(cr + rr)}\right] B.$$

This equation shows that the money supply depends on the currency–deposit ratio, the reserve–deposit ratio, and the monetary base.

A banking crisis that involved a considerable number of bank failures might change the behavior of depositors and bankers and alter the currency–deposit ratio and the reserve–deposit ratio. Suppose that the number of bank failures reduced public confidence in the banking system. People would then prefer to hold their money in currency (and perhaps stuff it in their mattresses) rather than deposit it in banks. This change in the behavior of depositors would cause massive withdrawals of deposits and, therefore, increase the currency–deposit ratio. In addition, the banking crisis would change the behavior of banks. Fearing massive withdrawals of deposits, banks would become more cautious and increase the amount of money they held in reserves, thereby increasing the reserve–deposit ratio. As the preceding formula for the money multiplier indicates, increases in both the currency–deposit ratio and the reserve–deposit ratio result in a decrease in the money multiplier and, therefore, a fall in the money supply.

4. Portfolio theories of money demand emphasize the role of money as a store of value. These theories stress that people hold money in their portfolio because it offers a safe nominal return. Therefore, portfolio theories suggest that the demand for money depends on the risk and return of money as well as all the other assets that people hold in their portfolios. In addition, the demand for money depends on total wealth because wealth measures the overall size of the portfolio.

In contrast, transactions theories of money demand stress the role of money as a medium of exchange. These theories stress that people hold money in order to make purchases. The demand for money depends on the cost of holding money (the interest rate) and the benefit (the ease of making transactions). Money demand, therefore, depends negatively on the interest rate and positively on income.

5. The Baumol–Tobin model analyzes how people trade off the costs and benefits of holding money. The benefit of holding money is convenience: people hold money to avoid making a trip to the bank every time they wish to purchase something. The cost of this convenience is the forgone interest they would have received had they left the money deposited in a savings account. If i is the nominal interest rate, Y is annual income, and F is the cost per trip to the bank, then the optimal number of trips to the bank is

$$N^* = \sqrt{\frac{iY}{2F}}$$

This formula reveals the following: As i increases, the optimal number of trips to the bank increases because the cost of holding money becomes greater. As Y increases, the optimal number of trips to the bank increases because of the need to make more transactions. As F increases, the optimal number of trips to the bank decreases because each trip becomes more costly.

Examining the optimal number of trips to the bank provides insight into average money holdings—that is, money demand. More frequent trips to the bank decrease the amount of money people hold, and less frequent trips increase this amount. We know that average money holding is $Y/(2N^*)$. By plugging this into the preceding expression for N^*, we find

$$\textit{Average Money Holding} = \sqrt{\frac{YF}{2i}}$$

Thus, the Baumol–Tobin model tells us that money demand depends positively on expenditure and negatively on the interest rate.

6. "Near money" refers to nonmonetary assets that have acquired some of the liquidity of money. For example, it used to be that assets held primarily as a store of value, such as mutual funds, were inconvenient to buy and sell. Today, mutual funds allow depositors to hold stocks and bonds and make withdrawals simply by writing checks from their accounts. The existence of near money complicates monetary policy by making the demand for money unstable. As a result, velocity of money becomes unstable, and the quantity of money gives faulty signals about aggregate demand.

Problems and Applications

1. The model of the money supply developed in Chapter 18 shows that

$$M = mB.$$

The money supply M depends on the money multiplier m and the monetary base B. The money multiplier can also be expressed in terms of the reserve–deposit ratio rr and the currency–deposit ratio cr. Rewriting the money supply equation:

$$M = \left[\frac{(cr + 1)}{(cr + rr)}\right] B.$$

This equation shows that the money supply depends on the currency–deposit ratio, the reserve–deposit ratio, and the monetary base.

To answer parts (a) through (c), we use the values for the money supply, the monetary base, the money multiplier, the reserve–deposit ratio, and the currency–deposit ratio from Table 18–1:

	August 1929	March 1933
Money supply	26.5	19.0
Monetary base	7.1	8.4
Money multiplier	3.7	2.3
Reserve–deposit ratio	0.14	0.21
Currency–deposit ratio	0.17	0.41

a. To determine what would happen to the money supply if the currency–deposit ratio had risen but the reserve–deposit ratio had remained the same, we need to recalculate the money multiplier and then plug this value into the money supply equation $M = mB$. To recalculate the money multiplier, use the 1933 value of the currency–deposit ratio and the 1929 value of the reserve–deposit ratio:

$$m = (cr_{1933} + 1)/(cr_{1933} + rr_{1929})$$
$$m = (0.41 + 1)/(0.41 + 0.14)$$
$$m = 2.56.$$

To determine the money supply under these conditions in 1933:

$$M_{1933} = mB_{1933}.$$

Plugging in the value for m just calculated and the 1933 value for B:

$$M_{1933} = 2.56 \times 8.4$$

$$M_{1933} = 21.504.$$

Therefore, under these circumstances, the money supply would have fallen from its 1929 level of 26.5 to 21.504 in 1933.

b. To determine what would have happened to the money supply if the reserve–deposit ratio had risen but the currency–deposit ratio had remained the same, we need to recalculate the money multiplier and then plug this value into the money supply equation $M = mB$. To recalculate the money multiplier, use the 1933 value of the reserve–deposit ratio and the 1929 value of the currency–deposit ratio:

$$m = (cr_{1929} + 1)/(cr_{1929} + rr_{1933})$$
$$m = (0.17 + 1)/(0.17 + 0.21)$$
$$m = 3.09.$$

To determine the money supply under these conditions in 1933:

$$M_{1933} = mB_{1933}.$$

Plugging in the value for m just calculated and the 1933 value for B:

$$M_{1933} = 3.09 \times 8.4$$
$$M_{1933} = 25.96.$$

Therefore, under these circumstances, the money supply would have fallen from its 1929 level of 26.5 to 25.96 in 1933.

c. From the calculations in parts (a) and (b), it is clear that the decline in the currency–deposit ratio was most responsible for the drop in the money multiplier and, therefore, the money supply.

2. a. The introduction of a tax on checks makes people more reluctant to use checking accounts as a means of exchange. Therefore, they hold more cash for transactions purposes, raising the currency–deposit ratio cr.

b. The money supply falls because the money multiplier, $\dfrac{cr + 1}{cr + rr}$, is decreasing in cr. Intuitively, the higher the currency–deposit ratio, the lower the proportion of the monetary base that is held by banks in the form of reserves and, hence, the less money banks can create.

c. The contraction of the money supply shifts the LM curve upward, raising interest rates and lowering output, as in Figure 18–2. This was not a very sensible action to take in 1932.

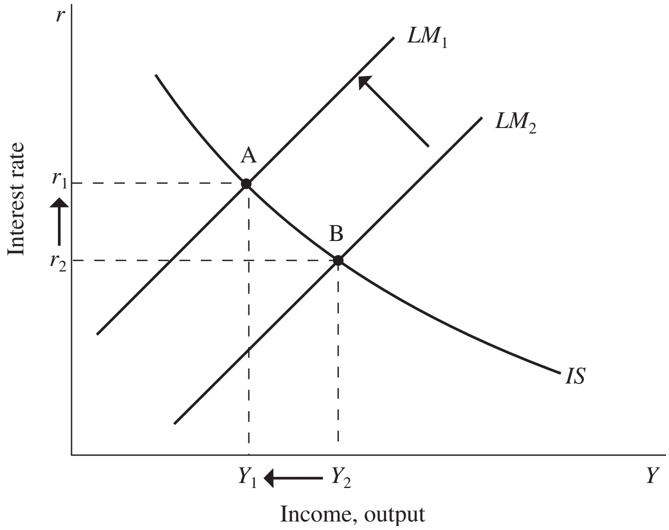


Figure 18–2

3. The epidemic of street crimes causes average cash holdings to fall and the number of trips to the bank to rise. In the Baumol–Tobin model, agents balance two costs: the fixed cost of a trip to the bank versus the cost of forgone interest from holding cash. The wave of street crime gives rise to a second cost of holding cash: it might be stolen. In particular, the higher one's average holdings of cash (i.e., the less frequently one goes to the bank) the greater the amount of money that is liable to be stolen. Bringing this new cost into the minimization problem provides an additional incentive to go to the bank more often and hold less cash.

4. a. Suppose you spend \$1,500 per year in cash. $Y = \$1,500$.
   b. Suppose a trip to the bank takes 0.5 hour, and you earn \$10 per hour. Then each trip to the bank costs you $(0.5 \times \$10) = \$5$. $F = \$5$.
   c. Assume that the interest rate on your checking account is 6 percent. $i = 0.06$.
   d. According to the Baumol–Tobin model, the optimal number of times to go to the bank is

$$N^* = \sqrt{\frac{iY}{2F}}.$$

Plugging in the values of i, Y, and F that we established in parts (a), (b), and (c), we find

$$N^* = \sqrt{\frac{(0.06 \times \$1,500)}{(2 \times \$5)}}.$$

$$= 3.$$

According to the Baumol–Tobin model, you should go to the bank three times per year. You should withdraw Y/N^* each time you go to the bank, or \$500.

   e. In practice, many people go to the bank about once a week and withdraw the amount they expect to spend that week.
   f. Most people find that they go to the bank more frequently and hold less money on average than the Baumol–Tobin model predicts. One possible explanation is that people fear they will be robbed. The threat of theft increases the opportunity cost of holding money and therefore leads people to go to the bank more often and hold less money. Modifying the Baumol–Tobin model to incorporate this additional cost of holding money might lead to more accurate predictions.

5. a. To write velocity as a function of trips to the bank, note that for simplicity, the presentation of the Baumol–Tobin model in the text ignored prices (implicitly holding them fixed). But conceptually, the model relates *nominal* expenditure PY to nominal money holdings.

From the quantity equation:

$$MV = PY.$$

Rewriting this equation in terms of velocity:

$$V = (PY)/M.$$

The Baumol–Tobin model tells us that average nominal money holdings is:

$$M = PY/2N.$$

We know that real average money holdings is:

$$M/P = Y/2N.$$

Substituting this expression into the velocity equation, we obtain:

$$V = PY/(PY/2N).$$

$$V = 2N.$$

This equation tells us that velocity increases as the number of trips to the bank increase. More trips to the bank means that fewer dollars are held on hand to finance the same amount of expenditure. Therefore, dollars must change hands more quickly. In other words, velocity increases.

b. To express velocity as a function of Y, i, and F, begin with the velocity expression from part (a), $V = 2N$. The formula for the optimal number of trips to the bank tells us that

$$N^* = \sqrt{\frac{iY}{2F}}.$$

Plugging N^* into the velocity expression, we obtain:

$$V = 2\sqrt{\frac{iY}{2F}}.$$

Velocity is now expressed as a function of Y, i, and F.

c. As the expression for velocity derived in part (b) indicates, an increase in the interest rate leads to an increase in velocity. Because the opportunity cost of holding money increases, people make more trips to the bank, and on average hold less money. The increase in velocity reflects the fact that fewer dollars are held to finance the same expenditure. Dollars must therefore change hands more quickly.

d. As the expression for velocity derived in part (b) indicates, nothing happens to velocity when the price level rises. An increase in the price level not only increases desired (nominal) expenditure but also increases desired money holdings by the same amount.

e. To see what happens to velocity as the economy grows, first note that Y and F appear in ratio to one another in the velocity expression derived in part (b). As the economy grows, Y increases, reflecting greater expenditure on goods and services. Yet, the wage will also rise, making the cost of going to the bank F higher. (In the Solow growth model, for example, the real wage grows at the same rate as real expenditure per person.) Therefore, in a growing economy, the ratio Y/F is likely to remain fixed, implying that there will be no trend in velocity.

f. From the velocity expression we derived in part (a), we can see that if N is fixed, then velocity is also fixed.

CHAPTER 19 Advances in Business Cycle Theory

Questions for Review

1. Real business cycle theory explains fluctuations in employment through fluctuations in the supply of labor. The theory emphasizes that the quantity of labor supplied depends on the economic incentives that workers face. Intertemporal substitution—that is, the willingness of workers to reallocate their labor over time—is especially important in determining how people respond to incentives. If today's wage or interest rate is temporarily high, for example, it is attractive to work more today relative to tomorrow.
2. There are four central disagreements in the debate over real business cycle theory. These disagreements have not yet been settled, and, as a result, they remain areas of active research. These areas are:
   i. **The interpretation of the labor market.** Over the business cycle, the unemployment rate varies widely. Advocates of real business cycle theory believe that fluctuations in employment result from changes in the amount people want to work—by assumption, the economy is always on the labor supply curve. They believe that unemployment statistics are difficult to interpret for at least two reasons: first, people may claim to be unemployed to collect unemployment-insurance benefits; second, the unemployed might be willing to work if they were offered the wage they receive in most years.

      Critics think that fluctuations in employment do not just reflect the amount that people want to work. They believe that the high unemployment rate in recessions suggests that the labor market does not clear—that is, that the wage does not adjust to equilibrate labor supply and labor demand.

   ii. **The importance of technology shocks**. Real business cycle advocates assume that economies experience fluctuations in their ability to produce goods and services from inputs of capital and labor. These fluctuations may arise from the weather, environmental regulations, and oil prices, as well as technology itself.

      Critics of real business cycle theory ask, "What are the shocks?" It seems likely to them that technological progress occurs gradually. Also, these critics question whether recessions are really times of technical regress. The accumulation of technology may slow down, but it seems unlikely that it goes into reverse.

   iii. **The neutrality of money**. Reductions in money growth and inflation are usually associated with periods of high unemployment. Most observers interpret this as evidence that monetary policy has a strong influence on the real economy. Real business cycle theory focuses on nonmonetary (that is, "real") causes of business fluctuations, arguing that the close correlation between money and output arises because fluctuations in output cause fluctuations in the money supply, not the reverse. Hence, advocates of real business cycle theory argue that monetary policy does not affect real variables such as output and employment.

   iv. **The flexibility of wages and prices**. Most of microeconomic analysis assumes that prices adjust to equilibrate supply and demand. Advocates of real business cycle theory believe that macroeconomists should make the same assumption. They argue that the stickiness of wages and prices is not important for understanding economic fluctuations. Critics of real business cycle theory point out that many wages and prices are not flexible. They believe that this inflexibility explains both the existence of unemployment and the non-neutrality of money.

3. Staggered price adjustment significantly slows the adjustment of the price level after a monetary contraction. When any one firm adjusts its price, that firm will be reluctant to change its price very much, since a large change would alter its real price (its price relative to other firms). The result of these incremental changes is that even after every firm in the economy has gone through one round of price adjustment, the aggregate price level will not have fully adjusted to its new equilibrium level.

4. Survey data indicate that there are large differences among firms in the frequency of price adjustment. However, sticky prices are quite common—the typical firm in the economy adjusts its prices once or twice a year. Firms give a wide range of reasons why they don't change prices more often. One interpretation is that different theories apply to different firms, depending on industry characteristics, and that price stickiness is a macroeconomic phenomenon without a single microeconomic explanation. Coordination failure tops the list of reasons cited.

Problems and Applications

1. In response to temporary good weather, Robinson Crusoe works harder. Hence, GDP rises from the combined effects of the good weather and the harder work. Crusoe works harder because of the intertemporal substitution of leisure. The price of leisure today is relatively high, because Crusoe needs to give up a lot of production in order to take leisure. Leisure in a couple of days will be relatively cheap because the weather will not be as good, so Crusoe will not be giving up as much production in order to take leisure. Faced with these prices, Crusoe will choose to consume less leisure today (work more) so that he can consume more leisure tomorrow.

   By contrast, if the weather improves permanently, there is no intertemporal substitution effect for Crusoe's labor—his productivity today is the same as it is tomorrow. There are, however, other reasons why Crusoe might want to change his work habits in this world of better weather. There is an income effect, since the better weather makes Crusoe richer and, hence, he can afford to work less hard. Offsetting this is a substitution effect, since the price of leisure in terms of forgone output is higher and, hence, Crusoe will motivated to work harder. Without observing Crusoe we do not know which of these two effects is stronger and, thus, we do not know whether he will work more or less.

   Even if Crusoe works less after the good weather, it is very likely that the GDP will still rise because of the higher level of productivity. The reason is that Crusoe will want to use his increased potential to make sure he has more of both things he likes—goods and leisure—so he is unlikely to increase his leisure so much that consumption falls. In microeconomic language we say that GDP rises because goods and leisure are both normal goods, i.e., goods that you want more of when your income rises.

2. Real business cycle theory assumes that the price level is fully flexible. As a result, in this chapter we have ignored the *LM* curve: it has no effect on real variables. In other words, we assume that the price level adjusts to keep the money market in equilibrium, so that the supply of real balances equals its demand:

   $$M/P = L(r, Y).$$

   The Federal Reserve determines the money supply M; the intersection of real aggregate supply and real aggregate demand determines the interest rate r and the level of output Y. Only the price level is free to adjust to ensure that the money market clears.

   a. An increase in output Y increases the demand for real money balances. If the Fed keeps the money supply M constant, then the price level must fall to restore equilibrium in the money market. Hence, P and Y fluctuate in opposite directions.

b. Now suppose the Fed adjusts the money supply to keep the price level P from changing. An increase in output Y increases the demand for real money balances. To keep the price level from falling, the Fed must increase the money supply. Similarly, if output falls, the Fed must reduce the money supply to keep the money market in equilibrium with a stable price level. Hence, M and Y fluctuate in the same direction.

c. The correlation between fluctuations in the money supply and fluctuations in output is not necessarily evidence against real business cycle theory. If the Fed follows the policy in part (b), in which it tries to keep the price level stable, then we will observe a close correlation between M and Y, without money having any effect on output. Rather, the correlation results from the endogenous response of the monetary authority to fluctuations in output.

3. a. Figure 19–1 shows the payoffs from this game. If they both work hard, they each get \$100 of profit less \$20 in effort for a total of \$80 each. If only one of them works hard, the hard worker gets \$70 in profit minus \$20 in effort while the other enjoys the entire \$70 in profit with no cost in terms of effort. Finally, if neither of them works, they each get \$60.

Figure 19–1

		Ben	
		hard	easy
Andy	hard	80 80	50 70
	easy	70 50	60 60

b. Andy and Ben would prefer that both work hard so they each get the maximum payoff, \$80.

c. If Andy expects Ben to work hard, he has a choice of also working hard and earning \$80, or of slacking off and getting \$70. As a result he will choose to work hard also. Ben faces the same options and would make the same decision. Working hard is an equilibrium: if both Andy and Ben expect the other to work hard, then they will both work hard and satisfy each other's expectations.

d. If Andy expects Ben to be lazy, he could work hard and get \$50 or he could be lazy and get \$60. As a result he will choose to be lazy. Ben faces the same options and would make the same decision. Being lazy is also an equilibrium: if both Andy and Ben expect the other to be lazy, they will both be lazy and satisfy each other's expectations.

e. This game is an example of the possibility of coordination failure in a business relationship. Andy and Ben could both end up being lazy even though they would both be better off working harder. If they could coordinate and both work harder, then they would be better off, but neither of them has the incentive to start working harder unilaterally. In practice coordination failures may be a more important problem in games with many players; with few players it is less difficult to coordinate. Also, the relationship between business partners (including coauthors) is more like a repeated game where each period the partners make choices about their work effort. In this repeated game there are strategies like "I work hard only if you did last time" that make it easier to stay in the good equilibrium.

4. a. Figure 19–2 shows marginal cost, demand, and marginal revenue. The marginal revenue curve lies below the demand curve, since lowering the price in order to move down the demand curve reduces the revenue from all of the previous units sold. The profit-maximizing quantity is where marginal revenue equals marginal cost. The monopolist then sets the price by choosing the point along the demand curve that corresponds to that quantity. On Figure 19–2, the consumer surplus is area A and the profit is area B.

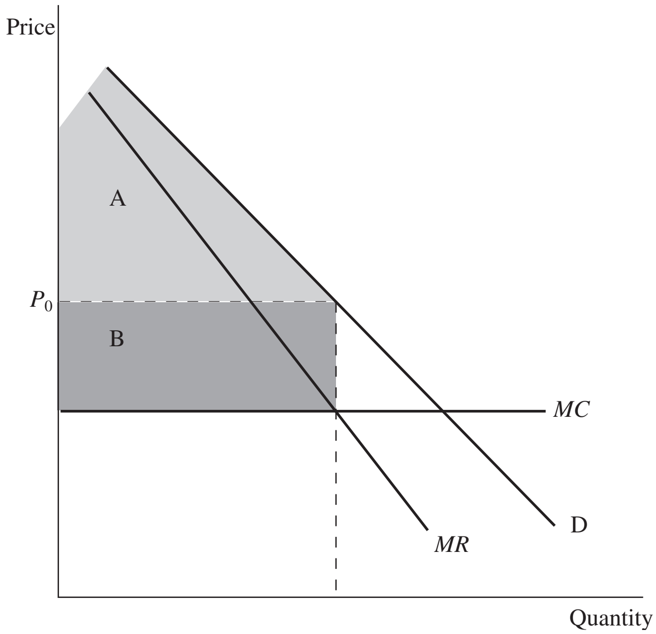


Figure 19–2

b. Figure 19–3 shows that at the higher price the consumer surplus is A. Compared with the optimum, the change in consumer surplus is – (B + C). Consumers lose both areas because fewer consumers enjoy the good and because the price is higher.

Profits go from D + E at the optimum to B + D. Compared with the optimum, the change in profits at the higher price is B – E. Producers lose because fewer goods are sold but gain because they get a higher price for each unit sold.

c. The firm will adjust its price if E – > menu cost. In making this decision it is ignoring the cost of the higher prices to consumer surplus. Society would be better off adjusting prices if the total social loss, C + E, were greater than the menu cost. In other words, when menu costs are present monopolists will not downwardly

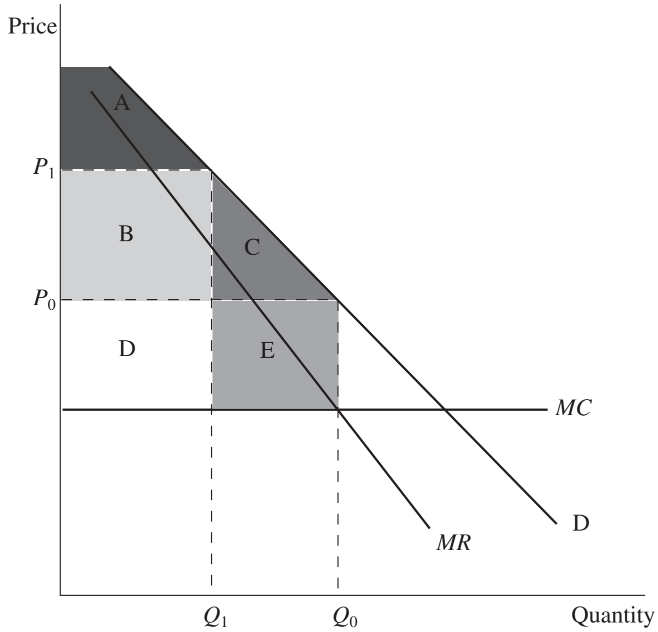


Figure 19–3

adjust their prices often enough.

Learning objectives

This chapter introduces you to

- the issues macroeconomists study
- the tools macroeconomists use
- some important concepts in macroeconomic analysis

Important issues in macroeconomics

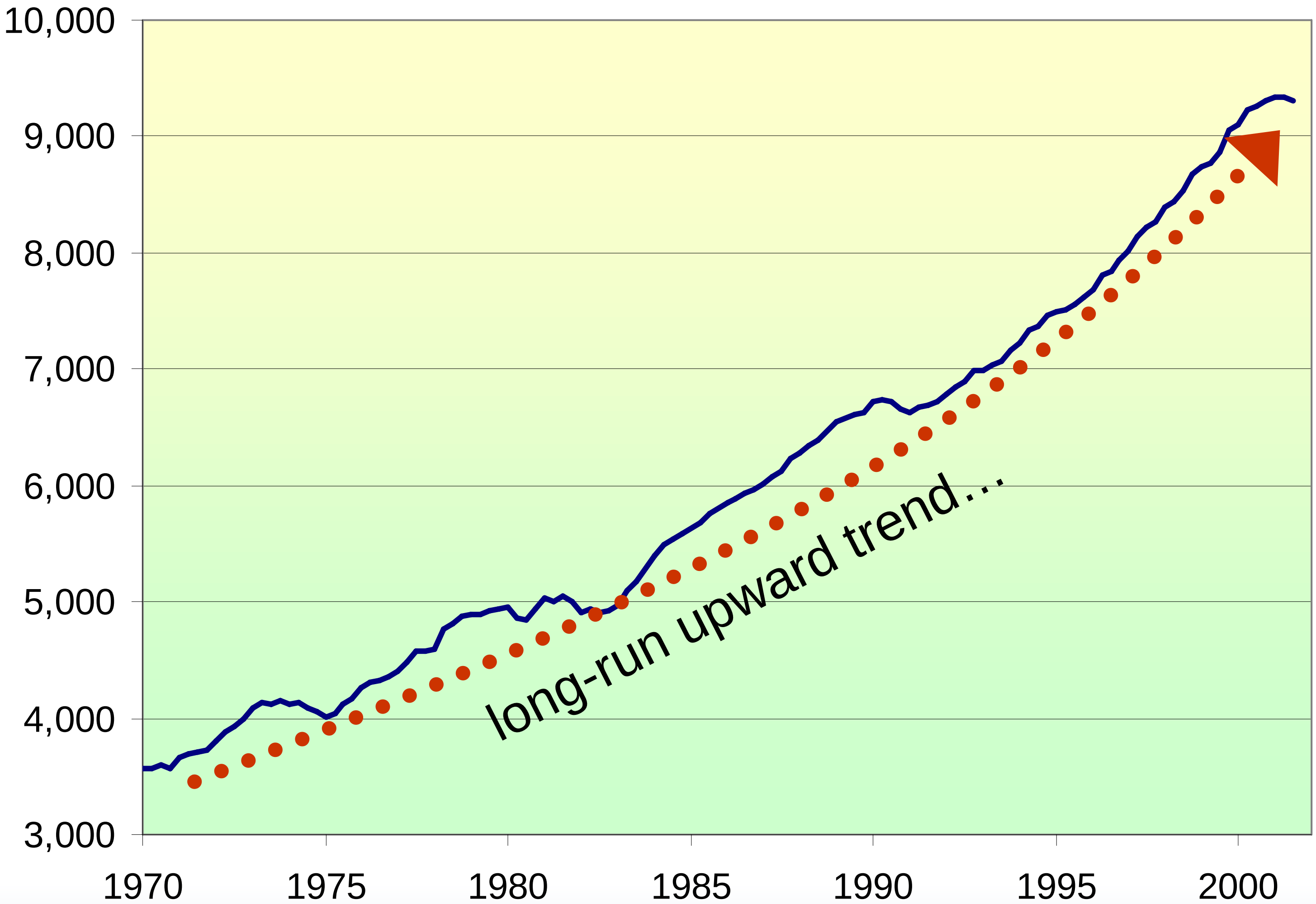
- Why does the cost of living keep rising?
- Why are millions of people unemployed, even when the economy is booming?
- Why are there recessions?
  Can the government do anything to combat recessions? Should it??

Important issues in macroeconomics

- What is the government budget deficit? How does it affect the economy?
- Why does the U.S. have such a huge trade deficit?
- Why are so many countries poor? What policies might help them grow out of poverty?

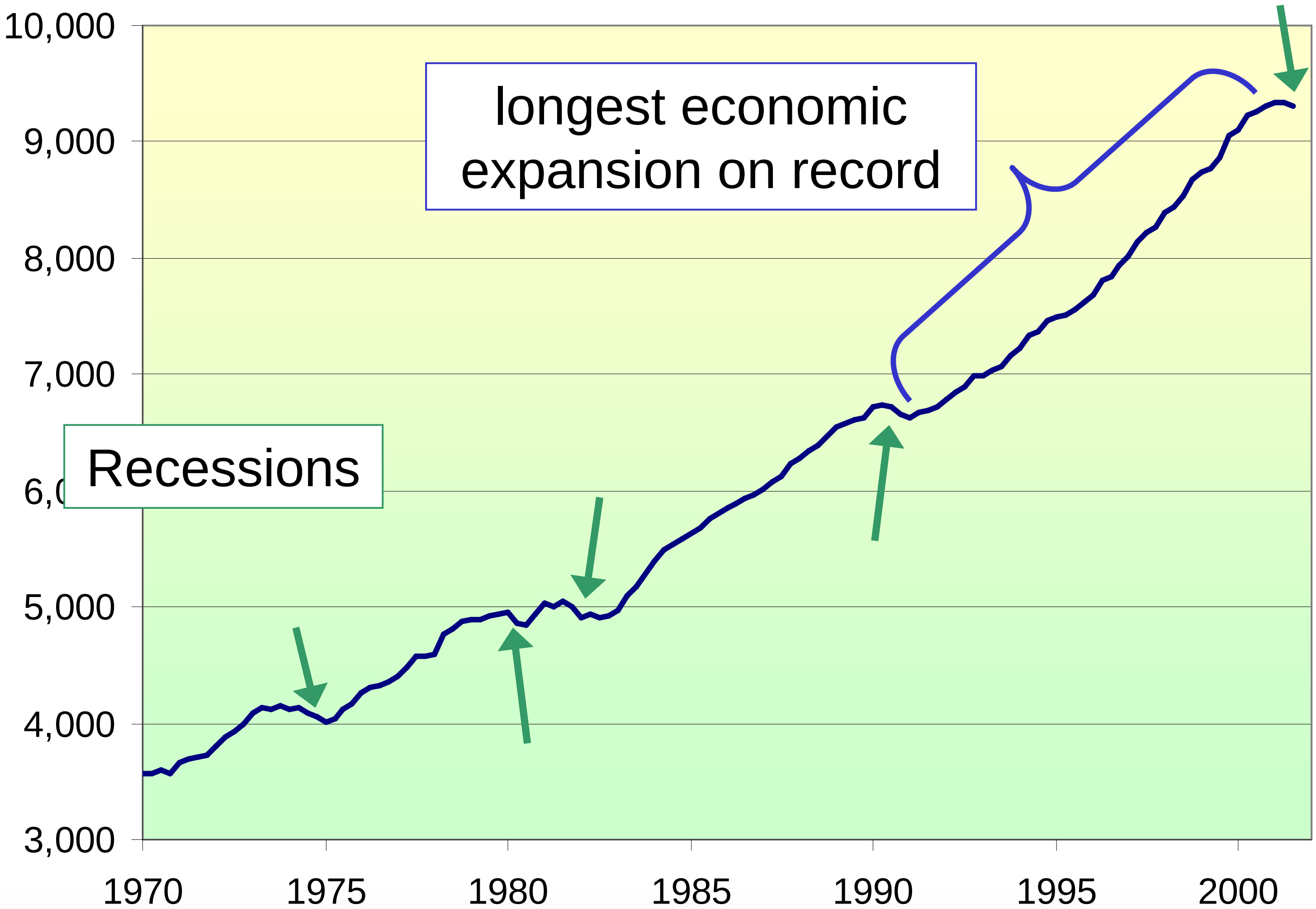
U.S. Gross Domestic Product

in billions of chained 1996 dollars



U.S. Gross Domestic Product

in billions of chained 1996 dollars



Why learn macroeconomics?

1. The macroeconomy affects society's well-being.
   - *example:*
     Unemployment and social problems

Unemployment and social problems

Each one-point increase in the unemployment rate is associated with:

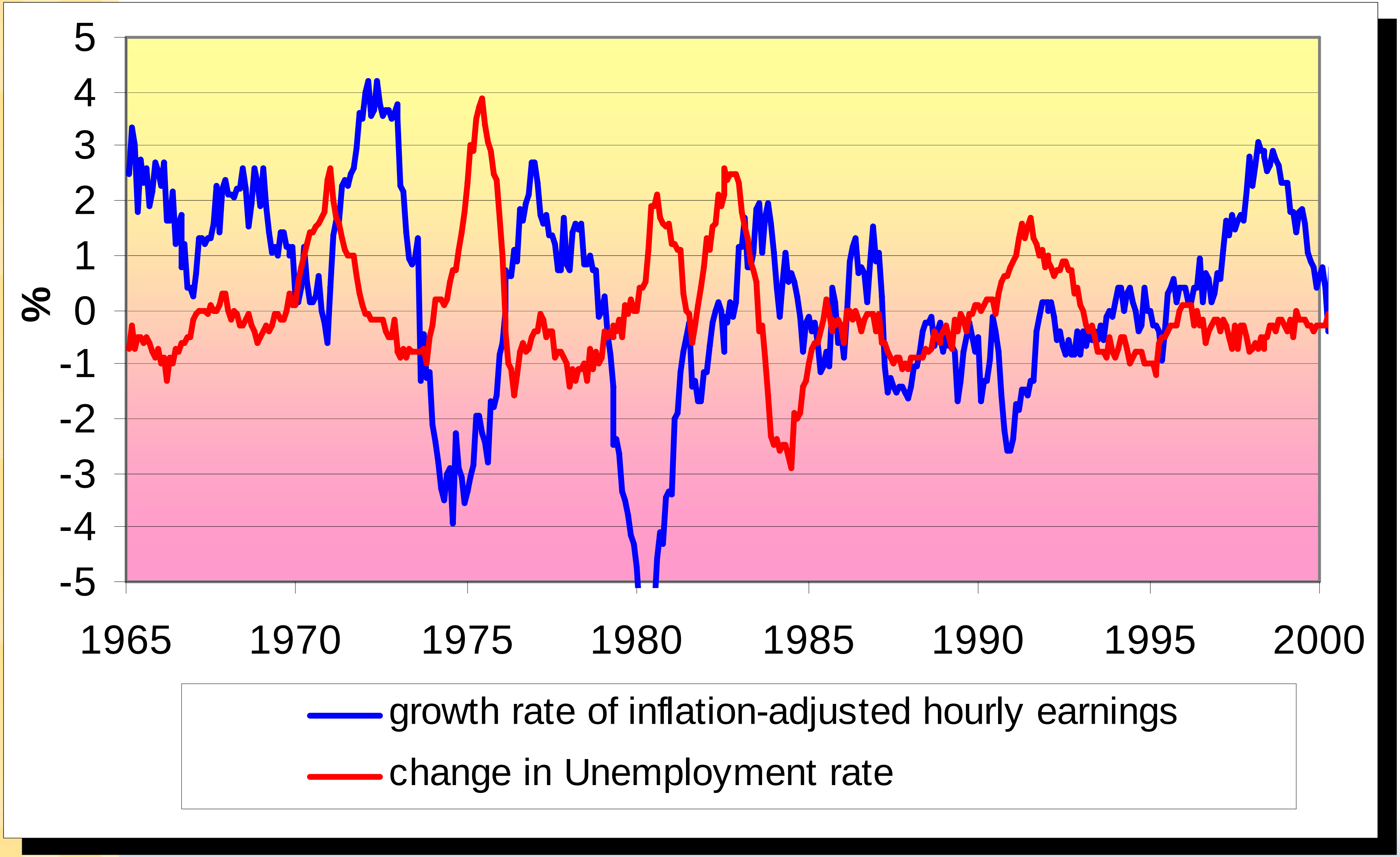
- 920 more suicides
- 650 more homicides
- 4000 more people admitted to state mental institutions
- 3300 more people sent to state prisons
- 37,000 more deaths
- increases in domestic violence and homelessness

Why learn macroeconomics?

1. The macroeconomy affects society's well-being.
   - *example:*
     Unemployment and social problems

2. The macroeconomy affects <u>your</u> well-being.
   - *example 1:*
     Unemployment and earnings growth
   - *example 2:*
     Interest rates and mortgage payments

Unemployment and earnings growth



Interest rates and mortgage payments

For a $150,000 30-year mortgage:

date	*actual rate on 30-year mortgage*	*monthly payment*	*annual payment*
Dec 2000	7.65%	$1064	$12,771
Dec 2001	6.84%	$981	$11,782

Why learn macroeconomics?

1. The macroeconomy affects society's well-being.
   - *example:*
     Unemployment and social problems
2. The macroeconomy affects your well-being.
   - *example 1:*
     Unemployment and earnings growth
   - *example 2:*
     Interest rates and mortgage payments
3. The macroeconomy affects politics & current events.
   - *example:*
     Inflation and unemployment in election years

Inflation and Unemployment in Election Years

year	*U rate*	*inflation rate*	*elec. outcome*
1976	7.7%	5.8%	Carter (D)
1980	7.1%	13.5%	Reagan (R)
1984	7.5%	4.3%	Reagan (R)
1988	5.5%	4.1%	Bush I (R)
1992	7.5%	3.0%	Clinton (D)
1996	5.4%	3.3%	Clinton (D)
2000	4.0%	3.4%	Bush II (R)

Economic models

...are simplied versions of a more complex reality

- irrelevant details are stripped away

Used to

- show the relationships between economic variables
- explain the economy's behavior
- devise policies to improve economic performance

Example of a model:
The supply & demand for new cars

- explains the factors that determine the price of cars and the quantity sold.
- assumes the market is **competitive**: each buyer and seller is too small to affect the market price
- Variables:

  Q^d = quantity of cars that buyers demand

  Q^s = quantity that producers supply

  P = price of new cars

  Y = aggregate income

  P_s = price of steel (an input)

The demand for cars

demand equation: $Q^d = D(P, Y)$

shows that the quantity of cars consumers demand is related to the price of cars and aggregate income.

Digression: Functional notation

- **General functional notation** shows only that the variables are related:

$$Q^d = D(\underbrace{P, Y}_{\text{A list of the variables that affect } Q^d})$$

A list of the variables that affect Q^d

Digression: Functional notation

- **General functional notation** shows only that the variables are related:

$$Q^d = D(P, Y)$$

- A **specific functional form** shows the precise quantitative relationship:

Examples:

1) $$Q^d = D(P, Y) = 60 - 10P + 2Y$$

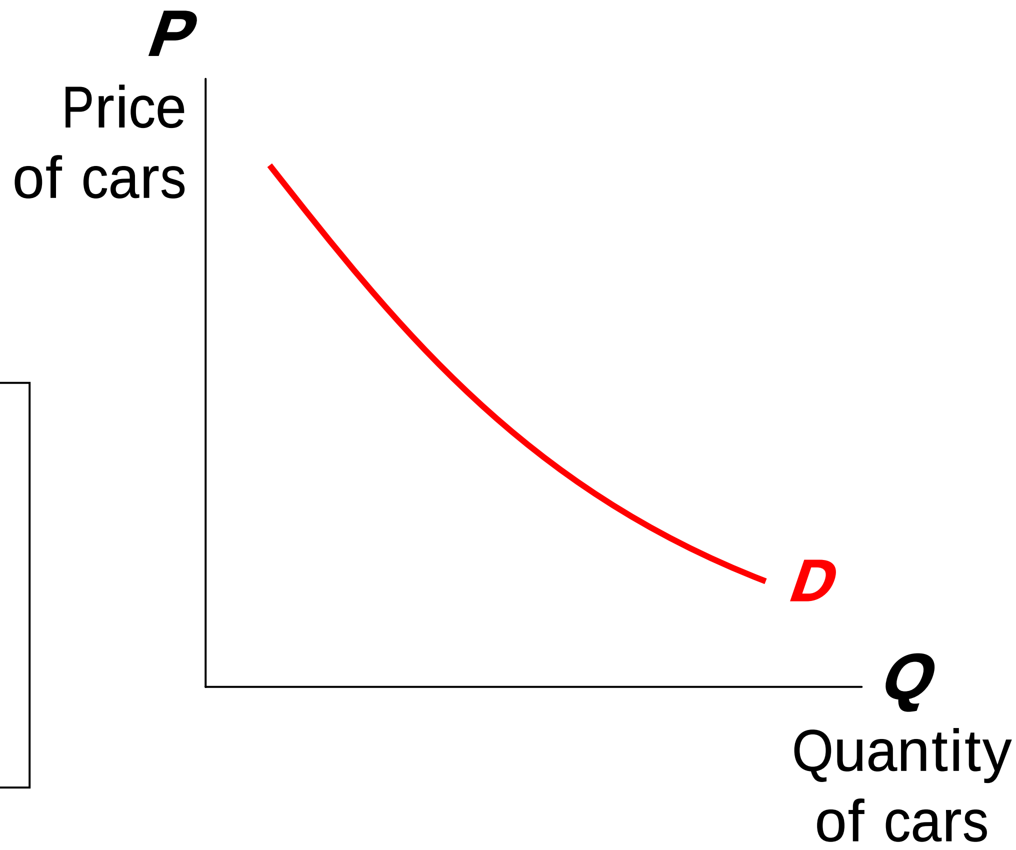
2) $$Q^d = D(P, Y) = \frac{0.3Y}{P}$$

The market for cars: **demand**

demand equation:

$$Q^d = D(P, Y)$$

The **demand curve** shows the relationship between quantity demanded and price, other things equal.

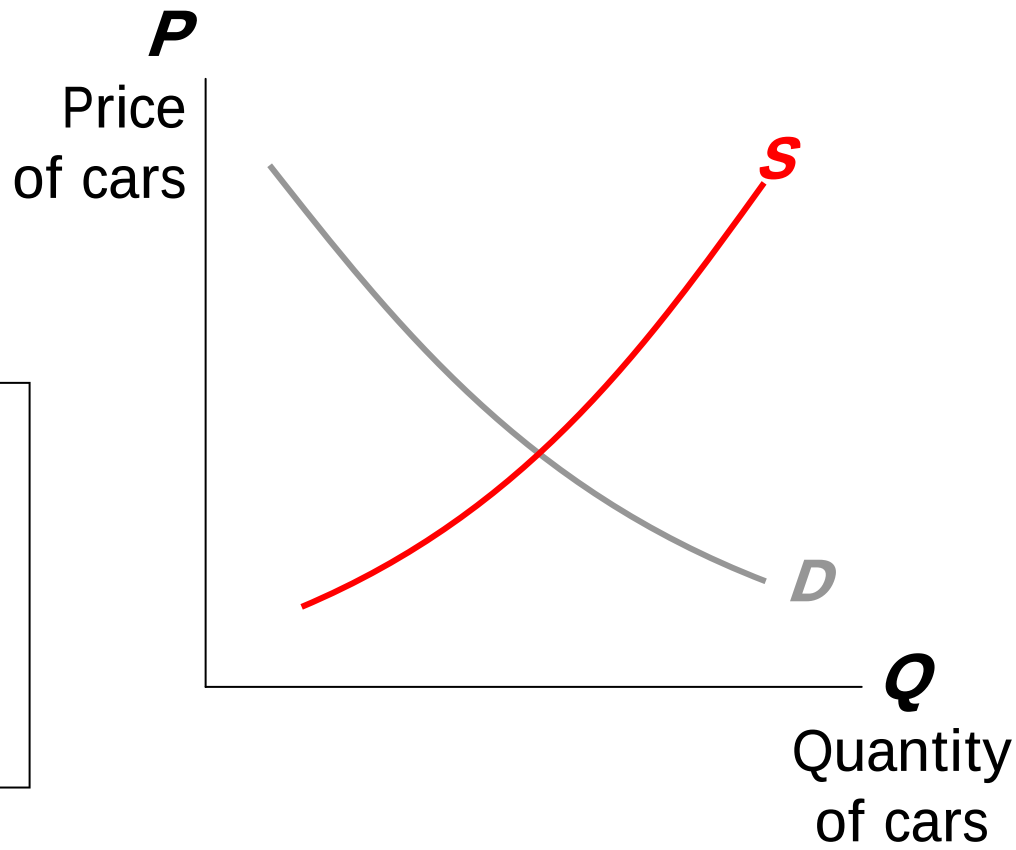


The market for cars: supply

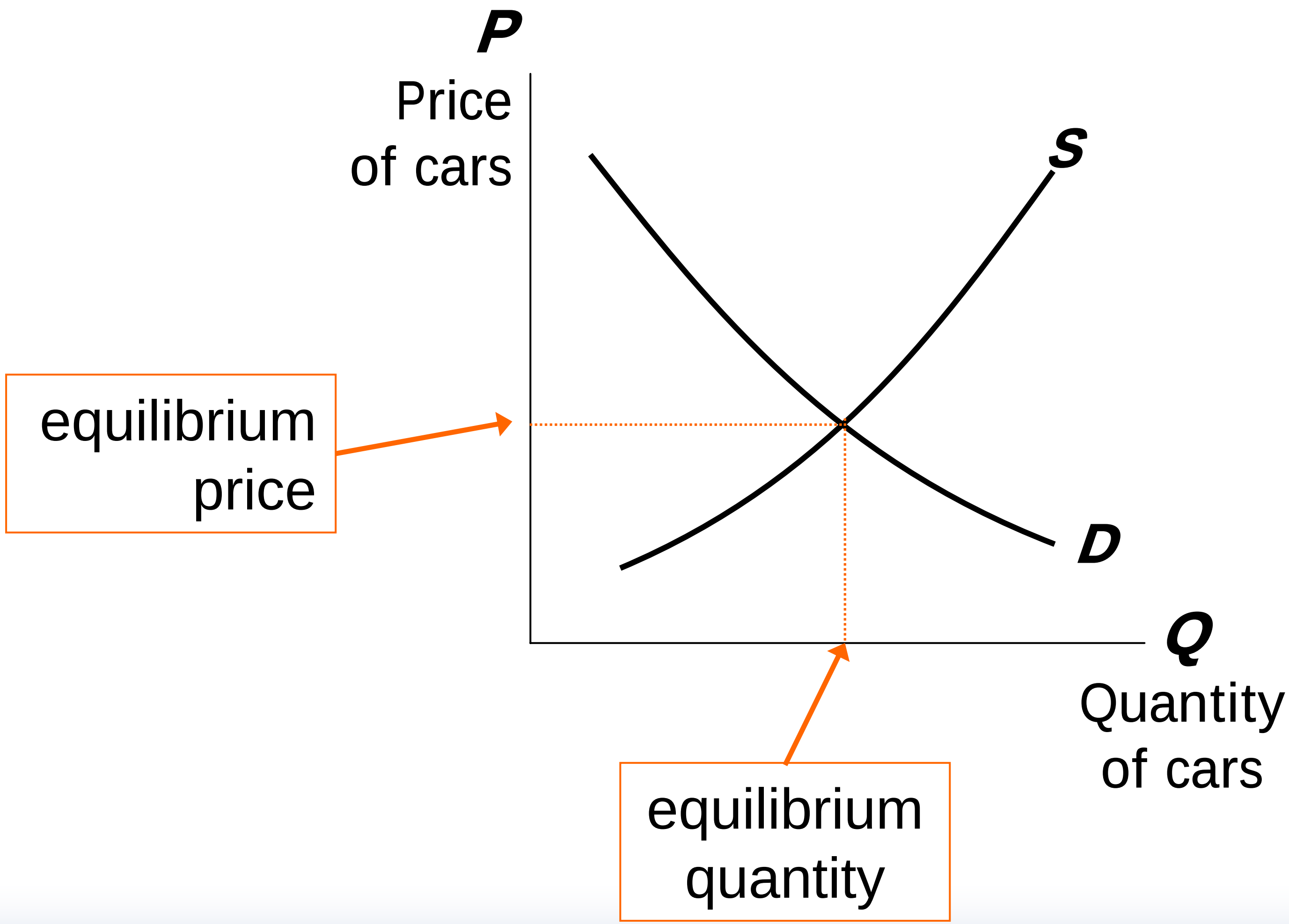
supply equation:

$$Q^s = S(P, P_s)$$

The **supply curve** shows the relationship between quantity supplied and price, other things equal.



The market for cars: **equilibrium**

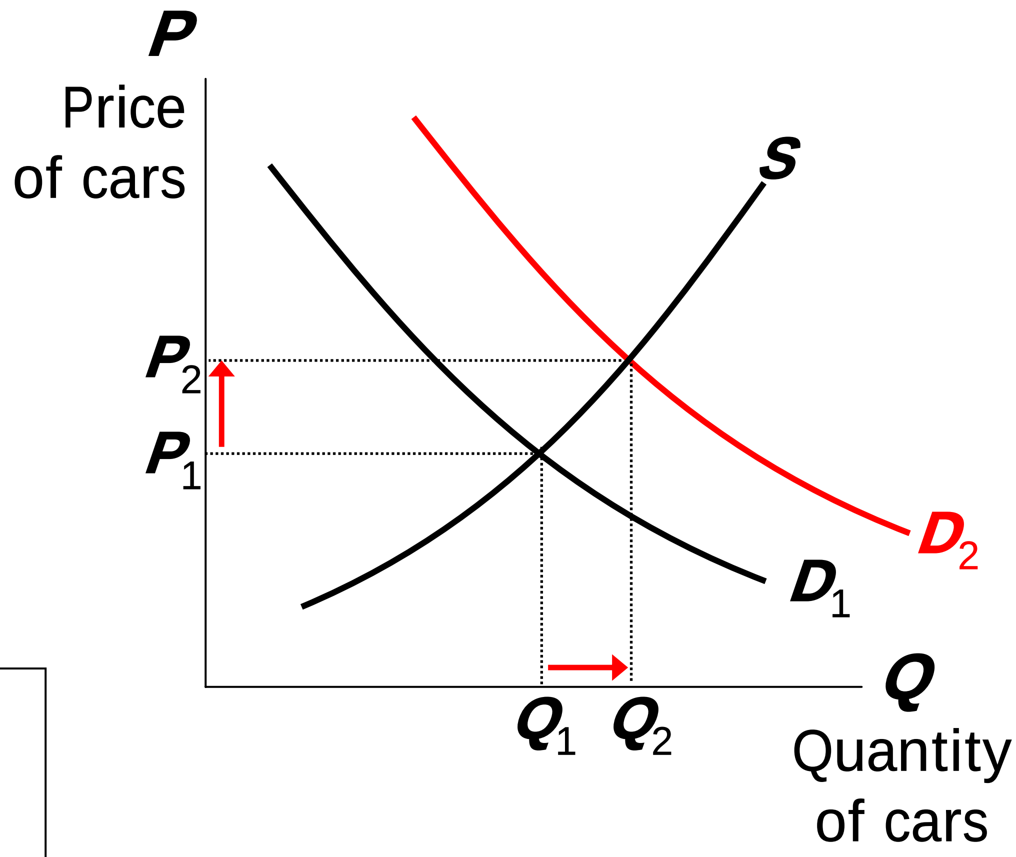


The effects of an increase in income:

demand equation:

$$Q^d = D(P, Y)$$

An increase in income increases the quantity of cars consumers demand at each price…



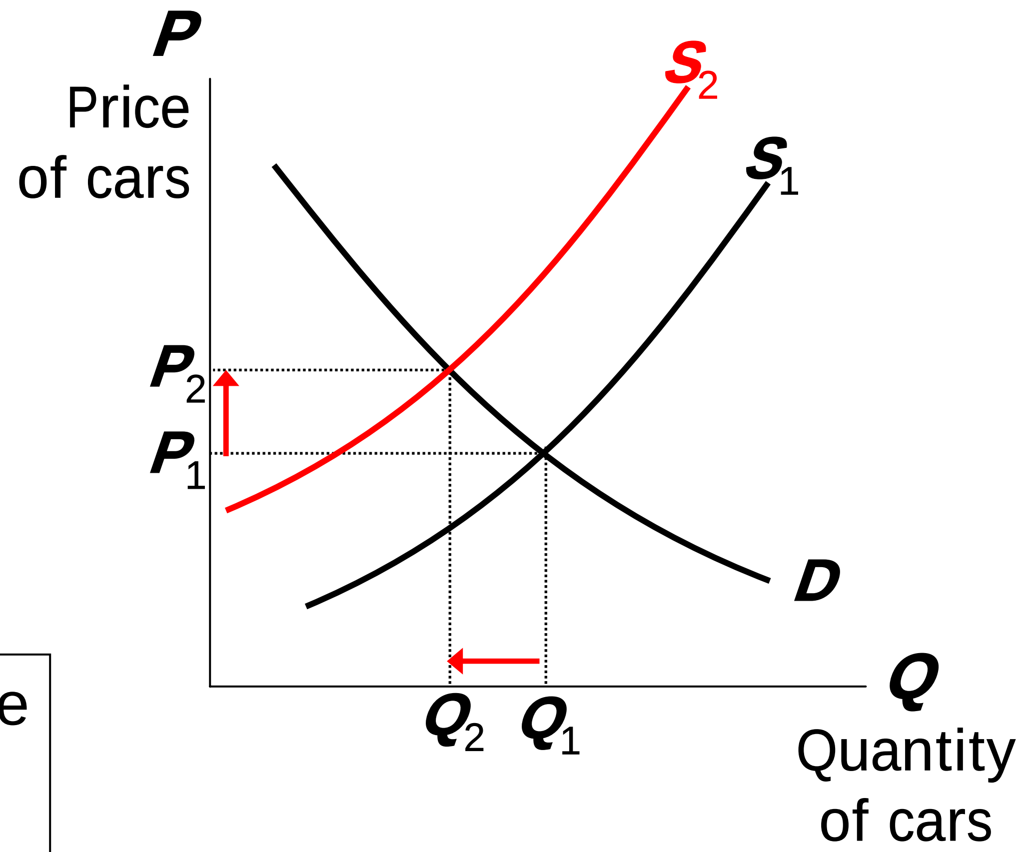
…which increases the equilibrium price and quantity.

The effects of a steel price increase:

supply equation:

$$Q^s = S(P, P_s)$$

An increase in P_s reduces the quantity of cars producers supply at each price…



…which increases the market price and reduces the quantity.

Endogenous vs. exogenous variables:

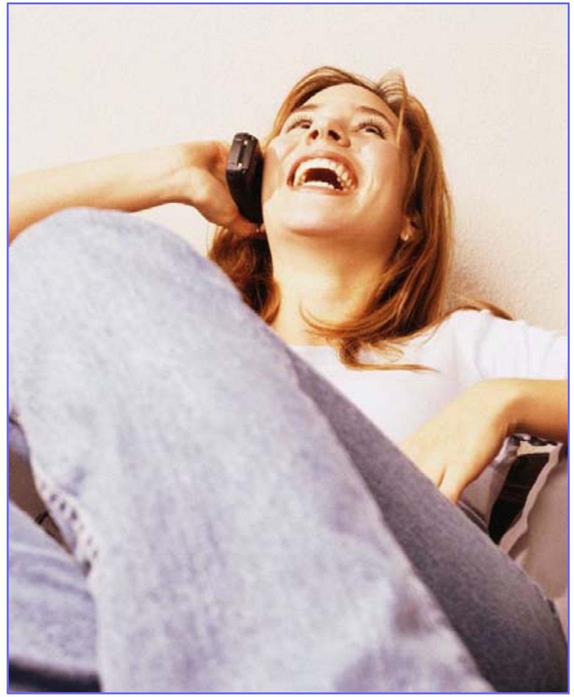
- The values of **endogenous** variables are determined in the model.
- The values of **exogenous** variables are determined outside the model: the model takes their values & behavior as given.
- In the model of supply & demand for cars,

endogenous: P, Q^d, Q^s

exogenous: Y, P_s

Now you try:

1. Write down demand and supply equations for wireless phones; include two exogenous variables in each equation.
2. Draw a supply-demand graph for wireless phones.
3. Use your graph to show how a change in one of your exogenous variables affects the model's endogenous variables.



A Multitude of Models

No one model can address all the issues we care about. For example,

- If we want to know how a fall in aggregate income affects new car prices, we can use the S/D model for new cars.
- But if we want to know <u>why</u> aggregate income falls, we need a different model.

A Multitude of Models

- So we will learn different models for studying different issues (e.g. unemployment, inflation, long-run growth).
- For each new model, you should keep track of
  - its assumptions,
  - which of its variables are endogenous and which are exogenous,
  - the questions it can help us understand,
  - and those it cannot.

Prices: Flexible Versus Sticky

- **Market clearing**: an assumption that prices are flexible and adjust to equate supply and demand.
- In the short run, many prices are **sticky**--- they adjust only sluggishly in response to supply/demand imbalances.
  For example,
  - labor contracts that fix the nominal wage for a year or longer
  - magazine prices that publishers change only once every 3-4 years

Prices: Flexible Versus Sticky

- The economy's behavior depends partly on whether prices are sticky or flexible:
- If prices are sticky, then demand won't always equal supply. This helps explain
  - unemployment (excess supply of labor)
  - the occasional inability of firms to sell what they produce
- Long run: prices flexible, markets clear, economy behaves very differently.

Outline of this book:

- Introductory material (chaps. 1 & 2)
- ***Classical Theory*** (chaps. 3-6)
  How the economy works in the long run, when prices are flexible
- ***Growth Theory*** (chaps. 7-8)
  The standard of living and its growth rate over the very long run
- ***Business Cycle Theory*** (chaps 9-13)
  How the economy works in the short run, when prices are sticky.

Outline of this book:

- ***Policy debates*** (Chaps. 14-15)
  Should the government try to smooth business cycle fluctuations? Is the government's debt a problem?

- ***Microeconomic foundations*** (Chaps. 16-19)
  Insights from looking at the behavior of consumers, firms, and other issues from a microeconomic perspective.

Chapter summary

1. Macroeconomics is the study of the economy as a whole, including
   - growth in incomes
   - changes in the overall level of prices
   - the unemployment rate
2. Macroeconomists attempt to explain the economy and to devise policies to improve its performance.

Chapter summary

3. Economists use different models to examine different issues.
4. Models with flexible prices describe the economy in the long run; models with sticky prices describe economy in the short run.
5. Macroeconomic events and performance arise from many microeconomic transactions, so macroeconomics uses many of the tools of microeconomics.

Learning objectives

In this chapter, you will learn about:

- Gross Domestic Product (GDP)
- the Consumer Price Index (CPI)
- the Unemployment Rate

Gross Domestic Product

Two definitions:

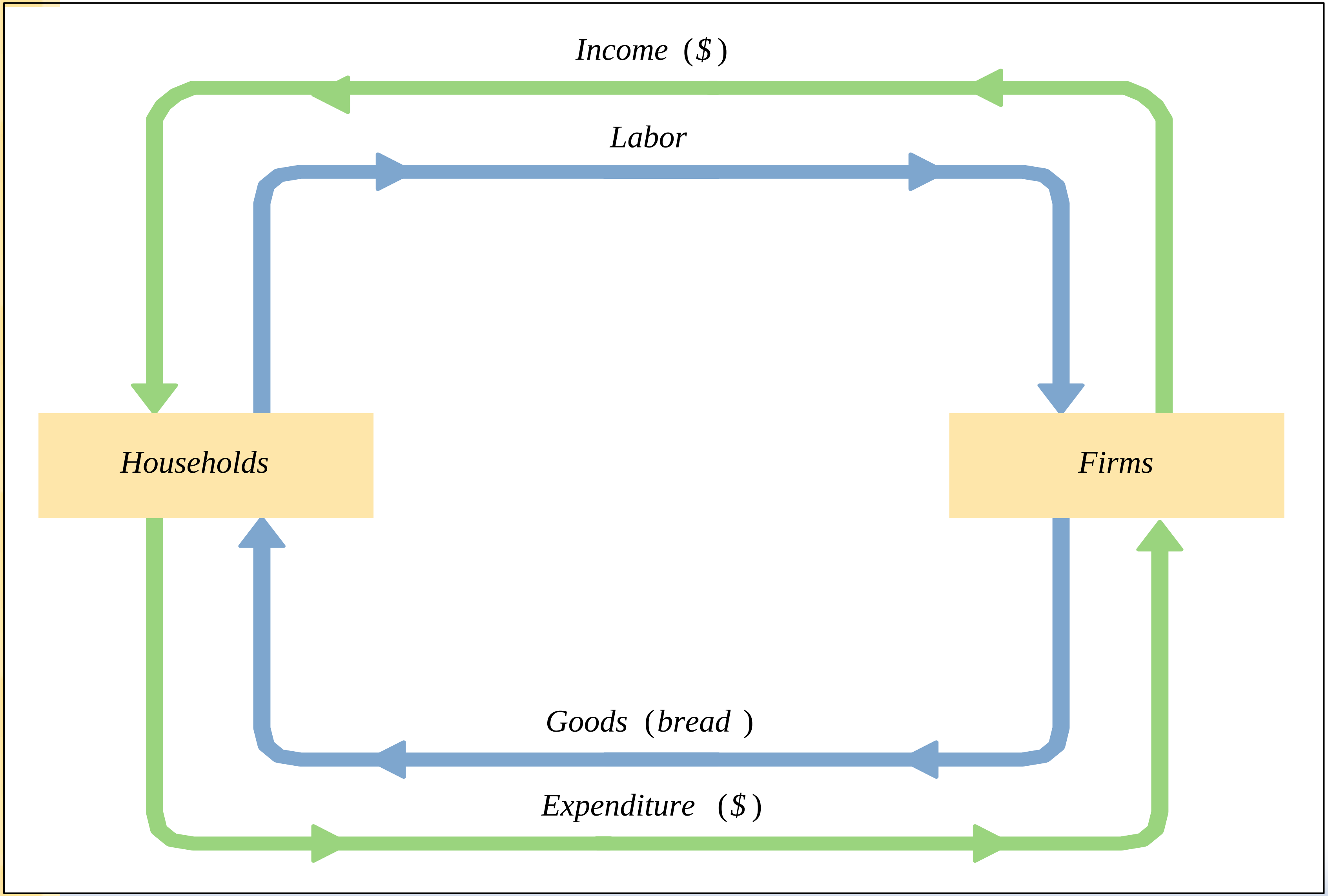
1. Total expenditure on domestically-produced final goods and services
2. Total income earned by domestically-located factors of production

Why expenditure = income

In every transaction,
the buyer's expenditure
becomes the seller's income.

Thus, the sum of all
expenditure equals
the sum of all income.

The Circular Flow



Value added

definition:

A firm's **value added** is

the value of its output

minus

the value of the intermediate goods

the firm used to produce that output.

Exercise: *(Problem 2, p.38)*

- A farmer grows a bushel of wheat and sells it to a miller for $1.00.
- The miller turns the wheat into flour and sells it to a baker for $3.00.
- The baker uses the flour to make a loaf of bread and sells it to an engineer for $6.00.
- The engineer eats the bread.

Compute

- *value added at each stage of production*
- *GDP*

Final goods, value added, and GDP

- GDP = value of final goods produced

  = sum of value added at all stages of production

- The value of the final goods already includes the value of the intermediate goods, so including intermediate goods in GDP would be double-counting.

The expenditure components of GDP

- consumption
- investment
- government spending
- net exports

Consumption (C)

def: the value of all goods and services bought by households. Includes:

- ***durable goods***
  last a long time
  ex: cars, home appliances
- ***non-durable goods***
  last a short time
  ex: food, clothing
- ***services***
  work done for consumers
  ex: dry cleaning, air travel.

U.S. Consumption, 2001

	$ billions	% of GDP
Consumption	$7,064.5	69.2%
Durables	858.3	8.4
Nondurables	2,055.1	20.1
Services	4,151.1	40.7

Investment (I)

def1: spending on [the factor of production] capital.

def2: spending on goods bought for future use.

Includes:

- ***business fixed investment***
  spending on plant and equipment that firms will use to produce other goods & services
- ***residential fixed investment***
  spending on housing units by consumers and landlords
- ***inventory investment***
  the change in the value of all firms' inventories

U.S. Investment, 2001

	$ billions	% of GDP
Investment	$1,633.9	16.0%
Business fixed	1,246.0	12.2
Residential fixed	446.3	4.4
Inventory	-58.4	-0.6

Investment vs. Capital

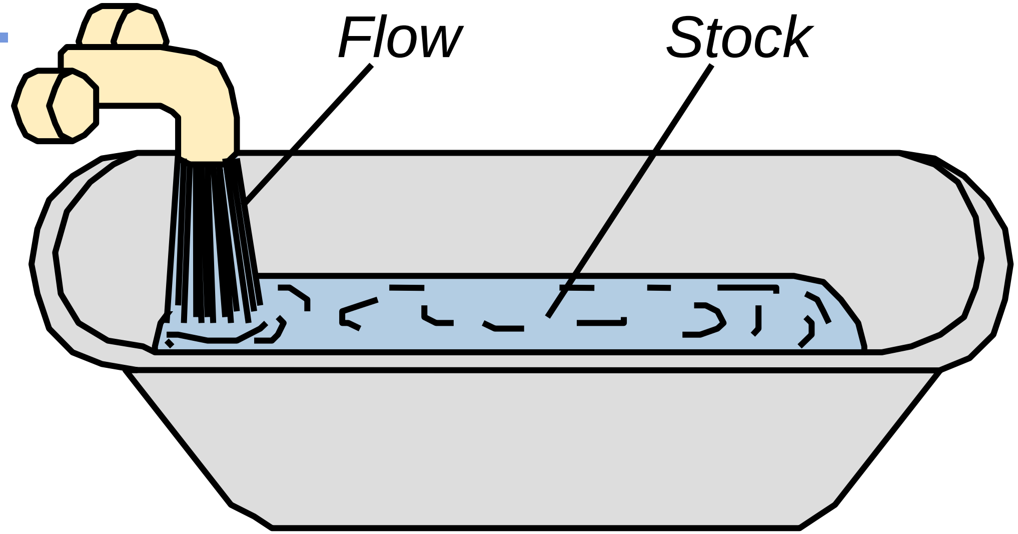
- Capital is one of the factors of production. At any given moment, the economy has a certain overall stock of capital.
- Investment is spending on new capital.

Investment vs. Capital

Example *(assumes no depreciation)*:

- 1/1/2002:
  economy has $500b worth of capital
- during 2002:
  investment = $37b
- 1/1/2003:
  economy will have $537b worth of capital

Stocks vs. Flows



More examples:

stock	*flow*
a person's wealth	a person's saving
# of people with college degrees	# of new college graduates
the govt. debt	the govt. budget deficit

Government spending (G)

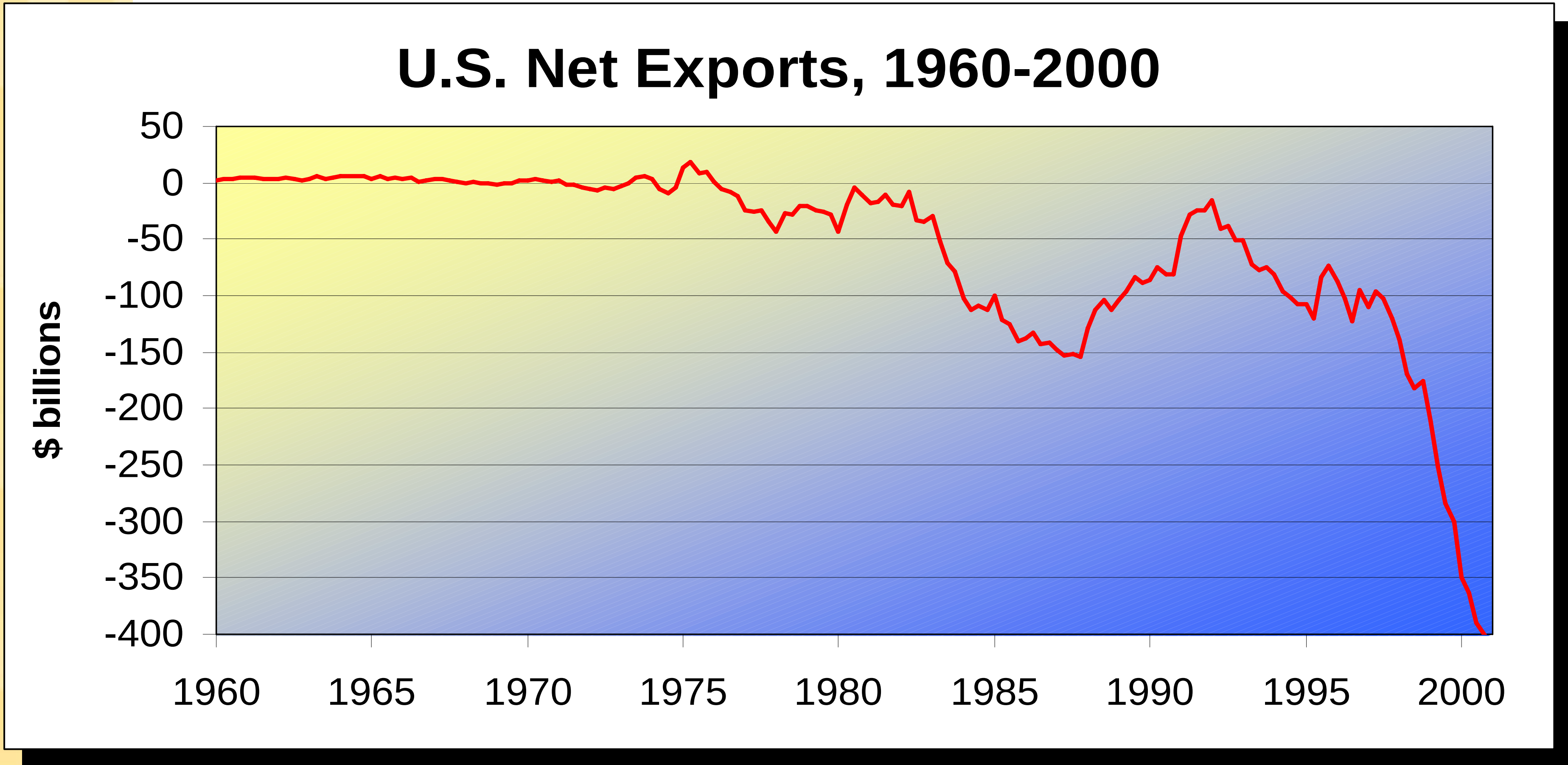
- **G** includes all government spending on goods and services.
- **G** excludes transfer payments (e.g. unemployment insurance payments), because they do not represent spending on goods and services.

Government spending, 2001

	$ billions	% of GDP
Gov spending	$1,839.5	18.0%
Federal	615.7	6.0
Non-defense	216.6	2.1
Defense	399.0	3.9
State & local	1,223.8	12.0

Net exports (NX = EX - IM)

def: the value of total exports (**EX**)
minus the value of total imports (**IM**)



An important identity

$$\mathbf{Y} = \mathbf{C} + \mathbf{I} + \mathbf{G} + \mathbf{NX}$$

where

Y = GDP = the value of total output

C + **I** + **G** + **NX** = aggregate expenditure

A question for you:

Suppose a firm

- produces $10 million worth of final goods
- but only sells $9 million worth.

Does this violate the expenditure = output identity?

Why output = expenditure

- Unsold output goes into inventory, and is counted as "inventory investment"...
...whether the inventory buildup was intentional or not.
- In effect, we are assuming that firms purchase their unsold output.

GDP:
An important and versatile concept

We have now seen that GDP measures

- total income
- total output
- total expenditure
- the sum of value-added at all stages in the production of final goods

GNP vs. GDP

- Gross **National** Product (GNP):
  total income earned by the nation's factors of production, regardless of where located

- Gross **Domestic** Product (GDP):
  total income earned by domestically-located factors of production, regardless of nationality.

(GNP – GDP) = (factor payments from abroad)
– (factor payments to abroad)

Discussion Question:

In your country,
which would you want
to be bigger, GDP or GNP?

Why?

(GNP – GDP) as a percentage of GDP

for selected countries, 1997.

U.S.A.	0.1%
Bangladesh	3.3
Brazil	-2.0
Canada	-3.2
Chile	-8.8
Ireland	-16.2
Kuwait	20.8
Mexico	-3.2
Saudi Arabia	3.3
Singapore	4.2

Real vs. Nominal GDP

- GDP is the value of all final goods and services produced.
- **Nominal GDP** measures these values using current prices.
- **Real GDP** measure these values using the prices of a base year.

Real GDP controls for inflation

Changes in nominal GDP can be due to:

- changes in prices
- changes in quantities of output produced

Changes in real GDP can <u>only</u> be due to changes in quantities,

because real GDP is constructed using constant base-year prices.

Practice problem, part 1

	2001		2002		2003	
	P	Q	P	Q	P	Q
good A	$30	900	$31	1,000	$36	1,050
good B	$100	192	$102	200	$100	205

- Compute nominal GDP in each year
- Compute real GDP in each year using 2001 as the base year.

Answers to practice problem, part 1

- Nominal GDP *multiply Ps & Qs from same year*

  2001: \$46,200 = \$30 × 900 + \$100 × 192

  2002: \$51,400

  2003: \$58,300

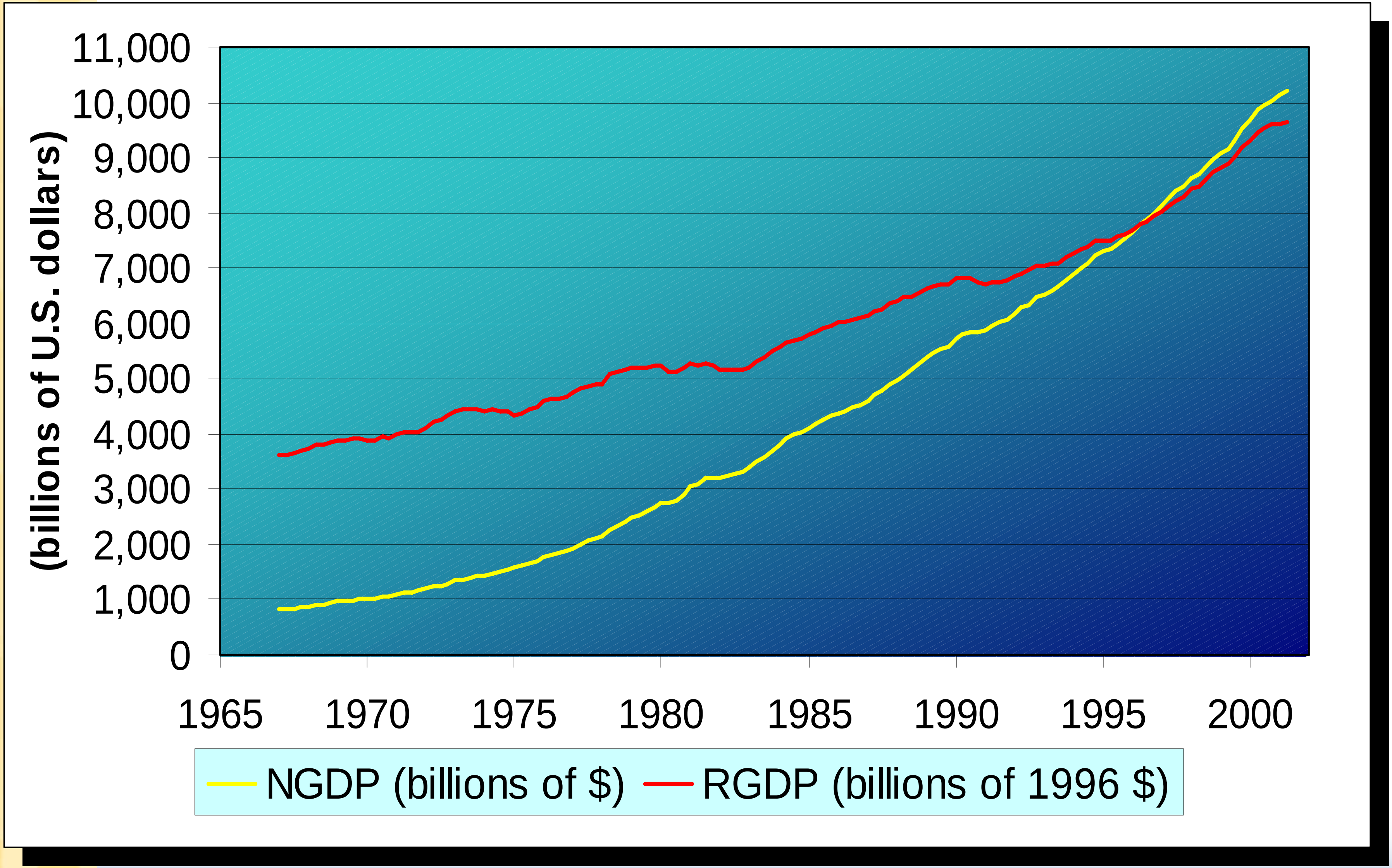
- Real GDP *multiply each year's Qs by 2001 Ps*

  2001: \$46,300

  2002: \$50,000

  2003: \$52,000 = \$30 × 1050 + \$100 × 205

U.S. Real & Nominal GDP, 1967-2001



GDP Deflator

- The **inflation rate** is the percentage increase in the overall level of prices.
- One measure of the price level is the **GDP Deflator**, defined as

$$\text{GDP deflator} = 100 \times \frac{\text{Nominal GDP}}{\text{Real GDP}}$$

Practice problem, part 2

	Nom. GDP	Real GDP	GDP deflator	inflation rate
2001	$46,200	$46,200		*n.a.*
2002	51,400	50,000		
2003	58,300	52,000		

- Use your previous answers to compute the GDP deflator in each year.
- Use GDP deflator to compute the inflation rate from 2001 to 2002, and from 2002 to 2003.

Answers to practice problem, part 2

	Nom. GDP	Real GDP	GDP deflator	inflation rate
2001	$46,200	$46,200	100.0	*n.a.*
2002	51,400	50,000	102.8	2.8%
2003	58,300	52,000	112.1	9.1%

Working with percentage changes

USEFUL TRICK #1 For any variables ***X*** and ***Y***,

the percentage change in ($\boldsymbol{X} \times \boldsymbol{Y}$)

$\approx$ the percentage change in ***X***

\+ the percentage change in ***Y***

EX: If your hourly wage rises 5%

and you work 7% more hours,

then your wage income rises approximately 12%.

Working with percentage changes

USEFUL TRICK #2

the percentage change in (X/Y)

$\approx$ the percentage change in X

$-$ the percentage change in Y

EX: GDP deflator = 100 × NGDP/RGDP.

If NGDP rises 9% and RGDP rises 4%,
then the inflation rate is approximately 5%.

Chain-weighted Real GDP

- Over time, relative prices change, so the base year should be updated periodically.
- In essence, “chain-weighted Real GDP” updates the base year every year.
- This makes chain-weighted GDP more accurate than constant-price GDP.
- But the two measures are highly correlated, and constant-price real GDP is easier to compute...
- ...so we’ll usually use constant-price real GDP.

Consumer Price Index (CPI)

- A measure of the overall level of prices
- Published by the **Bureau of Labor Statistics** (**BLS**)
- Used to
  - track changes in the typical household's cost of living
  - adjust many contracts for inflation (*i.e.* "COLAs")
  - allow comparisons of dollar figures from different years

How the BLS constructs the CPI

1. Survey consumers to determine composition of the typical consumer's "basket" of goods.
2. Every month, collect data on prices of all items in the basket; compute cost of basket
3. CPI in any month equals

$$100 \times \frac{\text{Cost of basket in that month}}{\text{Cost of basket in base period}}$$

Exercise: *Compute the CPI*

The basket contains 20 pizzas and 10 compact discs.

prices:

	pizza	CDs
2000	$10	$15
2001	$11	$15
2002	$12	$16
2003	$13	$15

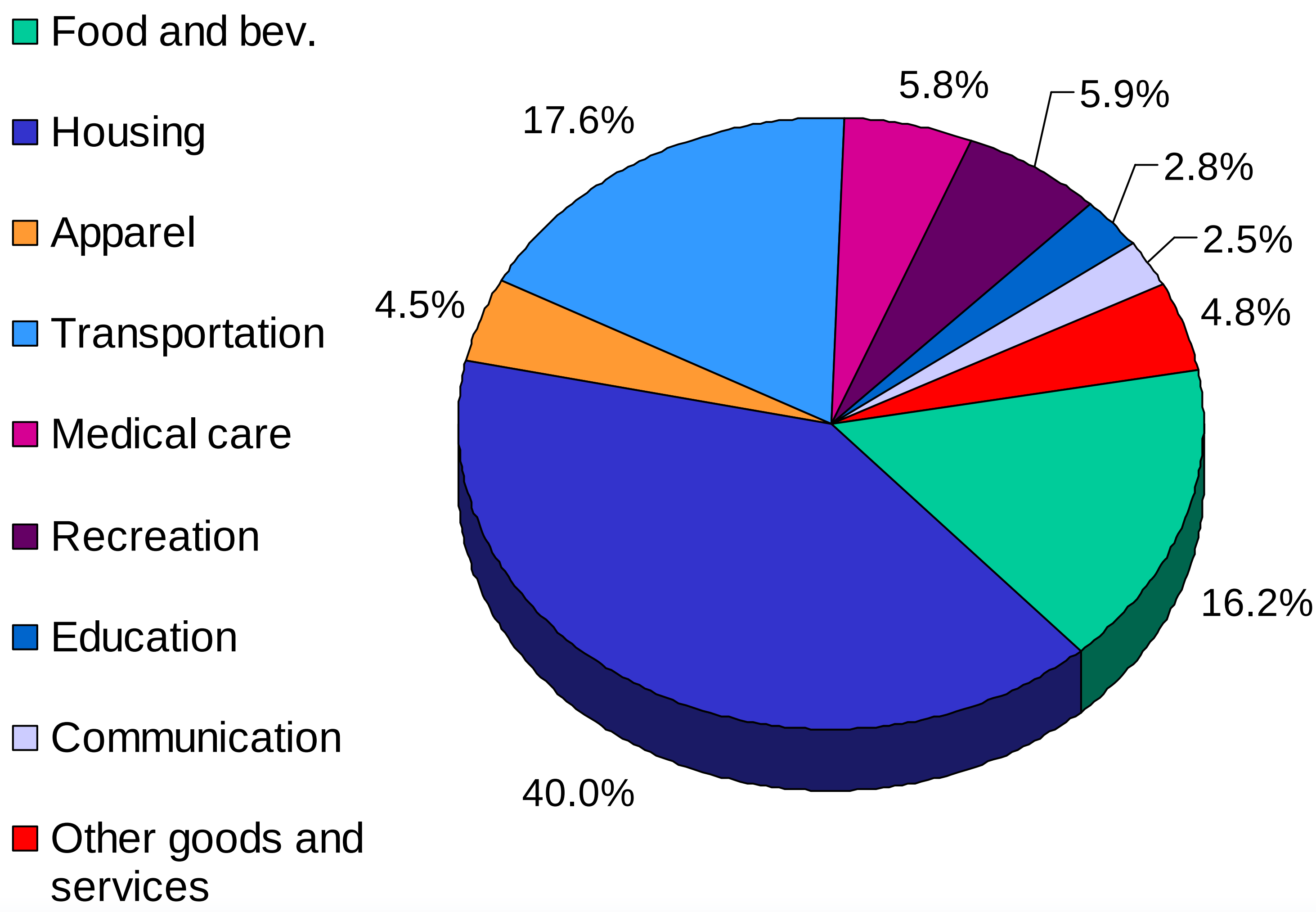
For each year, compute

- the cost of the basket
- the CPI (use 2000 as the base year)
- the inflation rate from the preceding year

answers:

	cost of basket	CPI	inflation rate
2000	$350	100.0	n.a.
2001	370	105.7	5.7%
2002	400	114.3	8.1%
2003	410	117.1	2.5%

The composition of the CPI's "basket"



Reasons why the CPI may overstate inflation

- **Substitution bias**: The CPI uses fixed weights, so it cannot reflect consumers' ability to substitute toward goods whose relative prices have fallen.
- **Introduction of new goods**: The introduction of new goods makes consumers better off and, in effect, increases the real value of the dollar. But it does not reduce the CPI, because the CPI uses fixed weights.
- **Unmeasured changes in quality**: Quality improvements increase the value of the dollar, but are often not fully measured.

The CPI's bias

- The Boskin Panel's "best estimate": The CPI overstates the true increase in the cost of living by 1.1% per year.
- Result: the BLS has refined the way it calculates the CPI to reduce the bias.
- It is now believed that the CPI's bias is slightly less than 1% per year.

CPI vs. GDP deflator

prices of capital goods

- included in GDP deflator (if produced domestically)
- excluded from CPI

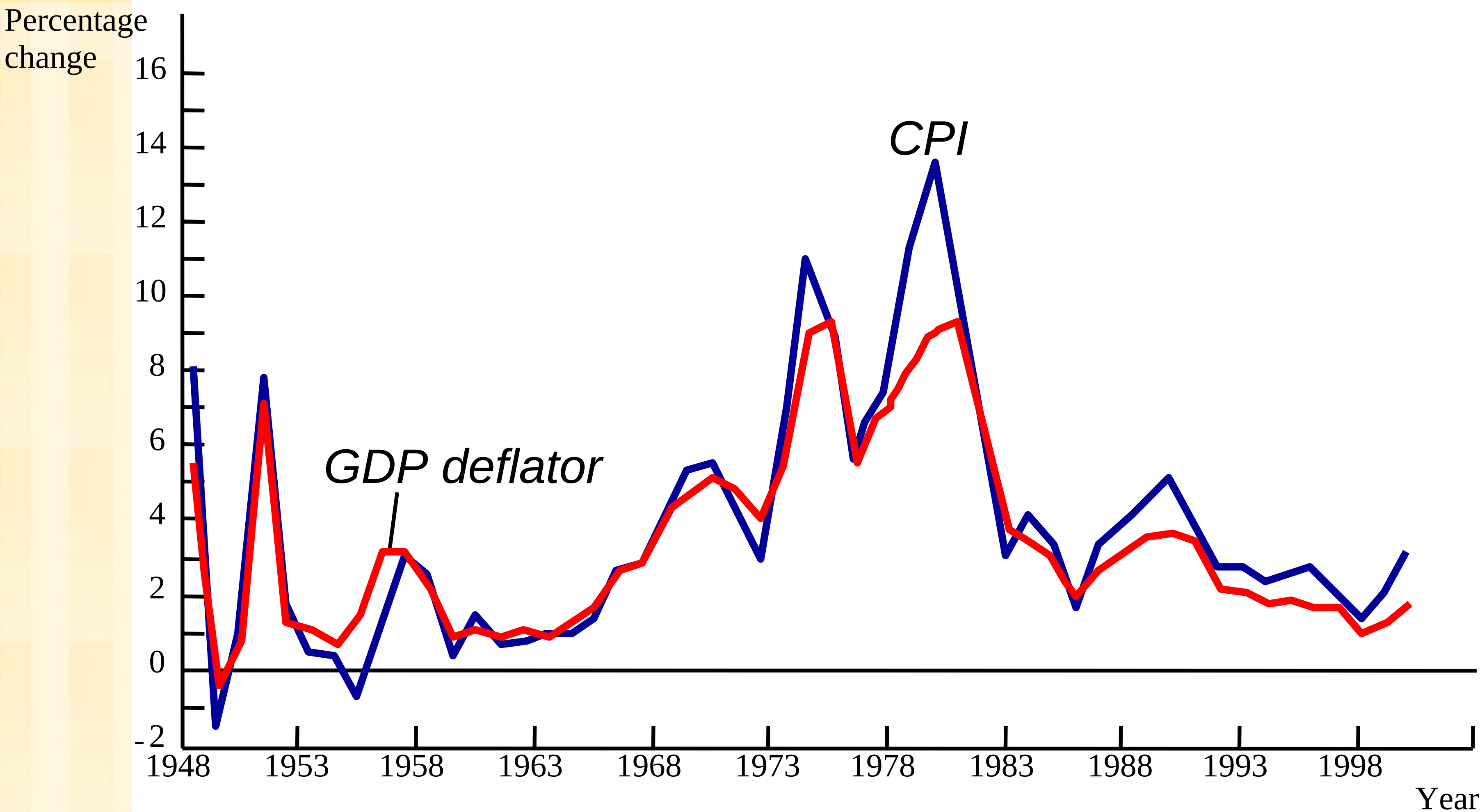
prices of imported consumer goods

- included in CPI
- excluded from GDP deflator

the basket of goods

- CPI: fixed
- GDP deflator: changes every year

Two measures of inflation



Categories of the population

- ***employed***
  working at a paid job
- ***unemployed***
  not employed but looking for a job
- ***labor force***
  the amount of labor available for producing goods and services; all employed plus unemployed persons
- ***not in the labor force***
  not employed, not looking for work.

Two important labor force concepts

- ***unemployment rate***
  percentage of the labor force that is unemployed

- ***labor force participation rate***
  the fraction of the adult population that 'participates' in the labor force

Exercise: *Compute labor force statistics*

U.S. adult population by group, April 2002		
Number employed	=	134.0 million
Number unemployed	=	8.6 million
Adult population	=	213.5 million

Use the above data to calculate

- the labor force
- the number of people not in the labor force
- the labor force participation rate
- the unemployment rate

Answers:

- data: E = 134.0, U = 8.6, POP = 213.5
- labor force

  $L = E + U = 134.0 + 8.6 = 142.6$
- not in labor force

  $NILF = POP - L = 213.5 - 142.6 = 70.9$
- unemployment rate

  $U/L = 8.6/142.6 = 0.06$ or 6.0%
- labor force participation rate

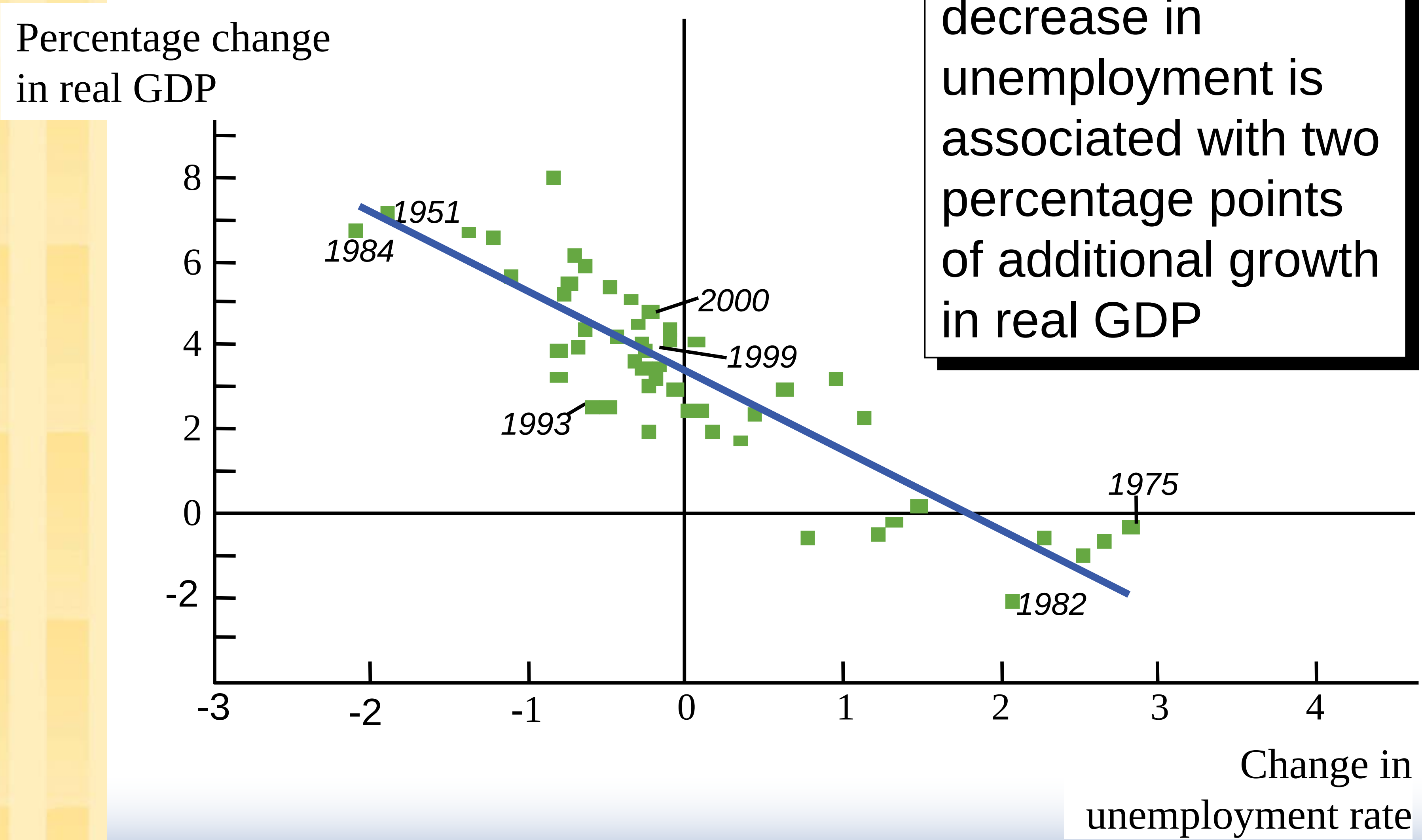
  $L/POP = 142.6/213.5 = 0.668$ or 68.8%

Okun's Law

- Employed workers help produce GDP, while unemployed workers do not.
  So one would expect
  a negative relationship between unemployment and real GDP.

- This relationship is clear in the data...

Okun's Law



Okun's Law states that a one-percent decrease in unemployment is associated with two percentage points of additional growth in real GDP

Chapter Summary

1. Gross Domestic Product (GDP) measures both total income and total expenditure on the economy's output of goods & services.

2. Nominal GDP values output at current prices; real GDP values output at constant prices. Changes in output affect both measures, but changes in prices only affect nominal GDP.

3. GDP is the sum of consumption, investment, government purchases, and net exports.

Chapter Summary

4. The overall level of prices can be measured by either
   - the Consumer Price Index (CPI), the price of a fixed basket of goods purchased by the typical consumer
   - the GDP deflator, the ratio of nominal to real GDP
5. The unemployment rate is the fraction of the labor force that is not employed. When unemployment rises, the growth rate of real GDP falls.

In this chapter you will learn:

- what determines the economy's total output/income
- how the prices of the factors of production are determined
- how total income is distributed
- what determines the demand for goods and services
- how equilibrium in the goods market is achieved

Outline of model

A closed economy, market-clearing model

Supply side

- factor markets (supply, demand, price)
- determination of output/income

Demand side

- determinants of ***C***, ***I***, and ***G***

Equilibrium

- goods market
- loanable funds market

Factors of production

K = capital,
tools, machines, and structures used in production

L = labor,
the physical and mental efforts of workers

The production function

- denoted $Y = F(K, L)$
- shows how much output (Y) the economy can produce from K units of capital and L units of labor.
- reflects the economy's level of technology.
- exhibits ***constant returns to scale***.

Returns to scale: a review

Initially $\quad Y_1 = F(K_1, L_1)$

Scale all inputs by the same factor z:

$K_2 = zK_1$ and $L_2 = zL_1$

(If z = 1.25, then all inputs are increased by 25%)

What happens to output, $Y_2 = F(K_2, L_2)$?

- If *constant returns to scale*, $Y_2 = zY_1$
- If *increasing returns to scale*, $Y_2 > zY_1$
- If *decreasing returns to scale*, $Y_2 < zY_1$

Exercise: *determine returns to scale*

Determine whether each of the following production functions has constant, increasing, or decreasing returns to scale:

a) $\boldsymbol{F(K,L)} = 2\boldsymbol{K} + 15\boldsymbol{L}$

b) $\boldsymbol{F(K,L)} = \sqrt{\boldsymbol{KL}}$

c) $\boldsymbol{F(K,L)} = 2\sqrt{\boldsymbol{K}} + 15\sqrt{\boldsymbol{L}}$

Assumptions of the model

1. Technology is fixed.
2. The economy's supplies of capital and labor are fixed at

$$K = \overline{K} \qquad \text{and} \qquad L = \overline{L}$$

Determining GDP

Output is determined by the fixed factor supplies and the fixed state of technology:

$$\bar{Y} = F(\bar{K}, \bar{L})$$

The distribution of national income

- determined by **factor prices**,
  the prices per unit that firms pay for the factors of production.
- The **wage** is the price of ***L***,
  the **rental rate** is the price of ***K***.

Notation

W	=	nominal wage
R	=	nominal rental rate
P	=	price of output
W/P	=	real wage (measured in units of output)
R/P	=	real rental rate

How factor prices are determined

- Factor prices are determined by supply and demand in factor markets.
- Recall: Supply of each factor is fixed.
- What about demand?

Demand for labor

- Assume markets are competitive:
  each firm takes ***W***, ***R***, and ***P*** as given

- Basic idea:
  A firm hires each unit of labor
  if the cost does not exceed the benefit.

  cost = real wage

  benefit = ***marginal product of labor***

Marginal product of labor (*MPL*)

def:

The extra output the firm can produce using an additional unit of labor (holding other inputs fixed):

$$MPL = F(K, L + 1) - F(K, L)$$

Exercise: *compute & graph MPL*

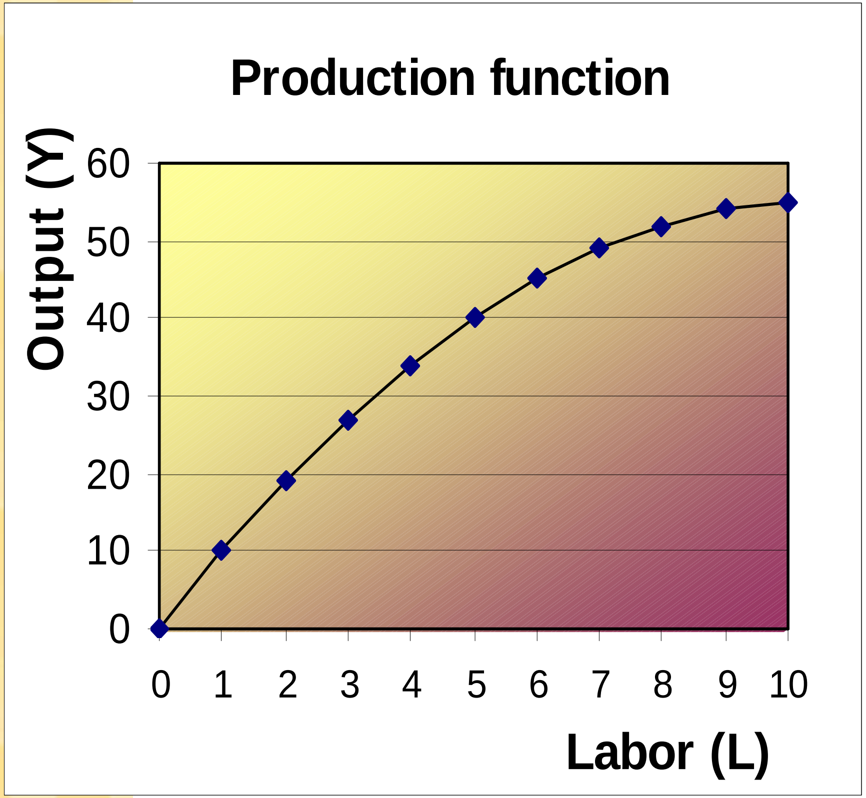
a. Determine ***MPL*** at each value of ***L***

b. Graph the production function

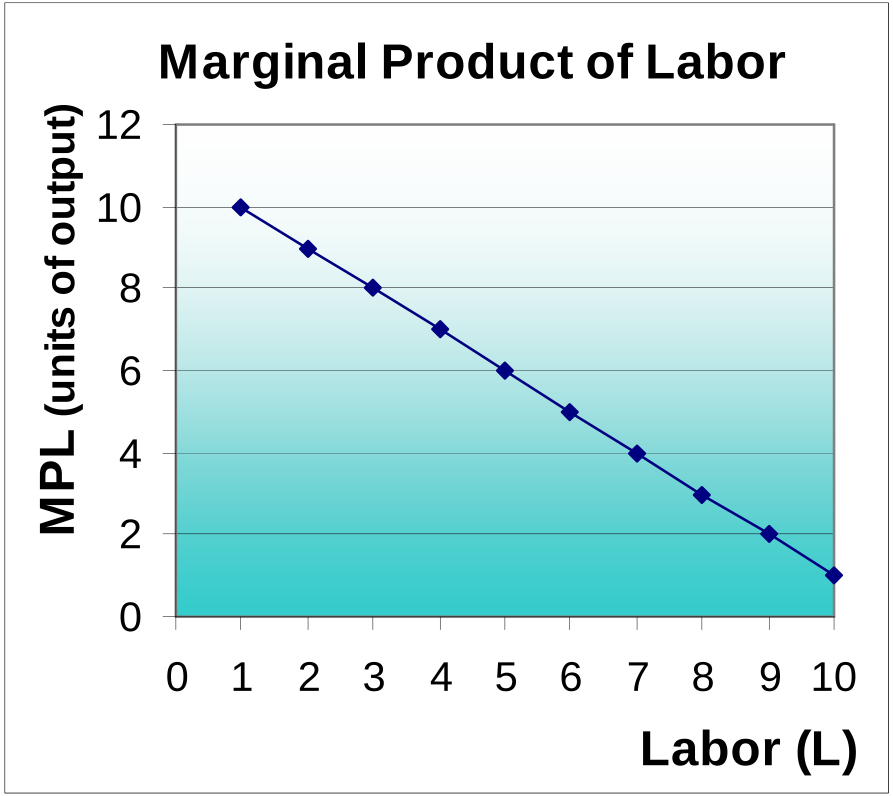
c. Graph the ***MPL*** curve with ***MPL*** on the vertical axis and ***L*** on the horizontal axis

L	***Y***	***MPL***
0	0	n.a.
1	10	?
2	19	?
3	27	8
4	34	?
5	40	?
6	45	?
7	49	?
8	52	?
9	54	?
10	55	?

answers:

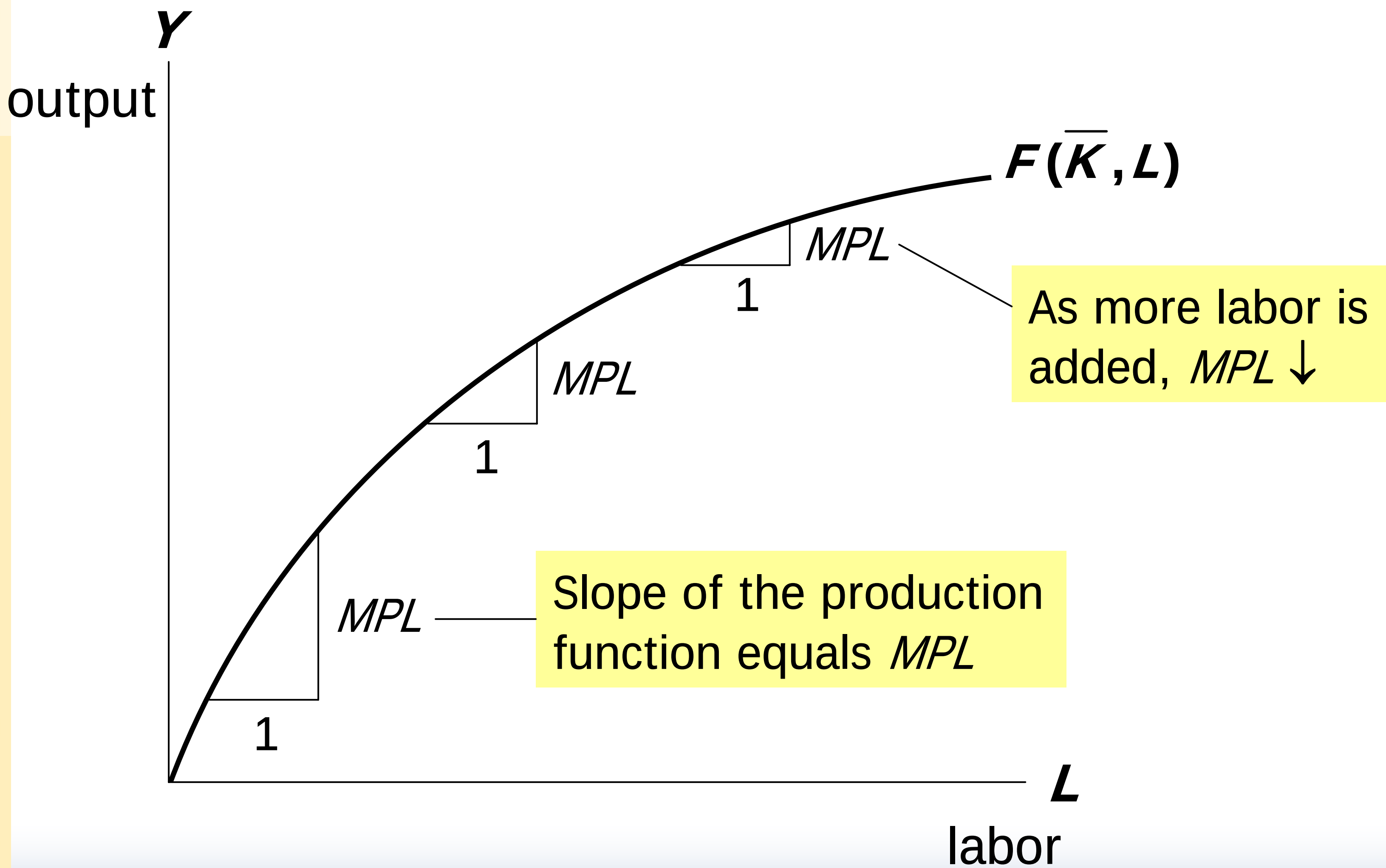


Production function
Output (Y)
60
50
40
30
20
10
0
0 1 2 3 4 5 6 7 8 9 10
Labor (L)



Marginal Product of Labor
MPL (units of output)
12
10
8
6
4
2
0
0 1 2 3 4 5 6 7 8 9 10
Labor (L)

The MPL and the production function



Diminishing marginal returns

- As a factor input is increased, its marginal product falls (other things equal).
- Intuition:
  $\uparrow \boldsymbol{L}$ while holding $\boldsymbol{K}$ fixed

  $\Rightarrow$ fewer machines per worker

  $\Rightarrow$ lower productivity

Check your understanding:

Which of these production functions have diminishing marginal returns to labor?

a) $F(K, L) = 2K + 15L$

b) $F(K, L) = \sqrt{KL}$

c) $F(K, L) = 2\sqrt{K} + 15\sqrt{L}$

Exercise (part 2)

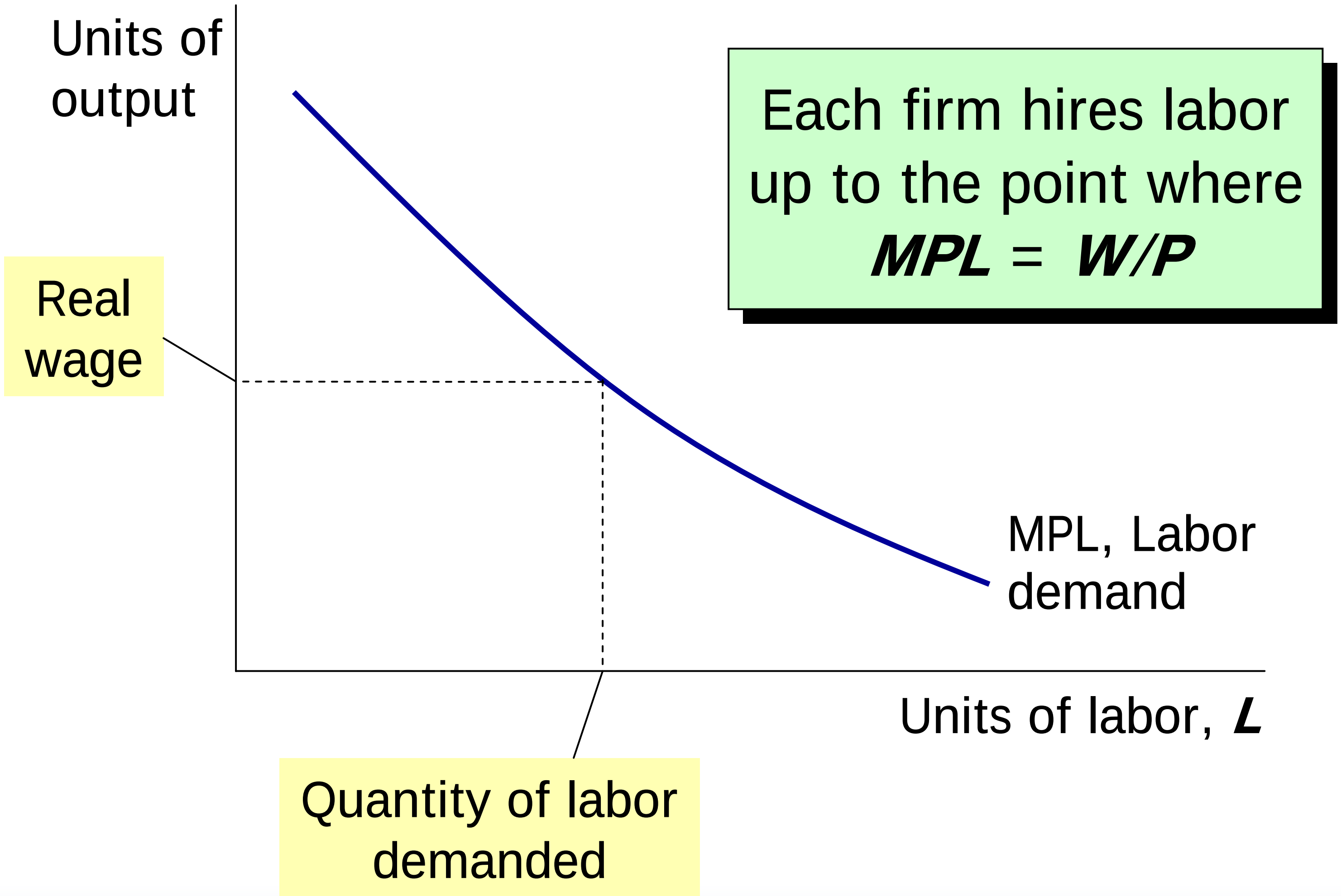
Suppose ***W/P*** = 6.

d. If ***L*** = 3, should firm hire more or less labor? Why?

e. If ***L*** = 7, should firm hire more or less labor? Why?

L	*Y*	MPL
0	0	n.a.
1	10	10
2	19	9
3	27	8
4	34	7
5	40	6
6	45	5
7	49	4
8	52	3
9	54	2
10	55	1

MPL and the demand for labor



Determining the rental rate

We have just seen that ***MPL*** = ***W/P***

The same logic shows that ***MPK*** = ***R/P***:

- diminishing returns to capital: ***MPK***↓ as ***K***↑
- The ***MPK*** curve is the firm's demand curve for renting capital.
- Firms maximize profits by choosing ***K*** such that ***MPK*** = ***R/P***.

The Neoclassical Theory of Distribution

- *states that each factor input is paid its marginal product*
- *accepted by most economists*

How income is distributed:

$$\text{total labor income} = \frac{W}{P}\bar{L} = MPL \times \bar{L}$$

$$\text{total capital income} = \frac{R}{P}\bar{K} = MPK \times \bar{K}$$

If production function has constant returns to scale, then

$$\underbrace{\bar{Y}}_{\text{national income}} = \underbrace{MPL \times \bar{L}}_{\text{labor income}} + \underbrace{MPK \times \bar{K}}_{\text{capital income}}$$

Outline of model

A closed economy, market-clearing model

Supply side

DONE ☑ factor markets (supply, demand, price)

DONE ☑ determination of output/income

Demand side

Next → ❑ determinants of ***C***, ***I***, and ***G***

Equilibrium

❑ goods market

❑ loanable funds market

Demand for goods & services

Components of aggregate demand:

C = consumer demand for g & s

I = demand for investment goods

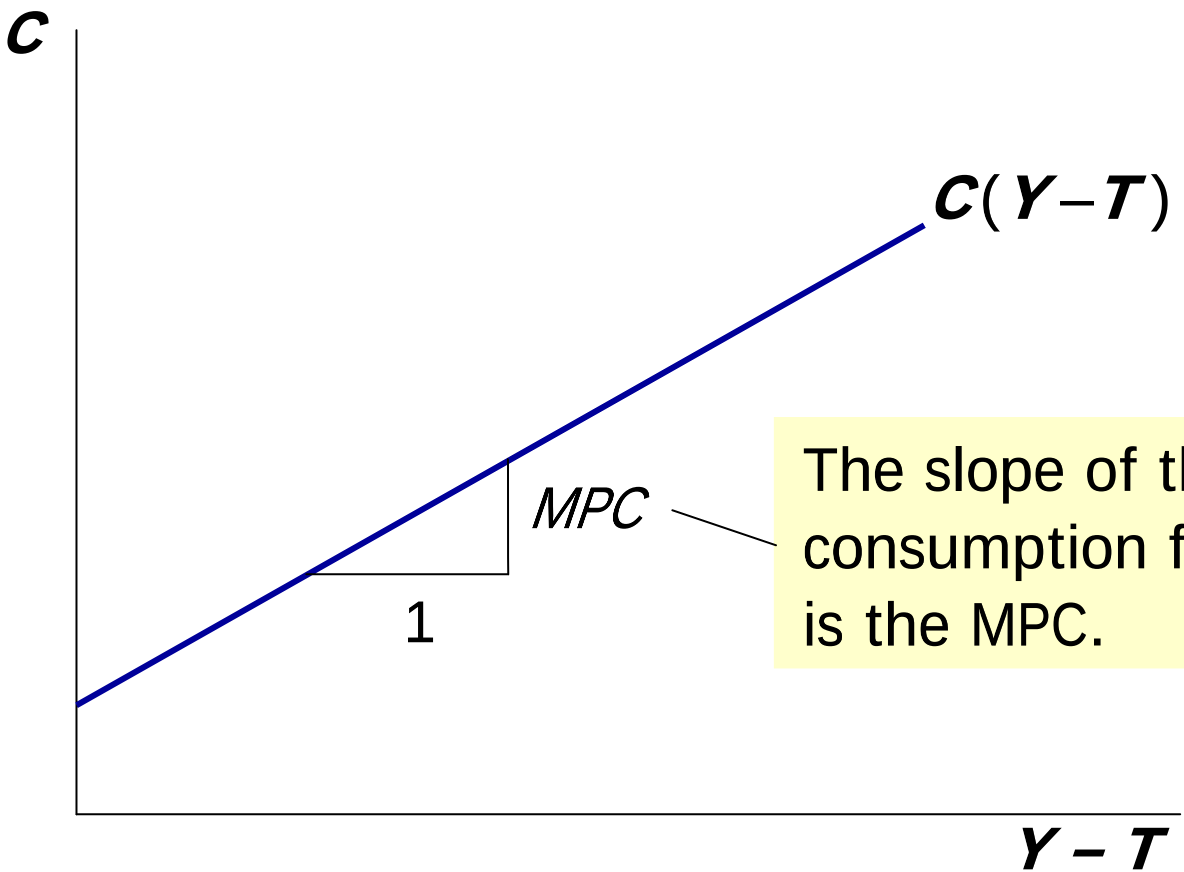
G = government demand for g & s

(closed economy: no ***NX***)

Consumption, C

- def: **disposable income** is total income minus total taxes: $Y - T$
- Consumption function: $C = C(Y - T)$
  Shows that $\uparrow(Y - T) \Rightarrow \uparrow C$
- def: The **marginal propensity to consume** is the increase in C caused by a one-unit increase in disposable income.

The consumption function



The slope of the consumption function is the MPC.

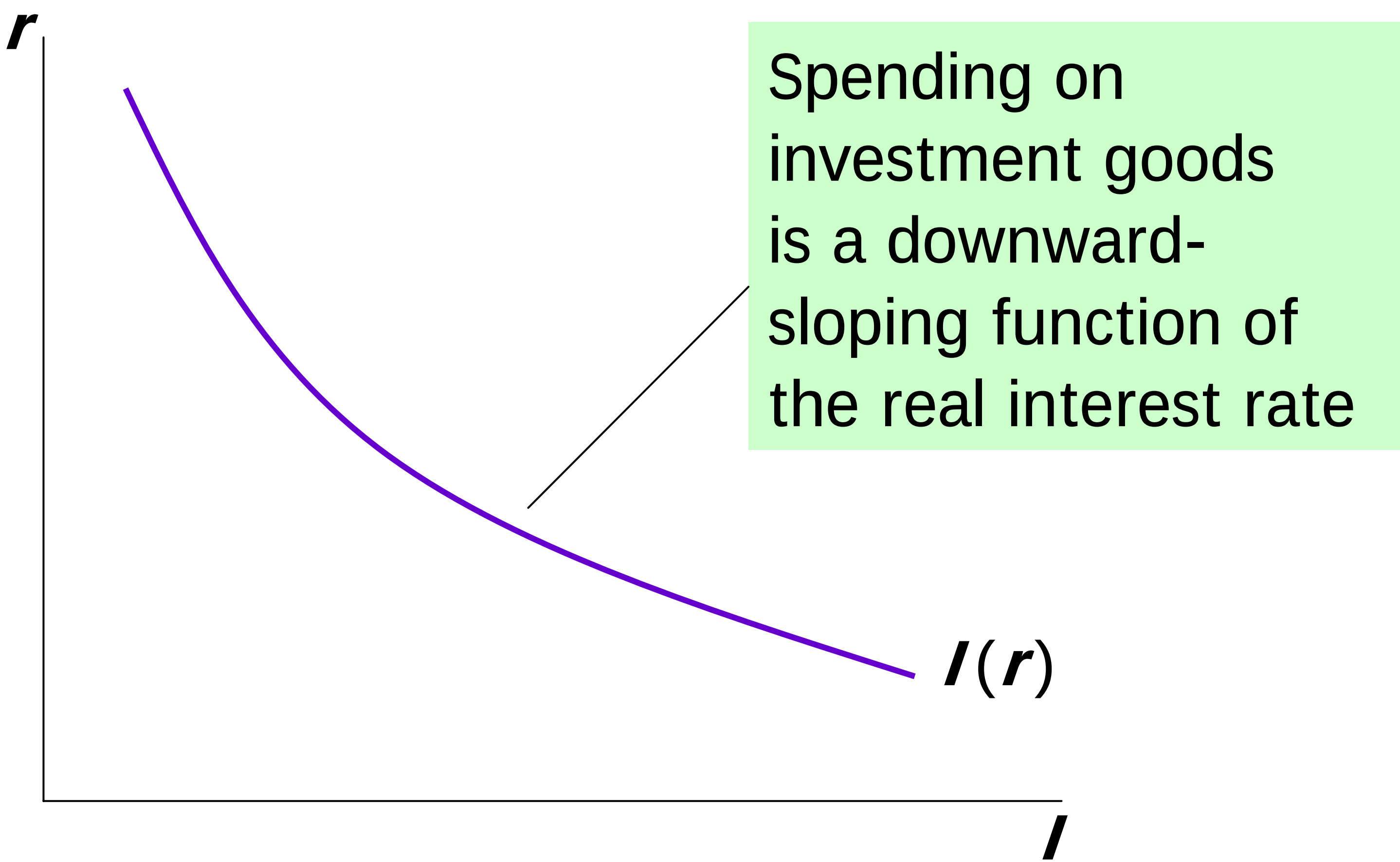
Investment, *I*

- The investment function is $I = I(r)$, where r denotes the **real interest rate**, the nominal interest rate corrected for inflation.
- The real interest rate is
  - the cost of borrowing
  - the opportunity cost of using one's own funds

  to finance investment spending.

  So, $\uparrow r \Rightarrow \downarrow I$

The investment function



Government spending, *G*

- ***G*** includes government spending on goods and services.
- ***G*** excludes *transfer payments*
- Assume government spending and total taxes are exogenous:

$$G = \overline{G} \qquad \text{and} \qquad T = \overline{T}$$

The market for goods & services

- Agg. demand: $C(\overline{Y} - \overline{T}) + I(r) + \overline{G}$
- Agg. supply: $\overline{Y} = F(\overline{K}, \overline{L})$
- Equilibrium: $\overline{Y} = C(\overline{Y} - \overline{T}) + I(r) + \overline{G}$

The real interest rate adjusts to equate demand with supply.

The loanable funds market

A simple supply-demand model of the financial system.

One asset: “loanable funds”

demand for funds: investment

supply of funds: saving

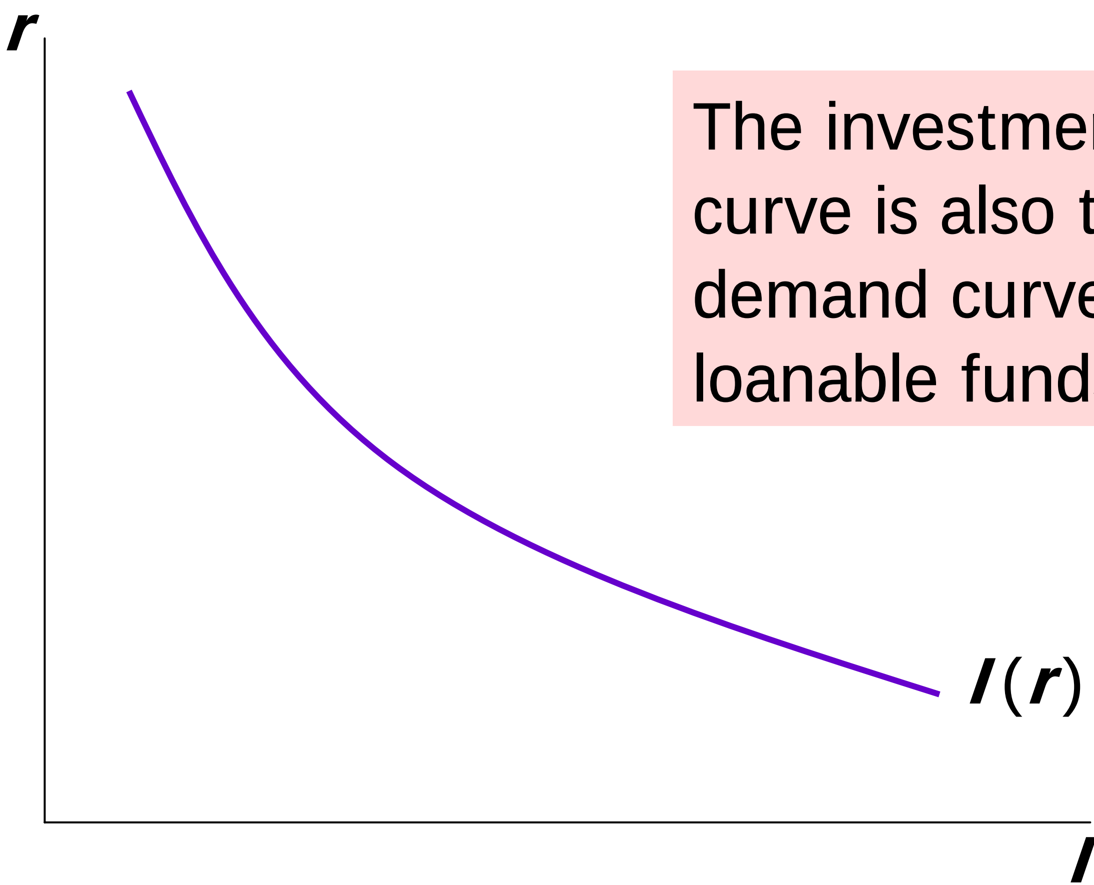
“price” of funds: real interest rate

Demand for funds: Investment

The demand for loanable funds:

- comes from investment:
  Firms borrow to finance spending on plant & equipment, new office buildings, etc. Consumers borrow to buy new houses.
- depends negatively on ***r***, the "price" of loanable funds (the cost of borrowing).

Loanable funds demand curve



The investment curve is also the demand curve for loanable funds.

Supply of funds: Saving

The supply of loanable funds comes from saving:

- Households use their saving to make bank deposits, purchase bonds and other assets. These funds become available to firms to borrow to finance investment spending.
- The government may also contribute to saving if it does not spend all of the tax revenue it receives.

Types of saving

- **private saving** = $(Y - T) - C$
- **public saving** = $T - G$
- **national saving**, S

$= \text{private saving} + \text{public saving}$

$= (Y - T) - C + T - G$

$= Y - C - G$

Notation: Δ *= change in a variable*

- For any variable $\boldsymbol{X}$, $\Delta\boldsymbol{X}$ = "the change in $\boldsymbol{X}$"

  Δ is the Greek (uppercase) letter *Delta*

Examples:

- If $\Delta \boldsymbol{L} = 1$ and $\Delta \boldsymbol{K} = 0$, then $\Delta \boldsymbol{Y} = \boldsymbol{MPL}$.

  More generally, if $\Delta \boldsymbol{K} = 0$, then $\boldsymbol{MPL} = \dfrac{\Delta \boldsymbol{Y}}{\Delta \boldsymbol{L}}$.

- $\Delta(\boldsymbol{Y} - \boldsymbol{T}) = \Delta \boldsymbol{Y} - \Delta \boldsymbol{T}$, so

$$\begin{aligned} \Delta \mathbf{C} &= \boldsymbol{MPC} \times (\Delta \boldsymbol{Y} - \Delta \boldsymbol{T}) \\ &= \boldsymbol{MPC}\,\Delta \boldsymbol{Y} - \boldsymbol{MPC}\,\Delta \boldsymbol{T} \end{aligned}$$

EXERCISE:

Calculate the change in saving

Suppose MPC = 0.8 and MPL = 20.

For each of the following, compute ΔS :

a. $\Delta G = 100$

b. $\Delta T = 100$

c. $\Delta Y = 100$

d. $\Delta L = 10$

Answers

$$\Delta S = \Delta Y - \Delta C - \Delta G \quad = \Delta Y - 0.8(\Delta Y - \Delta T) - \Delta G$$
$$= 0.2\Delta Y + 0.8\Delta T - \Delta G$$

a. $\Delta S = -100$

b. $\Delta S = 0.8 \times 100 = 80$

c. $\Delta S = 0.2 \times 100 = 20$

d. $\Delta Y = \text{MPL} \times \Delta L = 20 \times 10 = 200,$

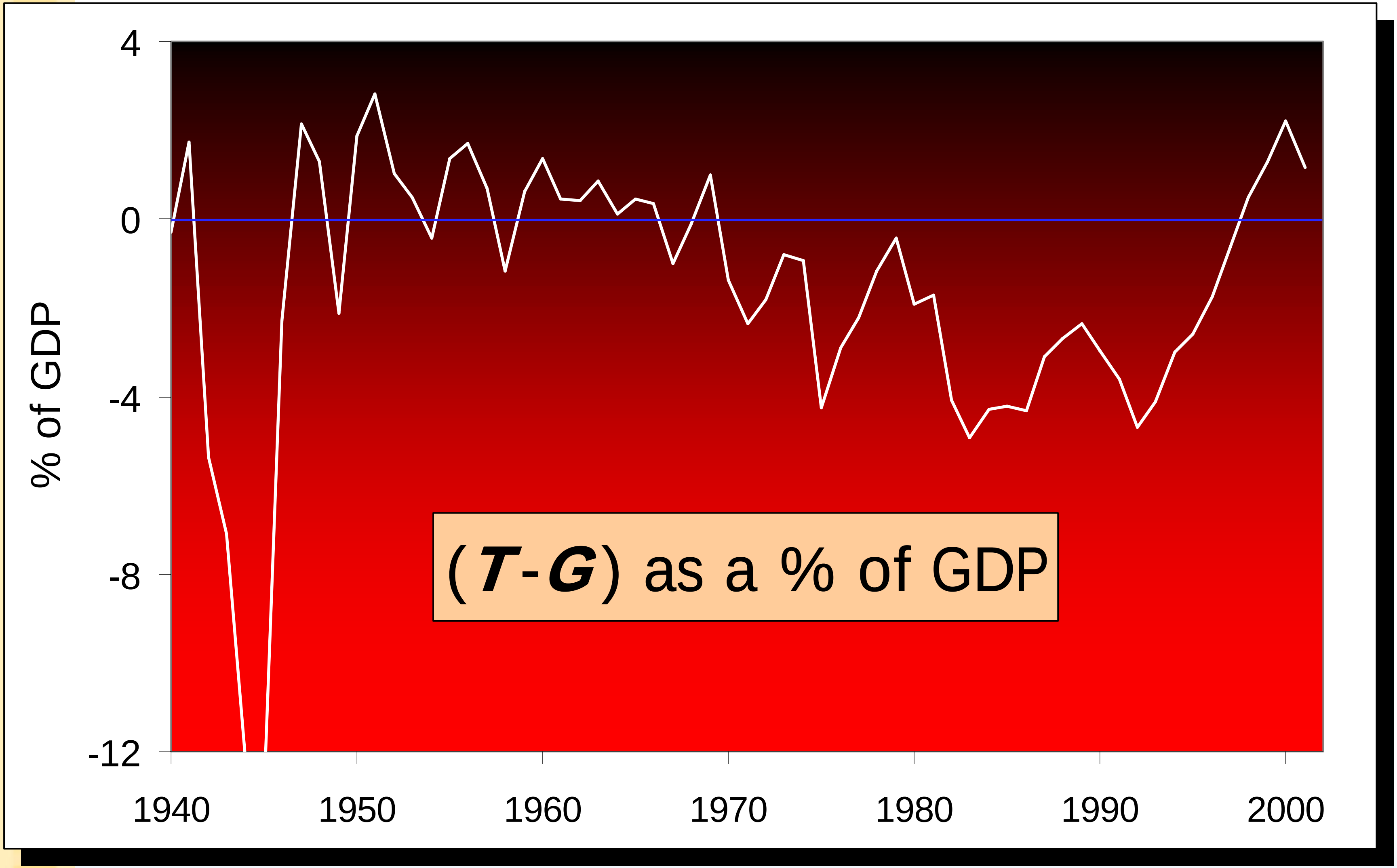
$\Delta S = 0.2 \times \Delta Y = 0.2 \times 200 = 40.$

digression:

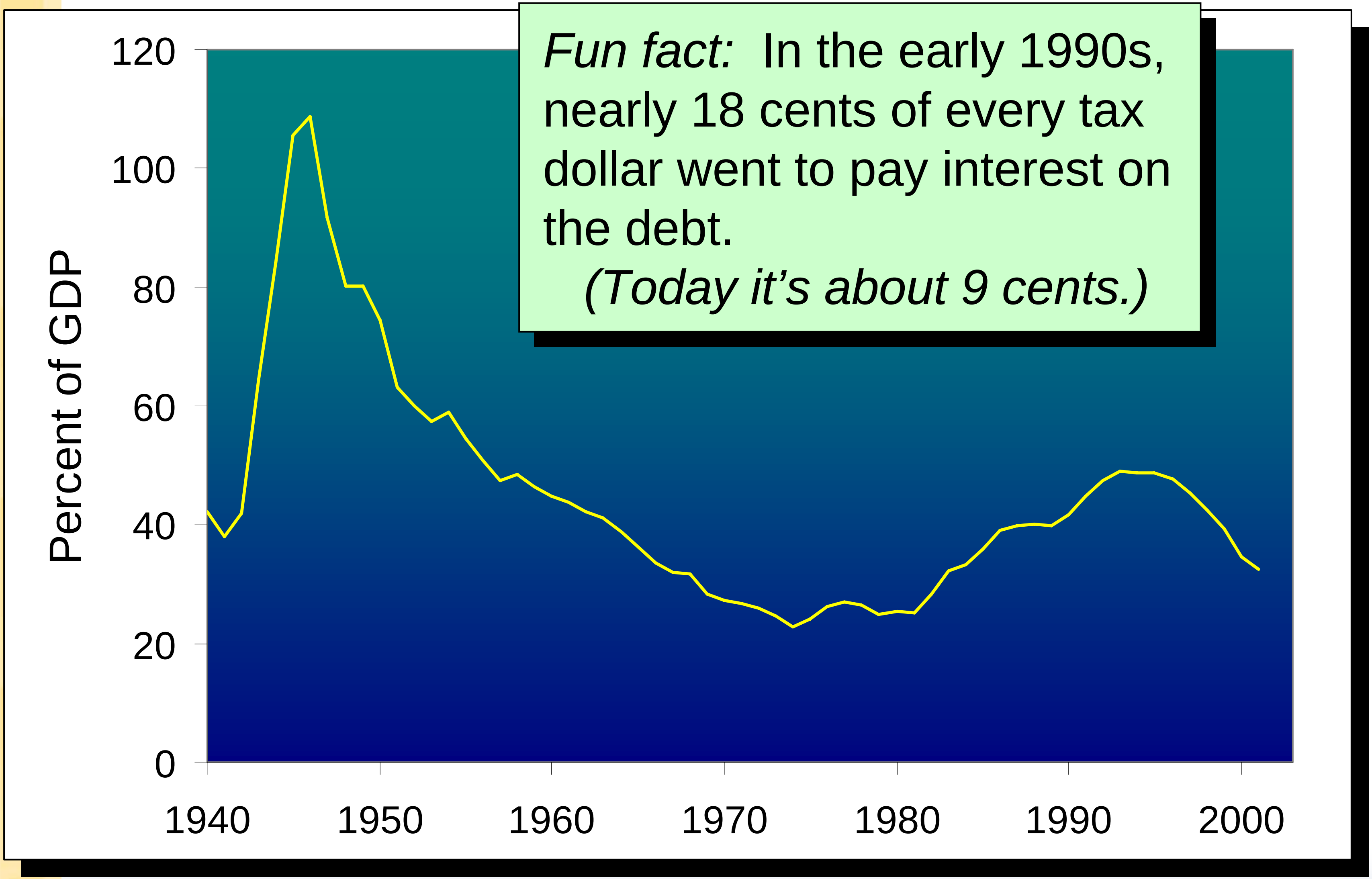
Budget surpluses and deficits

- When $T > G$,
  budget surplus = $(T - G)$ = public saving
- When $T < G$,
  budget deficit = $(G - T)$
  and public saving is negative.
- When $T = G$,
  budget is balanced and public saving = 0.

The U.S. Federal Government Budget



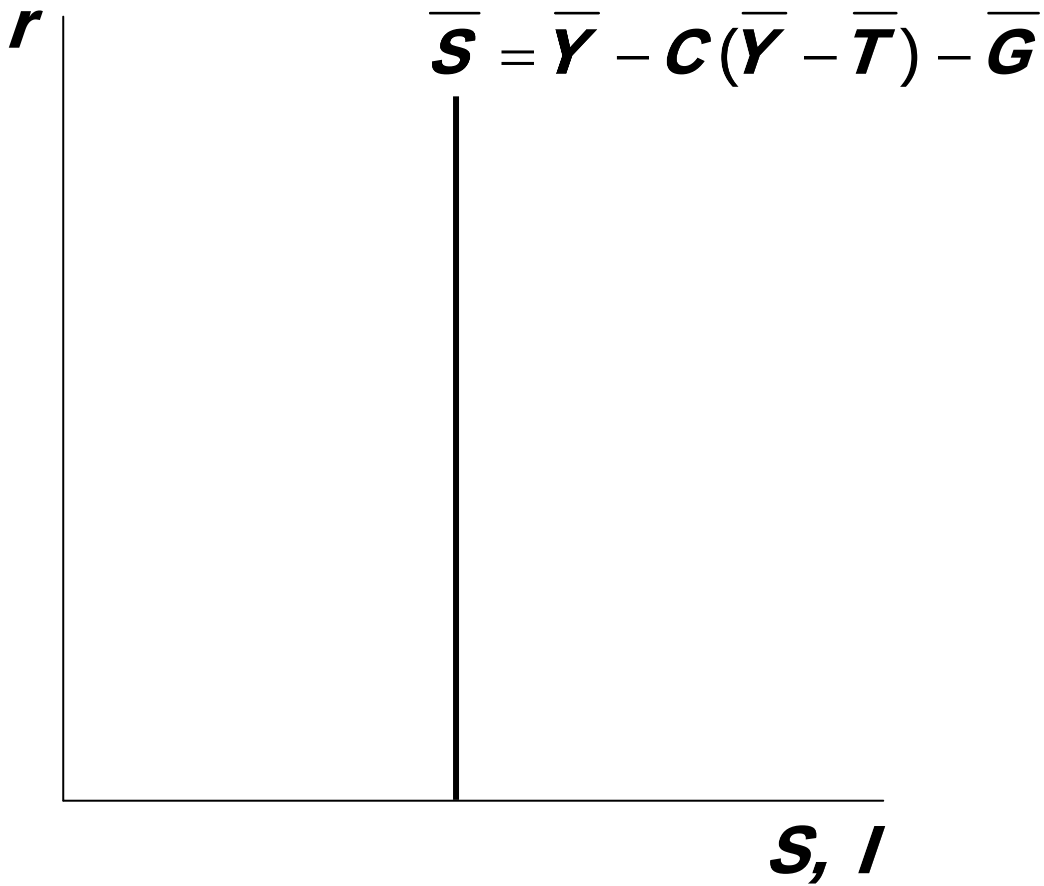
The U.S. Federal Government Debt



Fun fact: In the early 1990s, nearly 18 cents of every tax dollar went to pay interest on the debt.

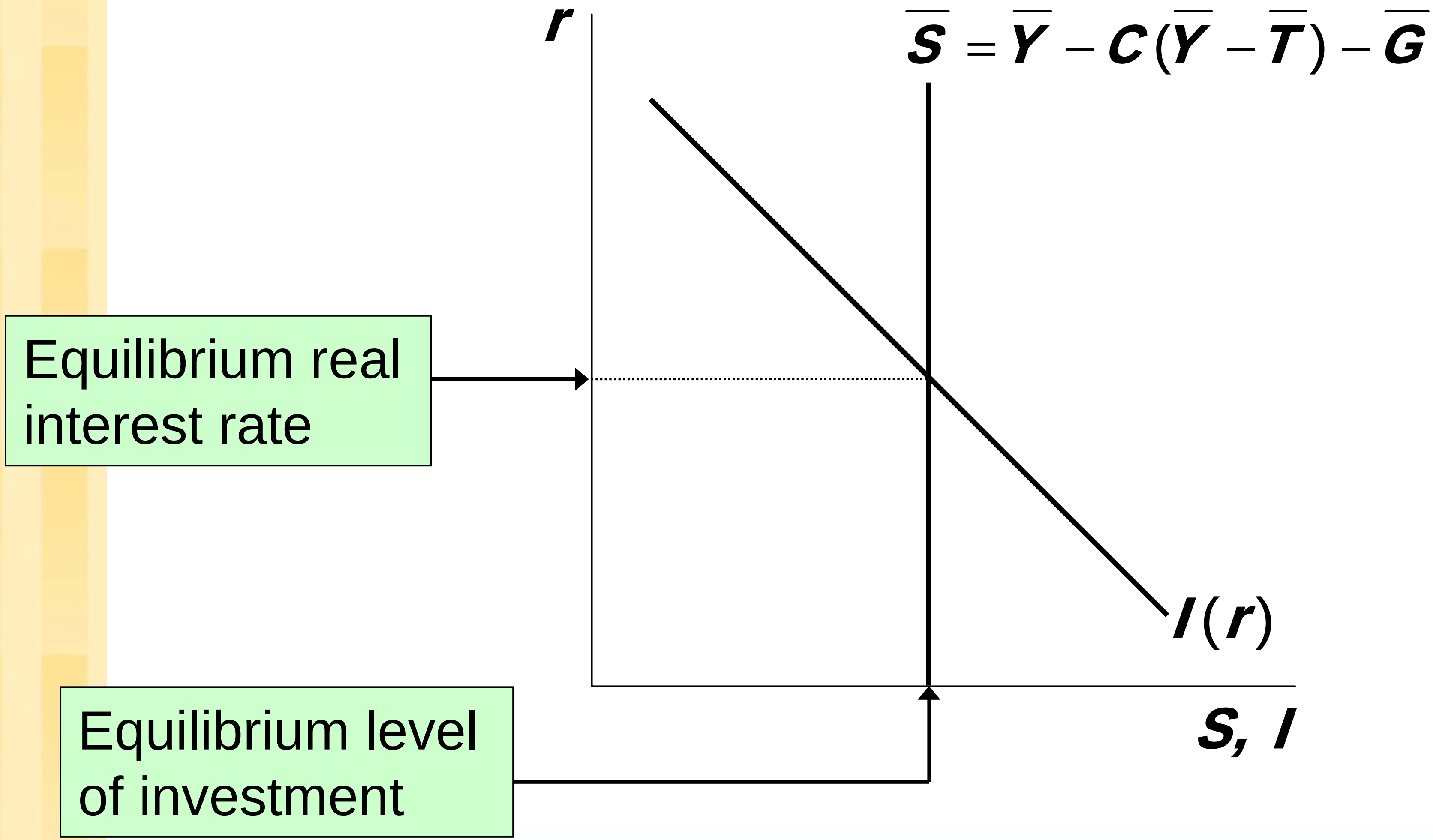
(Today it's about 9 cents.)

Loanable funds supply curve



National saving does not depend on ***r***, so the supply curve is vertical.

Loanable funds market equilibrium



The special role of *r*

r adjusts to equilibrate the goods market <u>and</u> the loanable funds market simultaneously:

If L.F. market in equilibrium, then

$$Y - C - G = I$$

Add $(C + G)$ to both sides to get

$$Y = C + I + G \quad \textit{(goods market eq'm)}$$

Thus,

Eq'm in L.F. market	$\Leftrightarrow$	Eq'm in goods market

Digression: mastering models

To learn a model well, be sure to know:

1. Which of its variables are endogenous and which are exogenous.
2. For each curve in the diagram, know
   a. definition
   b. intuition for slope
   c. all the things that can shift the curve
3. Use the model to analyze the effects of each item in 2c .

Mastering the loanable funds model

1. Things that shift the saving curve
   a. public saving
      i. fiscal policy: changes in ***G*** or ***T***
   b. private saving
      i. preferences
      ii. tax laws that affect saving
         - 401(k)
         - IRA
         - replace income tax with consumption tax

CASE STUDY

The Reagan Deficits

- Reagan policies during early 1980s:
  - increases in defense spending: $\Delta G > 0$
  - big tax cuts: $\Delta T < 0$

- According to our model, both policies reduce national saving:

$$\bar{S} = \bar{Y} - C(\bar{Y} - \bar{T}) - \bar{G}$$

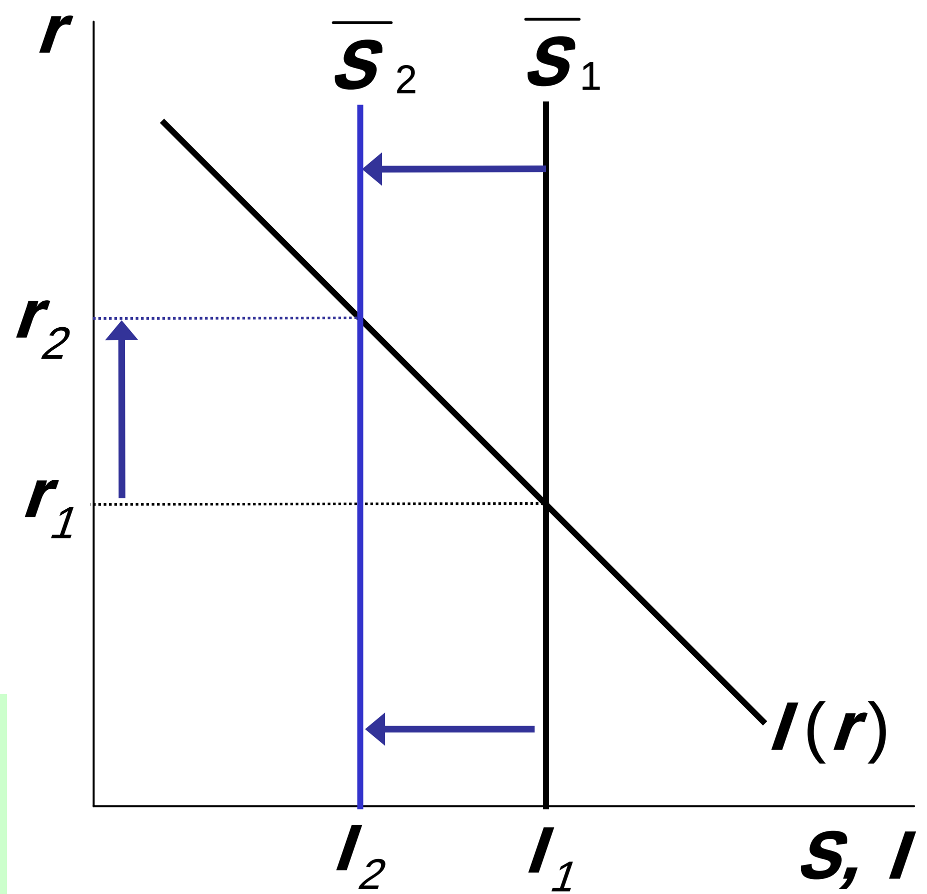
$$\boxed{\uparrow \bar{G} \Rightarrow \downarrow \bar{S}} \qquad \boxed{\downarrow \bar{T} \Rightarrow \uparrow C \Rightarrow \downarrow \bar{S}}$$

1. The Reagan deficits, cont.

1. The increase in the deficit reduces saving…

2. …which causes the real interest rate to rise…

3. …which reduces the level of investment.



Are the data consistent with these results?

variable	1970s	1980s
T* – *G	–2.2	–3.9
S	19.6	17.4
r	1.1	6.3
I	19.9	19.4

***T–G**, **S**, and **I** are expressed as a percent of GDP*

All figures are averages over the decade shown.

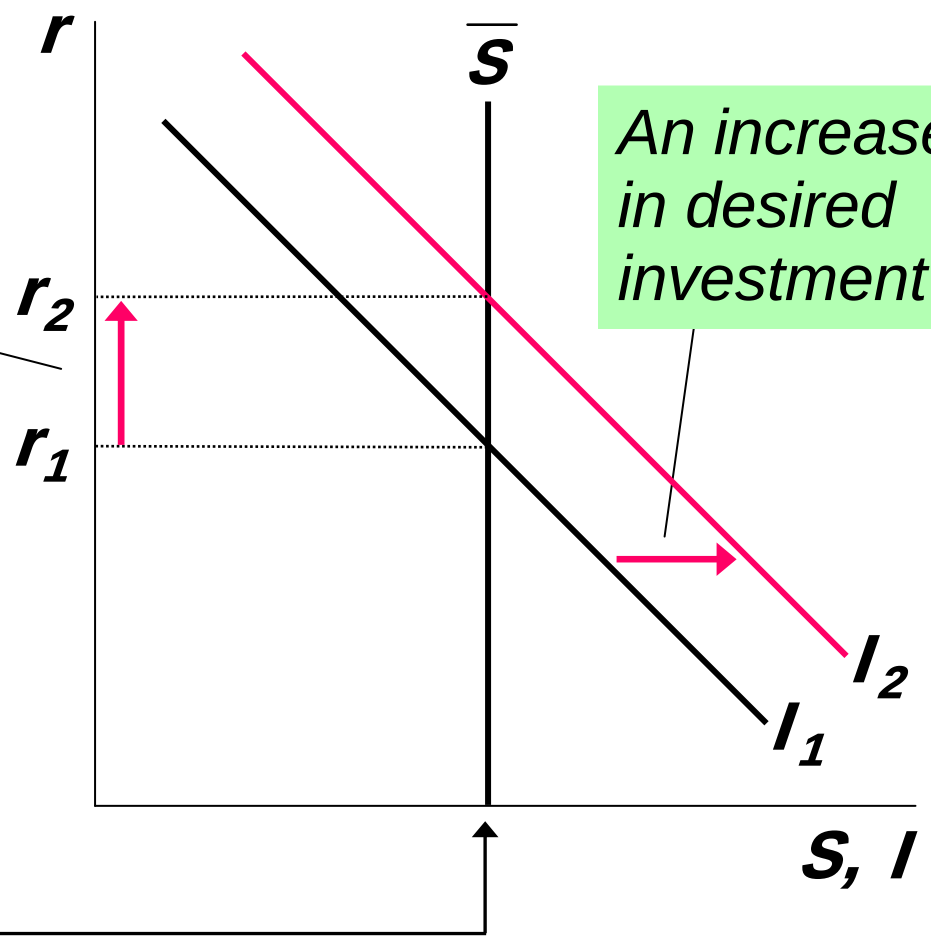
Now you try…

- Draw the diagram for the loanable funds model.
- Suppose the tax laws are altered to provide more incentives for private saving.
- What happens to the interest rate and investment?
- (Assume that ***T*** doesn’t change)

Mastering the loanable funds model

2. Things that shift the investment curve
   a. certain technological innovations
      - to take advantage of the innovation, firms must buy new investment goods
   b. tax laws that affect investment
      - investment tax credit

An increase in investment demand



An increase in desired investment…

…raises the interest rate.

But the equilibrium level of investment cannot increase because the supply of loanable funds is fixed.

Chapter summary

1. Total output is determined by
   - how much capital and labor the economy has
   - the level of technology
2. Competitive firms hire each factor until its marginal product equals its price.
3. If the production function has constant returns to scale, then labor income plus capital income equals total income (output).

Chapter summary

4. The economy's output is used for
   - consumption
     (which depends on disposable income)
   - investment
     (depends on the real interest rate)
   - government spending
     (exogenous)

5. The real interest rate adjusts to equate the demand for and supply of
   - goods and services
   - loanable funds

Chapter summary

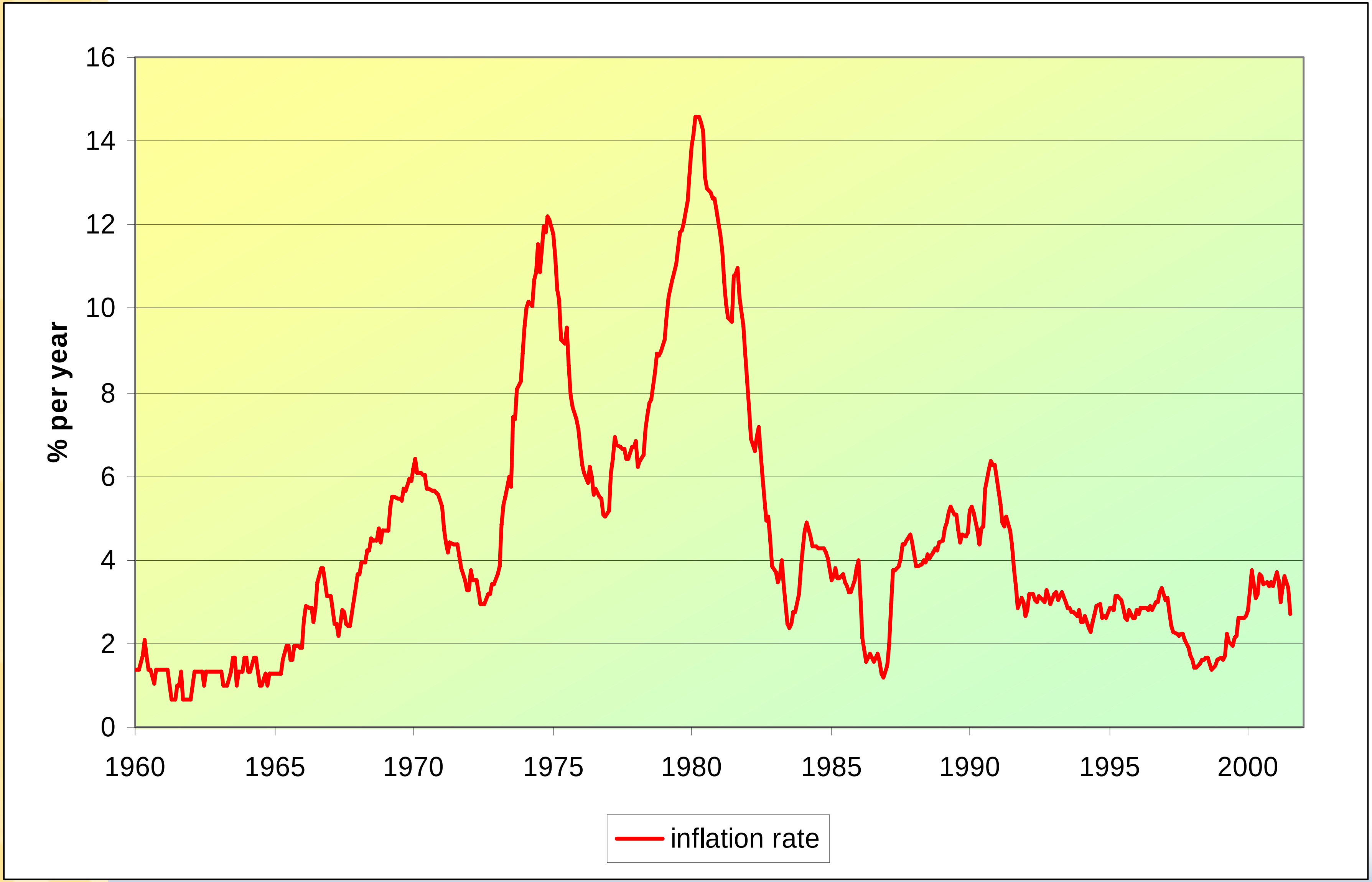
6. A decrease in national saving causes the interest rate to rise and investment to fall.

   An increase in investment demand causes the interest rate to rise, but does not affect the equilibrium level of investment if the supply of loanable funds is fixed.

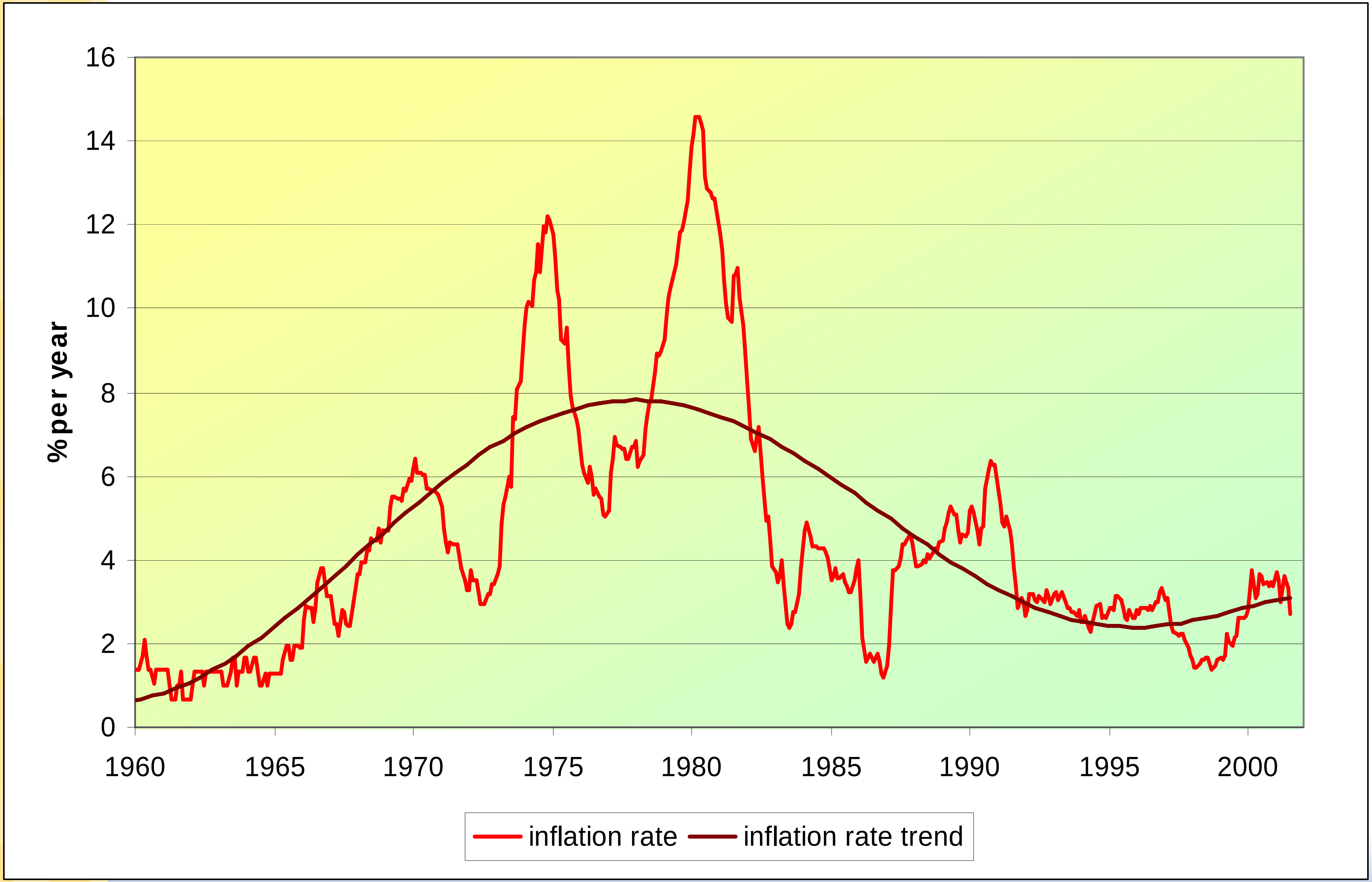
In this chapter you will learn

- The classical theory of inflation
  - causes
  - effects
  - social costs
- "Classical" -- assumes prices are flexible & markets clear.
- Applies to the long run.

U.S. inflation & its trend, 1960-2001



U.S. inflation & its trend, 1960-2001



The connection between money and prices

- Inflation rate = the percentage increase in the average level of prices.
- price = amount of money required to buy a good.
- Because prices are defined in terms of money, we need to consider the nature of money, the supply of money, and how it is controlled.

Money: definition

Money is the stock of assets that can be readily used to make transactions.

Money: functions

1. **medium of exchange**
   we use it to buy stuff
2. **store of value**
   transfers purchasing power from the present to the future
3. **unit of account**
   the common unit by which everyone measures prices and values

Money: types

1. **fiat money**
   - *has no intrinsic value*
   - *example: the paper currency we use*
2. **commodity money**
   - *has intrinsic value*
   - *examples: gold coins, cigarettes in P.O.W. camps*

Discussion Question

Which of these are money?

a. Currency

b. Checks

c. Deposits in checking accounts (called demand deposits)

d. Credit cards

e. Certificates of deposit (called time deposits)

The money supply & monetary policy

- The **money supply** is the quantity of money available in the economy.
- **Monetary policy** is the control over the money supply.

The central bank

- Monetary policy is conducted by a country's **central bank**.

- In the U.S., the central bank is called the **Federal Reserve** ("the **Fed**").

The Federal Reserve Building
Washington, DC

Money supply measures, April 2002

Symbol	Assets included	Amount (billions)
C	Currency	$598.7
M1	C + demand deposits, travelers' checks, other checkable deposits	1174.0
M2	M1 + small time deposits, savings deposits, money market mutual funds, money market deposit accounts	5480.1
M3	M2 + large time deposits, repurchase agreements, institutional money market mutual fund balances	8054.4

The Quantity Theory of Money

- A simple theory linking the inflation rate to the growth rate of the money supply.
- Begins with a concept called "**velocity**"...

Velocity

- *basic concept:* the rate at which money circulates
- *definition:* the number of times the average dollar bill changes hands in a given time period
- example: In 2001,
  - $500 billion in transactions
  - money supply = $100 billion
  - The average dollar is used in five transactions in 2001
  - So, velocity = 5

Velocity, *cont.*

- This suggests the following definition:

$$V = \frac{T}{M}$$

where

V = velocity

T = value of all transactions

M = money supply

Velocity, *cont.*

- Use nominal GDP as a proxy for total transactions.

Then,

$$V = \frac{P \times Y}{M}$$

where

P	=	price of output	(GDP deflator)
Y	=	quantity of output	(real GDP)
$P \times Y$	=	value of output	(nominal GDP)

The quantity equation

- The **quantity equation**

$$M \times V = P \times Y$$

follows from the preceding definition of velocity.

- It is an *identity:*
it holds by definition of the variables.

Money demand and the quantity equation

- ***M/P*** = **real money balances**, the purchasing power of the money supply.
- A simple money demand function:

  $$(M/P)^d = kY$$

  where

  k = how much money people wish to hold for each dollar of income.

  (***k*** is exogenous)

Money demand and the quantity equation

- money demand: $(\boldsymbol{M/P})^d = \boldsymbol{kY}$
- quantity equation: $\boldsymbol{M} \times \boldsymbol{V} = \boldsymbol{P} \times \boldsymbol{Y}$
- The connection between them: $\boldsymbol{k} = 1/\boldsymbol{V}$
- When people hold lots of money relative to their incomes (***k*** is high), money changes hands infrequently (***V*** is low).

back to the Quantity Theory of Money

- starts with quantity equation
- assumes ***V*** is constant & exogenous:

$$\boldsymbol{V} = \boldsymbol{\bar{V}}$$

- With this assumption, the quantity equation can be written as

$$\boldsymbol{M} \times \boldsymbol{\bar{V}} = \boldsymbol{P} \times \boldsymbol{Y}$$

The Quantity Theory of Money, *cont.*

$$M \times \overline{V} = P \times Y$$

How the price level is determined:

- With V constant, the money supply determines nominal GDP ($P \times Y$)
- Real GDP is determined by the economy's supplies of K and L and the production function (chap 3)
- The price level is
  P = (nominal GDP)/(real GDP)

The Quantity Theory of Money, *cont.*

- *Recall from Chapter 2:*
  The growth rate of a product equals the sum of the growth rates.
- The quantity equation in growth rates:

$$\frac{\Delta \boldsymbol{M}}{\boldsymbol{M}} + \frac{\Delta \boldsymbol{V}}{\boldsymbol{V}} = \frac{\Delta \boldsymbol{P}}{\boldsymbol{P}} + \frac{\Delta \boldsymbol{Y}}{\boldsymbol{Y}}$$

The quantity theory of money assumes $\boldsymbol{V}$ is constant, so $\frac{\Delta \boldsymbol{V}}{\boldsymbol{V}} = 0$.

The Quantity Theory of Money, *cont.*

Let π (Greek letter "pi") denote the inflation rate:

$$\pi = \frac{\Delta P}{P}$$

The result from the preceding slide was:

$$\frac{\Delta M}{M} = \frac{\Delta P}{P} + \frac{\Delta Y}{Y}$$

Solve this result for π to get

$$\boxed{\pi = \frac{\Delta M}{M} - \frac{\Delta Y}{Y}}$$

The Quantity Theory of Money, *cont.*

$$\pi = \frac{\Delta \boldsymbol{M}}{\boldsymbol{M}} - \frac{\Delta \boldsymbol{Y}}{\boldsymbol{Y}}$$

- Normal economic growth requires a certain amount of money supply growth to facilitate the growth in transactions.
- Money growth in excess of this amount leads to inflation.

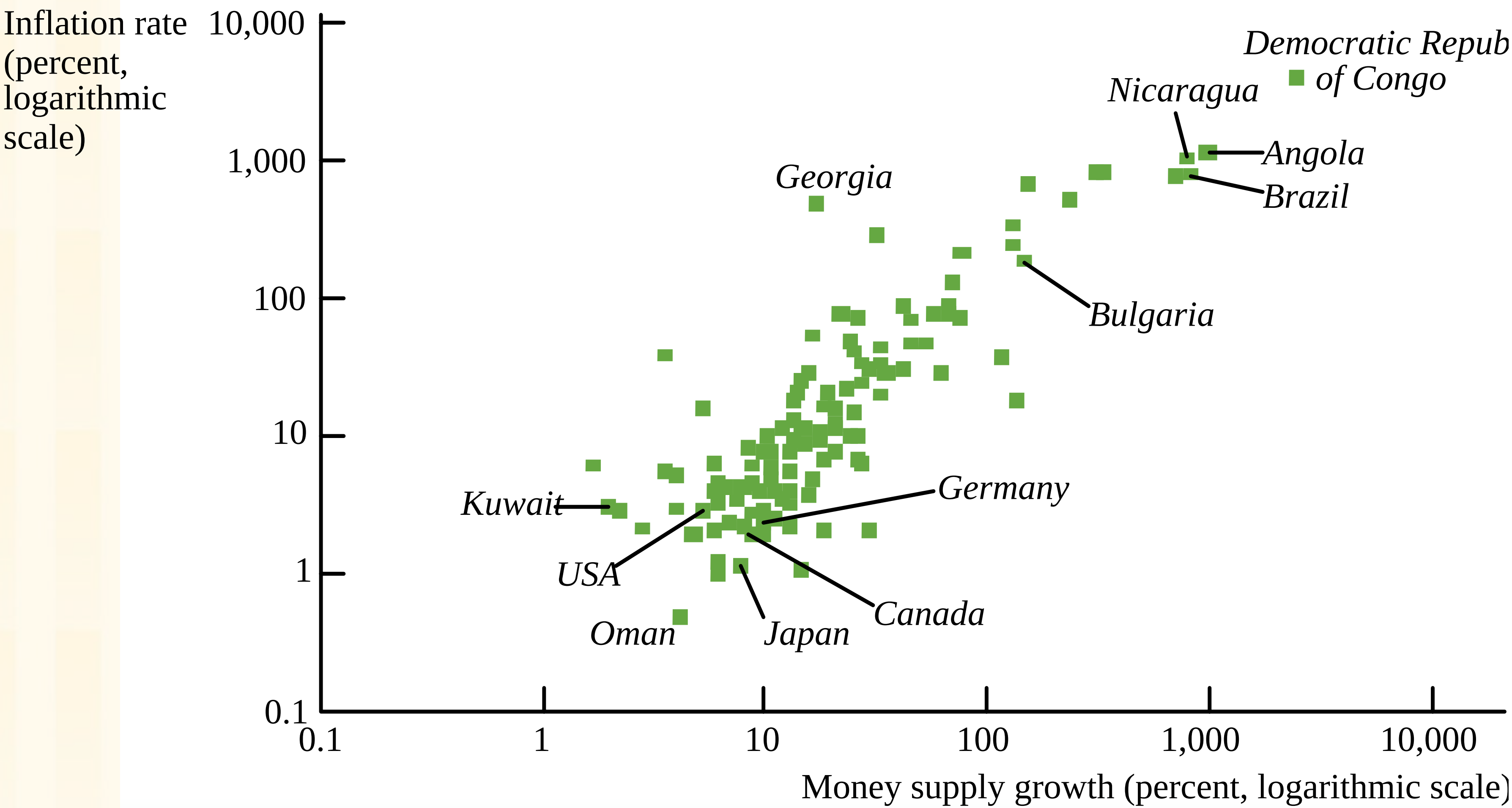
The Quantity Theory of Money, *cont.*

$$\pi = \frac{\Delta M}{M} - \frac{\Delta Y}{Y}$$

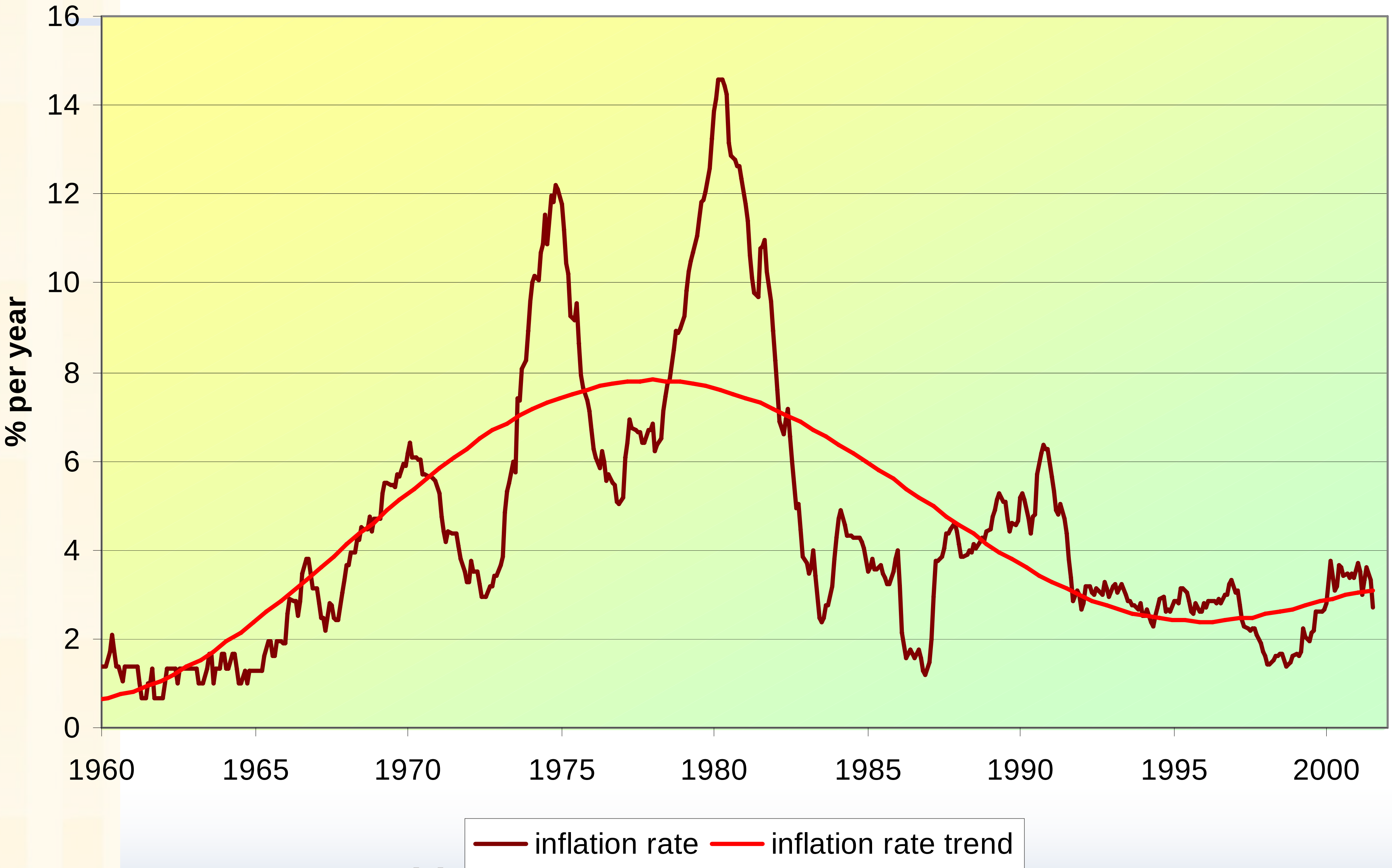
$\Delta Y/Y$ depends on growth in the factors of production and on technological progress (all of which we take as given, for now).

Hence, the Quantity Theory of Money predicts a one-for-one relation between changes in the money growth rate and changes in the inflation rate.

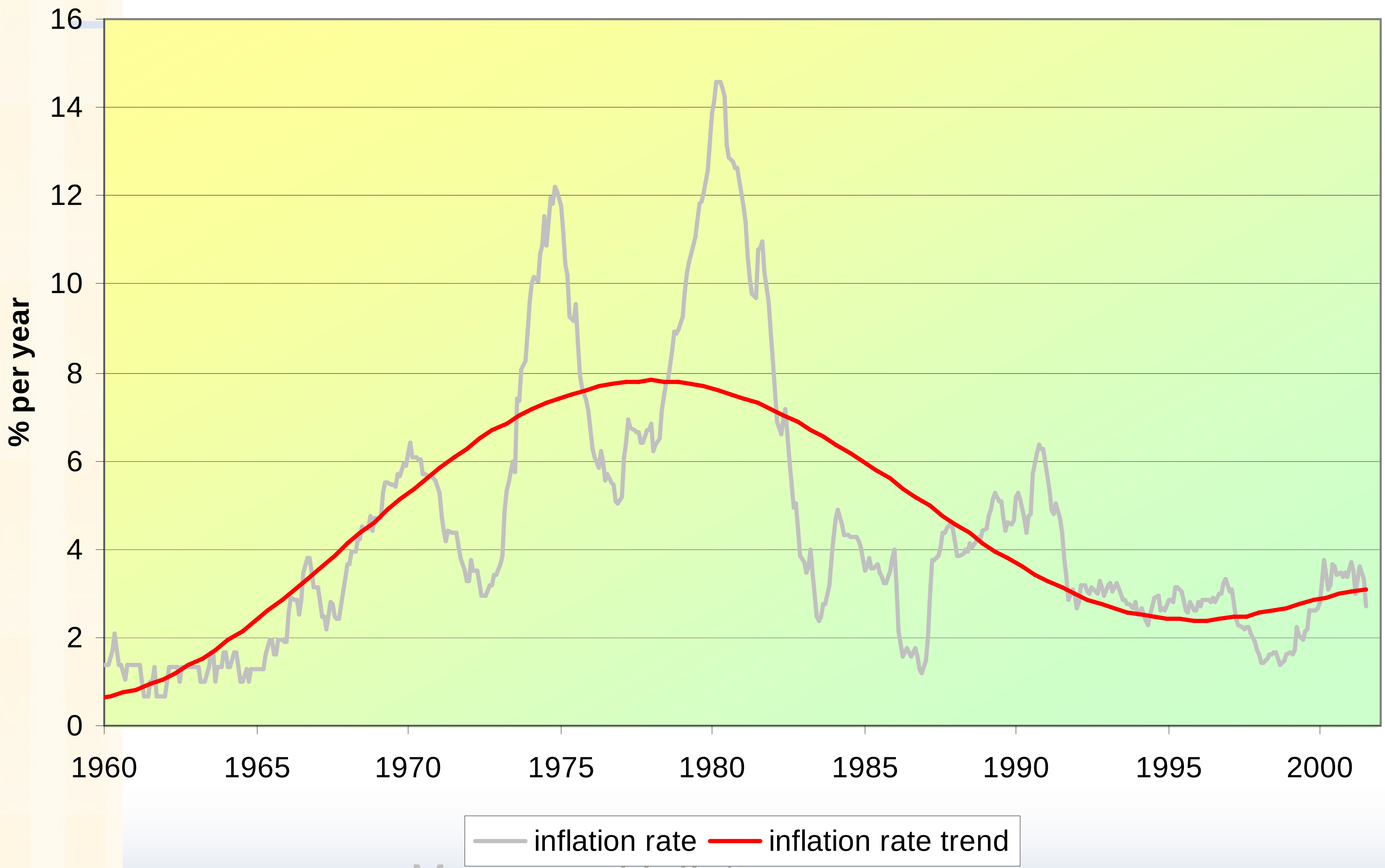
International data on inflation and money growth



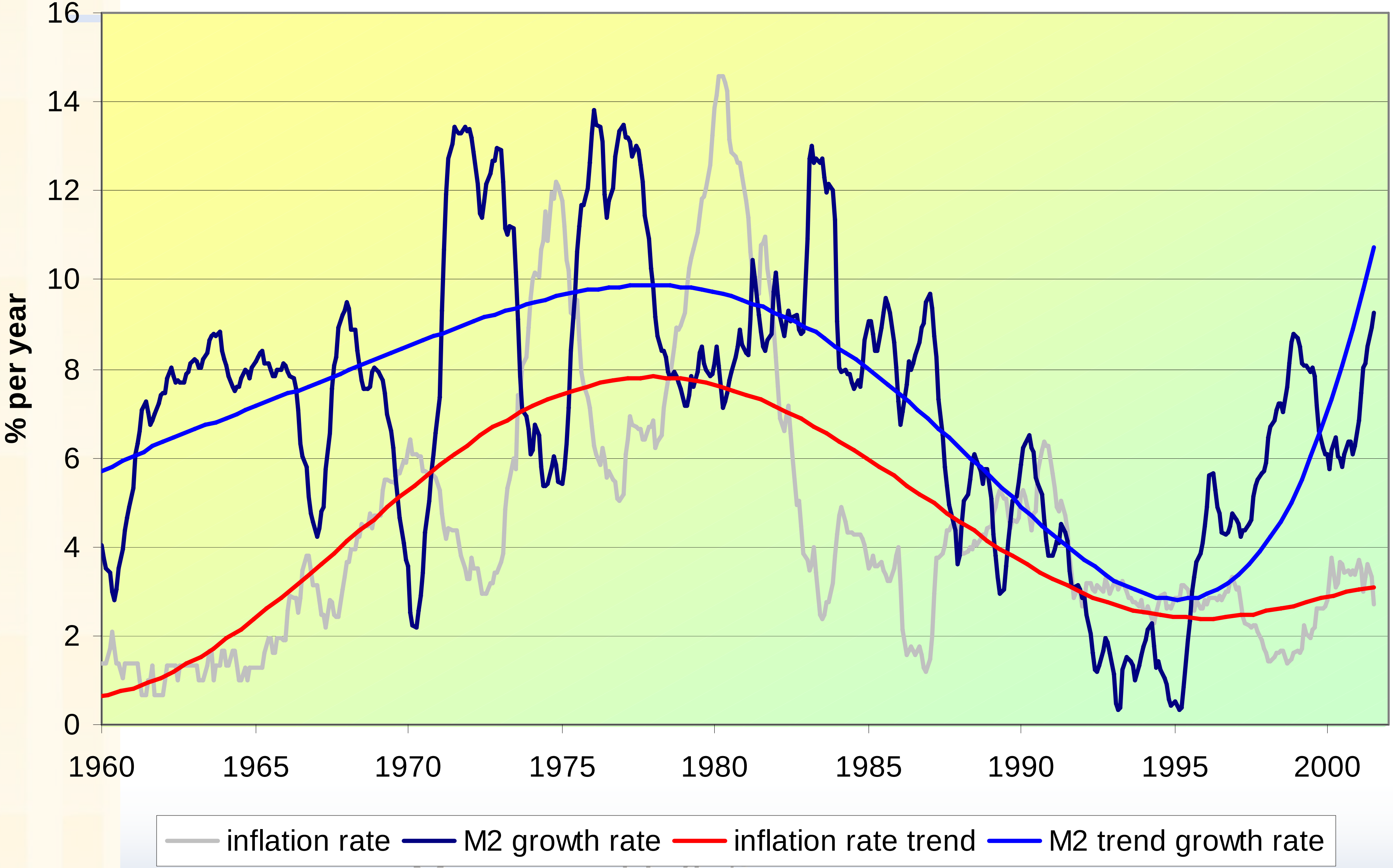
U.S. Inflation & Money Growth, 1960-2001



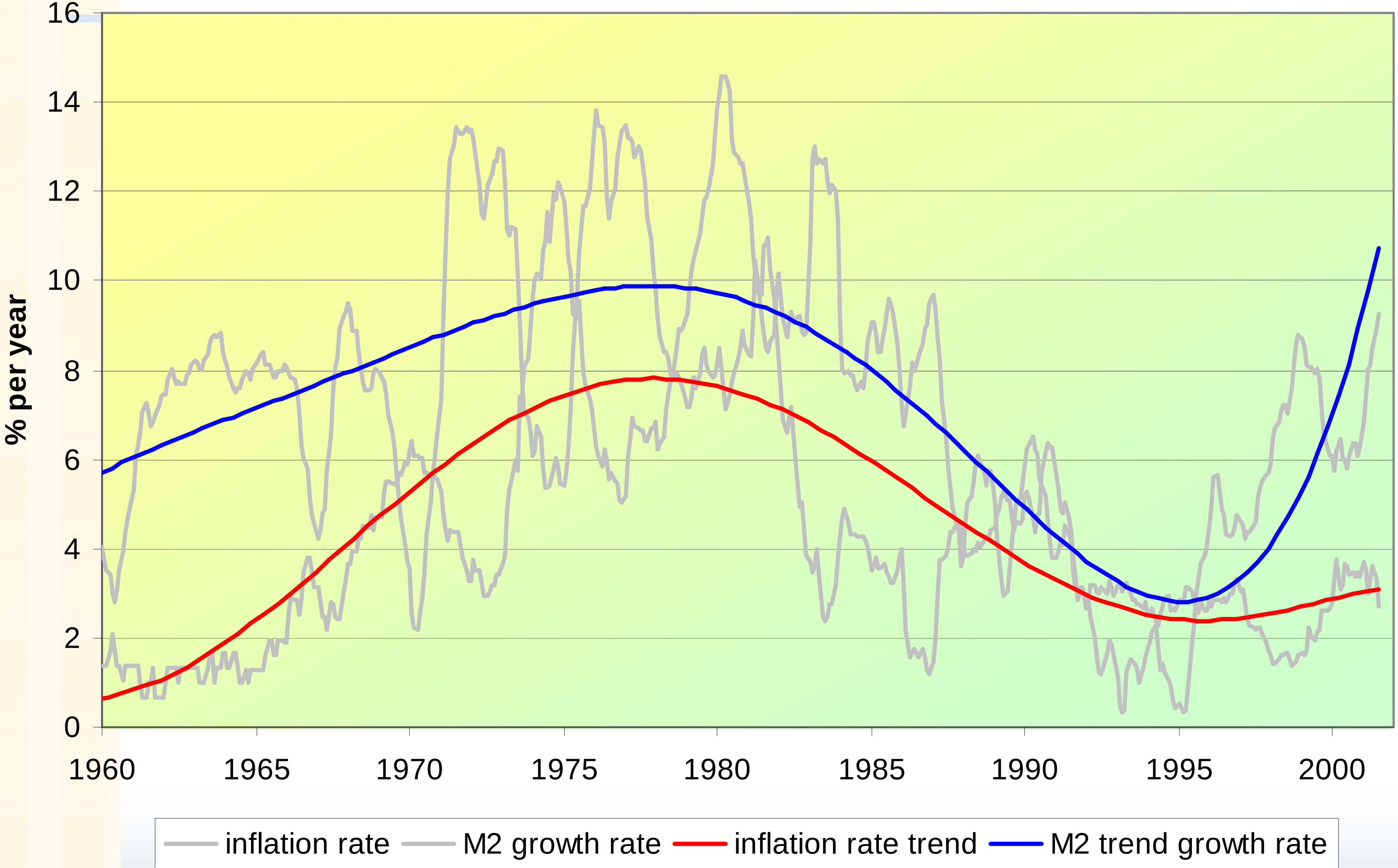
U.S. Inflation & Money Growth, 1960-2001



U.S. Inflation & Money Growth, 1960-2001



U.S. Inflation & Money Growth, 1960-2001



Seigniorage

- To spend more without raising taxes or selling bonds, the govt can print money.
- The "revenue" raised from printing money is called **seigniorage**
  (pronounced SEEN-your-ige)
- The **inflation tax**:
  Printing money to raise revenue causes inflation. Inflation is like a tax on people who hold money.

Inflation and interest rates

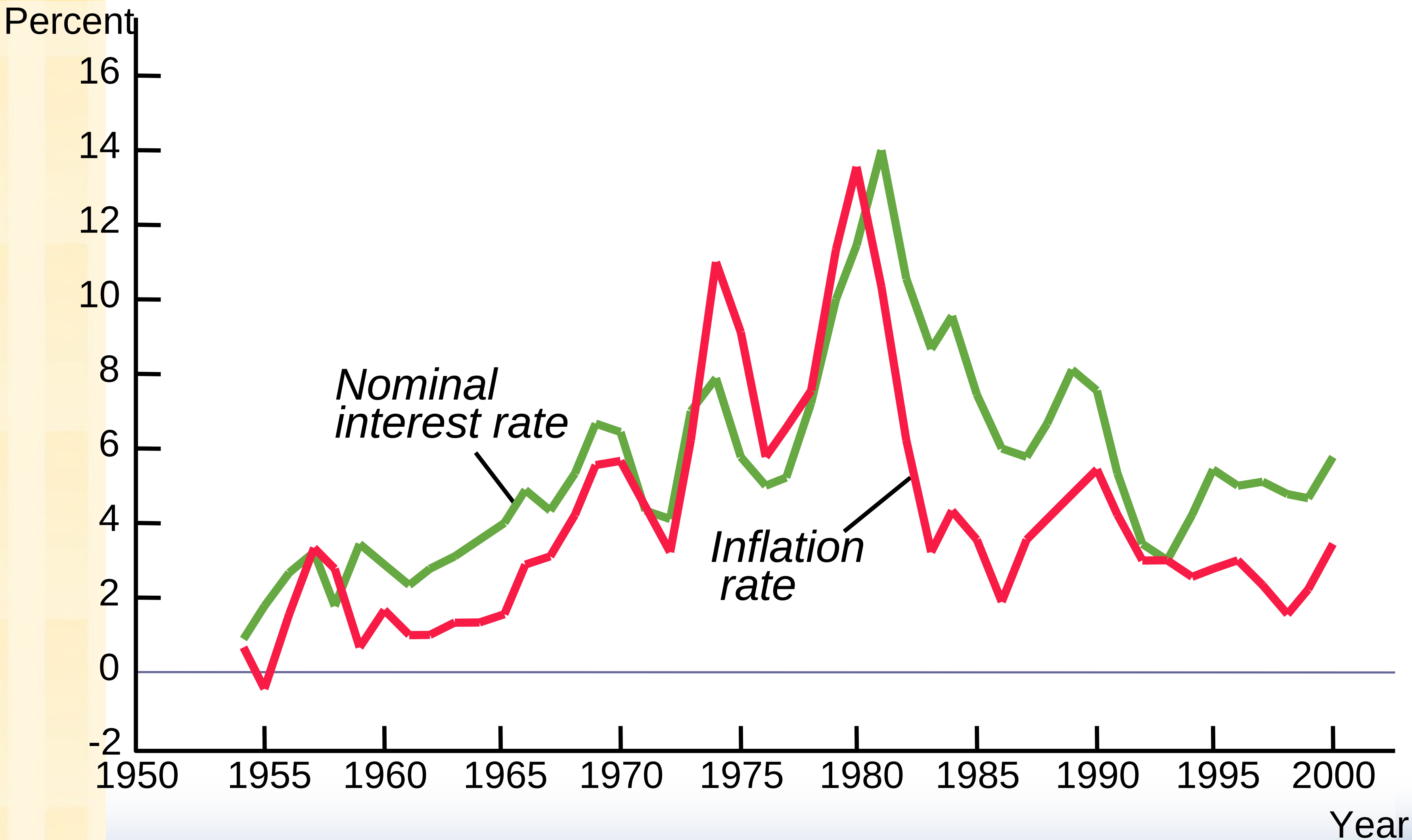
- Nominal interest rate, $\boldsymbol{i}$
  not adjusted for inflation
- Real interest rate, $\boldsymbol{r}$
  adjusted for inflation:

$$\boldsymbol{r} = \boldsymbol{i} - \pi$$

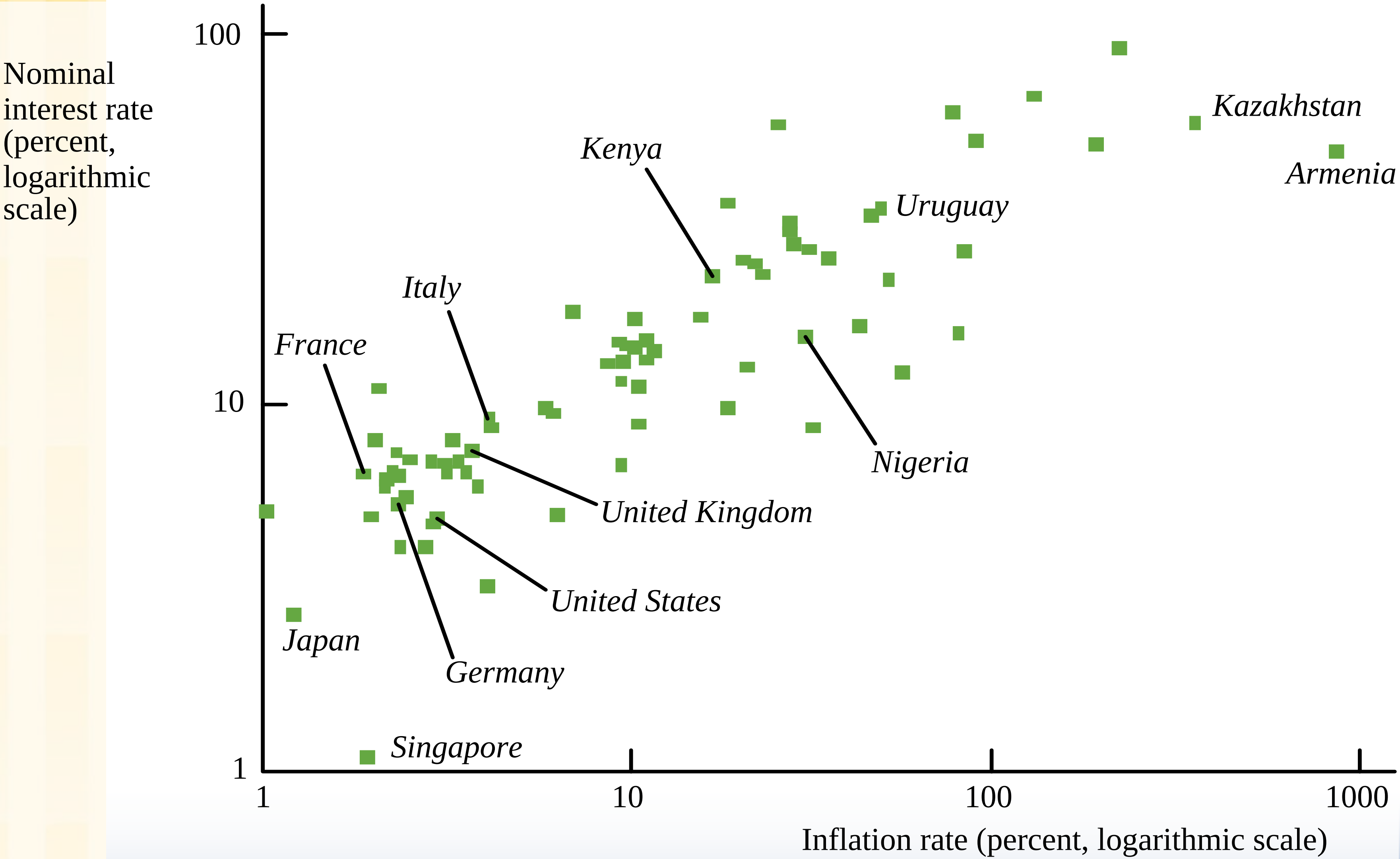
The Fisher Effect

- The Fisher equation: $\boldsymbol{i} = \boldsymbol{r} + \pi$
- Chap 3: $\boldsymbol{S} = \boldsymbol{I}$ determines $\boldsymbol{r}$.
- Hence, an increase in π causes an equal increase in $\boldsymbol{i}$.
- This one-for-one relationship is called the **Fisher effect**.

U.S. inflation and nominal interest rates, 1952-1998



Inflation and nominal interest rates across countries



Exercise:

Suppose ***V*** is constant, ***M*** is growing 5% per year, ***Y*** is growing 2% per year, and ***r*** = 4.

a. Solve for ***i*** (the nominal interest rate).

b. If the Fed increases the money growth rate by 2 percentage points per year, find $\Delta \boldsymbol{i}$.

c. Suppose the growth rate of ***Y*** falls to 1% per year.
   - What will happen to π?
   - What must the Fed do if it wishes to keep π constant?

Answers:

Suppose V is constant, M is growing 5% per year, Y is growing 2% per year, and $r = 4$.

a. First, find $\pi = 5 - 2 = 3$.

Then, find $i = r + \pi = 4 + 3 = 7$.

b. $\Delta i = 2$, same as the increase in the money growth rate.

c. If the Fed does nothing, $\Delta\pi = 1$.

To prevent inflation from rising, Fed must reduce the money growth rate by 1 percentage point per year.

Two real interest rates

- π = actual inflation rate
  (not known until after it has occurred)
- π^e = expected inflation rate
- $i - \pi^e$ = ***ex ante*** real interest rate:
  what people expect at the time they buy a bond or take out a loan
- $i - \pi$ = ***ex post*** real interest rate:
  what people actually end up earning on their bond or paying on their loan

Money demand and the nominal interest rate

- The Quantity Theory of Money assumes that the demand for real money balances depends only on real income $\boldsymbol{Y}$.
- We now consider another determinant of money demand: the nominal interest rate.
- The nominal interest rate $\boldsymbol{i}$ is the opportunity cost of holding money (instead of bonds or other interest-earning assets).
- Hence, $\uparrow \boldsymbol{i} \Rightarrow \downarrow$ in money demand.

The money demand function

$$(\boldsymbol{M}/\boldsymbol{P})^{\mathrm{d}} = \boldsymbol{L}(\boldsymbol{i}, \boldsymbol{Y})$$

$(\boldsymbol{M/P})^{\mathrm{d}}$ = real money demand, depends

- negatively on $\boldsymbol{i}$

  $\boldsymbol{i}$ is the opp. cost of holding money

- positively on $\boldsymbol{Y}$

  higher $\boldsymbol{Y}$ $\Rightarrow$ more spending

  $\Rightarrow$ so, need more money

($\boldsymbol{L}$ is used for the money demand function because money is the most liquid asset.)

The money demand function

$$(M/P)^d = L(i, Y)$$

$$= L(r + \pi^e, Y)$$

When people are deciding whether to hold money or bonds, they don't know what inflation will turn out to be.

Hence, the nominal interest rate relevant for money demand is $r + \pi^e$.

Equilibrium

$$\frac{\boldsymbol{M}}{\boldsymbol{P}} = \underline{\boldsymbol{L}(\boldsymbol{r} + \pi^{\boldsymbol{e}}, \boldsymbol{Y})}$$

The supply of real money balances

Real money demand

What determines what

$$\frac{M}{P} = L(r + \pi^e, Y)$$

variable	how determined *(in the long run)*
M	exogenous (the Fed)
r	adjusts to make $S = I$
Y	$\overline{Y} = F(\overline{K}, \overline{L})$
P	adjusts to make $\frac{M}{P} = L(i, Y)$

How *P* responds to ΔM

$$\frac{M}{P} = L(r + \pi^e, Y)$$

- For given values of r, Y, and π^e, a change in M causes P to change by the same percentage --- just like in the Quantity Theory of Money.

What about expected inflation?

- Over the long run, people don't consistently over- or under-forecast inflation, so $\pi^e = \pi$ on average.
- In the short run, π^e may change when people get new information.
- EX: Suppose Fed announces it will increase ***M*** next year. People will expect next year's ***P*** to be higher, so π^e rises.
- This will affect ***P*** now, even though ***M*** hasn't changed yet.

(continued...)

How P responds to $\Delta\pi^e$

$$\frac{M}{P} = L(r + \pi^e, Y)$$

- For given values of r, Y, and M,

$$\uparrow \pi^e \;\Rightarrow\; \uparrow i \quad \text{(the Fisher effect)}$$

$$\Rightarrow\; \downarrow (M/P)^d$$

$$\Rightarrow\; \uparrow P \quad \text{to make } (M/P) \text{ fall}$$

to re-establish eq'm

Discussion Question

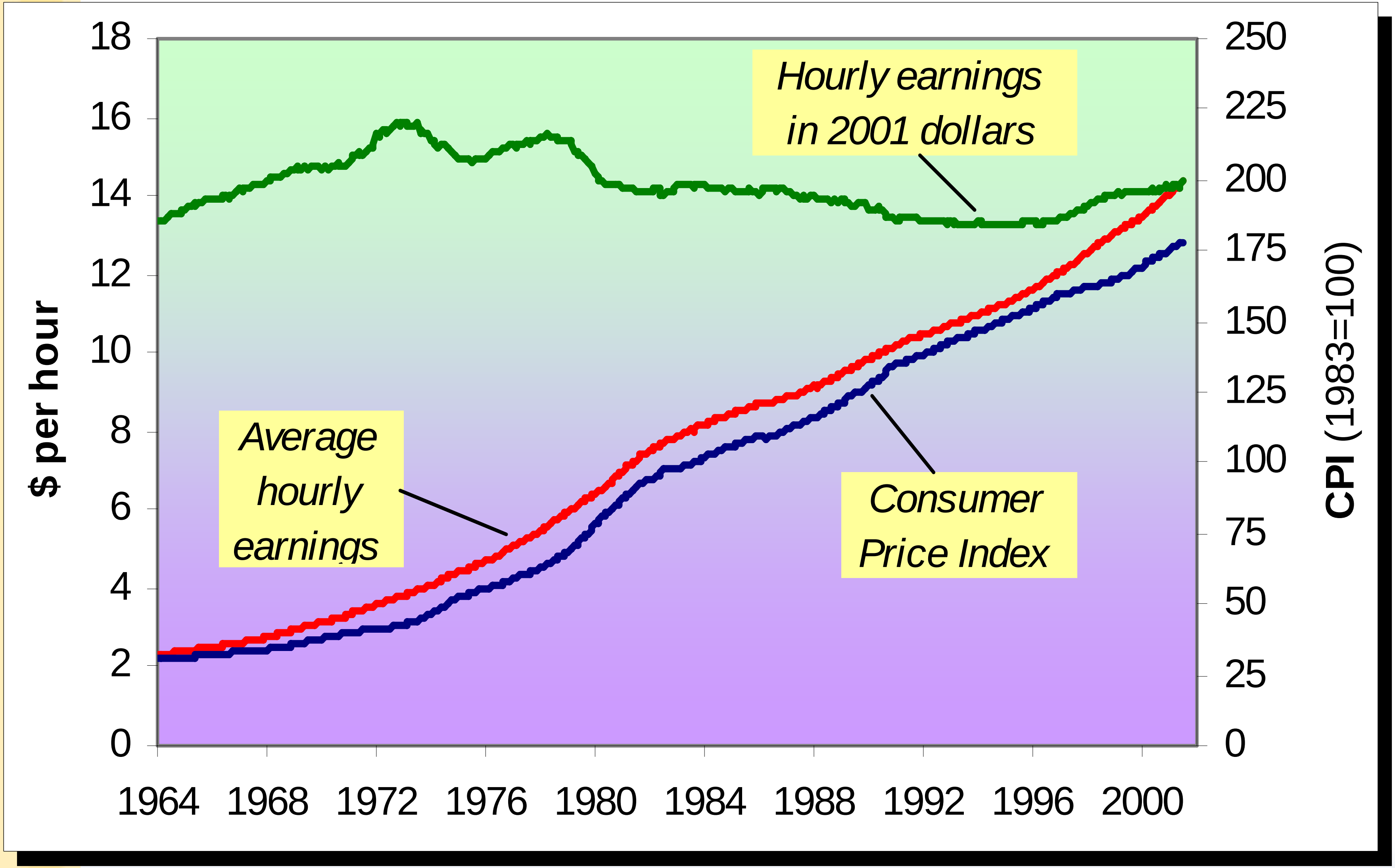
Why is inflation bad?

- What costs does inflation impose on society? List all the ones you can think of.
- Focus on the long run.
- Think like an economist.

A common misperception

- Common misperception:
  inflation reduces real wages
- This is true only in the short run, when nominal wages are fixed by contracts.
- (Chap 3) In the long run,
  the real wage is determined by labor supply and the marginal product of labor,
  not the price level or inflation rate.
- Consider the data...

Average hourly earnings & the CPI



The classical view of inflation

- *The classical view:*
  A change in the price level is merely a change in the units of measurement.

So why, then, is inflation a social problem?

The social costs of inflation

...fall into two categories:

1. costs when inflation is expected
2. additional costs when inflation is different than people had expected.

The costs of expected inflation: 1. shoeleather cost

- def: the costs and inconveniences of reducing money balances to avoid the inflation tax.
- $\uparrow \pi \;\Rightarrow\; \uparrow \boldsymbol{i}$

  $\Rightarrow\; \downarrow$ real money balances
- Remember: In long run, inflation doesn't affect real income or real spending.
- So, same monthly spending but lower average money holdings means more frequent trips to the bank to withdraw smaller amounts of cash.

The costs of expected inflation: 2. menu costs

- def: The costs of changing prices.
- Examples:
  - print new menus
  - print & mail new catalogs
- The higher is inflation, the more frequently firms must change their prices and incur these costs.

The costs of expected inflation:
3. relative price distortions

- Firms facing menu costs change prices infrequently.
- Example:
  Suppose a firm issues new catalog each January. As the general price level rises throughout the year, the firm's relative price will fall.
- Different firms change their prices at different times, leading to relative price distortions...
- ...which cause microeconomic inefficiencies in the allocation of resources.

The costs of expected inflation:
4. unfair tax treatment

Some taxes are not adjusted to account for inflation, such as the capital gains tax.

Example:

- 1/1/2001: you bought $10,000 worth of Starbucks stock
- 12/31/2001: you sold the stock for $11,000, so your nominal capital gain was $1000 (10%).
- Suppose π = 10% in 2001.
  Your real capital gain is $0.
- But the govt requires you to pay taxes on your $1000 nominal gain!!

The costs of expected inflation: 4. General inconvenience

- Inflation makes it harder to compare nominal values from different time periods.
- This complicates long-range financial planning.

Additional cost of *unexpected* inflation: arbitrary redistributions of purchasing power

- Many long-term contracts not indexed, but based on π^e.
- If π turns out different from π^e, then some gain at others' expense.

  Example: borrowers & lenders

  - If $\pi > \pi^e$, then $(r - \pi) < (r - \pi^e)$ and purchasing power is transferred from lenders to borrowers.
  - If $\pi < \pi^e$, then purchasing power is transferred from borrowers to lenders.

Additional cost of high inflation: increased uncertainty

- When inflation is high, it's more variable and unpredictable:
  π turns out different from π^e more often, and the differences tend to be larger
  (though not systematically positive or negative)

- Arbitrary redistributions of wealth become more likely.

- This creates higher uncertainty, which makes risk averse people worse off.

One benefit of inflation

- Nominal wages are rarely reduced, even when the equilibrium real wage falls.
- Inflation allows the real wages to reach equilibrium levels without nominal wage cuts.
- Therefore, moderate inflation improves the functioning of labor markets.

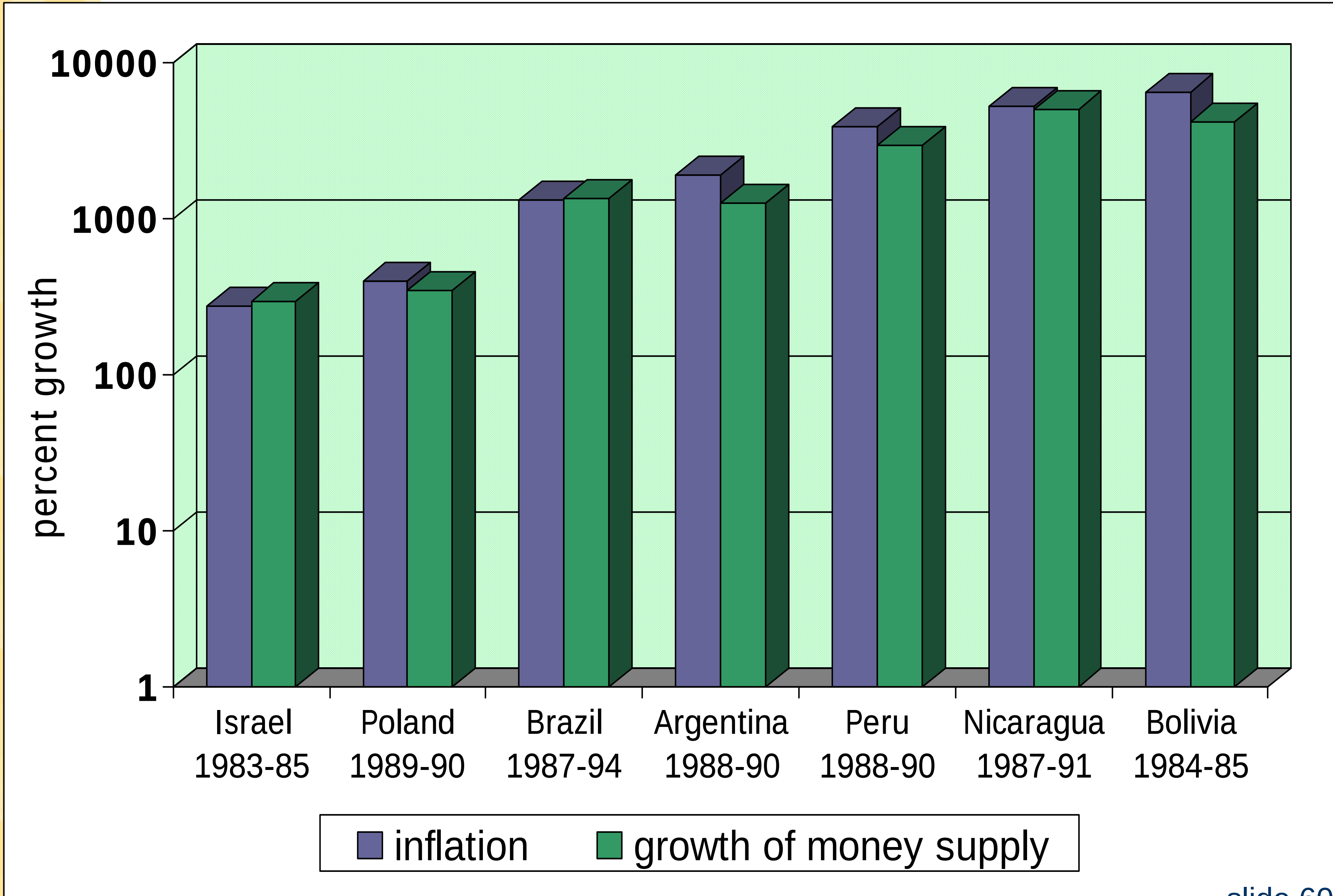
Hyperinflation

- def: $\pi \geq 50\%$ per month
- All the costs of moderate inflation described above become ***HUGE*** under hyperinflation.
- Money ceases to function as a store of value, and may not serve its other functions (unit of account, medium of exchange).
- People may conduct transactions with barter or a stable foreign currency.

What causes hyperinflation?

- Hyperinflation is caused by excessive money supply growth:
- When the central bank prints money, the price level rises.
- If it prints money rapidly enough, the result is hyperinflation.

Recent episodes of hyperinflation



Why governments create hyperinflation

- When a government cannot raise taxes or sell bonds,
- it must finance spending increases by printing money.
- In theory, the solution to hyperinflation is simple: stop printing money.
- In the real world, this requires drastic and painful fiscal restraint.

The Classical Dichotomy

Real variables are measured in physical units: quantities and relative prices, e.g.

- quantity of output produced
- real wage: output earned per hour of work
- real interest rate: output earned in the future by lending one unit of output today

Nominal variables*:* measured in money units, e.g.

- nominal wage: dollars per hour of work
- nominal interest rate: dollars earned in future by lending one dollar today
- the price level: the amount of dollars needed to buy a representative basket of goods

The Classical Dichotomy

- Note: Real variables were explained in Chap 3, nominal ones in Chap 4.
- ***Classical Dichotomy***: the theoretical separation of real and nominal variables in the classical model, which implies nominal variables do not affect real variables.
- ***Neutrality of Money***: Changes in the money supply do not affect real variables.

  In the real world, money is approximately neutral in the long run.

Chapter summary

1. Money
   - the stock of assets used for transactions
   - serves as a medium of exchange, store of value, and unit of account.
   - Commodity money has intrinsic value, fiat money does not.
   - Central bank controls money supply.

2. Quantity theory of money
   - assumption: velocity is stable
   - conclusion: the money growth rate determines the inflation rate.

Chapter summary

3. Nominal interest rate
   - equals real interest rate + inflation rate.
   - Fisher effect: nominal interest rate moves one-for-one w/ expected inflation.
   - is the opp. cost of holding money

4. Money demand
   - depends on income in the Quantity Theory
   - more generally, it also depends on the nominal interest rate;
     if so, then changes in expected inflation affect the current price level.

Chapter summary

5. Costs of inflation
   - *Expected inflation*
     shoeleather costs, menu costs,
     tax & relative price distortions,
     inconvenience of correcting figures for inflation
   - *Unexpected inflation*
     all of the above plus arbitrary redistributions of wealth between debtors and creditors

Chapter summary

6. Hyperinflation
   - caused by rapid money supply growth when money printed to finance govt budget deficits
   - stopping it requires fiscal reforms to eliminate govt's need for printing money

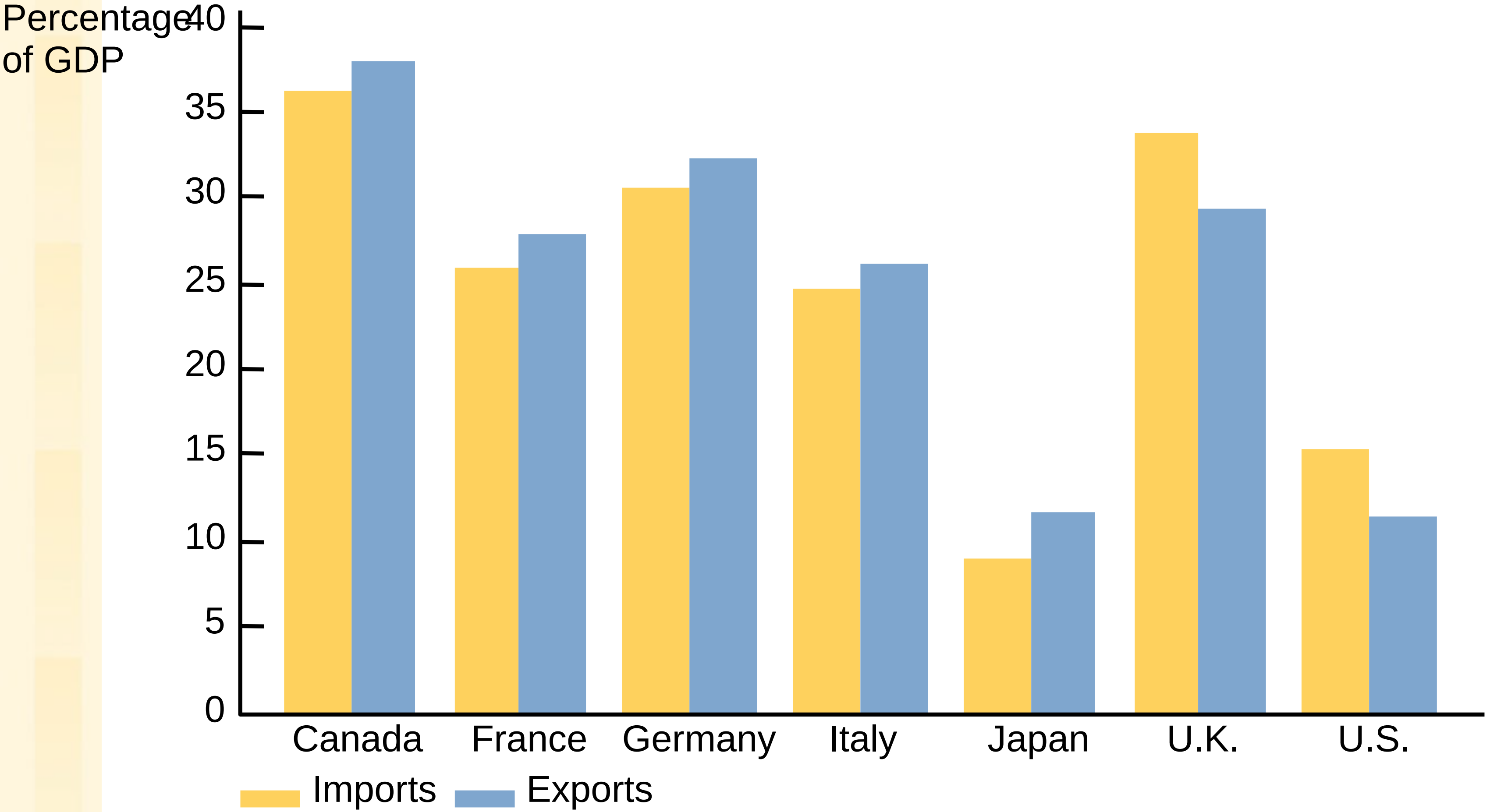
Chapter summary

7. Classical dichotomy
   - In classical theory, money is neutral--does not affect real variables.
   - So, we can study how real variables are determined w/o reference to nominal ones.
   - Then, eq'm in money market determines price level and all nominal variables.
   - Most economists believe the economy works this way in the long run.

Chapter objectives

- accounting identities for the open economy
- small open economy model
  - what makes it “small”
  - how the trade balance and exchange rate are determined
  - how policies affect trade balance & exchange rate

Imports and Exports as a percentage of output: 2000



In an open economy,

- spending need not equal output
- saving need not equal investment

Preliminaries

$$C = C^d + C^f$$

$$I = I^d + I^f$$

$$G = G^d + G^f$$

superscripts:

d = spending on domestic goods

f = spending on foreign goods

EX = exports = foreign spending on domestic goods

IM = imports = $C^f + I^f + G^f$ = spending on foreign goods

Preliminaries, *cont.*

NX = net exports (*a.k.a.* the "trade balance")
   = ***EX*** – ***IM***

- If ***NX*** > 0,
  country has a **trade surplus**
  equal to ***NX***
- If ***NX*** < 0,
  country has a **trade deficit**
  equal to – ***NX***

GDP = expenditure on domestically produced g & s

$$Y = C^d + I^d + G^d + EX$$

$$= (C - C^f) + (I - I^f) + (G - G^f) + EX$$

$$= C + I + G + EX - (C^f + I^f + G^f)$$

$$= C + I + G + EX - IM$$

$$= C + I + G + NX$$

The national income identity in an open economy

$$Y = C + I + G + NX$$

or, $$NX = Y - \underbrace{(C + I + G)}_{\text{domestic spending}}$$

net exports

output

International capital flows

- **Net capital outflows**

  $= S - I$

  = net outflow of "loanable funds"

  = net purchases of foreign assets

  the country's purchases of foreign assets minus foreign purchases of domestic assets

- When $S > I$, country is a net lender

- When $S < I$, country is a net borrower

Another important identity

$$NX = Y - (C + I + G)$$

implies

$$NX = (Y - C - G) - I$$

$$= \quad S \quad - \quad I$$

trade balance = net capital outflows

Saving and Investment in a Small Open Economy

- An open-economy version of the loanable funds model from chapter 3.
- Includes many of the same elements:

production function: $Y = \bar{Y} = F(\bar{K}, \bar{L})$

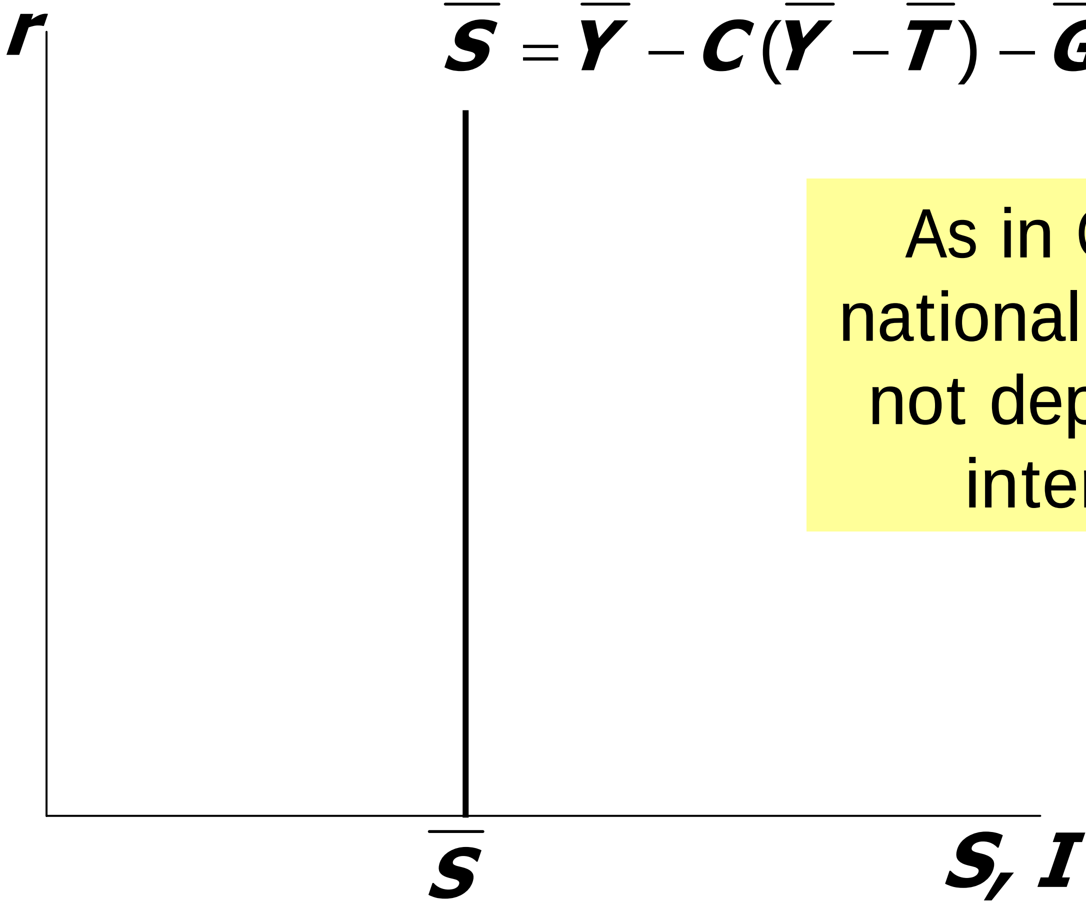
consumption function: $C = C(Y - T)$

investment function: $I = I(r)$

exogenous policy variables: $G = \bar{G}, \quad T = \bar{T}$

National Saving: The Supply of Loanable Funds

$$\bar{S} = \bar{Y} - C(\bar{Y} - \bar{T}) - \bar{G}$$



As in Chapter 3, national saving does not depend on the interest rate

Assumptions re: capital flows

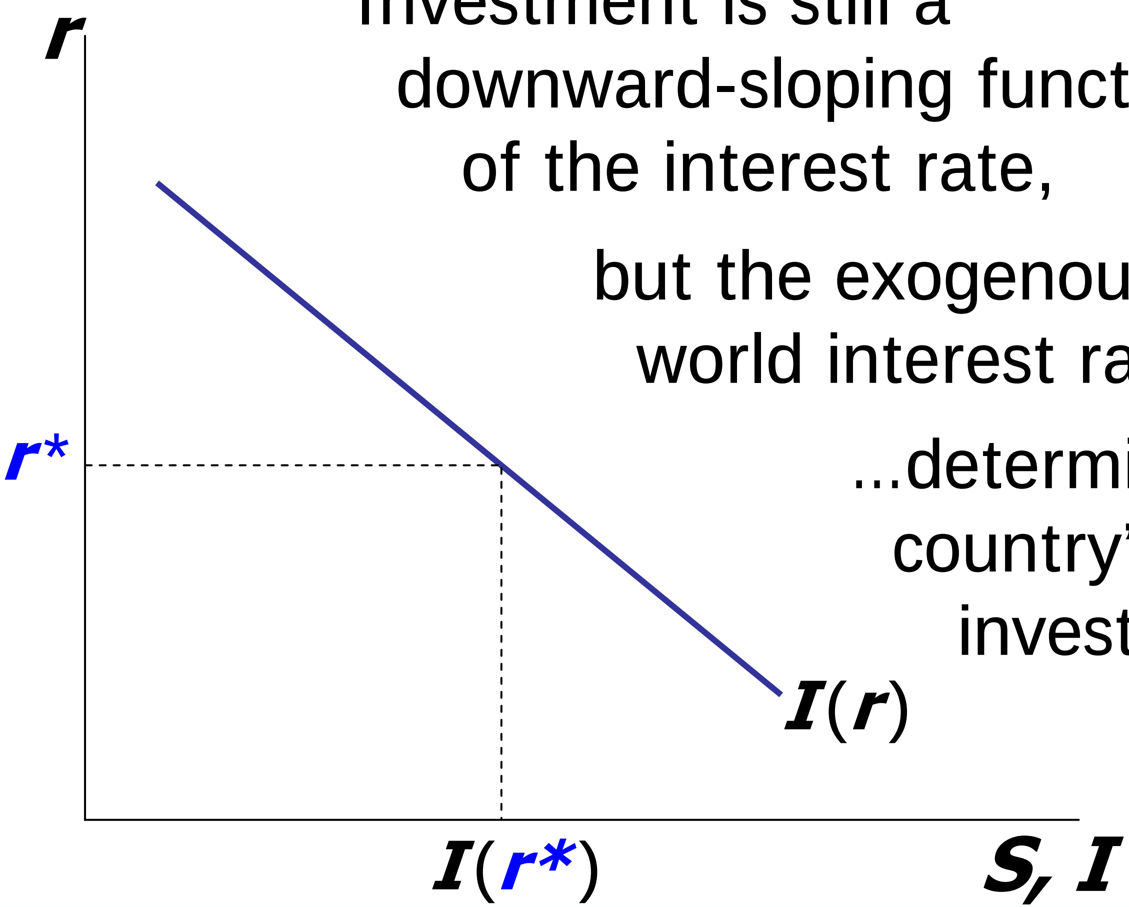
a. domestic & foreign bonds are perfect substitutes (same risk, maturity, etc.)

b. **perfect capital mobility**: no restrictions on international trade in assets

c. economy is **small**: cannot affect the world interest rate, denoted r^*

> a & b imply $r = r^*$
>
> c implies r^* is exogenous

Investment: The Demand for Loanable Funds



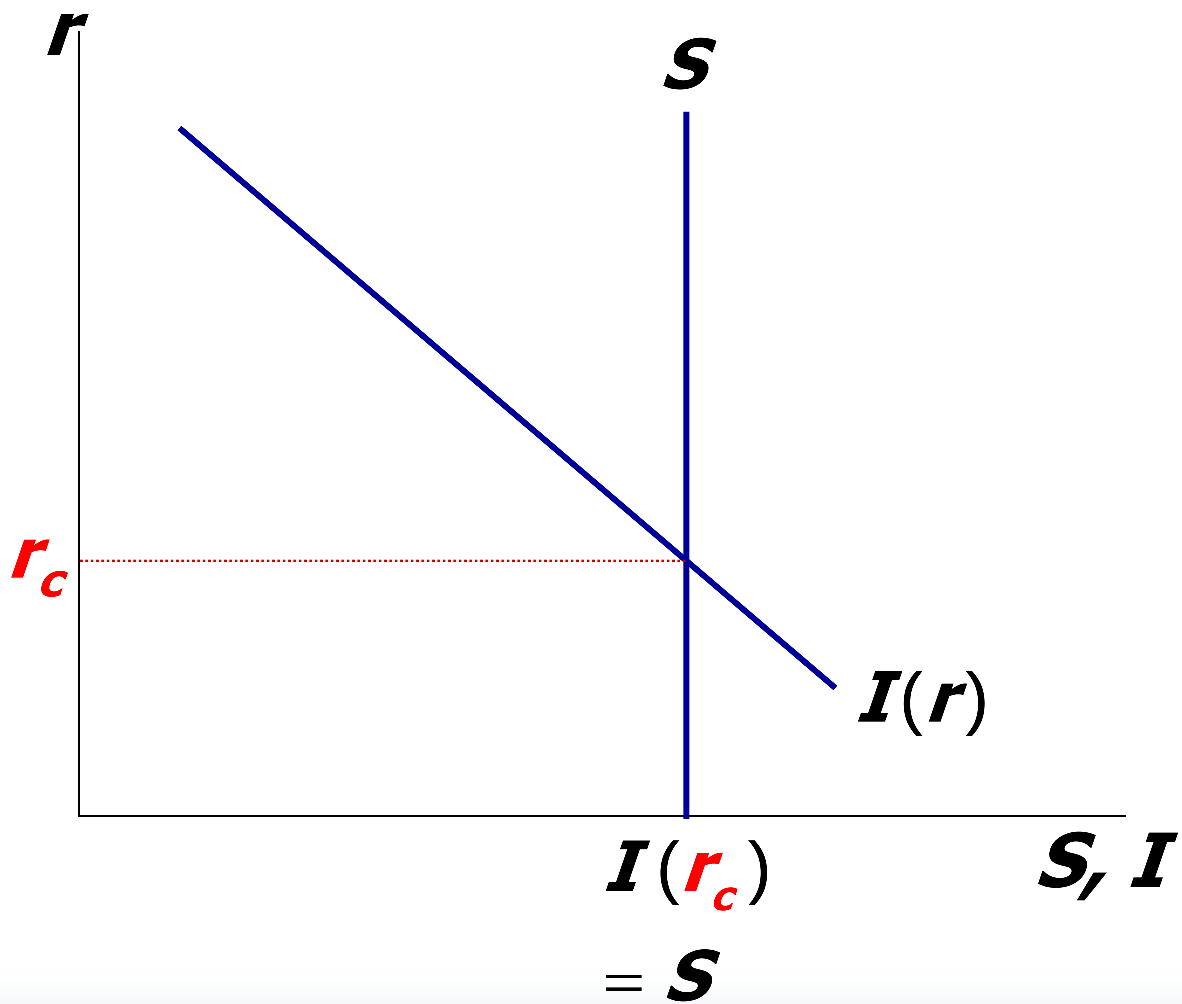
Investment is still a downward-sloping function of the interest rate,

but the exogenous world interest rate...

...determines the country's level of investment.

If the economy were closed…

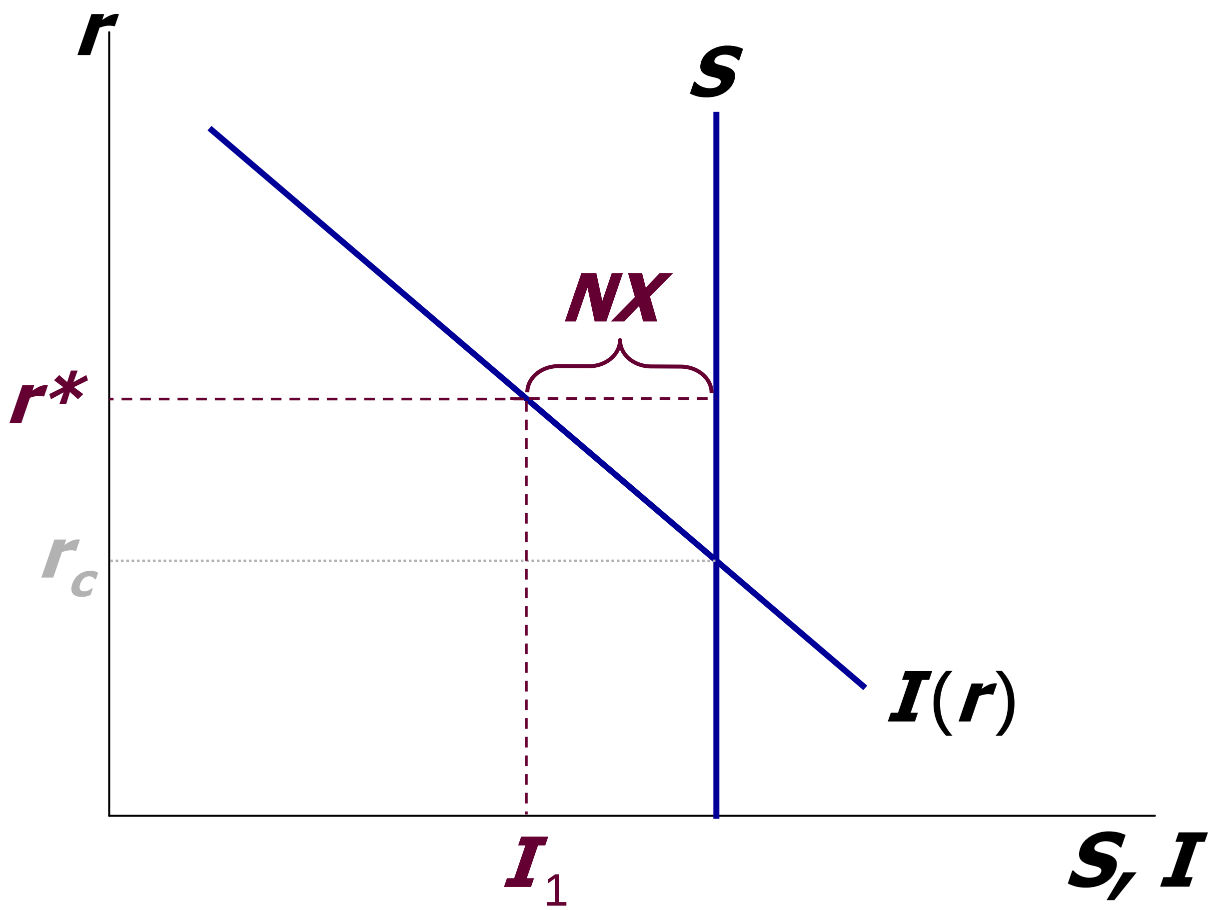
...the interest rate would adjust to equate investment and saving:



But in a small open economy…

the exogenous world interest rate determines investment...

...and the difference between saving and investment determines net capital outflows and net exports



Three experiments

1. Fiscal policy at home
2. Fiscal policy abroad
3. An increase in investment demand

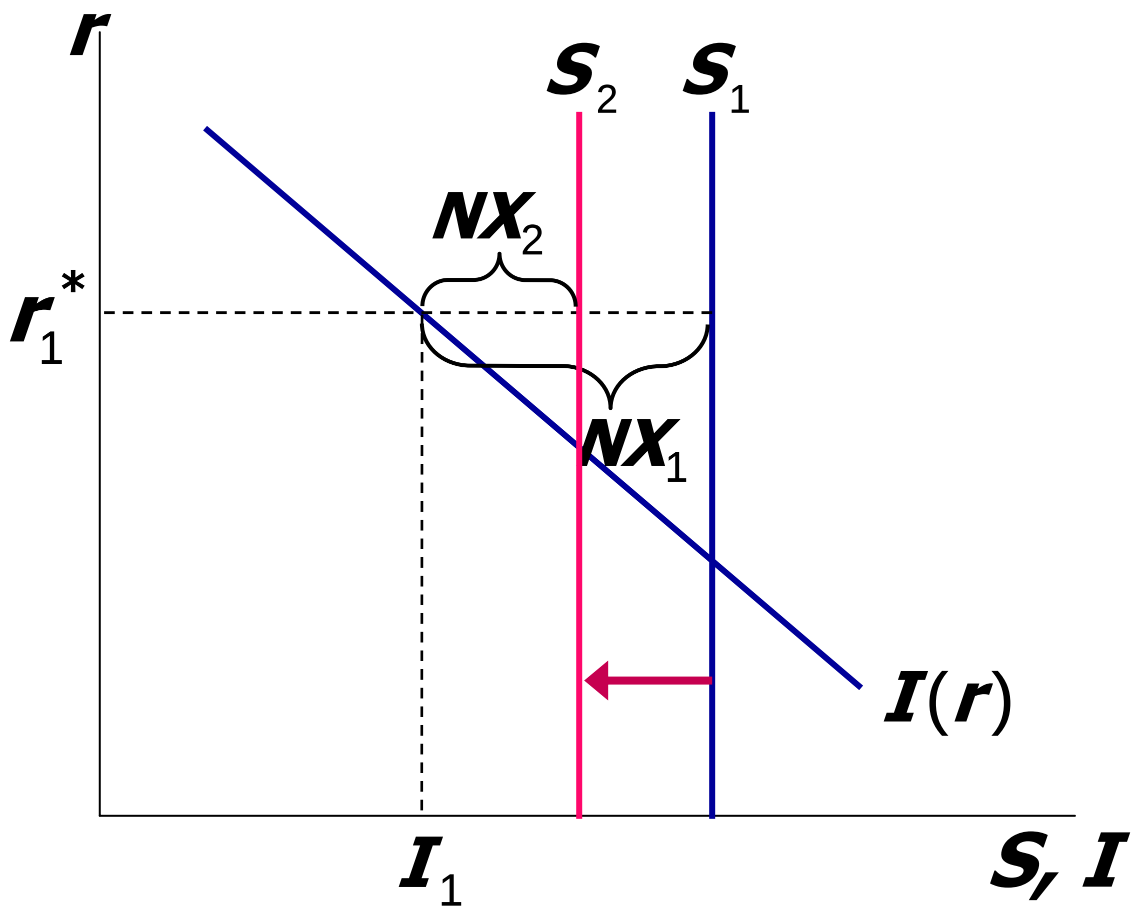
1. Fiscal policy at home

An increase in ***G*** or decrease in ***T*** reduces saving.

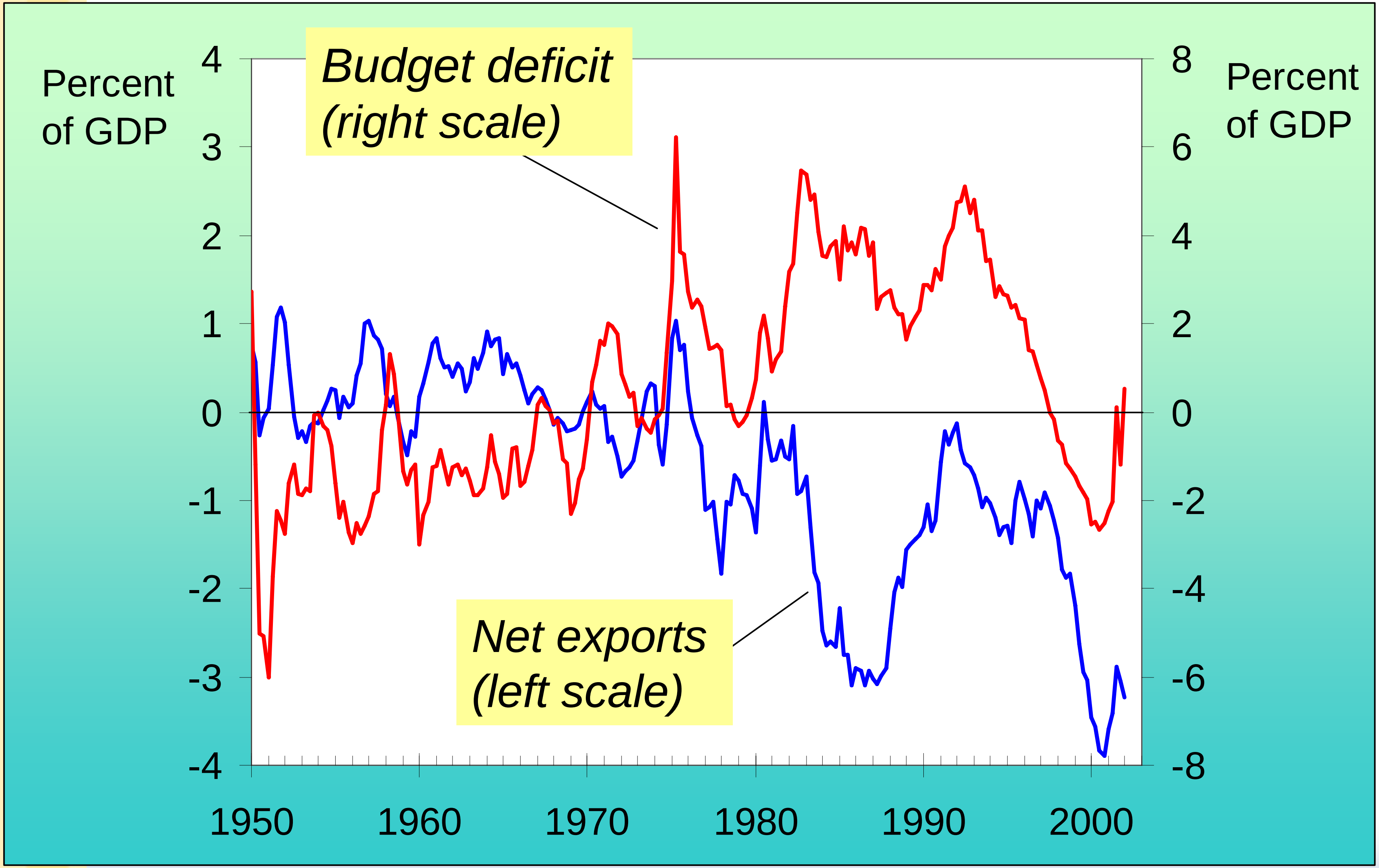
Results:

$$\Delta \boldsymbol{I} = 0$$

$$\Delta \boldsymbol{NX} = \Delta \boldsymbol{S} < 0$$



NX and the Government Budget Deficit



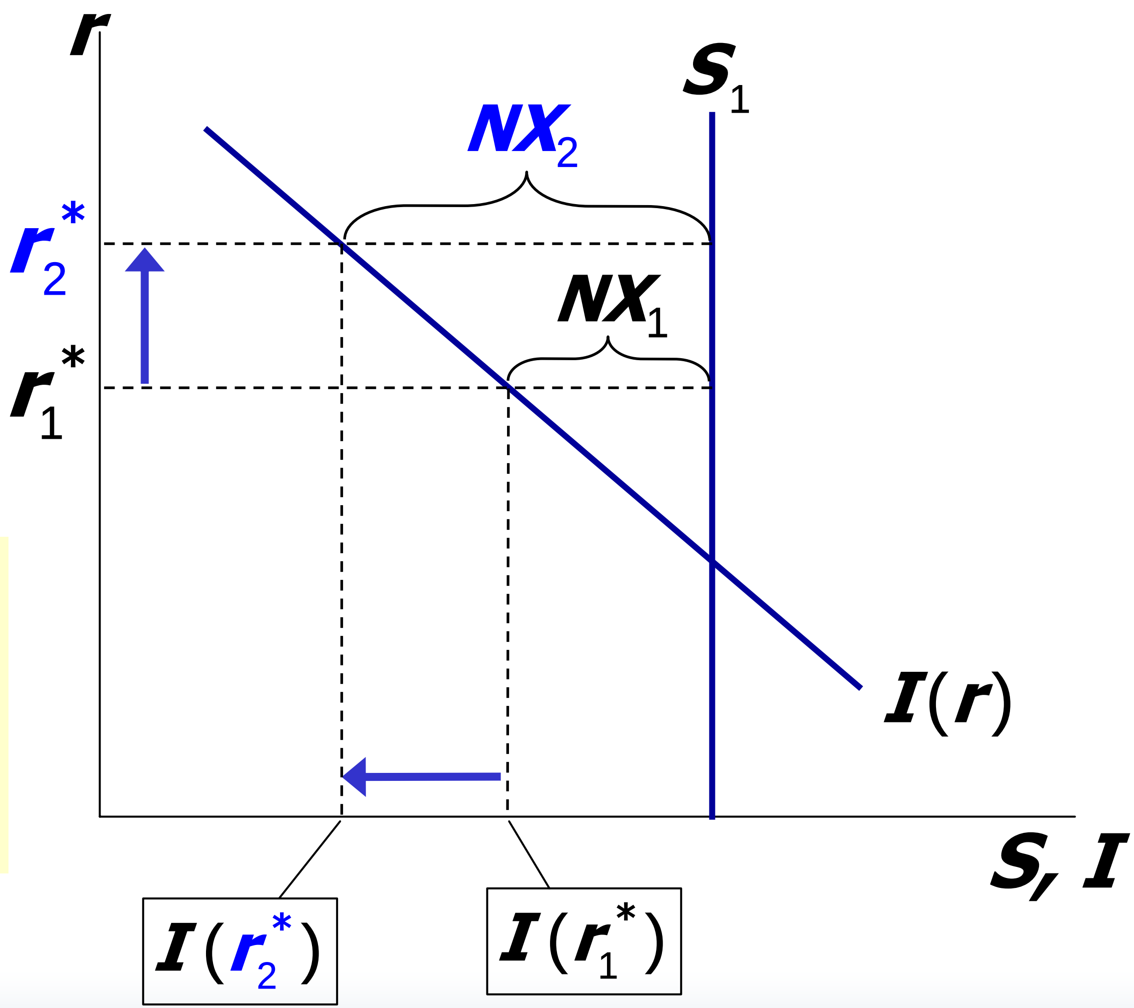
2. Fiscal policy abroad

Expansionary fiscal policy abroad raises the world interest rate.

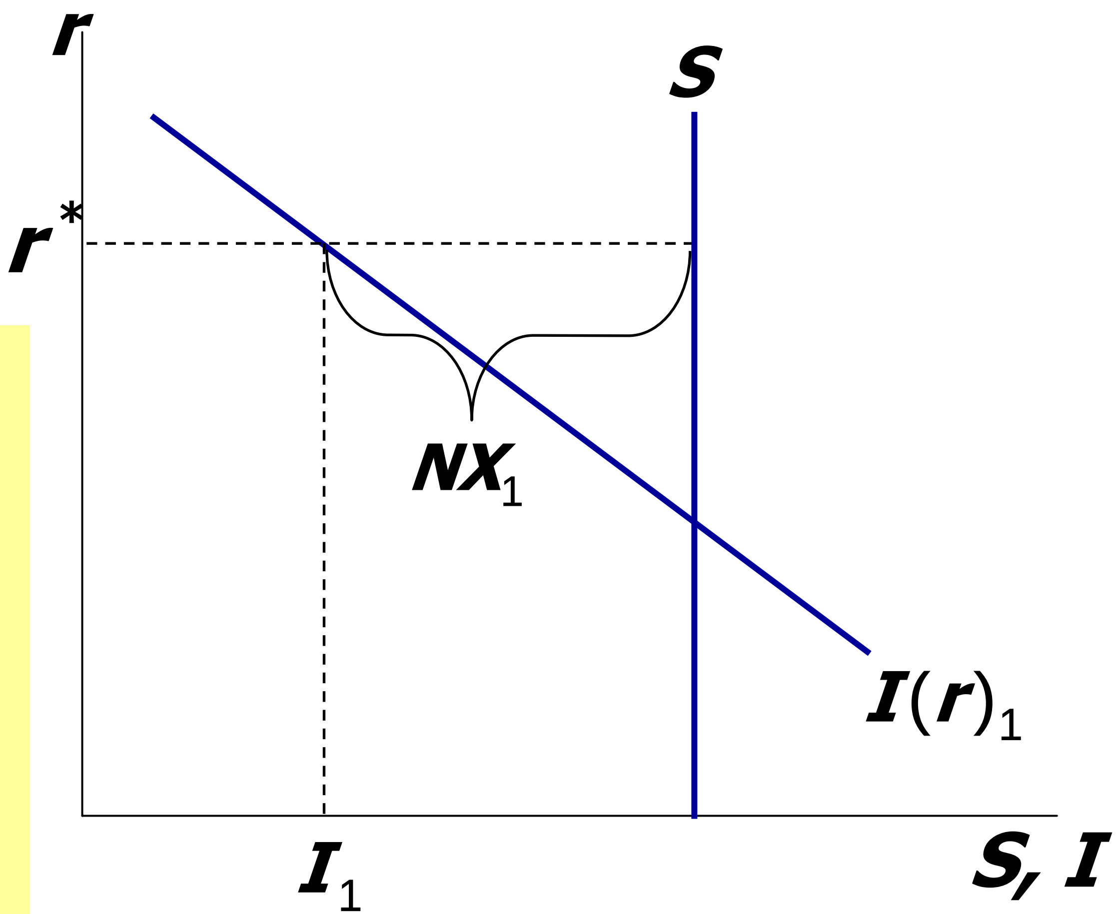
Results:

$$\Delta I < 0$$

$$\Delta NX = -\Delta I > 0$$



3. An increase in investment demand



EXERCISE:

Use the model to determine the impact of an increase in investment demand on ***NX***, ***S***, ***I***, and net capital outflow.

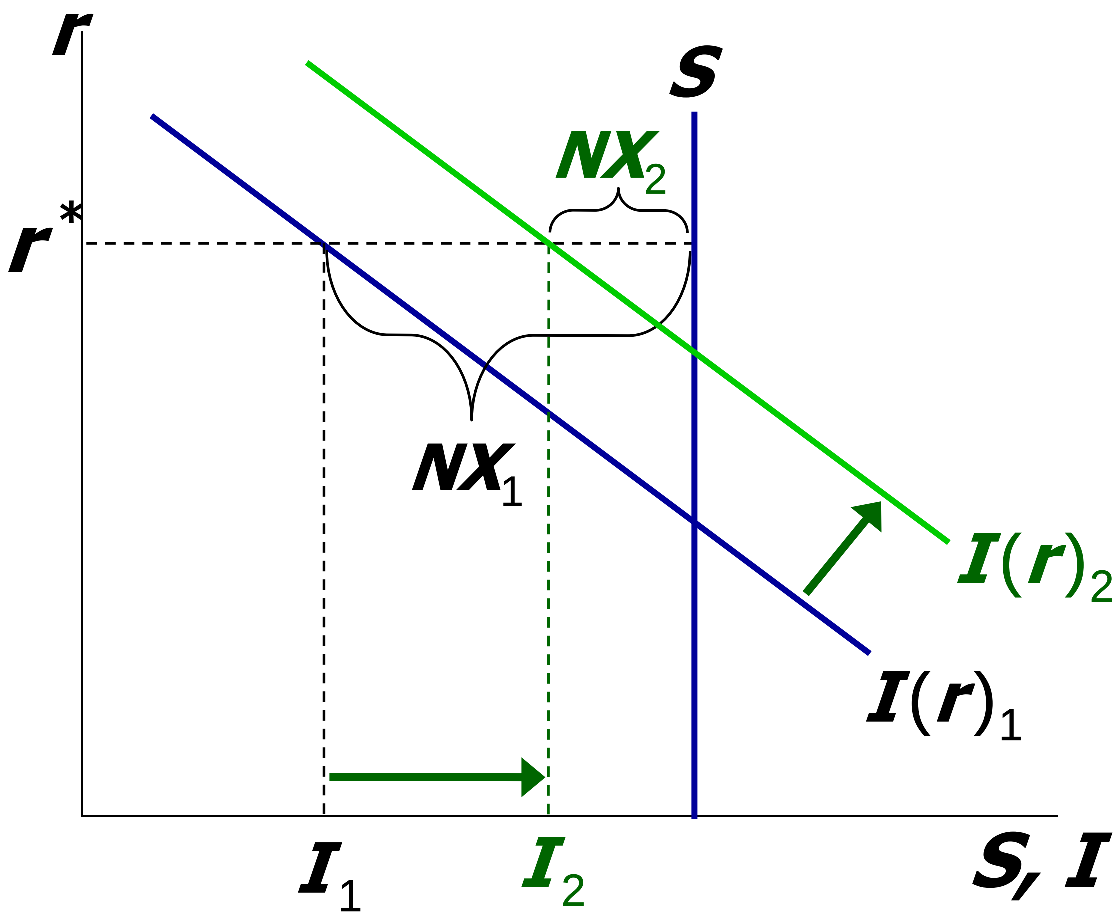
3. An increase in investment demand

ANSWERS:

$\Delta I > 0$,

$\Delta S = 0$,

net capital outflows and net exports fall by the amount ΔI



The nominal exchange rate

e = nominal exchange rate,
the relative price of
domestic currency
in terms of foreign currency

(e.g. Yen per Dollar)

Exchange rates as of June 6, 2002

country	*exchange rate*
Euro	1.06 Euro/$
Japan	124.3 Yen/$
Mexico	9.7 Pesos/$
Russia	31.4 Rubles/$
South Africa	9.8 Rand/$
Turkey	1,444,063.1 Liras/$
U.K.	0.68 Pounds/$

The real exchange rate

ε = real exchange rate, the relative price of domestic goods in terms of foreign goods

(e.g. Japanese Big Macs per U.S. Big Mac)

the lowercase Greek letter epsilon

Understanding the units of ε

$$\varepsilon = \frac{e \times P}{P^*}$$

$$= \frac{(\text{Yen per \$}) \times (\text{\$ per unit U.S. goods})}{\text{Yen per unit Japanese goods}}$$

$$= \frac{\text{Yen per unit U.S. goods}}{\text{Yen per unit Japanese goods}}$$

$$= \begin{array}{c}\text{Units of Japanese goods} \\ \text{per unit of U.S. goods}\end{array}$$

~ McZample ~

- one good: Big Mac
- price in Japan:

  $P^* = 200$ Yen
- price in USA:

  $P = \$2.50$
- nominal exchange rate

  $e = 120$ Yen/$

$$\varepsilon = \frac{e \times P}{P^*}$$

$$= \frac{120 \times \$2.50}{200 \text{ Yen}} = 1.5$$

To buy a U.S. Big Mac, someone from Japan would have to pay an amount that could buy 1.5 Japanese Big Macs.

ε in the real world & our model

- *In the real world:*
  We can think of ε as the relative price of a basket of domestic goods in terms of a basket of foreign goods
- *In our macro model:*
  There's just one good, "output."
  So ε is the relative price of one country's output in terms of the other country's output

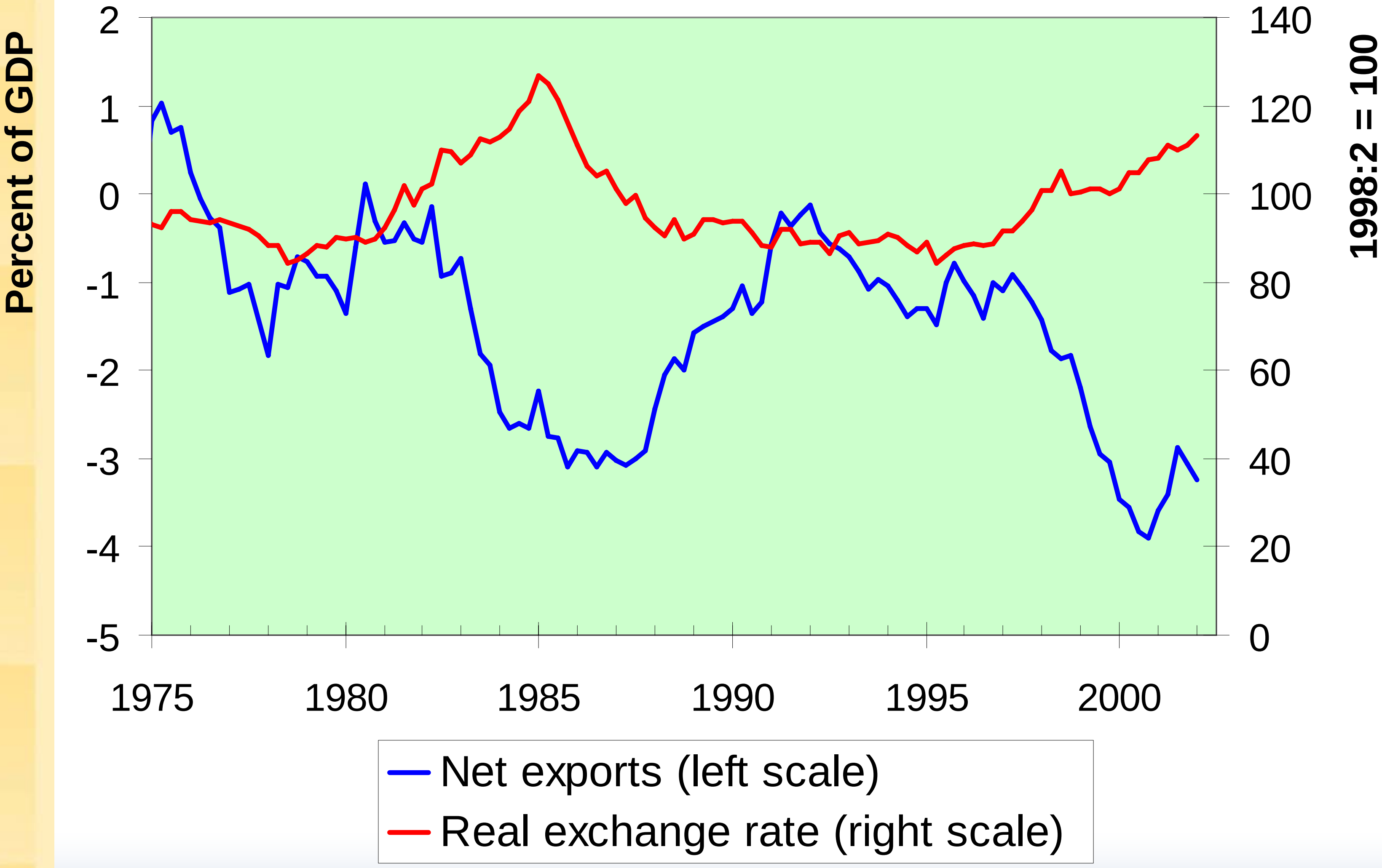
How ***NX*** depends on ε

$\uparrow \varepsilon \;\Rightarrow$ U.S. goods become more expensive relative to foreign goods

$\Rightarrow \downarrow \boldsymbol{EX}, \; \uparrow \boldsymbol{IM}$

$\Rightarrow \downarrow \boldsymbol{NX}$

U.S. Net Exports and the Real Exchange Rate, 1975-2002



The net exports function

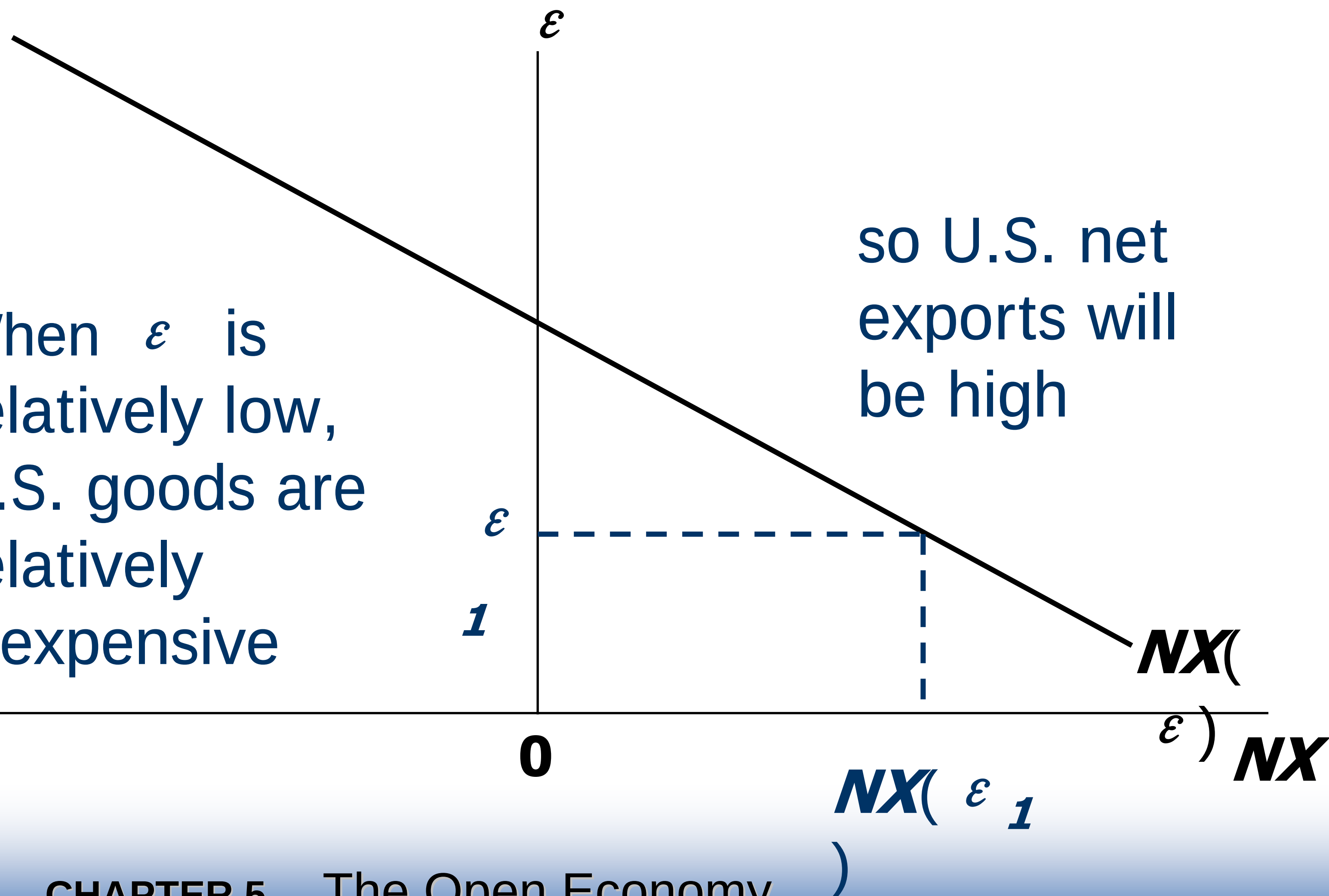
- The **net exports function** reflects this inverse relationship between $\boldsymbol{NX}$ and ε :

$$\boldsymbol{NX} = \boldsymbol{NX}(\varepsilon)$$

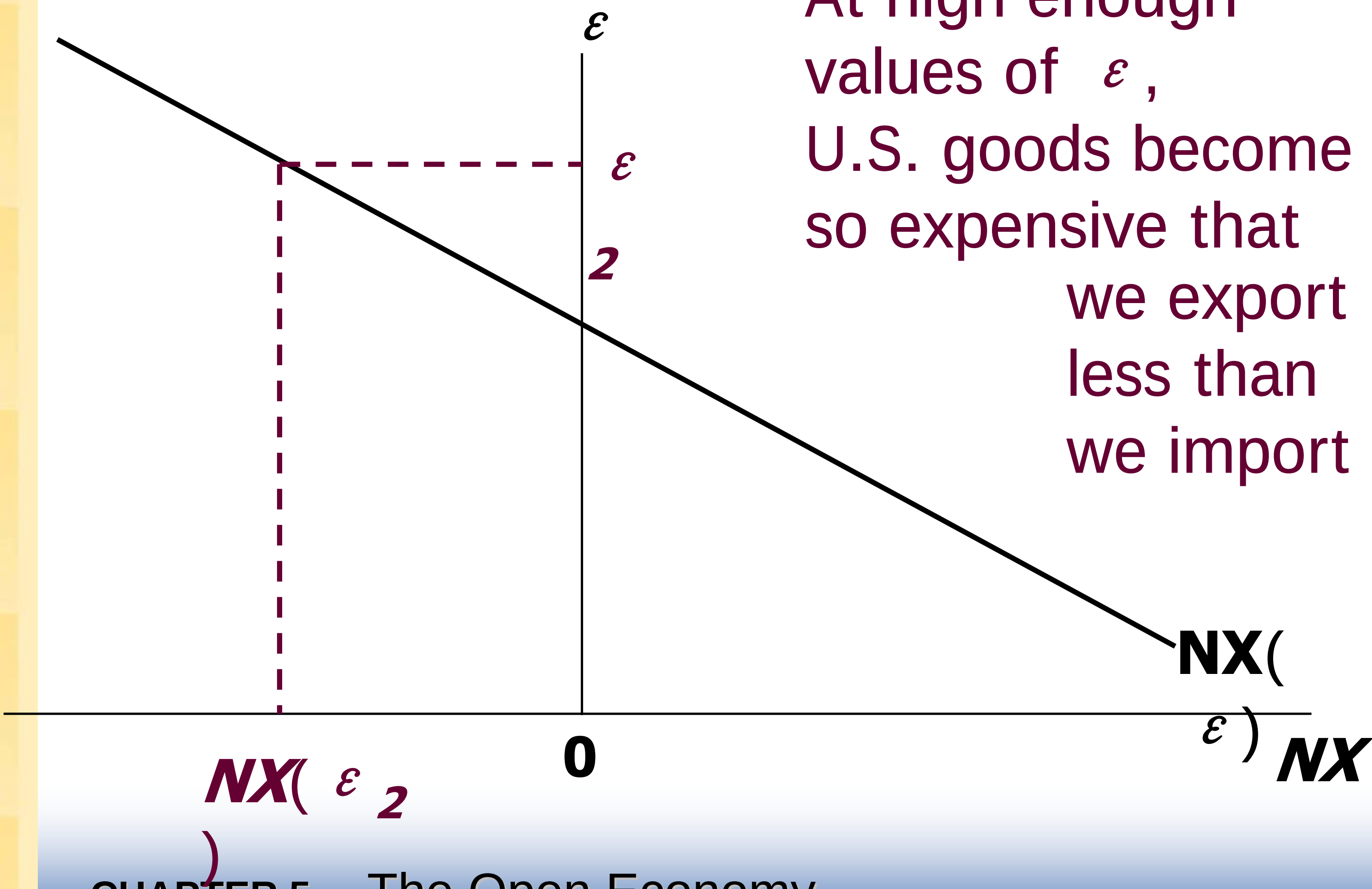
The *NX* curve for the U.S.

When ε is relatively low, U.S. goods are relatively inexpensive

so U.S. net exports will be high



The *NX* curve for the U.S.



At high enough values of ε, U.S. goods become so expensive that we export less than we import

How ε is determined

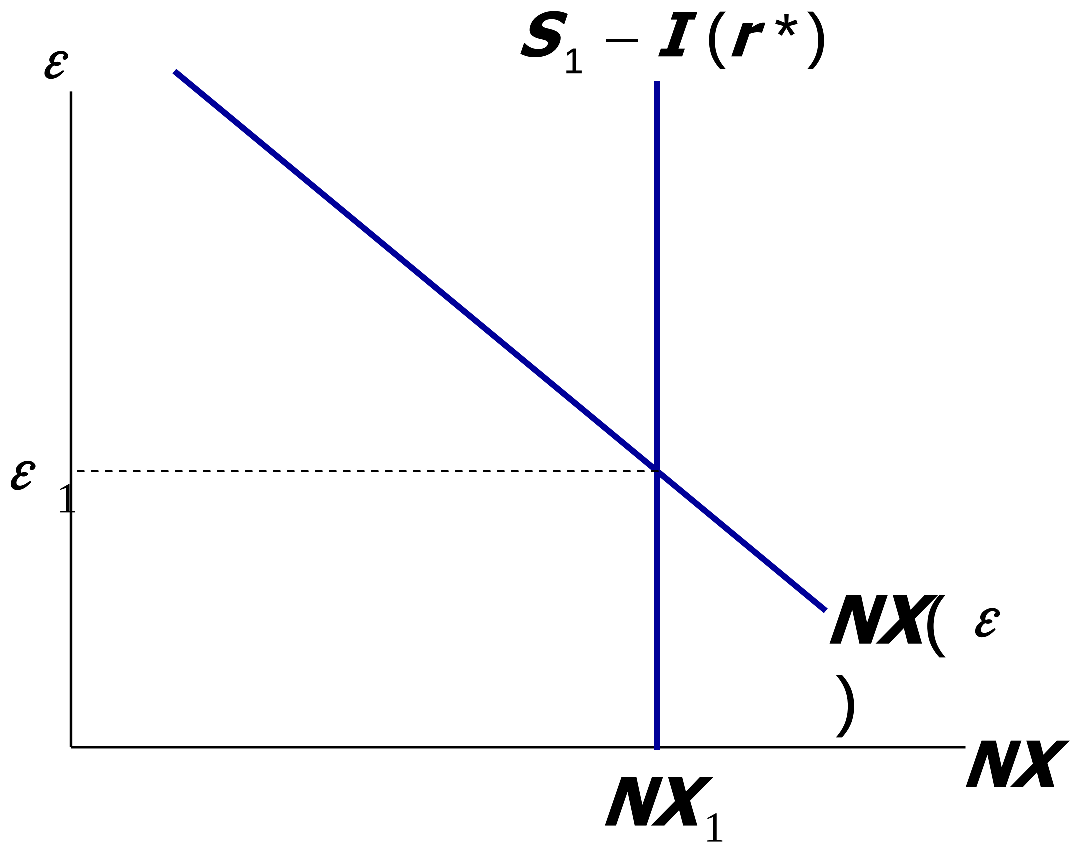
- The accounting identity says $NX = S - I$
- We saw earlier how $S - I$ is determined:
  - S depends on domestic factors (output, fiscal policy variables, etc)
  - I is determined by the world interest rate r^*
- So, ε must adjust to ensure

$$NX(\varepsilon) = \overline{S} - I(r^*)$$

How ε is determined

Neither ***S*** nor ***I*** depend on ε, so the net capital outflow curve is vertical.

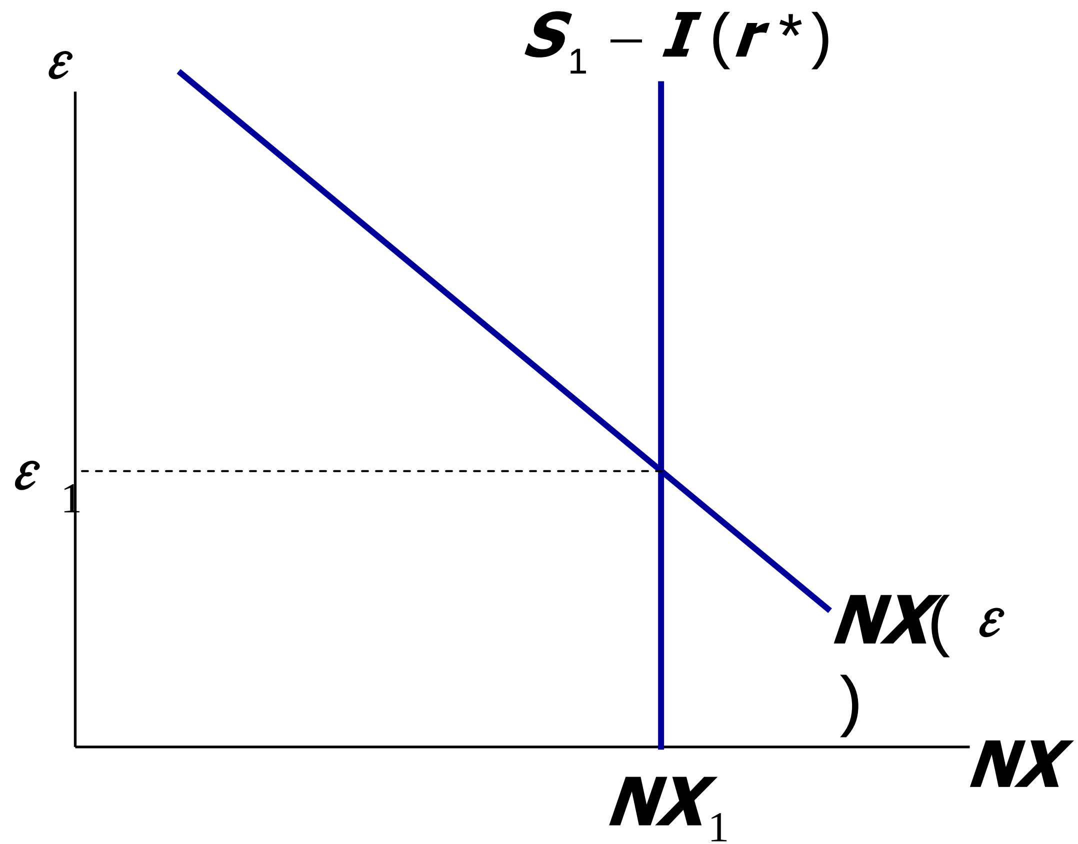
ε adjusts to equate ***NX*** with net capital outflow, ***S*** – ***I***.



Interpretation: supply and demand in the foreign exchange market

demand:
Foreigners need dollars to buy U.S. net exports.

supply:
The net capital outflow ($S - I$) is the supply of dollars to be invested abroad.

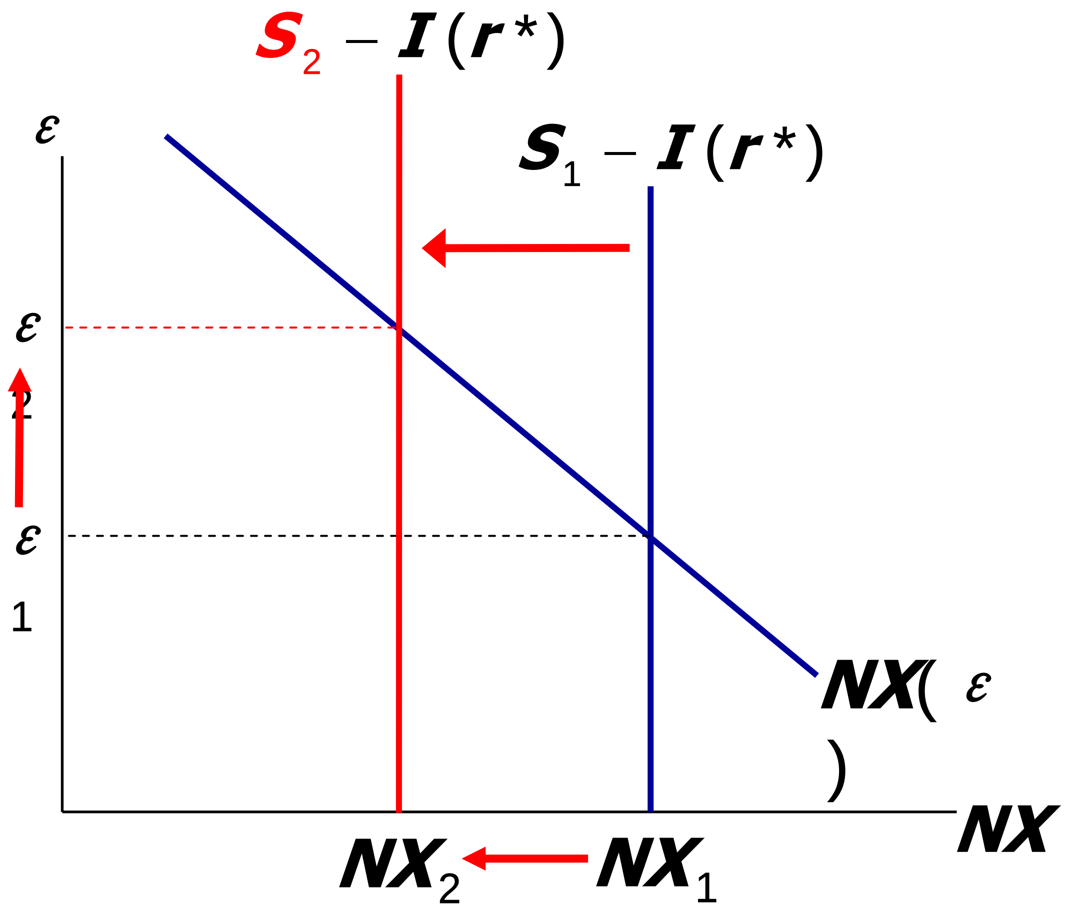


Four experiments

1. Fiscal policy at home
2. Fiscal policy abroad
3. An increase in investment demand
4. Trade policy to restrict imports

1. Fiscal policy at home

A fiscal expansion reduces national saving, net capital outflows, and the supply of dollars in the foreign exchange market...

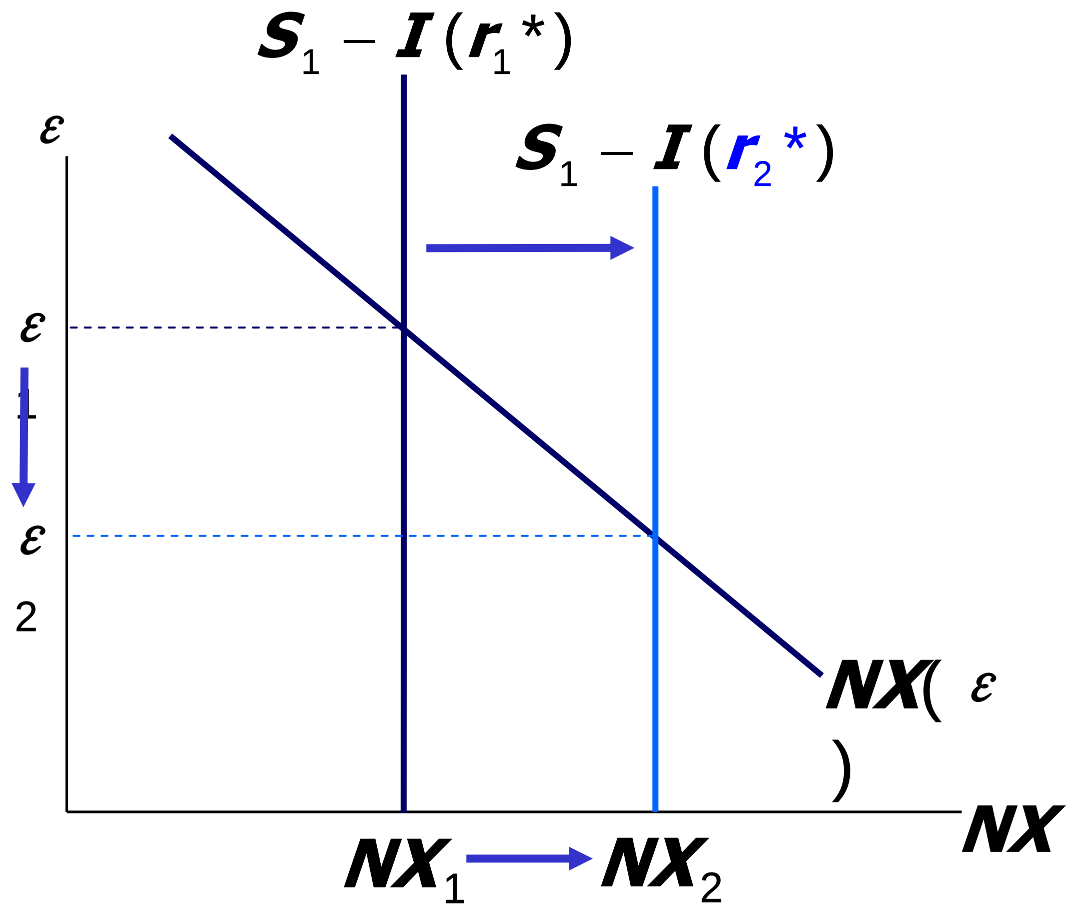


...causing the real exchange rate to rise and ***NX*** to fall.

2. Fiscal policy abroad

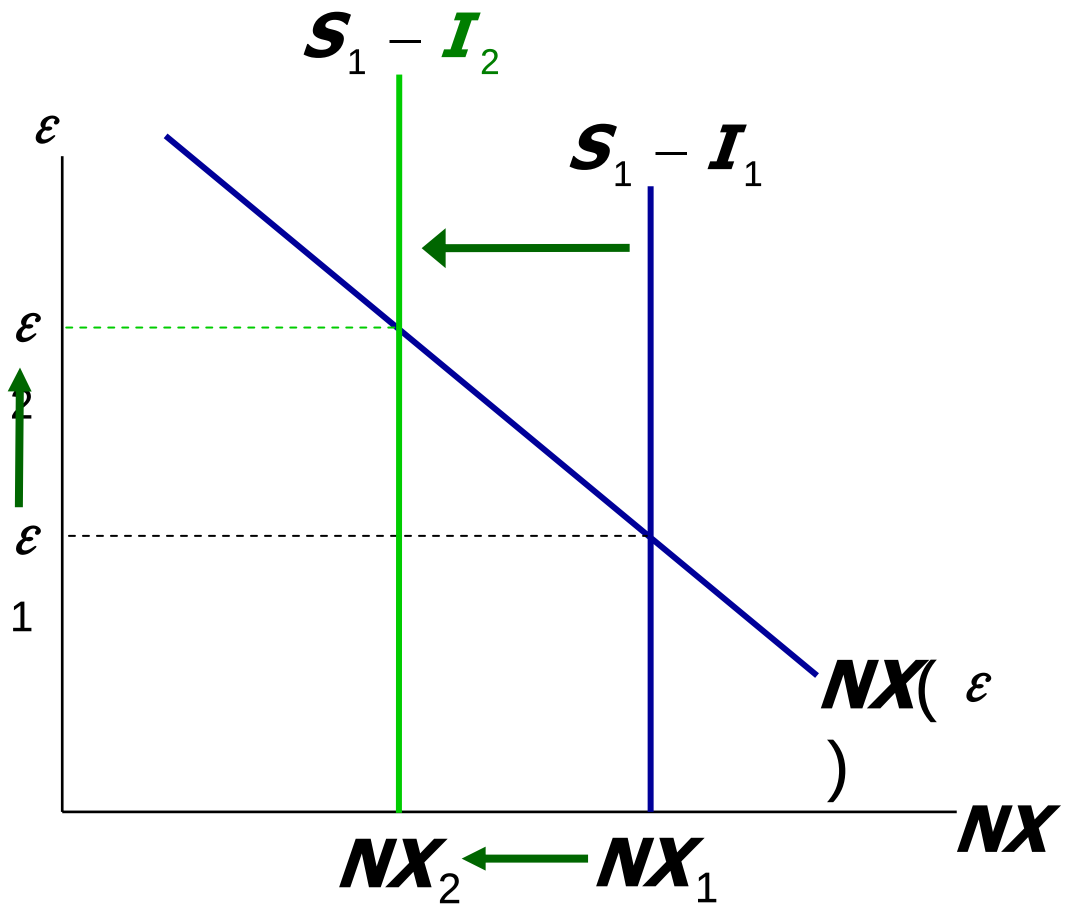
An increase in ***r****
reduces investment, increasing net capital outflows and the supply of dollars in the foreign exchange market...

...causing the real exchange rate to fall and ***NX*** to rise.



3. An increase in investment demand

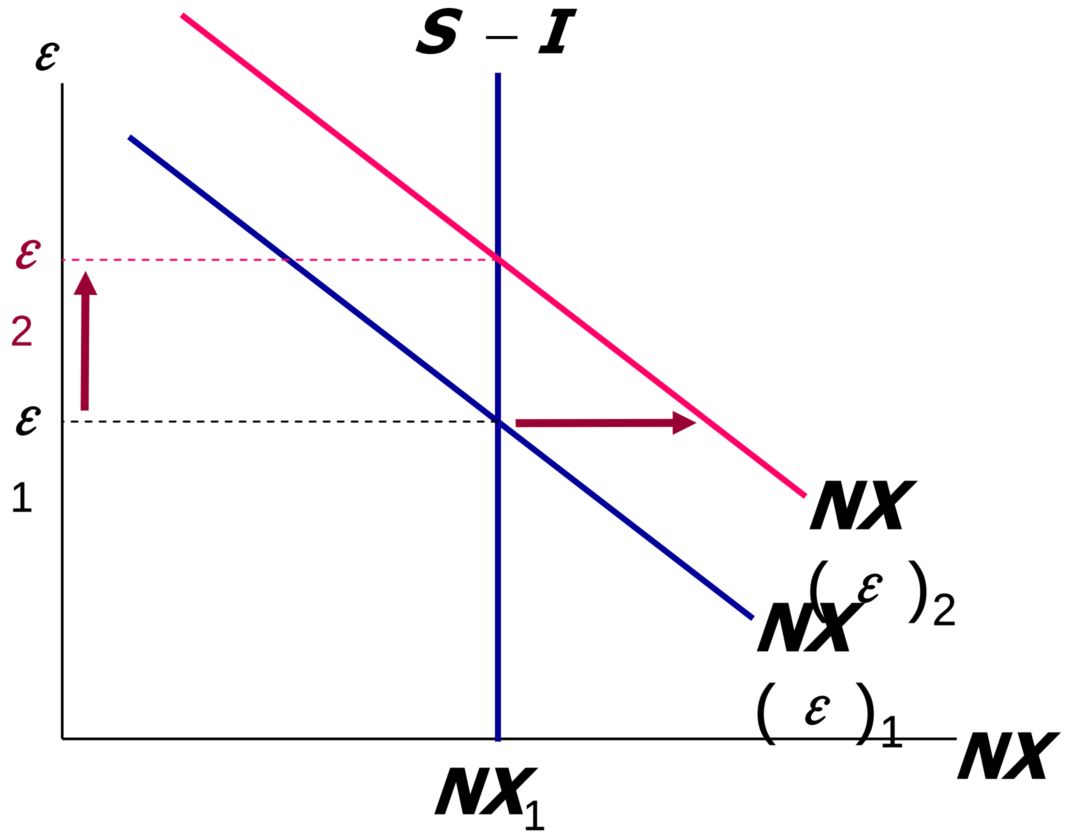
An increase in investment reduces net capital outflows and the supply of dollars in the foreign exchange market...



...causing the real exchange rate to rise and ***NX*** to fall.

4. Trade policy to restrict imports

At any given value of ε, an import quota $\Rightarrow \downarrow IM \Rightarrow \uparrow NX$ $\Rightarrow$ demand for dollars shifts right



Trade policy doesn't affect S or I, so capital flows and the supply of dollars remains fixed.

4. Trade policy to restrict imports

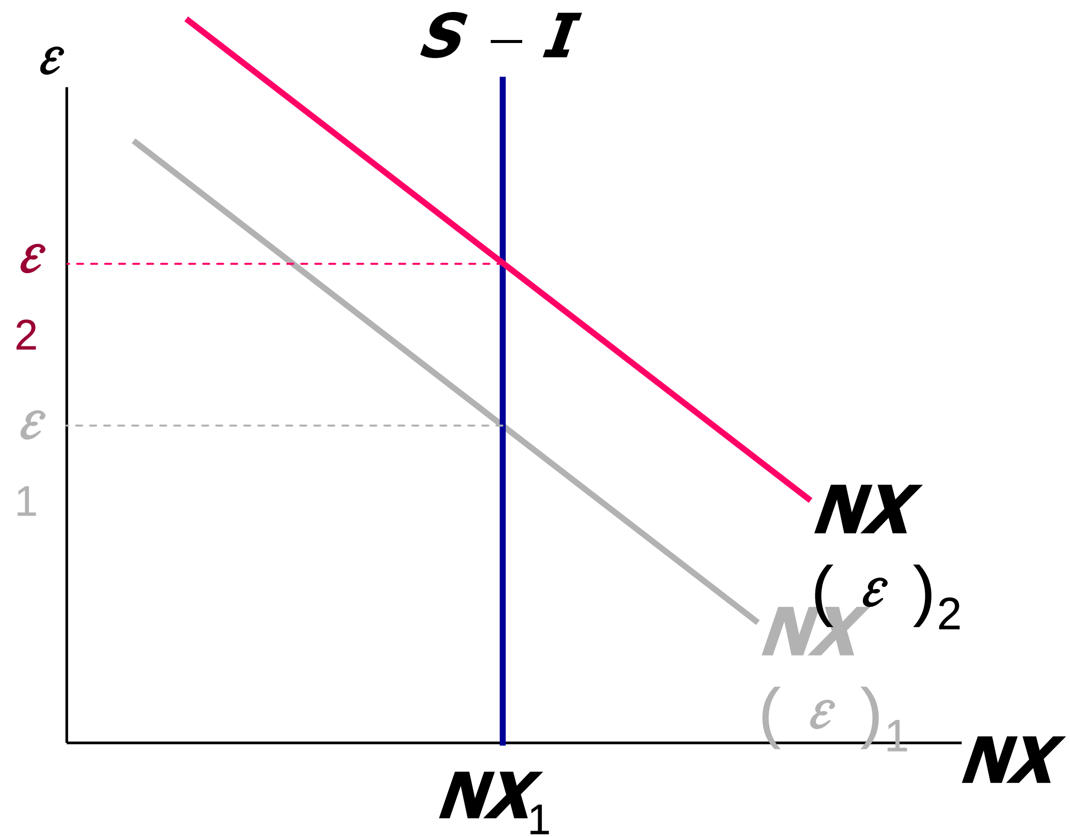
Results:

$\Delta \varepsilon > 0$
(demand increase)

$\Delta \boldsymbol{NX} = 0$
(supply fixed)

$\Delta \boldsymbol{IM} < 0$
(policy)

$\Delta \boldsymbol{EX} < 0$
(rise in ε)



The Determinants of the Nominal Exchange Rate

- Start with the expression for the real exchange rate:

$$\varepsilon = \frac{e \times P}{P^*}$$

- Solve it for the nominal exchange rate:

$$e = \varepsilon \times \frac{P^*}{P}$$

The Determinants of the Nominal Exchange Rate

- So $\boldsymbol{e}$ depends on the real exchange rate and the price levels at home and abroad...
- ...and we know how each of them is determined:

$$\frac{M^*}{P^*} = L^*(r^* + \pi^*, Y^*)$$

$$e = \varepsilon \times \frac{P^*}{P}$$

$$NX(\varepsilon) = \overline{S} - I(r^*)$$

$$\frac{M}{P} = L(r^* + \pi, Y)$$

The Determinants of the Nominal Exchange Rate

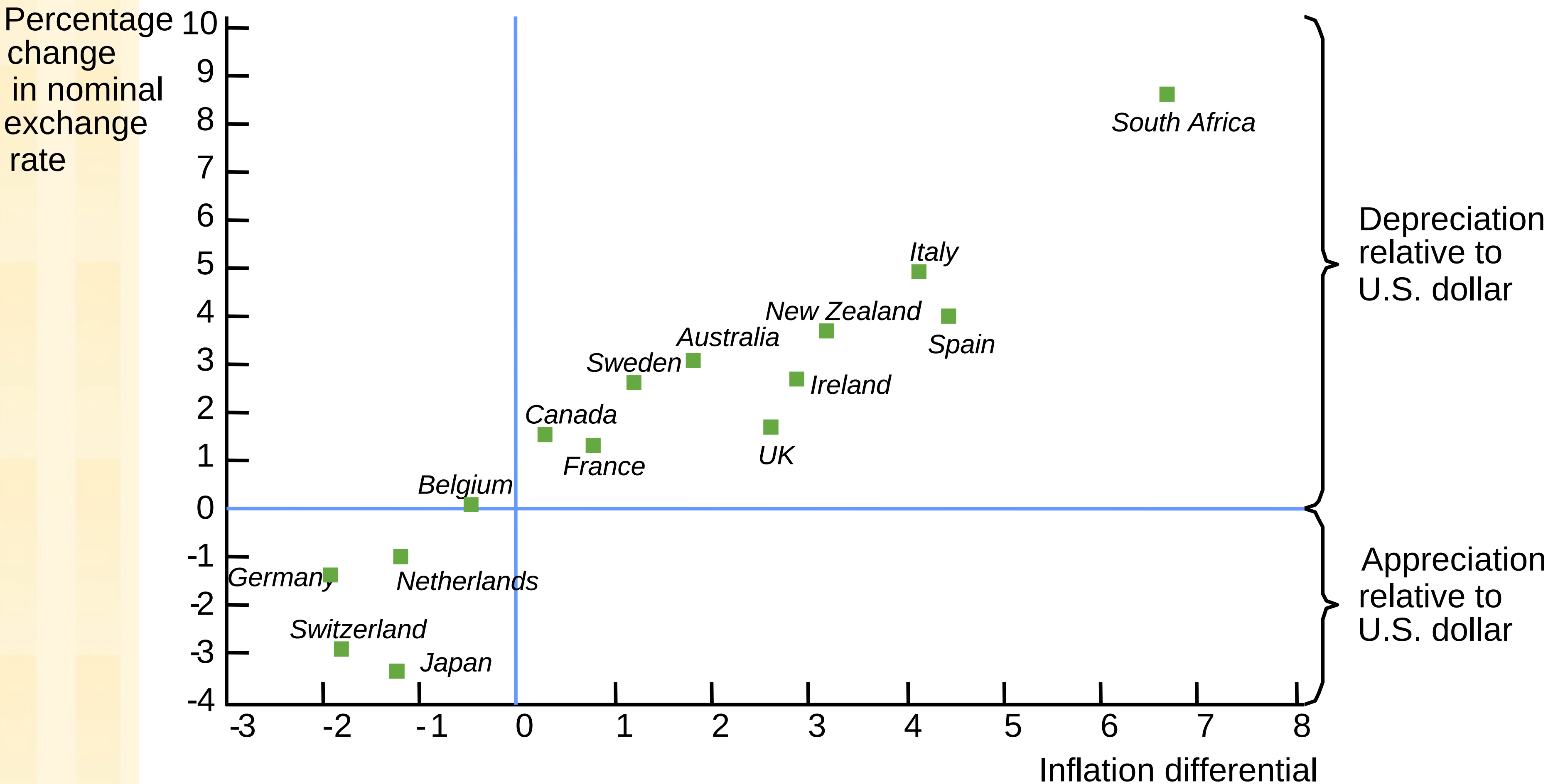
$$e = \varepsilon \times \frac{P^*}{P}$$

- We can rewrite this equation in terms of growth rates (*see "arithmetic tricks for working with percentage changes," Chap 2*):

$$\frac{\Delta e}{e} = \frac{\Delta \varepsilon}{\varepsilon} + \frac{\Delta P^*}{P^*} - \frac{\Delta P}{P} = \frac{\Delta \varepsilon}{\varepsilon} + \pi^* - \pi$$

- For a given value of ε,
the growth rate of e equals the difference between foreign and domestic inflation rates.

Inflation and nominal exchange rates



Purchasing Power Parity (PPP)

- def1: a doctrine that states that goods must sell at the same (currency-adjusted) price in all countries.
- def2: the nominal exchange rate adjusts to equalize the cost of a basket of goods across countries.
- Reasoning: arbitrage, the law of one price

Purchasing Power Parity (PPP)

- PPP: $\underbrace{e \times P}$ $= P^*$

Cost of a basket of foreign goods, in foreign currency.

Cost of a basket of domestic goods, in foreign currency.

Cost of a basket of domestic goods, in domestic currency.

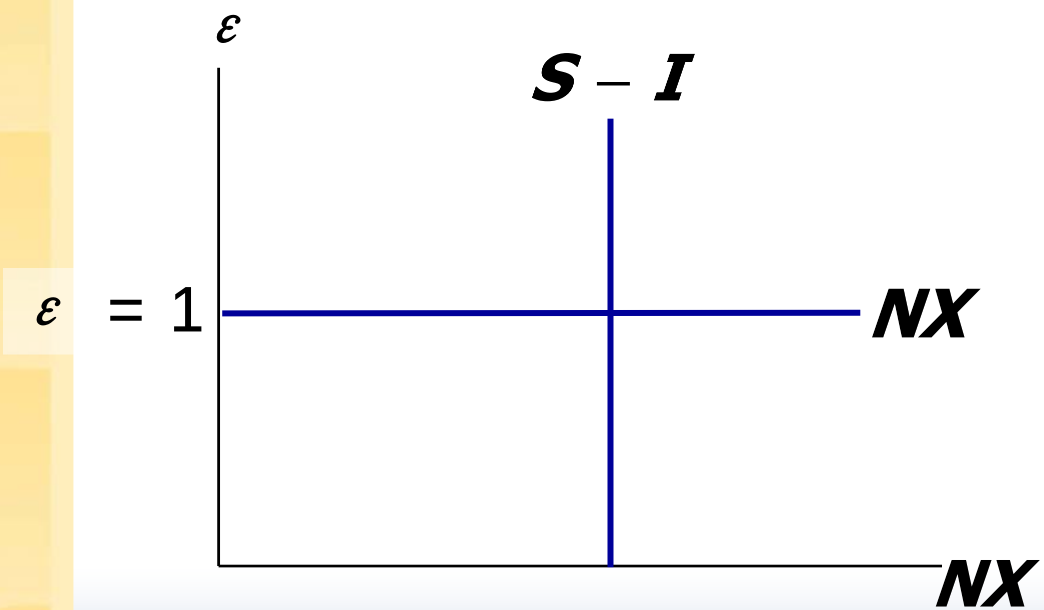
- Solve for e: $e = P^*/P$
- PPP implies that the nominal exchange rate between two countries equals the ratio of the countries' price levels.

Purchasing Power Parity (PPP)

- If $e = P^*/P$,

  then $\varepsilon = e \times \dfrac{P}{P^*} = \dfrac{P^*}{P} \times \dfrac{P}{P^*} = 1$

  and the NX curve is horizontal:



Under PPP, changes in ($S - I$) have no impact on ε or e.

Does PPP hold in the real world?

No, for two reasons:

1. International arbitrage not possible.
   - nontraded goods
   - transportation costs
2. Goods of different countries not perfect substitutes.

Nonetheless, PPP is a useful theory:

- It's simple & intuitive
- In the real world, nominal exchange rates have a tendency toward their PPP values over the long run.

CASE STUDY

The Reagan Deficits revisited

	1970s	1980s	actual change	closed economy	small open economy
G – T	2.2	3.9	↑	↑	↑
S	19.6	17.4	↓	↓	↓
r	1.1	6.3	↑	↑	no change
I	19.9	19.4	↓	↓	no change
NX	-0.3	-2.0	↓	no change	↓
ε	115.1	129.4	↑	no change	↑

Data: decade averages; all except ***r*** *and* ε *are expressed as a percent of GDP;* ε *is a trade-weighted index.*

The U.S. as a large open economy

- So far, we've learned long-run models for two extreme cases:
  - closed economy (chapter 3)
  - small open economy (chapter 5)
- A large open economy---like the U.S.---is in between these two extremes.
- The analysis of policies or other exogenous changes in a large open economy is a mixture of the results for the closed & small open economy cases.
- For example...

A fiscal expansion in three models

A fiscal expansion causes national saving to fall.
The effects of this depend on the degree of openness:

	closed economy	*large open economy*	*small open economy*
r	rises	rises, but not as much as in closed economy	no change
I	falls	falls, but not as much as in closed economy	no change
NX	no change	falls, but not as much as in small open economy	falls

Chapter summary

1. Net exports--the difference between
   - exports and imports
   - a country's output (Y) and its spending ($C + I + G$)
2. Net capital outflow equals
   - purchases of foreign assets minus foreign purchases of the country's assets
   - the difference between saving and investment
3. National income accounts identities:
   - $Y = C + I + G + NX$
   - trade balance $NX = S - I$ net capital outflow

Chapter summary

4. Impact of policies on ***NX***:
   - ***NX*** increases if policy causes ***S*** to rise or ***I*** to fall
   - ***NX*** does not change if policy affects neither ***S*** nor ***I***. Example: trade policy
5. Exchange rates
   - nominal: the price of a country's currency in terms of another country's currency
   - real: the price of a country's goods in terms of another country's goods.
   - The real exchange rate equals the nominal rate times the ratio of prices of the two countries.

Chapter summary

6. How the real exchange rate is determined
   - ***NX*** depends negatively on the real exchange rate, other things equal
   - The real exchange rate adjusts to equate ***NX*** with net capital outflow
7. How the nominal exchange rate is determined
   - ***e*** equals the real exchange rate times the country's price level relative to the foreign price level.
   - For a given value of the real exchange rate, the percentage change in the nominal exchange rate equals the difference between the foreign & domestic inflation rates.

Chapter objectives

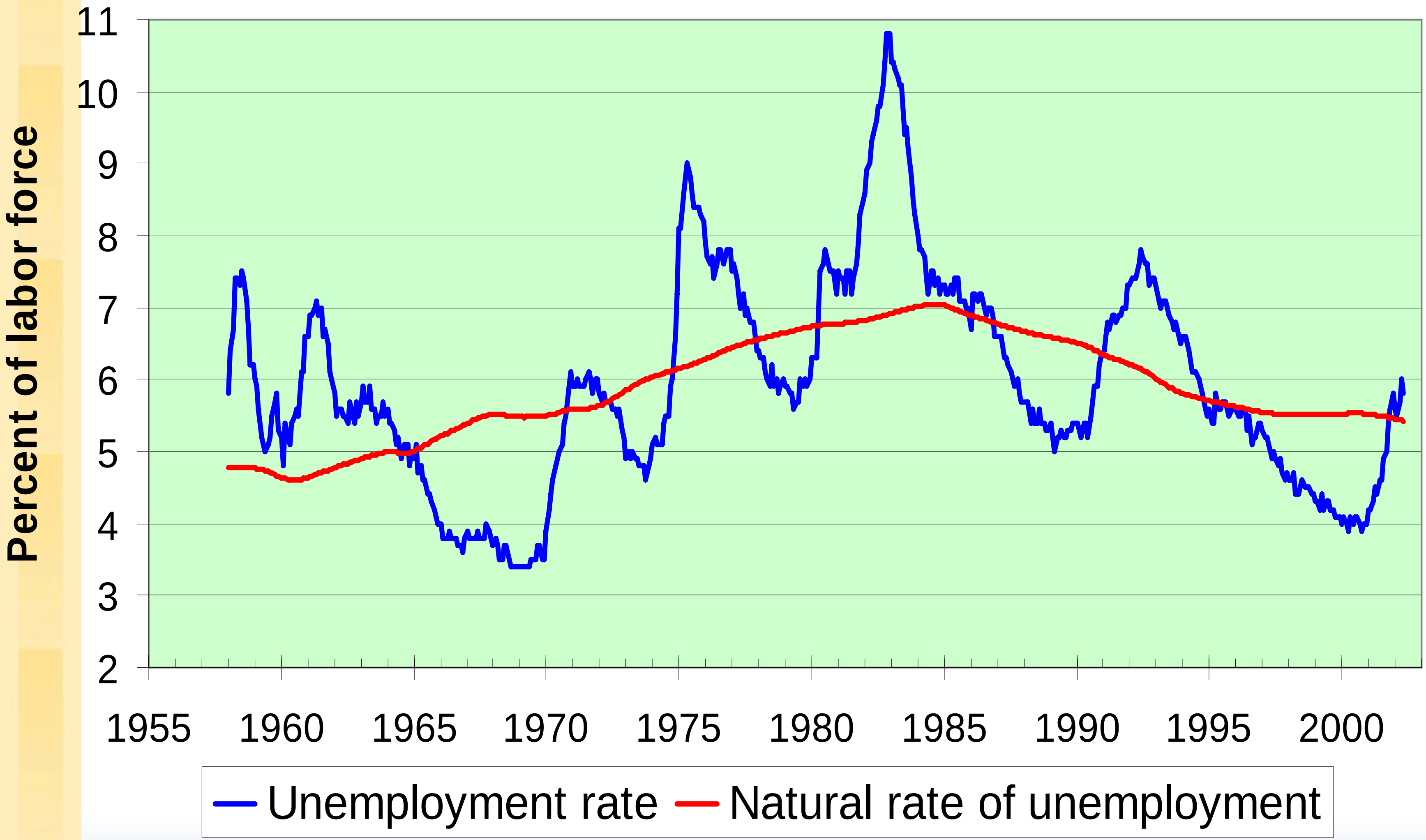
The natural rate of unemployment:

- what it means
- what causes it
- understanding its behavior in the real world

Natural Rate of Unemployment

- **Natural rate of unemployment**:
  the average rate of unemployment around which the economy fluctuates.
- In a recession, the actual unemployment rate rises above the natural rate.
- In a boom, the actual unemployment rate falls below the natural rate.

U.S. Unemployment, 1958-2002



A first model of the natural rate

Notation:

L = # of workers in labor force

E = # of employed workers

U = # of unemployed

U/L = unemployment rate

Assumptions:

1. ***L*** is exogenously fixed.
2. During any given month,

   s = fraction of employed workers that become separated from their jobs,

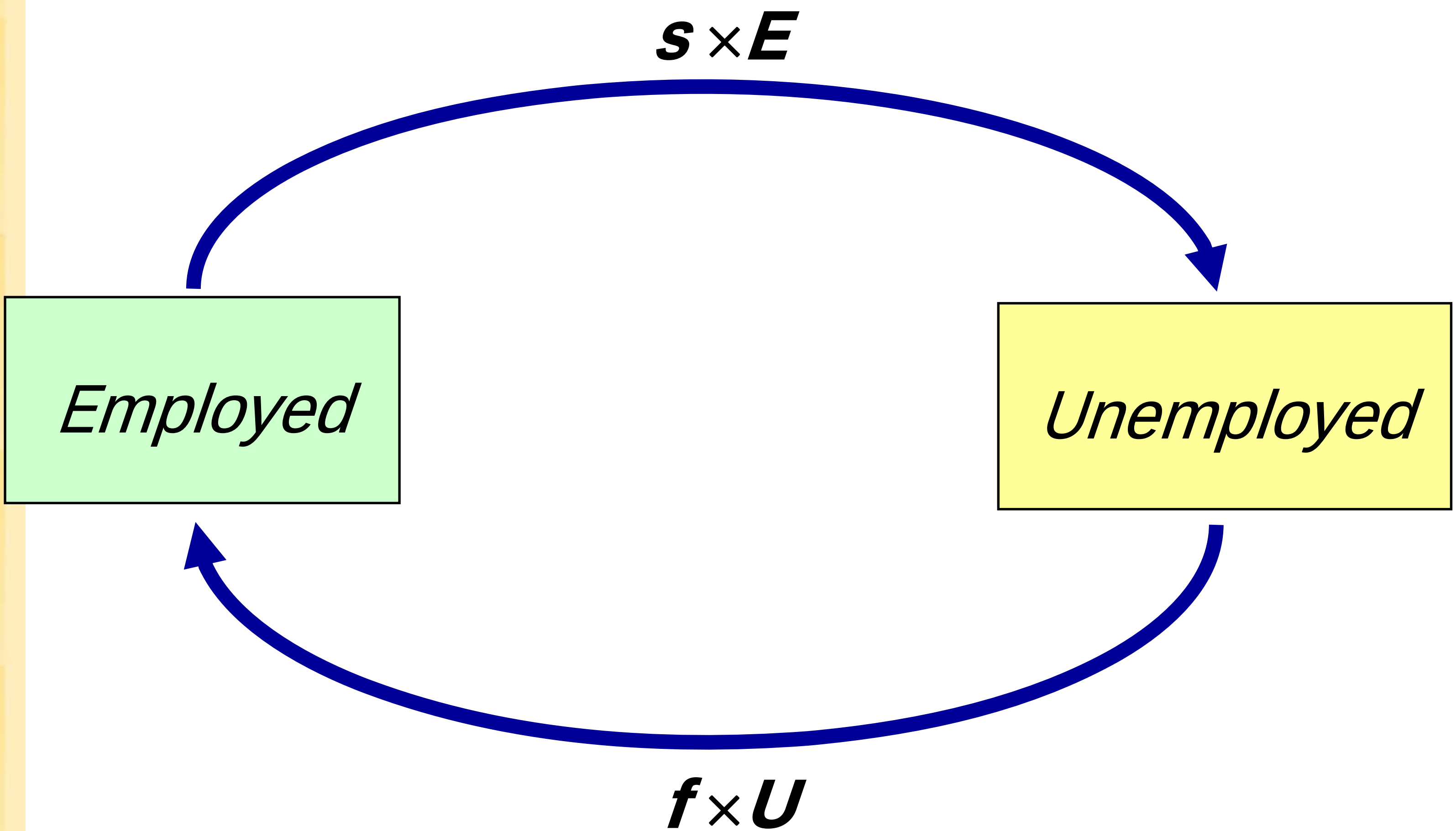
   f = fraction of unemployed workers that find jobs.

s = rate of job **s**eparations

f = rate of job **f**inding

(both exogenous)

The transitions between employment and unemployment



The steady state condition

- Definition: the labor market is in steady state, or long-run equilibrium, if the unemployment rate is constant.
- The steady-state condition is:

$$s \times E = f \times U$$

# of employed people who lose or leave their jobs

# of unemployed people who find jobs

Solving for the "equilibrium" U rate

$$f \times U = s \times E$$
$$= s \times (L - U)$$
$$= s \times L - s \times U$$

Solve for ***U/L***:

$$(f + s) \times U = s \times L$$

so,

$$\boxed{\frac{U}{L} = \frac{s}{s + f}}$$

Example:

- Each month, 1% of employed workers lose their jobs ($s = 0.01$)
- Each month, 19% of unemployed workers find jobs ($f = 0.19$)
- Find the natural rate of unemployment:

$$\frac{U}{L} = \frac{s}{s+f} = \frac{0.01}{0.01+0.19} = 0.05\text{, or } 5\%$$

policy implication

- A policy that aims to reduce the natural rate of unemployment will succeed only if it lowers ***s*** or increases ***f***.

Why is there unemployment?

- If job finding were instantaneous ($\boldsymbol{f} = 1$), then all spells of unemployment would be brief, and the natural rate would be near zero.
- There are two reasons why $\boldsymbol{f} < 1$:
    1. job search
    2. wage rigidity

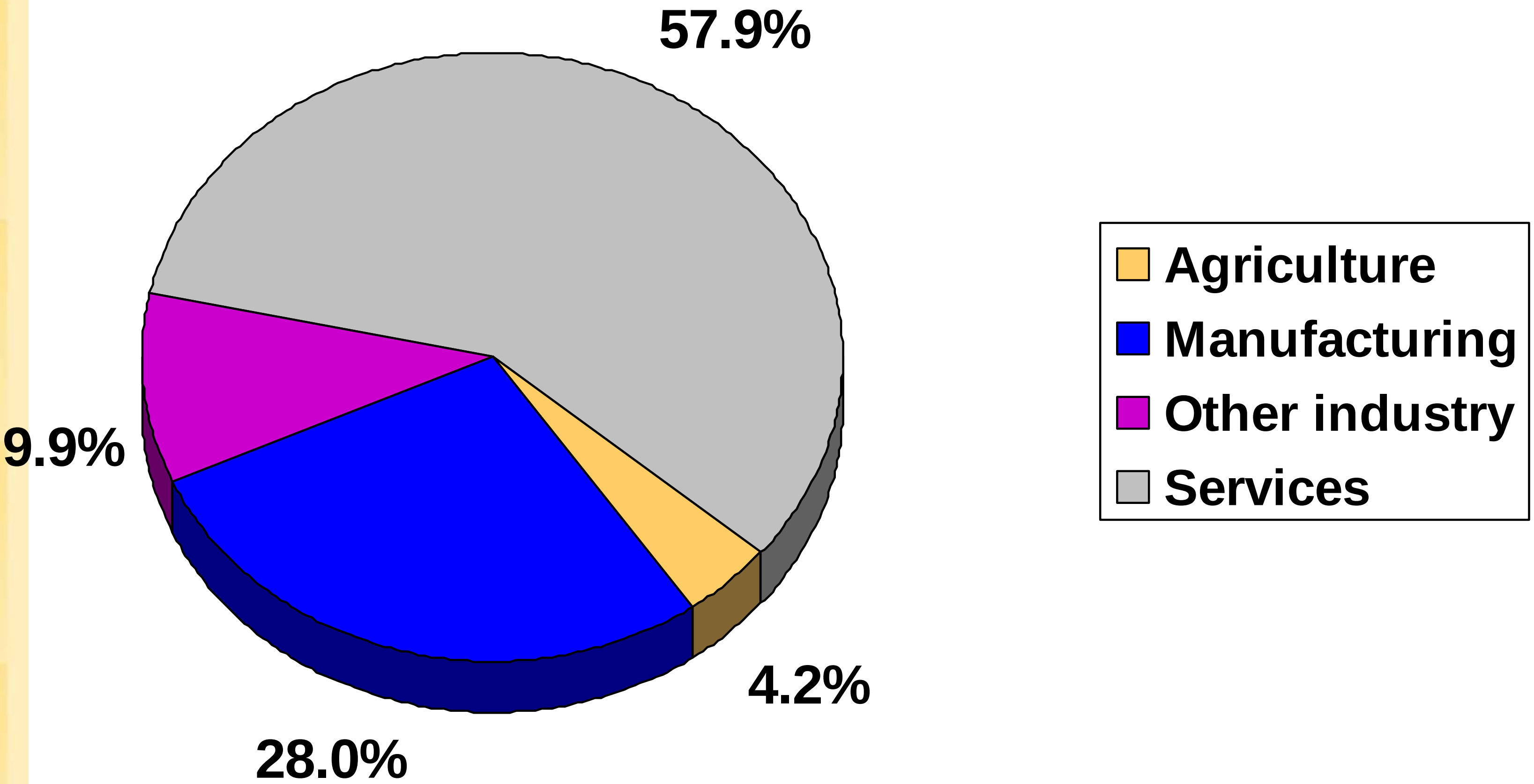
Job Search & Frictional Unemployment

- **frictional unemployment**: caused by the time it takes workers to search for a job
- occurs even when wages are flexible and there are enough jobs to go around
- occurs because
  - workers have different abilities, preferences
  - jobs have different skill requirements
  - geographic mobility of workers not instantaneous
  - flow of information about vacancies and job candidates is imperfect

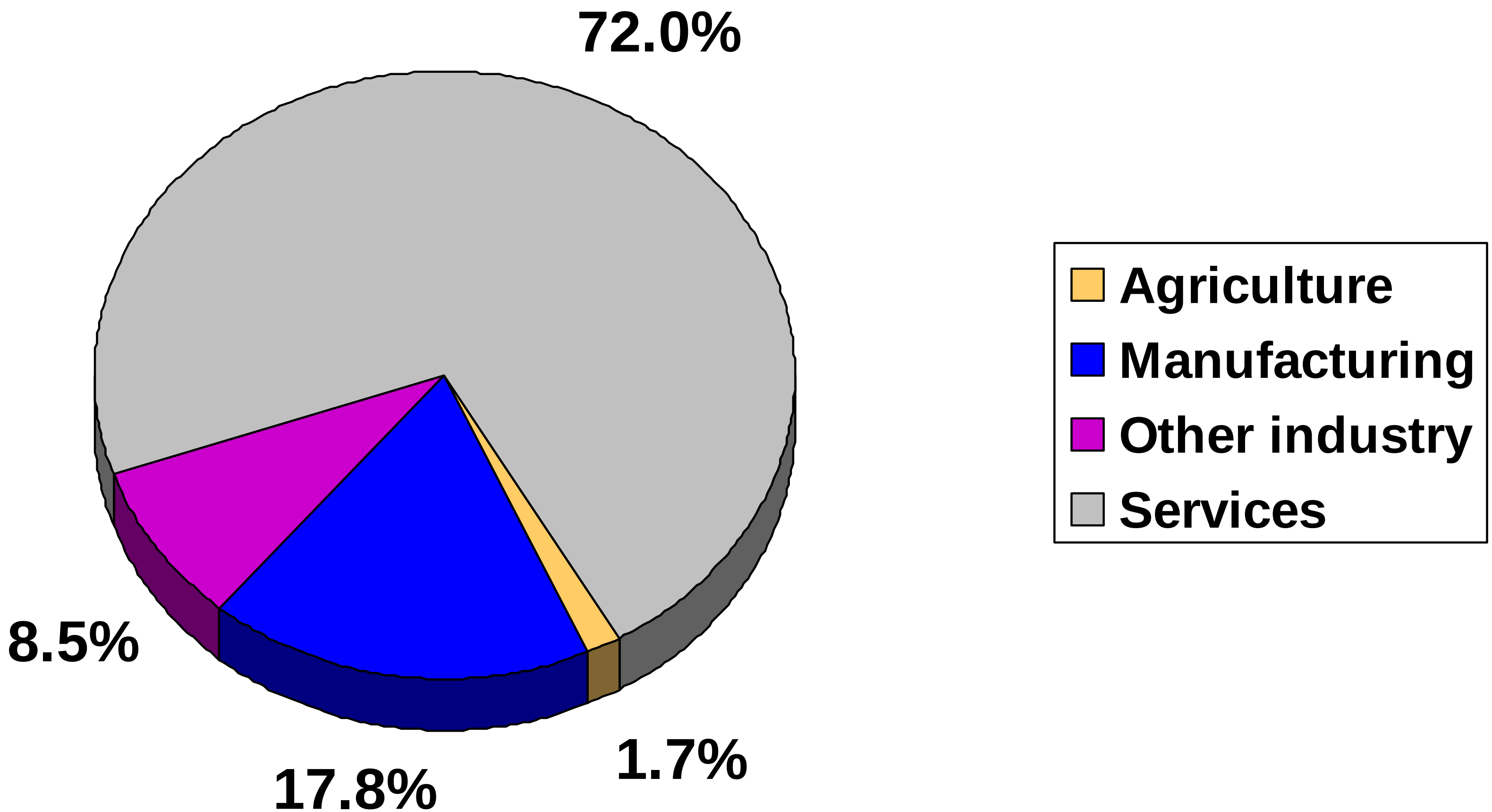
Sectoral shifts

- def: changes in the composition of demand among industries or regions
- *example:* Technological change increases demand for computer repair persons, decreases demand for typewriter repair persons
- *example:* A new international trade agreement causes greater demand for workers in the export sectors and less demand for workers in import-competing sectors.
- It takes time for workers to change sectors, so sectoral shifts cause frictional unemployment.

Industry shares in U.S. GDP, 1960



Industry shares in U.S. GDP, 1997



Sectoral shifts abound

- more examples:
  - Late 1800s: decline of agriculture, increase in manufacturing
  - Late 1900s: relative decline of manufacturing, increase in service sector
  - 1970s energy crisis caused a shift in demand away from huge gas guzzlers toward smaller cars.
- In our dynamic economy, smaller (though still significant) sectoral shifts occur frequently, contributing to frictional unemployment.

Public Policy and Job Search

Govt programs affecting unemployment

- *Govt employment agencies:* disseminate info about job openings to better match workers & jobs
- *Public job training programs:* help workers displaced from declining industries get skills needed for jobs in growing industries

Unemployment insurance (UI)

- UI pays part of a worker's former wages for a limited time after losing his/her job.
- UI increases search unemployment, because it:
  - reduces the opportunity cost of being unemployed
  - reduces the urgency of finding work
  - hence, reduces f
- Studies: The longer a worker is eligible for UI, the longer the duration of the average spell of unemployment.

Benefits of UI

- By allowing workers more time to search,

  UI may lead to better matches between jobs and workers,

  which would lead to greater productivity and higher incomes.

Why is there unemployment?

The natural rate of unemployment: $\dfrac{U}{L} = \dfrac{s}{s+f}$

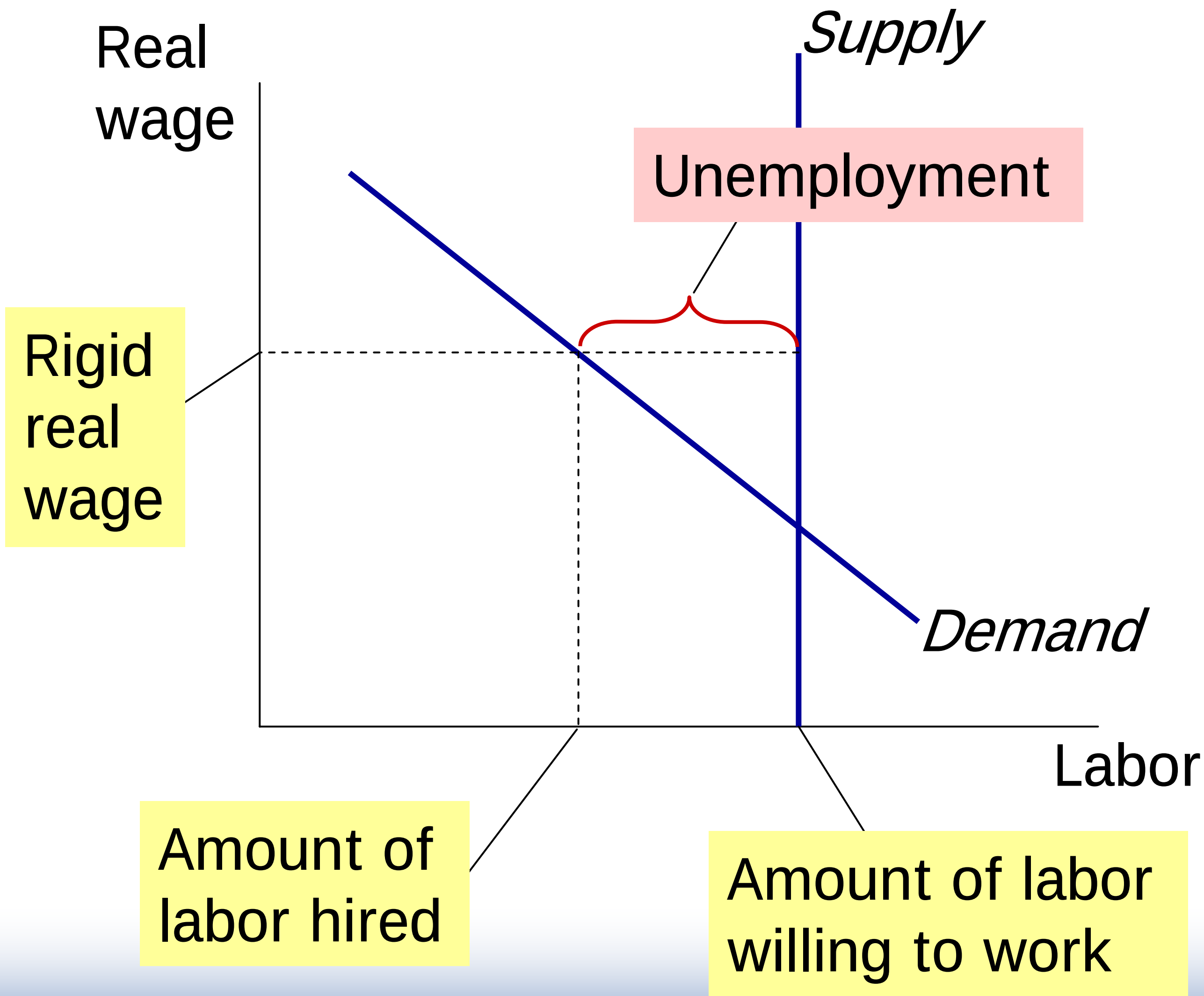
- There are two reasons why $f < 1$:

DONE ✓ 1. job search

Next → 2. wage rigidity

Unemployment from real wage rigidity

If the real wage is stuck above the eq'm level, then there aren't enough jobs to go around.



Unemployment from real wage rigidity

If the real wage is stuck above the eq'm level, then there aren't enough jobs to go around.

Then, firms must ration the scarce jobs among workers.

Structural unemployment: the unemployment resulting from real wage rigidity and job rationing.

Reasons for wage rigidity

1. Minimum wage laws
2. Labor unions
3. Efficiency wages

The minimum wage

- The minimum wage is well below the eq'm wage for most workers, so it cannot explain the majority of natural rate unemployment.
- However, the minimum wage may exceed the eq'm wage of unskilled workers, especially teenagers.
- If so, then we would expect that increases in the minimum wage would increase unemployment among these groups.

The minimum wage in the real world:

- In Sept 1996, the minimum wage was raised from \$4.25 to \$4.75. Here's what happened:

Unemployment rates, before & after		
	3rd Q 1996	1st Q 1997
Teenagers	16.6%	17.0%
Single mothers	8.5%	9.1%
All workers	5.3%	5.3%

- Other studies: A 10% increase in the minimum wage increases teenage unemployment by 1-3%.

Labor unions

- Unions exercise monopoly power to secure higher wages for their members.
- When the union wage exceeds the eq'm wage, unemployment results.
- Employed union workers are **insiders** whose interest is to keep wages high.
- Unemployed non-union workers are **outsiders** and would prefer wages to be lower (so that labor demand would be high enough for them to get jobs).

Union membership and wage ratios by industry, 2001

industry	# employed (1000s)	U % of total	RBU % of total	wage ratio
mining	531	12.3%	12.9%	103.4
construction	6,881	18.4	19.0	151.0
manufacturing	18,149	14.6	15.5	105.9
transportation	4,441	24.1	25.4	127.8
comm. and pub util	2,981	22.6	23.7	104.2
wholesale trade	4,540	5.5	5.9	105.8
retail trade	20,505	4.5	5.0	117.8
fin, insu, and real est	7,648	2.1	2.8	90.1
services	34,261	5.9	6.8	103.3
government	19,155	37.4	41.8	121.1
all	**119,092**	**13.6%**	**15.0%**	**118.0**

RBU = nonunion workers represented by a union
wage ratio = 100×(union + RBU wage)/(nonunion wage)

Efficiency Wage Theory

- Theories in which high wages increase worker productivity:
  - attract higher quality job applicants
  - increase worker effort and reduce "shirking"
  - reduce turnover, which is costly
  - improve health of workers

    (in developing countries)
- The increased productivity justifies the cost of paying above-equilibrium wages.
- The result: unemployment

Question for Discussion:

- Use the material we've just covered to come up with a policy or policies to try to reduce the natural rate of unemployment.
- Note whether your policy targets frictional or structural unemployment.

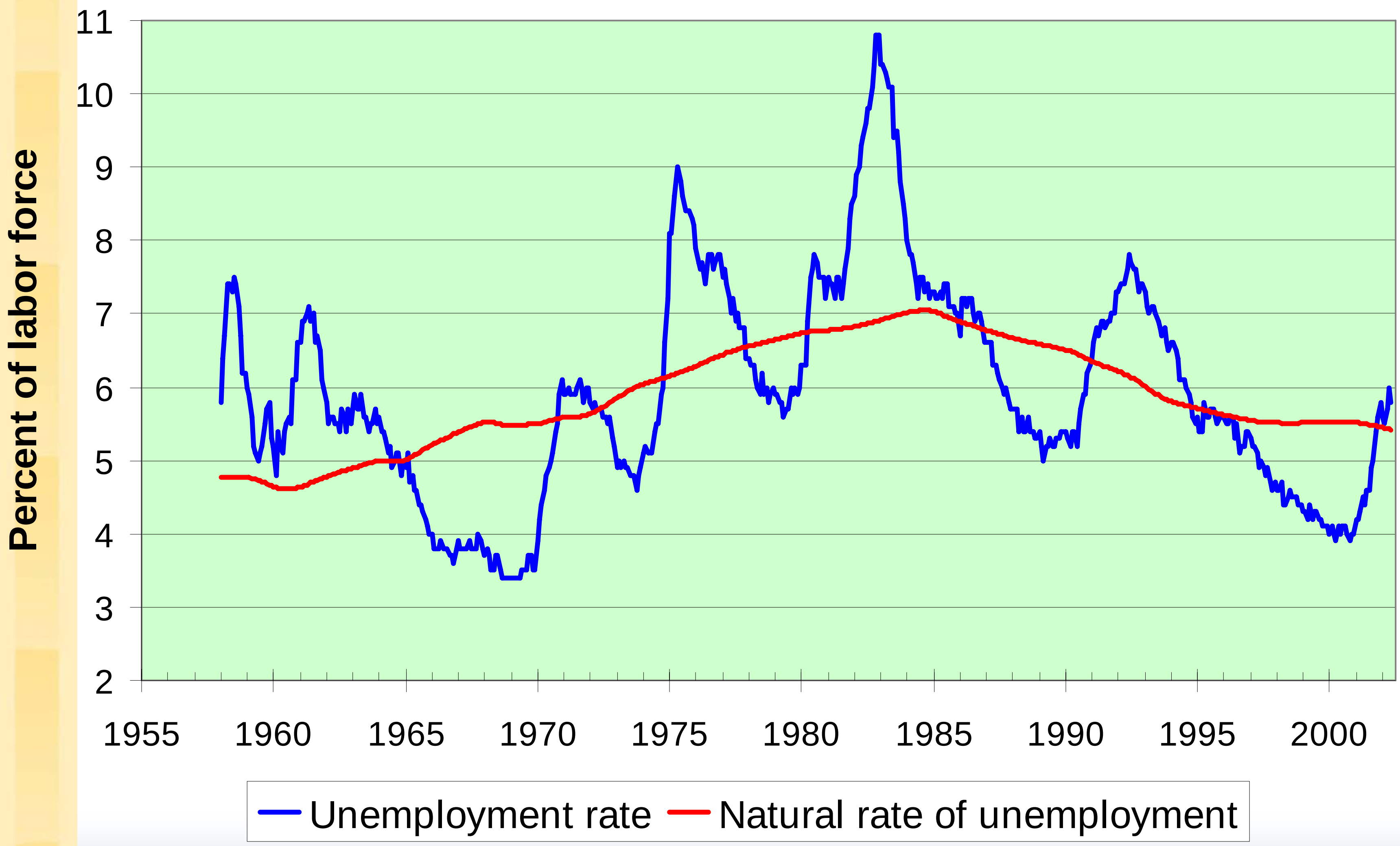
The duration of U.S. unemployment,
average over 1993-2002

# of weeks unemployed	# of unemployed persons as % of total # of unemployed	amount of time these workers spent unemployed as % of total time all workers spent unemployed
1-4	39%	6.5%
5-14	31%	20.5%
15 or more	30%	73.0%

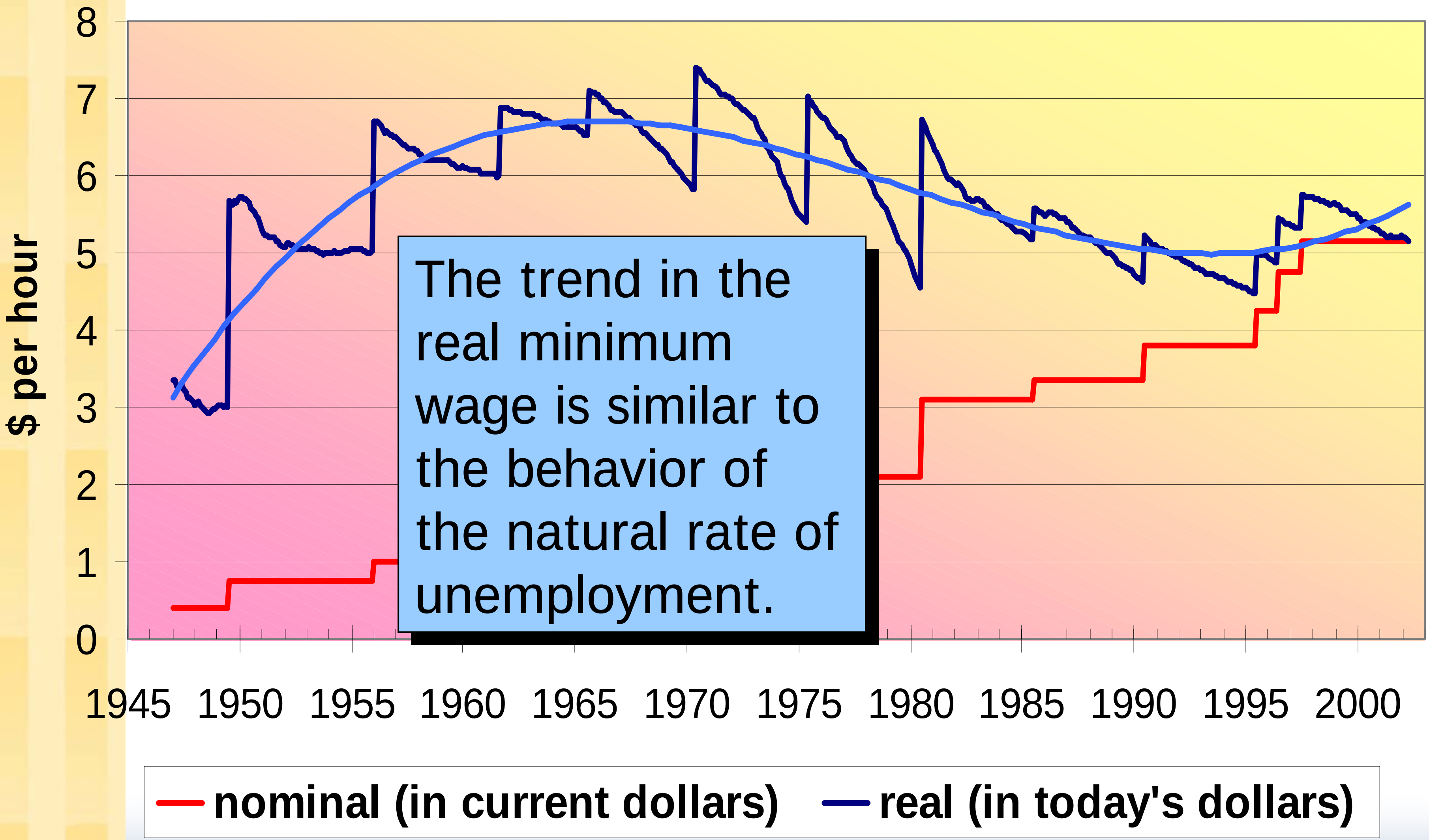
The duration of unemployment

- The data:
  - More spells of unemployment are short-term than medium-term or long-term.
  - Yet, most of the total time spent unemployed is attributable to the long-term unemployed.
- This long-term unemployment is probably structural and/or due to sectoral shifts among vastly different industries.
- Knowing this is important because it can help us craft policies that are more likely to succeed.

Actual & natural rates of unemployment in the U.S.



EXPLAINING THE TREND:
The minimum wage



EXPLAINING THE TREND:
Union membership

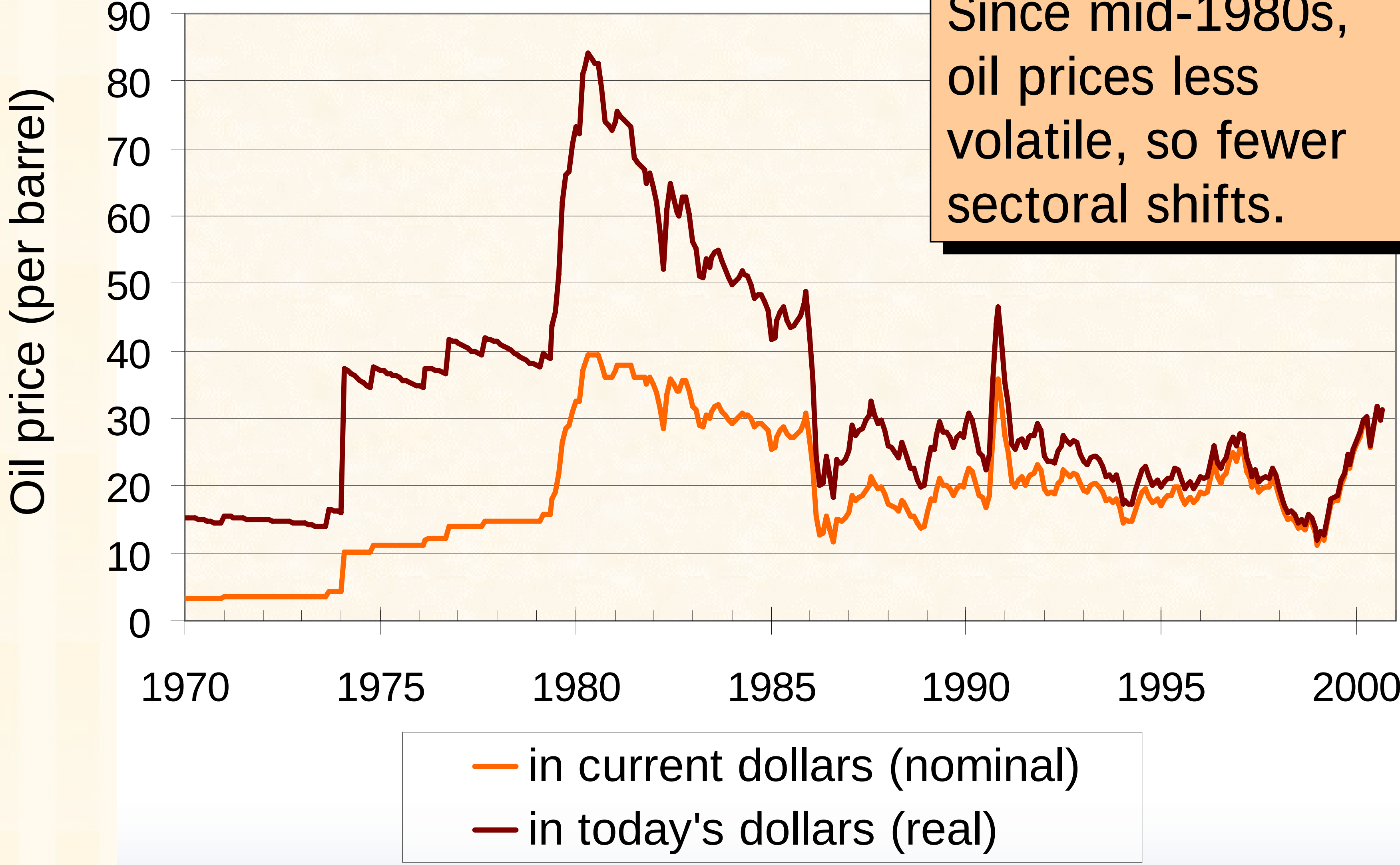
Union membership
selected years

year	percent of labor force
1930	12%
1945	35%
1954	35%
1970	27%
1983	20.1%
2001	13.5%

Since the early 1980s, the natural rate of unemploy-ment and union membership have both fallen.

But, from 1950s to about 1980, the natural rate rose while union membership fell.

EXPLAINING THE TREND:
Sectoral shifts



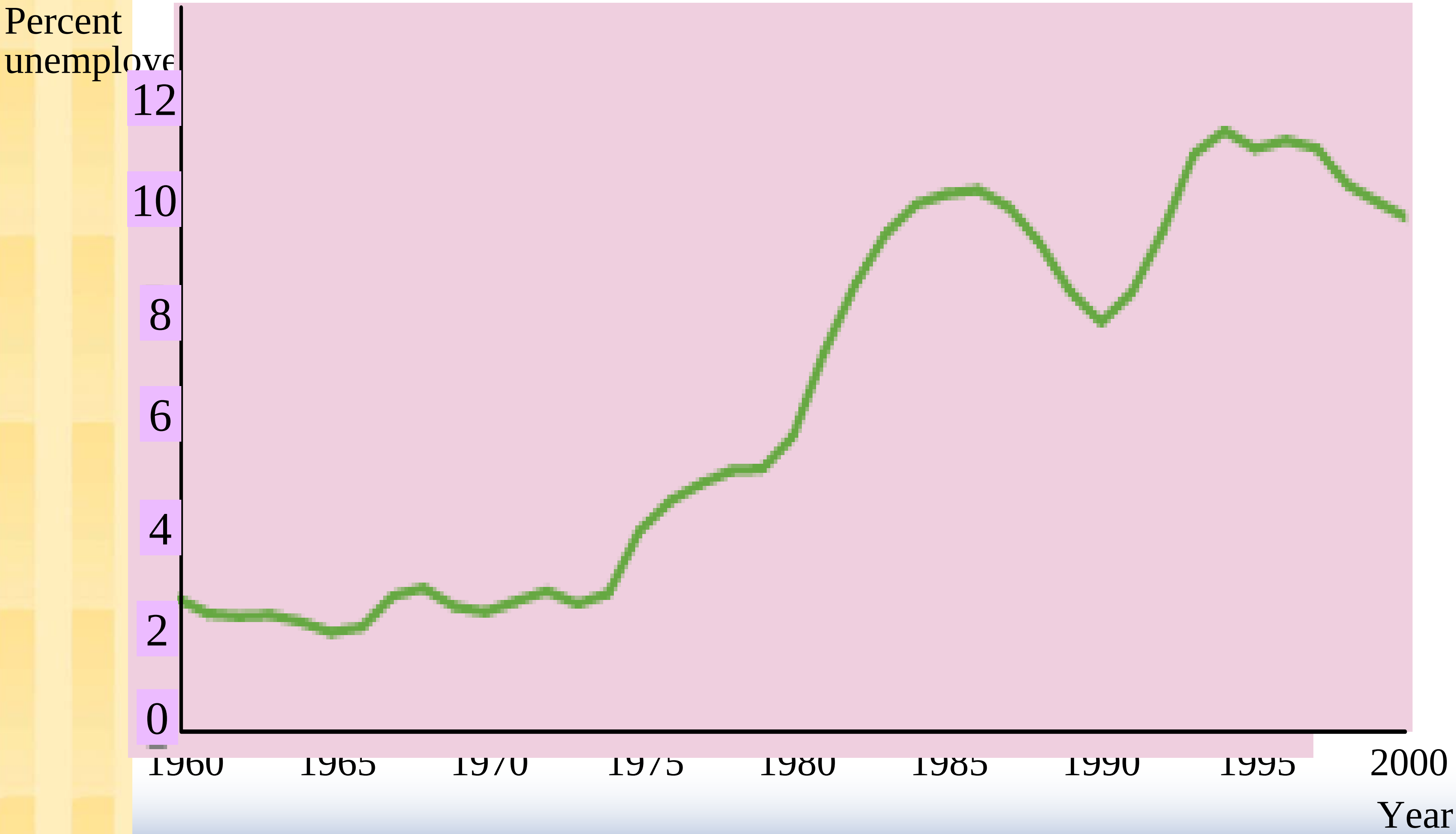
Since mid-1980s, oil prices less volatile, so fewer sectoral shifts.

EXPLAINING THE TREND: Demographics

- 1970s:
  The Baby Boomers were young.
  Young workers change jobs more frequently (high value of ***s***).

- Late 1980s through today:
  Baby Boomers aged. Middle-aged workers change jobs less often (low ***s***).

The rise in European Unemployment



The rise in European Unemployment

Two explanations:

1. Most countries in Europe have generous social insurance programs.
2. Shift in demand from unskilled to skilled workers, due to technological change.

This demand shift occurred in the U.S., too. But wage rigidity is less of a problem here, so the shift caused an increase in the skilled-to-unskilled wage gap instead of an increase in unemployment.

Chapter summary

1. The natural rate of unemployment
   - the long-run average or "steady state" rate of unemployment
   - depends on the rates of job separation and job finding
2. Frictional unemployment
   - due to the time it takes to match workers with jobs
   - may be increased by unemployment insurance

Chapter summary

3. Structural unemployment
   - results from wage rigidity - the real wage remains above the equilibrium level
   - causes: minimum wage, unions, efficiency wages
4. Duration of unemployment
   - most spells are short term
   - but most weeks of unemployment are attributable to a small number of long-term unemployed persons

Chapter summary

5. Behavior of the natural rate in the U.S.
   - rose from 1950s to early 1980s, then fell
   - possible explanations:
     trends in real minimum wage,
     union membership, prevalence of sectoral shifts, and aging of the Baby Boomers

6. European unemployment
   - has risen sharply since 1980
   - probably due to generous unemployment insurance there and a technology-driven shift in demand away from unskilled workers

Chapter 7 learning objectives

- Learn the closed economy Solow model
- See how a country's standard of living depends on its saving and population growth rates
- Learn how to use the "Golden Rule" to find the optimal savings rate and capital stock

The importance of economic growth

…for poor countries

selected poverty statistics

In the poorest one-fifth of all countries,

- daily caloric intake is 1/3 lower than in the richest fifth
- the infant mortality rate is 200 per 1000 births, compared to 4 per 1000 births in the richest fifth.

selected poverty statistics

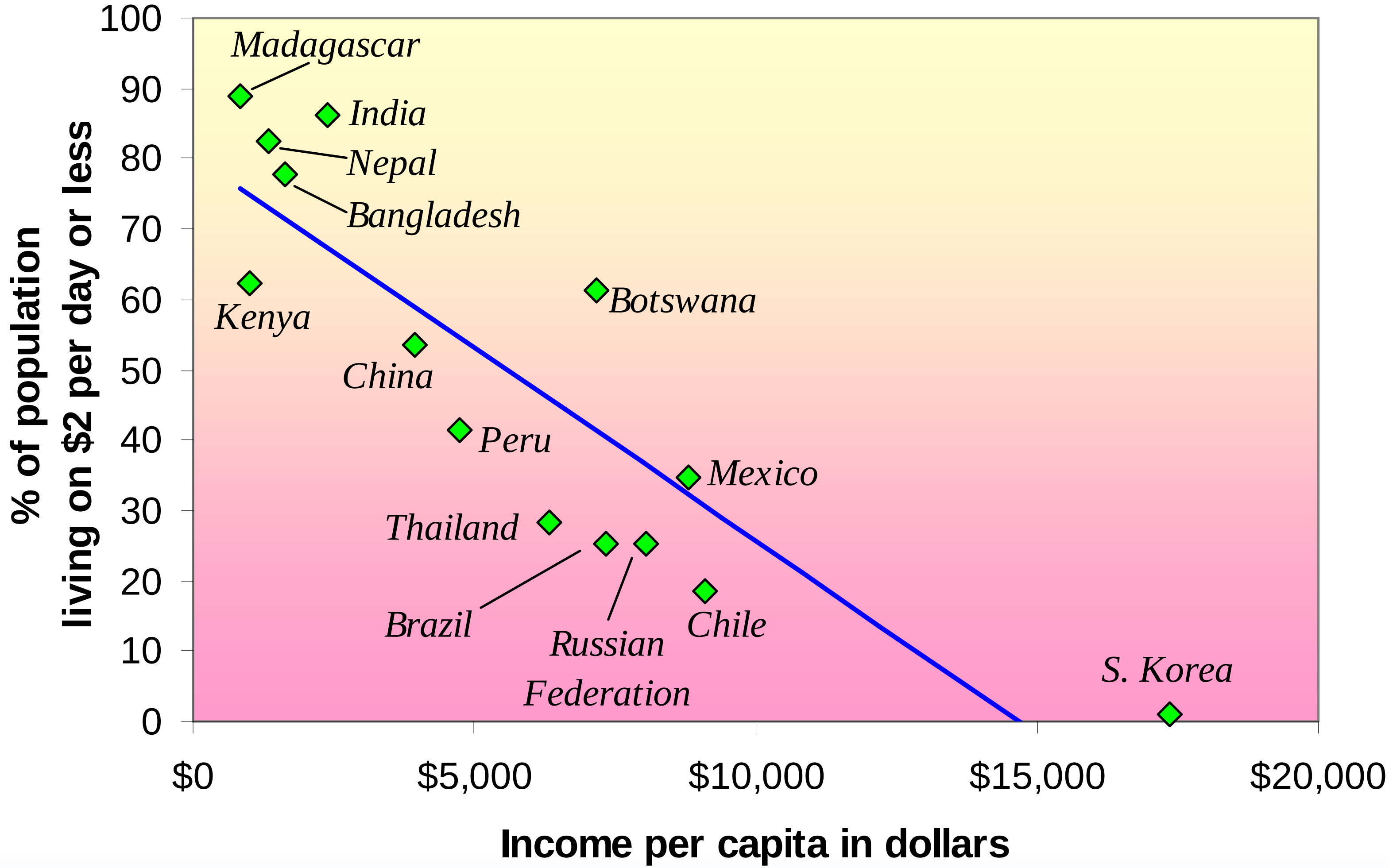
- In Pakistan, 85% of people live on less than $2/day
- One-fourth of the poorest countries have had famines during the past 3 decades. (none of the richest countries had famines)
- Poverty is associated with the oppression of women and minorities

Estimated effects of economic growth

- A 10% increase in income is associated with a 6% decrease in infant mortality
- Income growth also reduces poverty. Example:

Growth and Poverty in Indonesia		
	change in income per capita	change in # of persons living below poverty line
1984-96	+76%	-25%
1997-99	-12%	+65%

Income and poverty in the world
selected countries, 2000



The importance of economic growth

...for poor countries

...for rich countries

Huge effects from tiny differences

In rich countries like the U.S.,
if government policies or "shocks"
have even a small impact on the
long-run growth rate,
they will have a huge impact
on our standard of living
in the long run...

Huge effects from tiny differences

annual growth rate of income per capita	percentage increase in standard of living after...		
	...25 years	...50 years	...100 years
2.0%	64.0%	169.2%	624.5%
2.5%	85.4%	243.7%	1,081.4%

Huge effects from tiny differences

If the annual growth rate of
U.S. real GDP per capita
had been just
one-tenth of one percent higher
during the 1990s,
the U.S. would have generated
an additional $449 billion of income
during that decade

The lessons of growth theory

...can make a positive difference in the lives of hundreds of millions of people.

These lessons help us

- understand why poor countries are poor
- design policies that can help them grow
- learn how our own growth rate is affected by shocks and our government's policies

The Solow Model

- due to Robert Solow, won Nobel Prize for contributions to the study of economic growth
- a major paradigm:
  - widely used in policy making
  - benchmark against which most recent growth theories are compared
- looks at the determinants of economic growth and the standard of living in the long run

How Solow model is different from Chapter 3's model

1. ***K*** is no longer fixed:
   investment causes it to grow,
   depreciation causes it to shrink.

2. ***L*** is no longer fixed:
   population growth causes it to grow.

3. The consumption function is simpler.

How Solow model is different from Chapter 3's model

4. No ***G*** or ***T***
   (only to simplify presentation;
   we can still do fiscal policy experiments)

5. Cosmetic differences.

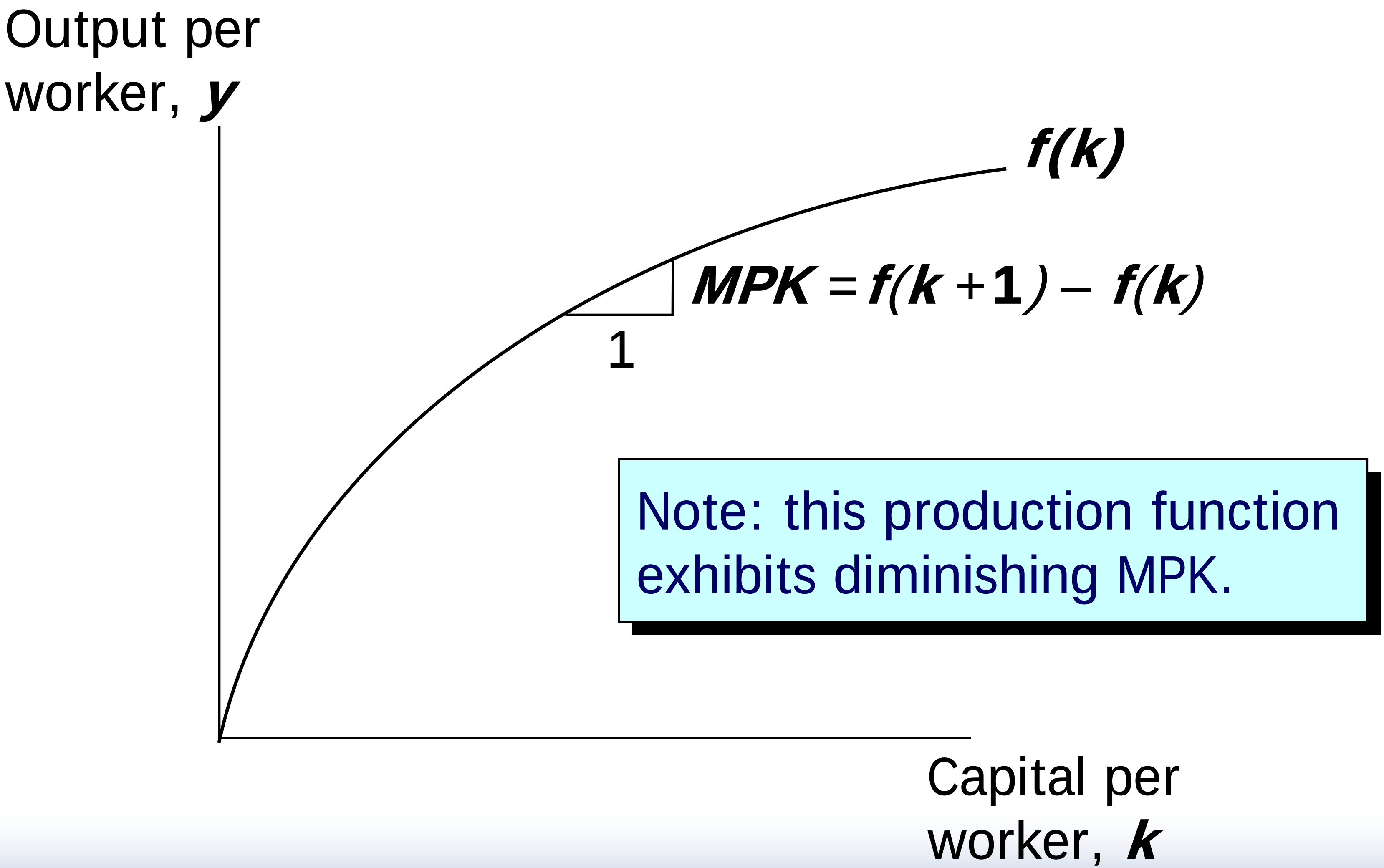
The production function

- In aggregate terms: $Y = F(K, L)$
- Define: $y = Y/L$ = output per worker
  $k = K/L$ = capital per worker
- Assume constant returns to scale:
  $zY = F(zK, zL)$ for any $z > 0$
- Pick $z = 1/L$. Then

$$Y/L = F(K/L, 1)$$
$$y = F(k, 1)$$
$$y = f(k)$$

where $f(k) = F(k, 1)$

The production function



The national income identity

- $\boldsymbol{Y} = \boldsymbol{C} + \boldsymbol{I}$ (*remember, no* $\boldsymbol{G}$)
- In "per worker" terms:

$$\boldsymbol{y} = \boldsymbol{c} + \boldsymbol{i}$$

where $\boldsymbol{c} = \boldsymbol{C/L}$ and $\boldsymbol{i} = \boldsymbol{I/L}$

The consumption function

- s = the saving rate,
  the fraction of income that is saved
  (s is an exogenous parameter)

  Note: s is the only lowercase variable that is not equal to its uppercase version divided by L

- Consumption function: $c = (1 - s)y$
  (per worker)

Saving and investment

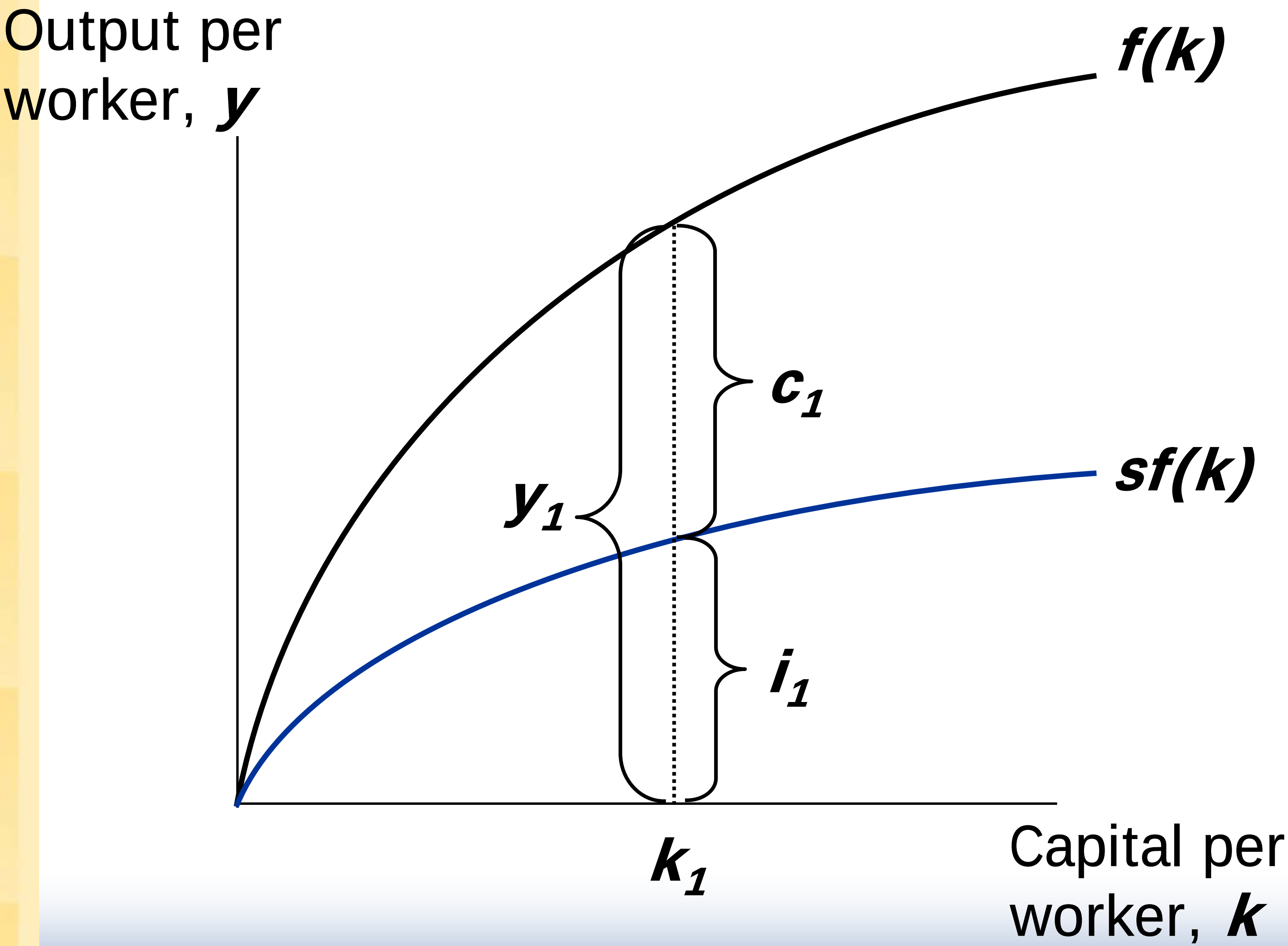
- saving (per worker) $= y - c$
  $= y - (1 - s)y$
  $= sy$
- National income identity is $y = c + i$

  Rearrange to get: $i = y - c = sy$

  (investment = saving, like in chap. 3!)
- Using the results above,

$$i = sy = sf(k)$$

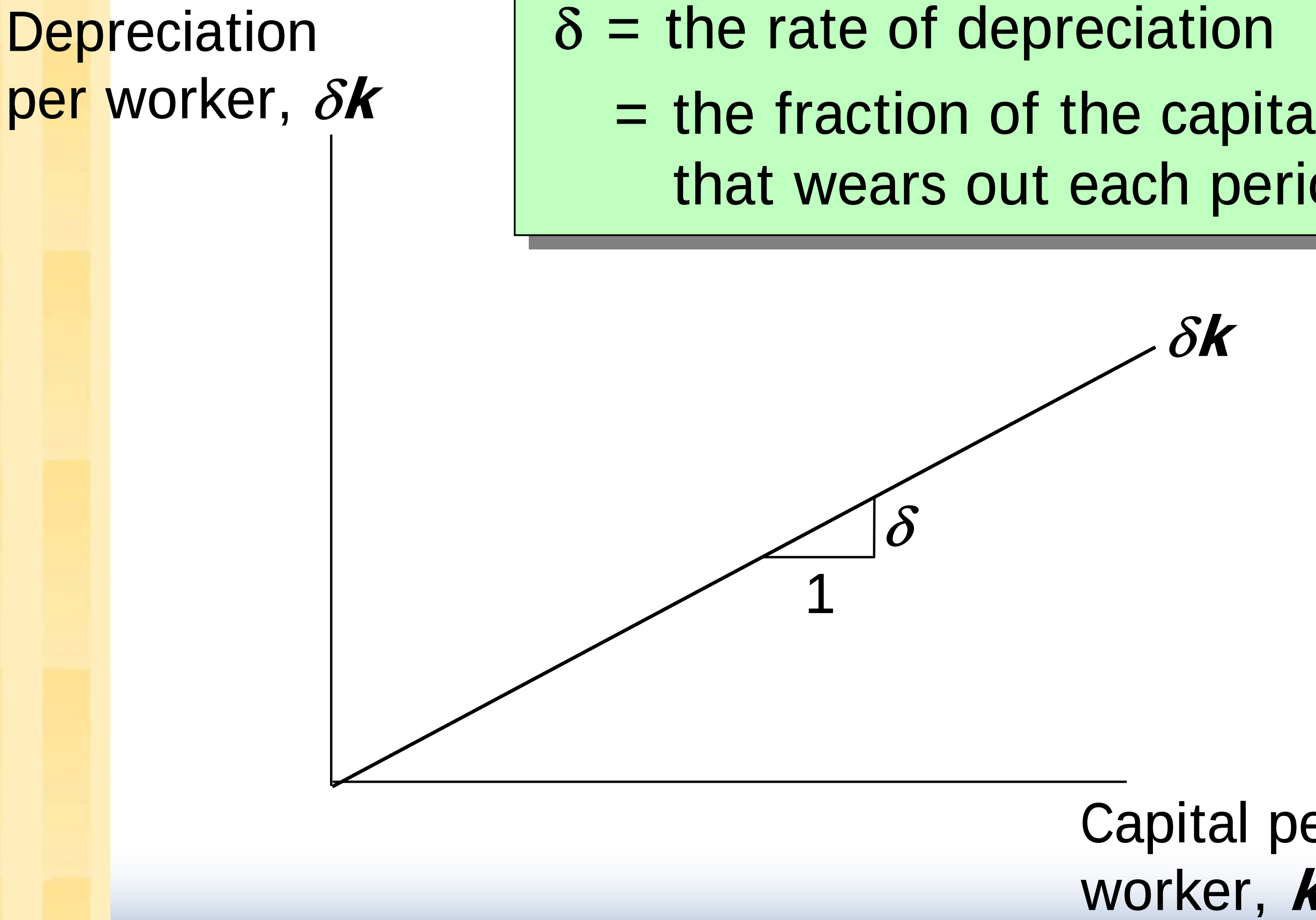
Output, consumption, and investment



Depreciation

δ = the rate of depreciation

= the fraction of the capital stock that wears out each period



Capital accumulation

The basic idea:

Investment makes the capital stock bigger,

depreciation makes it smaller.

Capital accumulation

Change in capital stock = investment – depreciation

$\Delta k = i - \delta k$

Since $i = sf(k)$, this becomes:

$$\boxed{\Delta k = s\,f(k) - \delta k}$$

The equation of motion for *k*

$$\boxed{\Delta k = s f(k) - \delta k}$$

- the Solow model's central equation
- Determines behavior of capital over time...
- ...which, in turn, determines behavior of all of the other endogenous variables because they all depend on ***k***. E.g.,

  income per person: $y = f(k)$

  consump. per person: $c = (1 - s)\, f(k)$

The steady state

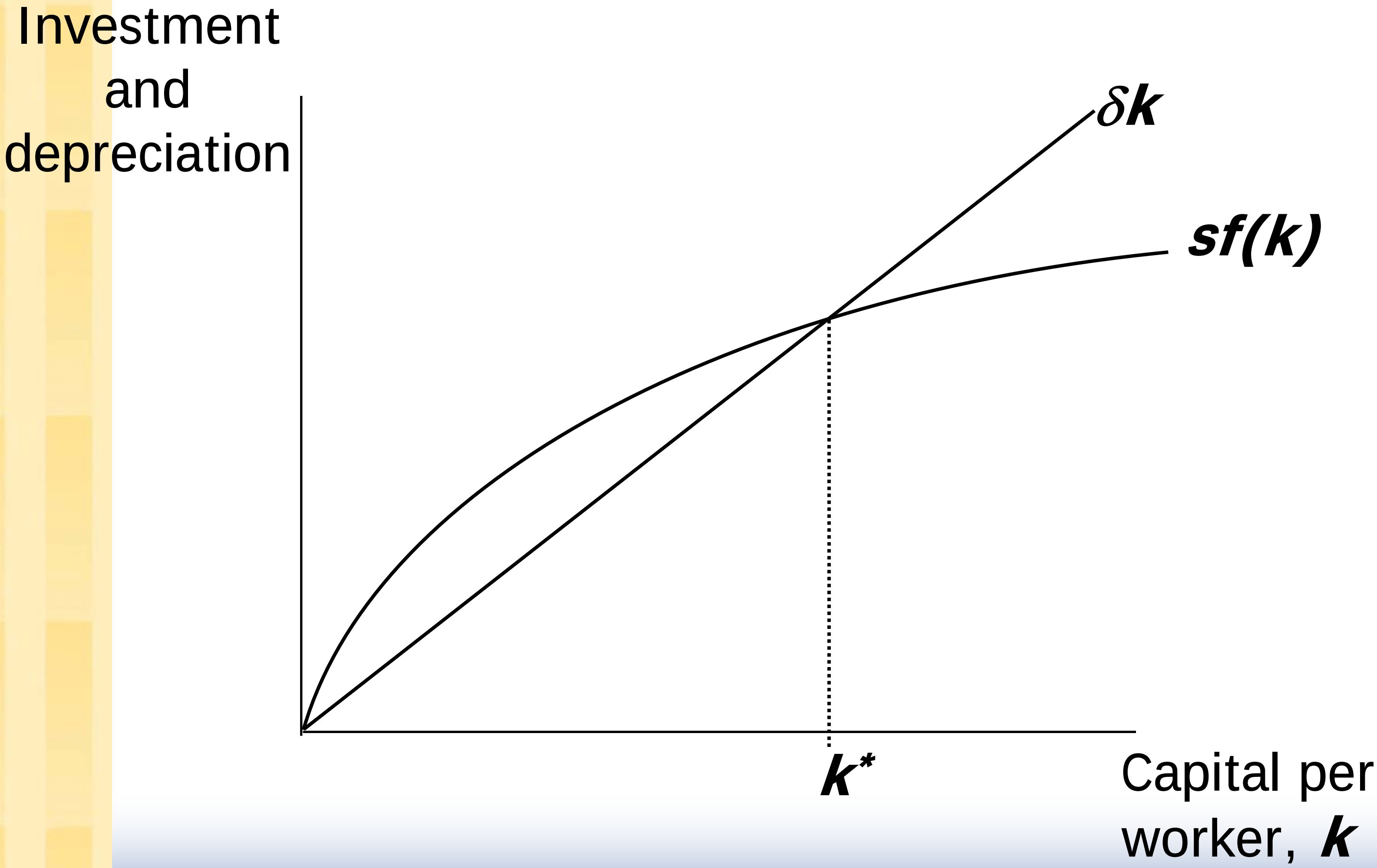
$$\Delta k = s f(k) - \delta k$$

If investment is just enough to cover depreciation
[$sf(k) = \delta k$],
then capital per worker will remain constant:

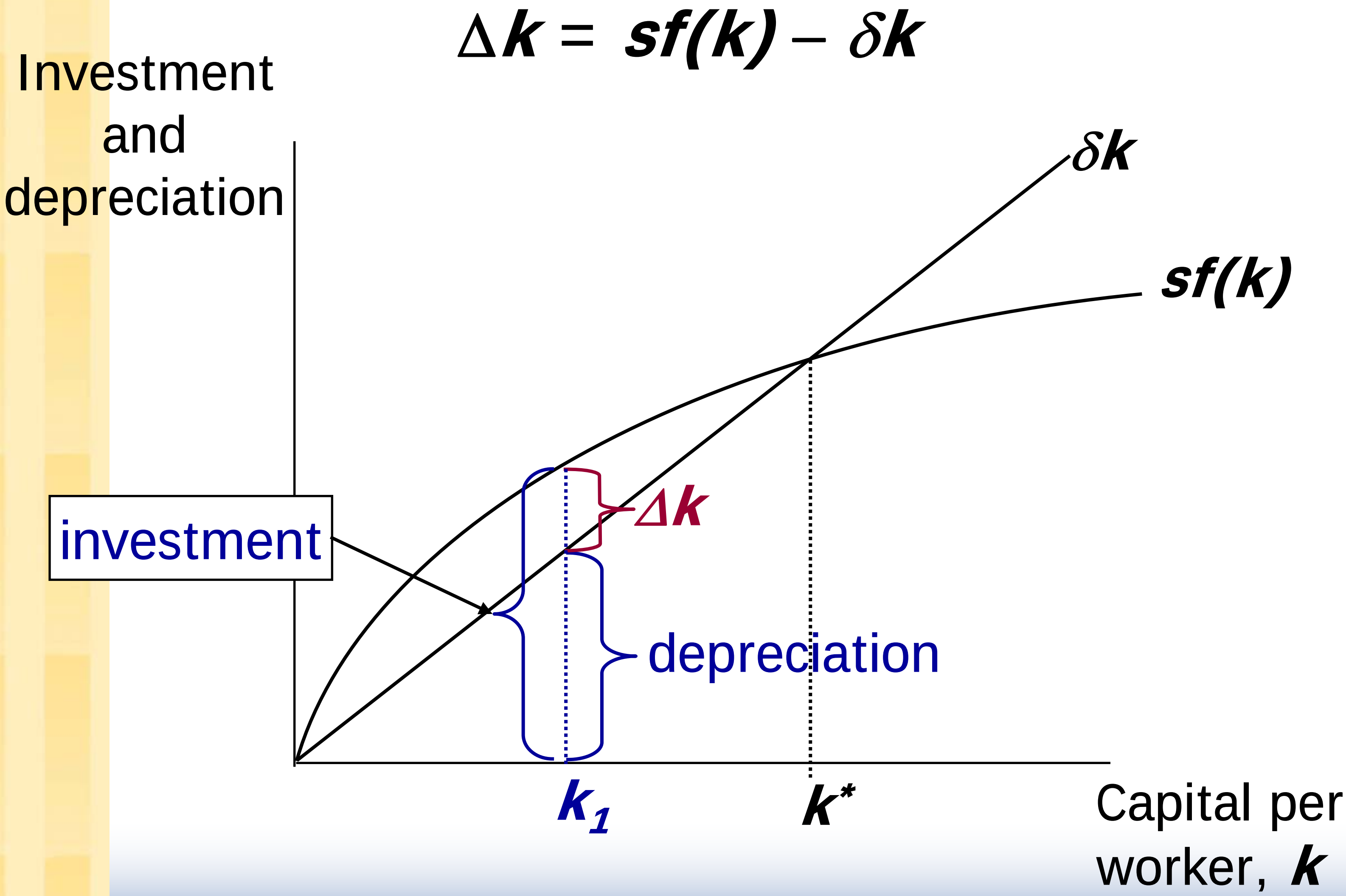
$$\Delta k = 0.$$

This constant value, denoted k^*, is called the ***steady state capital stock***.

The steady state

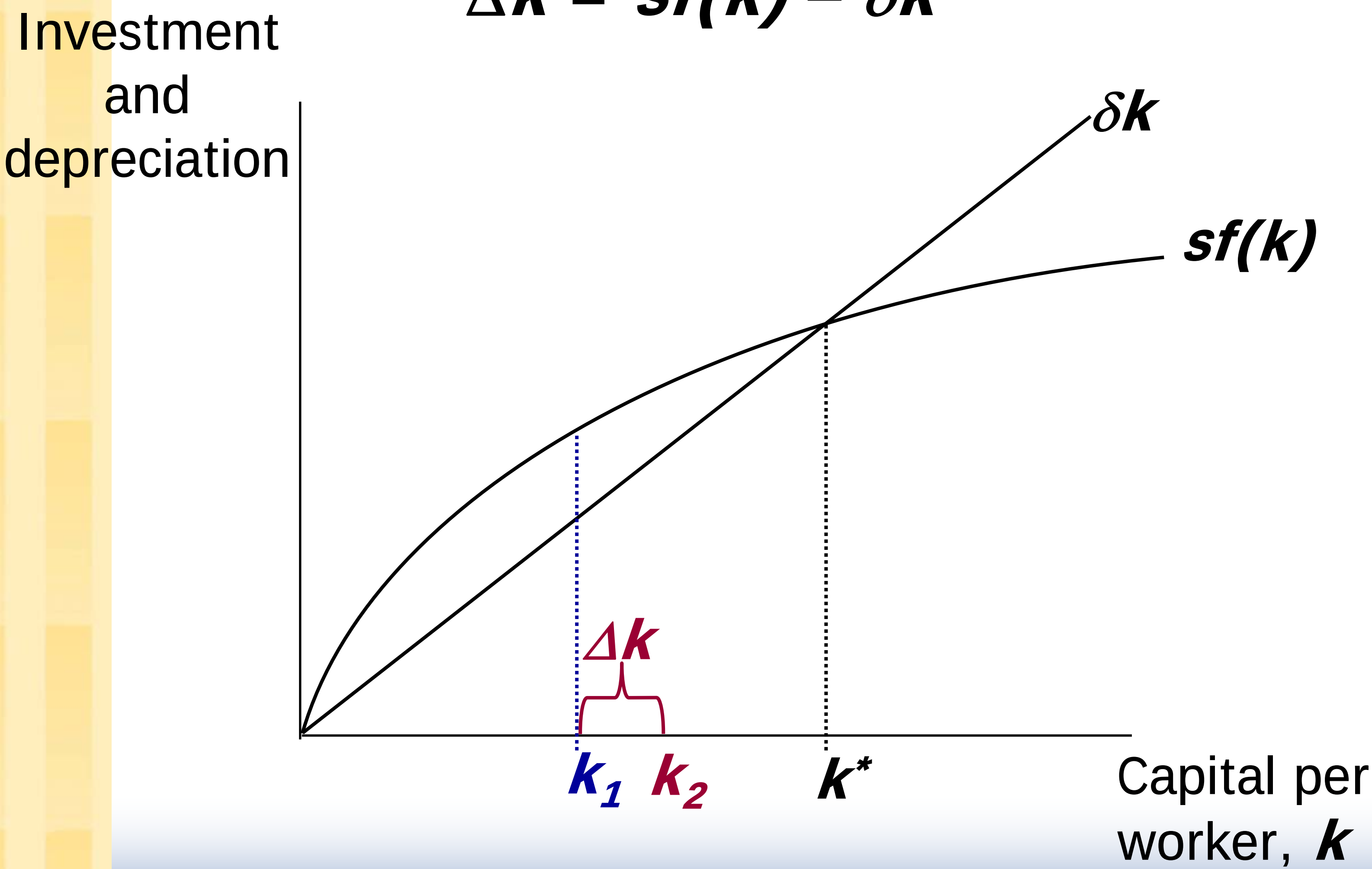


Moving toward the steady state



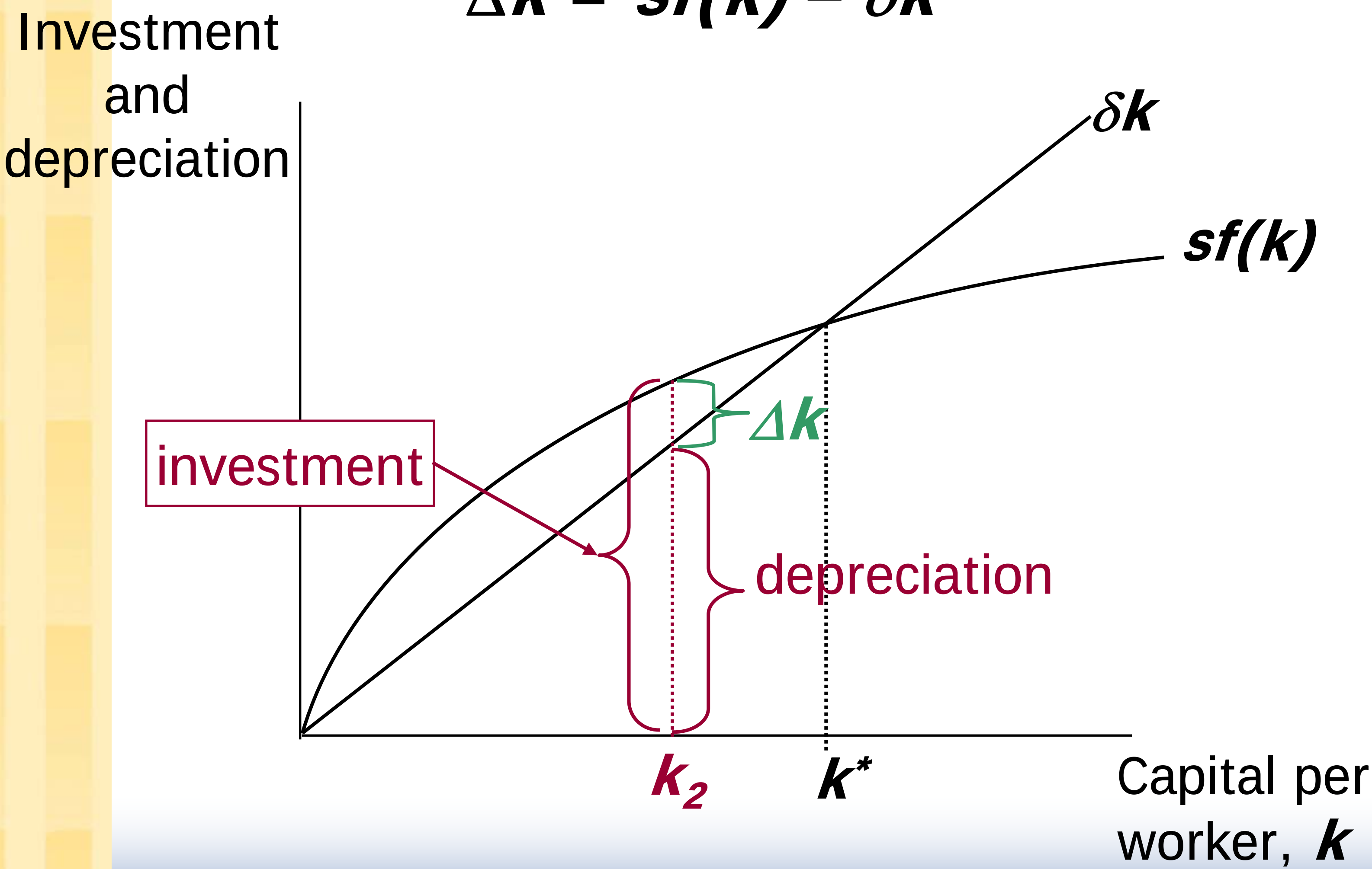
Moving toward the steady state

$$\Delta k = sf(k) - \delta k$$



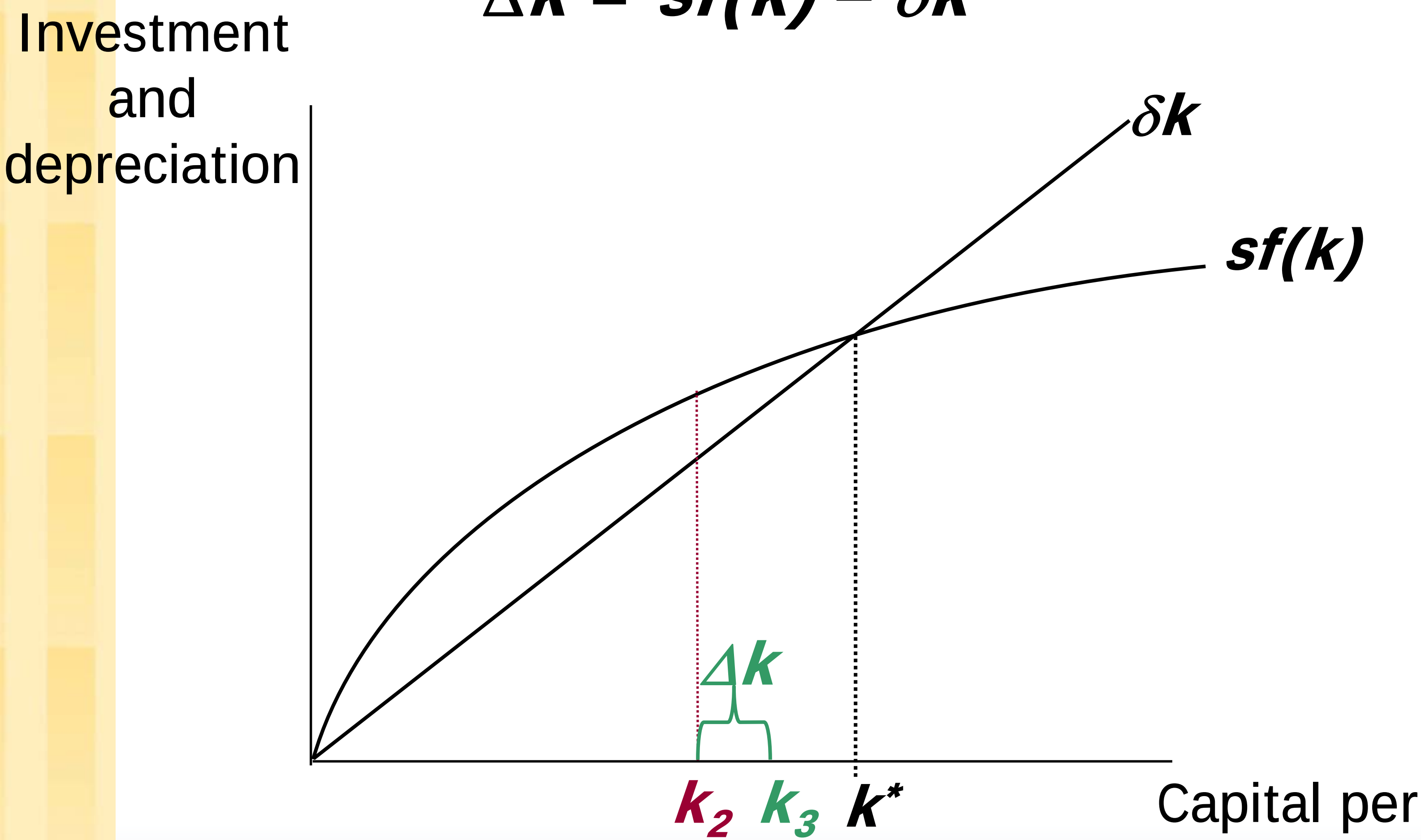
Moving toward the steady state

$$\Delta k = sf(k) - \delta k$$



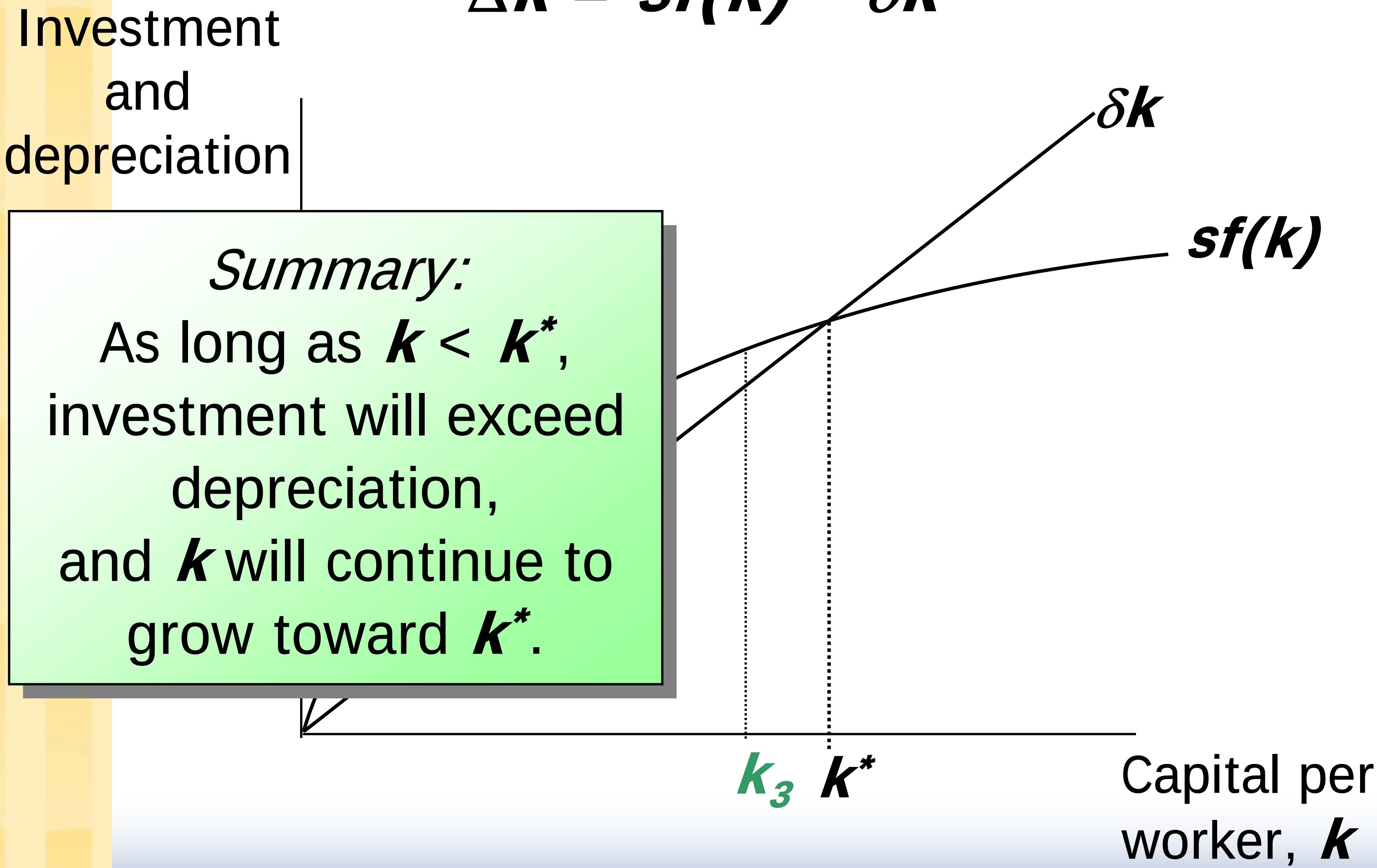
Moving toward the steady state

$$\Delta k = sf(k) - \delta k$$



Moving toward the steady state

$$\Delta k = sf(k) - \delta k$$



Summary:
As long as $k < k^*$, investment will exceed depreciation, and k will continue to grow toward k^*.

Now you try:

Draw the Solow model diagram, labeling the steady state $\boldsymbol{k^*}$.

On the horizontal axis, pick a value greater than $\boldsymbol{k^*}$ for the economy's initial capital stock. Label it $\boldsymbol{k_1}$.

Show what happens to $\boldsymbol{k}$ over time. Does $\boldsymbol{k}$ move toward the steady state or away from it?

A numerical example

Production function (aggregate):

$$Y = F(K, L) = \sqrt{K \times L} = K^{1/2}L^{1/2}$$

To derive the per-worker production function, divide through by L:

$$\frac{Y}{L} = \frac{K^{1/2}L^{1/2}}{L} = \left(\frac{K}{L}\right)^{1/2}$$

Then substitute $y = Y/L$ and $k = K/L$ to get

$$y = f(k) = k^{1/2}$$

A numerical example, *cont.*

Assume:

- $s = 0.3$
- $\delta = 0.1$
- initial value of $k = 4.0$

Approaching the Steady State: A Numerical Example

Assumptions: $y = \sqrt{k}$; $s = 0.3$; $\delta = 0.1$; initial $k = 4.0$

Year	***k***	***y***	***c***	***i***	δ***k***	Δ***k***
1	4.000	2.000	1.400	0.600	0.400	0.200
2	4.200	2.049	1.435	0.615	0.420	0.195
3	4.395	2.096	1.467	0.629	0.440	0.189

Approaching the Steady State: A Numerical Example

Assumptions: $y = \sqrt{k}$; $s = 0.3$; $\delta = 0.1$; initial $k = 4.0$

Year	k	y	c	i	δk	Δk
1	4.000	2.000	1.400	0.600	0.400	0.200
2	4.200	2.049	1.435	0.615	0.420	0.195
3	4.395	2.096	1.467	0.629	0.440	0.189
4	4.584	2.141	1.499	0.642	0.458	0.184
…						
10	5.602	2.367	1.657	0.710	0.560	0.150
…						
25	7.351	2.706	1.894	0.812	0.732	0.080
…						
100	8.962	2.994	2.096	0.898	0.896	0.002
…						
∞	9.000	3.000	2.100	0.900	0.900	0.000

Exercise: solve for the steady state

Continue to assume

$$s = 0.3, \quad \delta = 0.1, \quad \text{and} \quad y = k^{1/2}$$

Use the equation of motion

$$\Delta k = s\,f(k) - \delta k$$

to solve for the steady-state values of k, y, and c.

Solution to exercise:

$\Delta \boldsymbol{k} = 0$ def. of steady state

$\boldsymbol{s}\,\boldsymbol{f}(\boldsymbol{k}^*) = \delta \boldsymbol{k}^*$ eq'n of motion with $\Delta \boldsymbol{k} = 0$

$0.3\sqrt{\boldsymbol{k}^*} = 0.1\boldsymbol{k}^*$ using assumed values

$$3 = \frac{\boldsymbol{k}^*}{\sqrt{\boldsymbol{k}^*}} = \sqrt{\boldsymbol{k}^*}$$

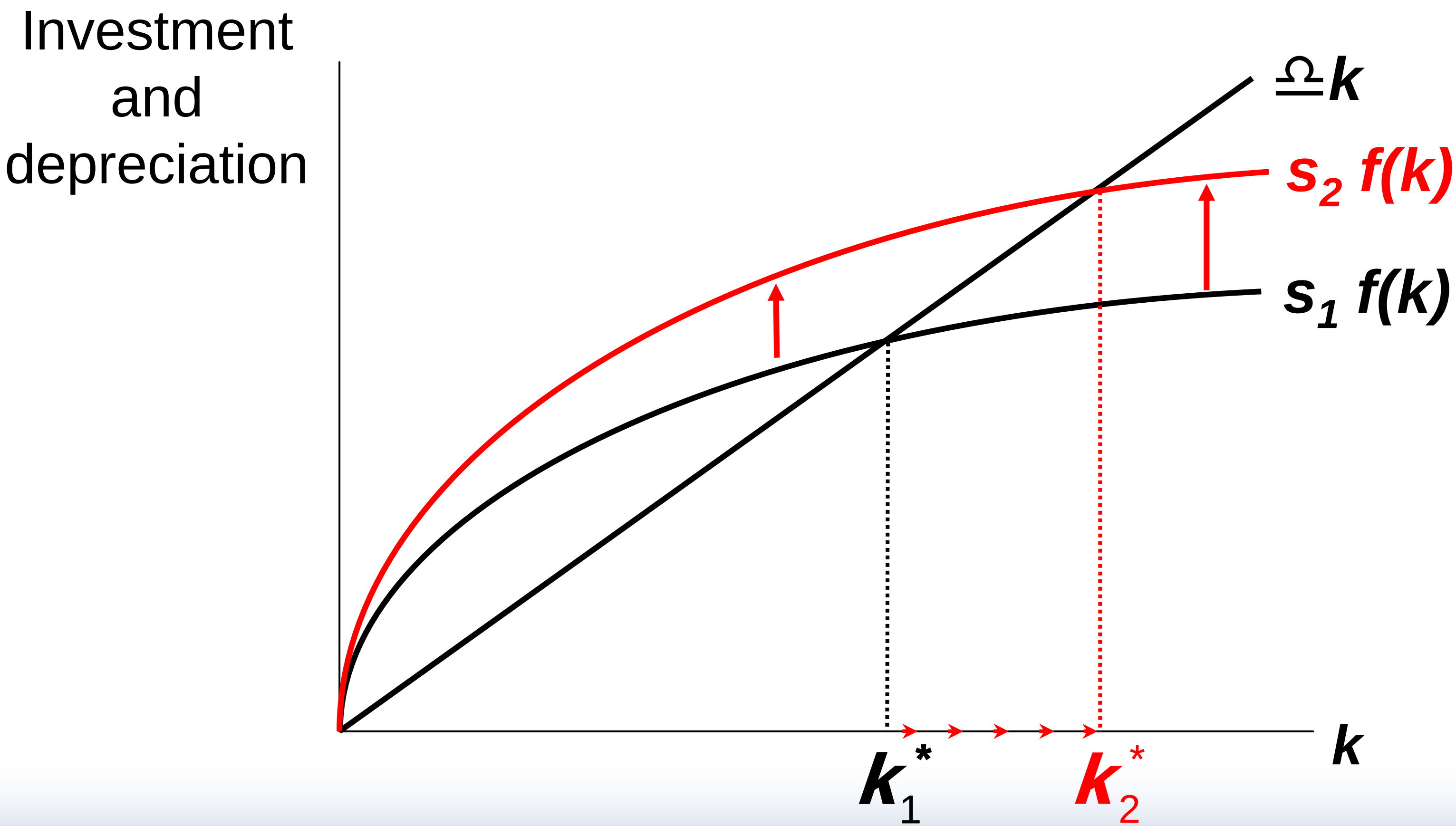
Solve to get: $\boldsymbol{k}^* = 9$ and $\boldsymbol{y}^* = \sqrt{\boldsymbol{k}^*} = 3$

Finally, $\boldsymbol{c}^* = (1 - \boldsymbol{s})\boldsymbol{y}^* = 0.7 \times 3 = 2.1$

An increase in the saving rate

An increase in the saving rate raises investment...

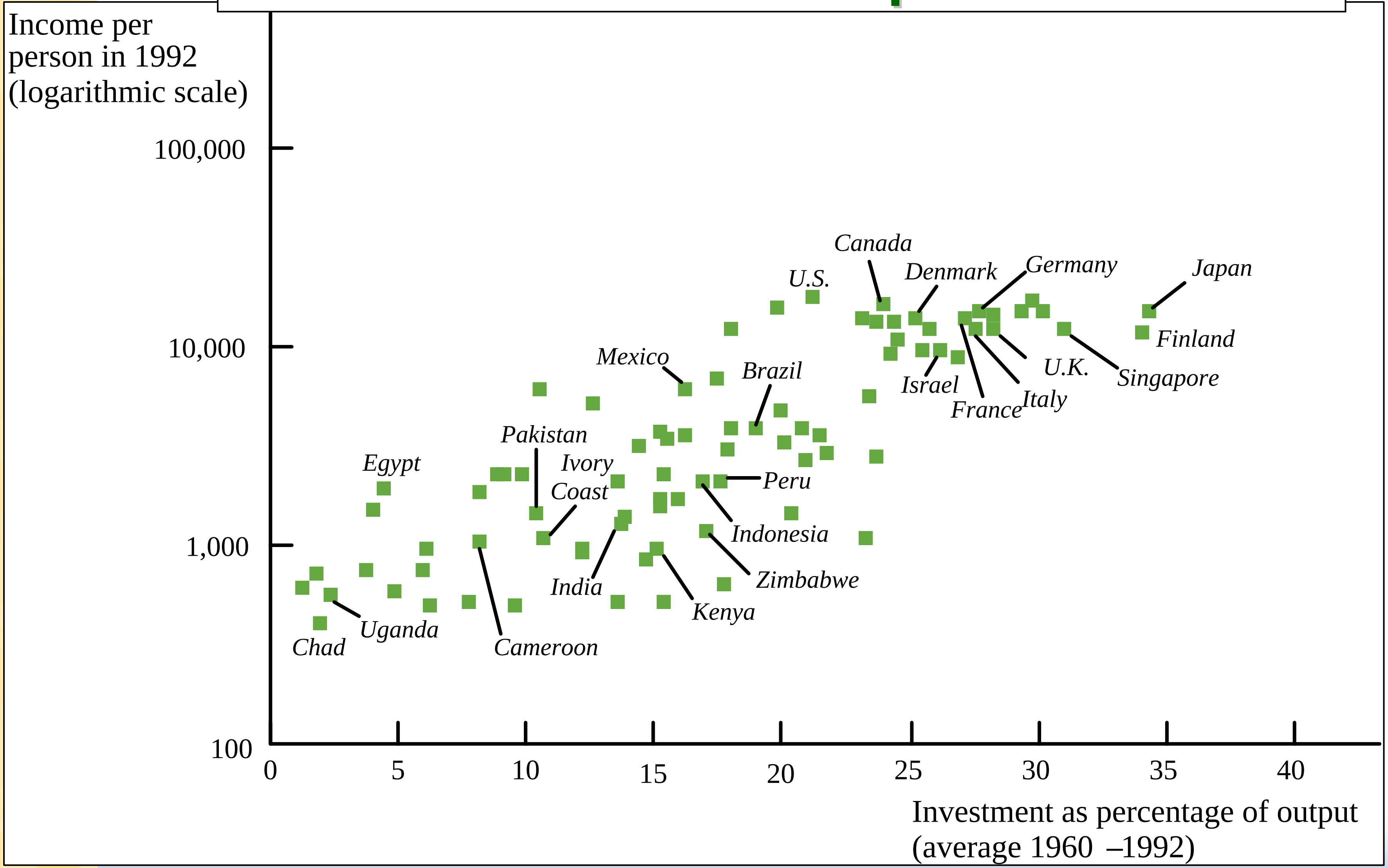
...causing the capital stock to grow toward a new steady state:



Prediction:

- Higher $s \Rightarrow$ higher k^*.
- And since $y = f(k)$,
  higher $k^* \Rightarrow$ higher y^* .
- Thus, the Solow model predicts that countries with higher rates of saving and investment will have higher levels of capital and income per worker in the long run.

International Evidence on Investment Rates and Income per Person



The Golden Rule: introduction

- Different values of s lead to different steady states. How do we know which is the "best" steady state?
- Economic well-being depends on consumption, so the "best" steady state has the highest possible value of consumption per person: $c^* = (1-s)\ f(k^*)$
- An increase in s
  - leads to higher k^* and y^*, which may raise c^*
  - reduces consumption's share of income $(1-s)$, which may lower c^*
- So, how do we find the s and k^* that maximize c^*?

The Golden Rule Capital Stock

k^*_{gold} = the **Golden Rule level of capital,** the steady state value of k that maximizes consumption.

To find it, first express c^* in terms of k^*:

$$c^* = y^* - i^*$$
$$= f(k^*) - i^*$$
$$= f(k^*) - \delta k^*$$

In general:

$$i = \Delta k + \delta k$$

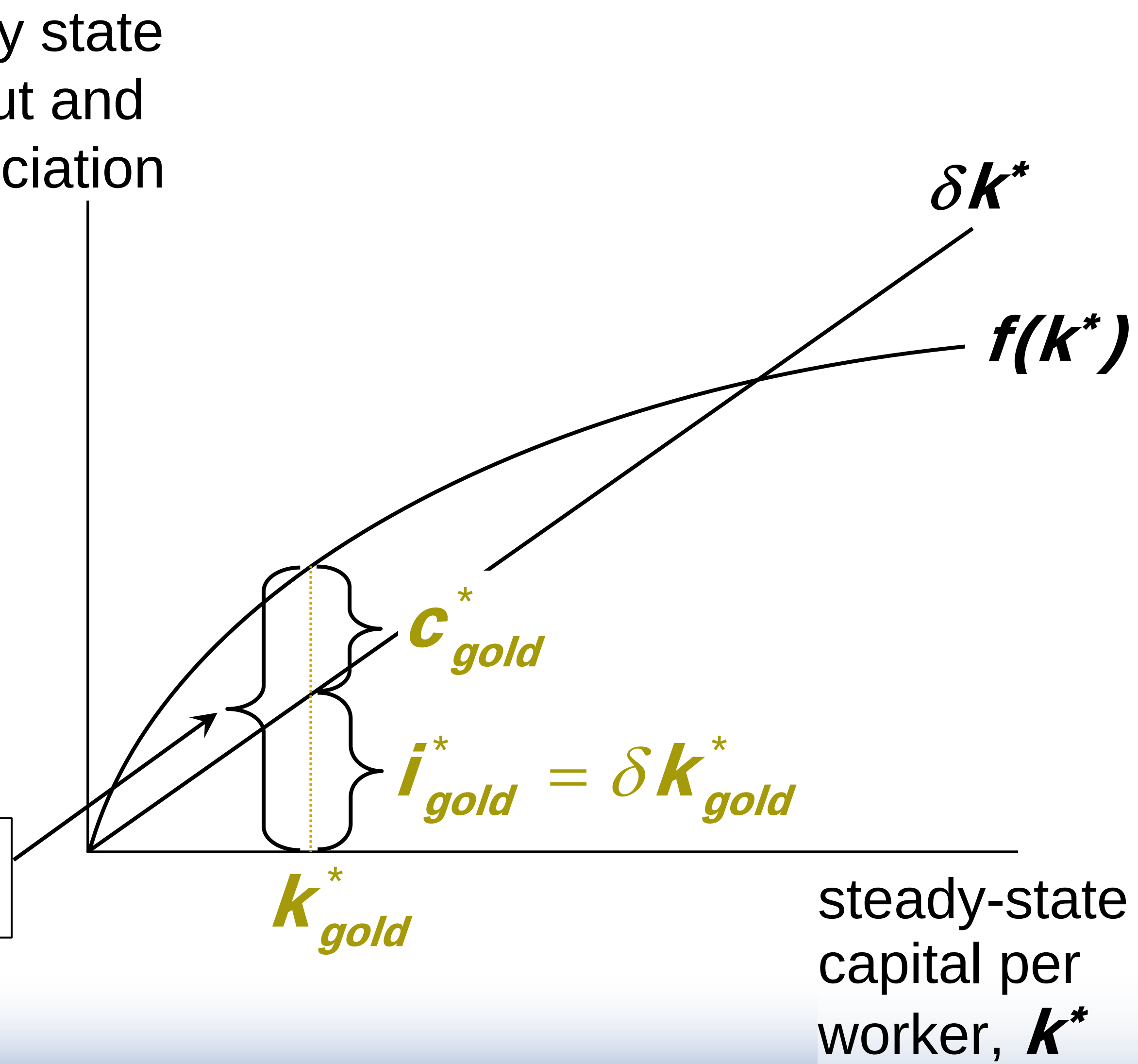
In the steady state:

$$i^* = \delta k^*$$

because $\Delta k = 0$.

The Golden Rule Capital Stock

Then, graph $f(k^*)$ and δk^*, and look for the point where the gap between them is biggest.



$$\boxed{y^*_{gold} = f(k^*_{gold})}$$

The Golden Rule Capital Stock

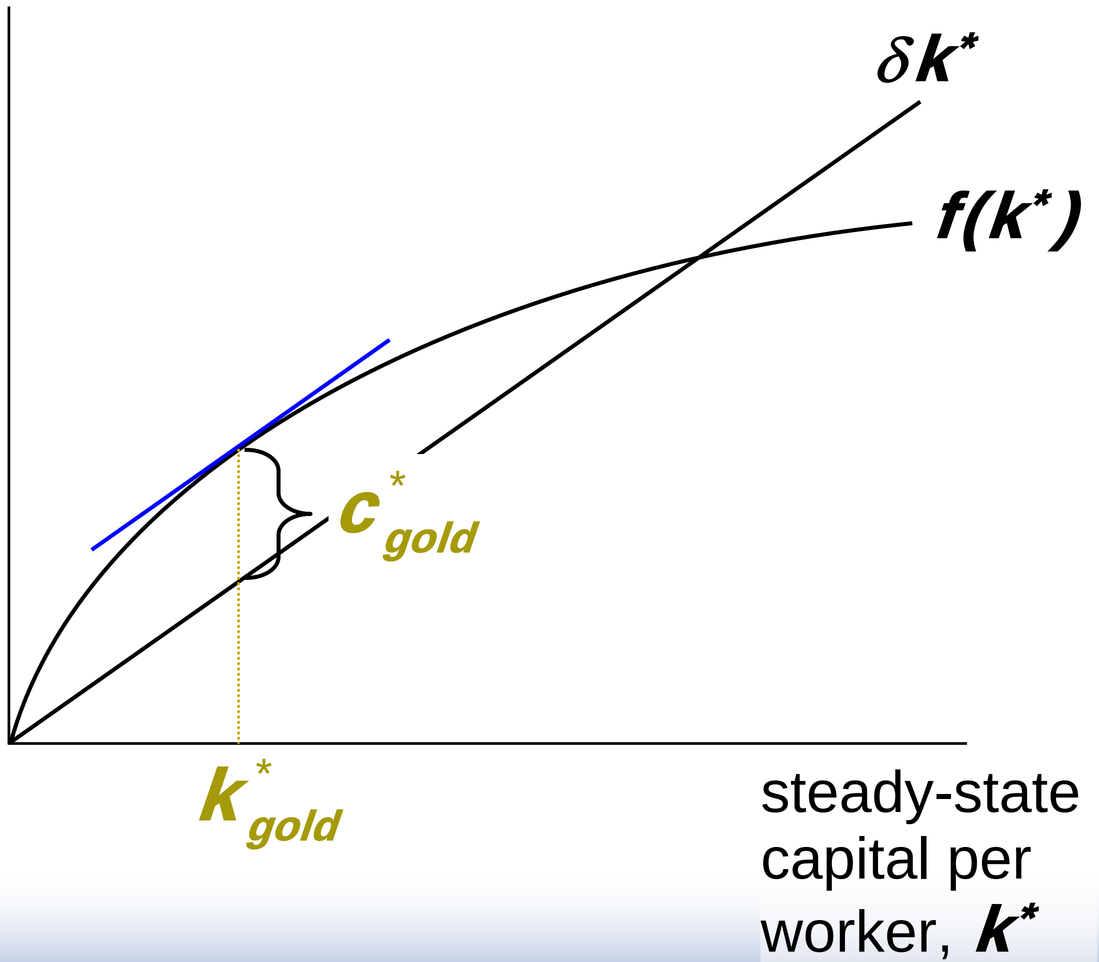
$c^* = f(k^*) - \delta k^*$

is biggest where the slope of the production func.

equals

the slope of the depreciation line:

$\text{MPK} = \delta$



The transition to the Golden Rule Steady State

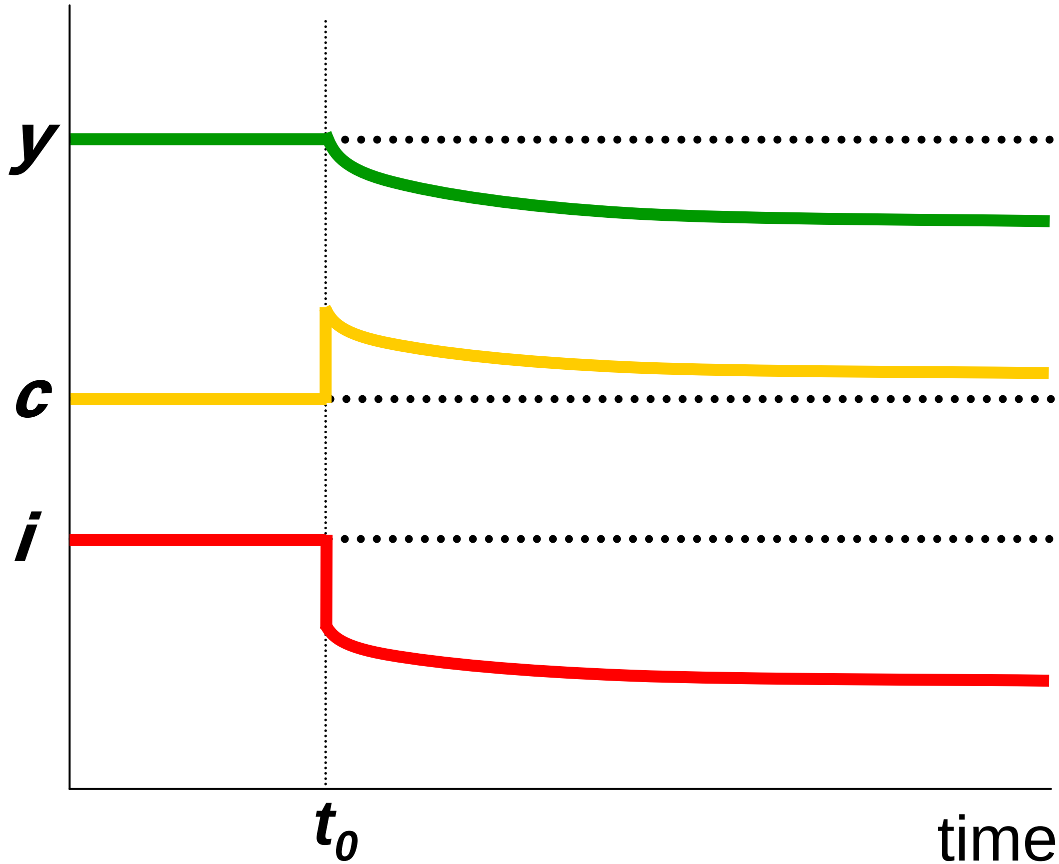
- The economy does NOT have a tendency to move toward the Golden Rule steady state.
- Achieving the Golden Rule requires that policymakers adjust ***s***.
- This adjustment leads to a new steady state with higher consumption.
- But what happens to consumption during the transition to the Golden Rule?

Starting with too much capital

If $k^* > k^*_{gold}$

then increasing c^* requires a fall in s.

In the transition to the Golden Rule, consumption is higher at all points in time.

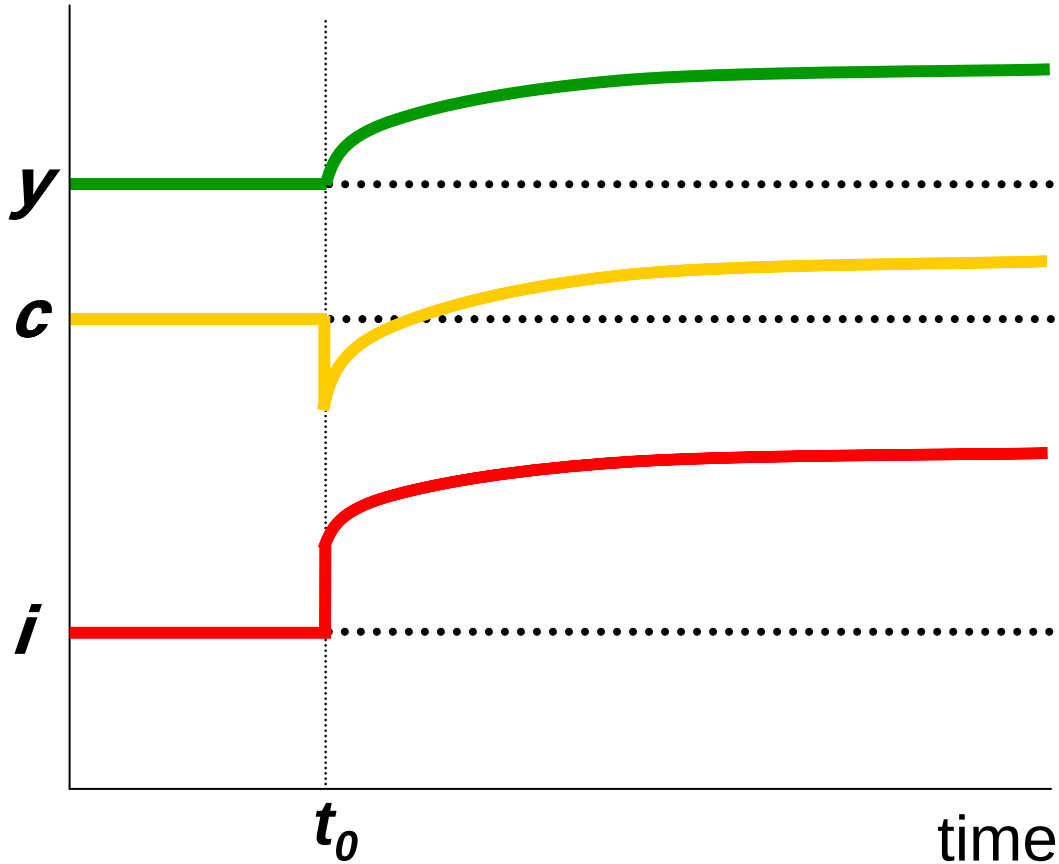


Starting with too little capital

If $k^* < k^*_{gold}$

then increasing c^* requires an increase in s.

Future generations enjoy higher consumption, but the current one experiences an initial drop in consumption.



Population Growth

- Assume that the population--and labor force--grow at rate $\boldsymbol{n}$.   ($\boldsymbol{n}$ is exogenous)

$$\frac{\Delta \boldsymbol{L}}{\boldsymbol{L}} = \boldsymbol{n}$$

- EX: Suppose $\boldsymbol{L}$ = 1000 in year 1 and the population is growing at 2%/year ($\boldsymbol{n}$ = 0.02).

  Then $\Delta \boldsymbol{L} = \boldsymbol{n}\,\boldsymbol{L} = 0.02 \times 1000 = 20$,
  so $\boldsymbol{L}$ = 1020 in year 2.

Break-even investment

$(\delta + n)k$ = **break-even investment**, the amount of investment necessary to keep k constant.

Break-even investment includes:

- δk to replace capital as it wears out
- $n k$ to equip new workers with capital (*otherwise,* k *would fall as the existing capital stock would be spread more thinly over a larger population of workers*)

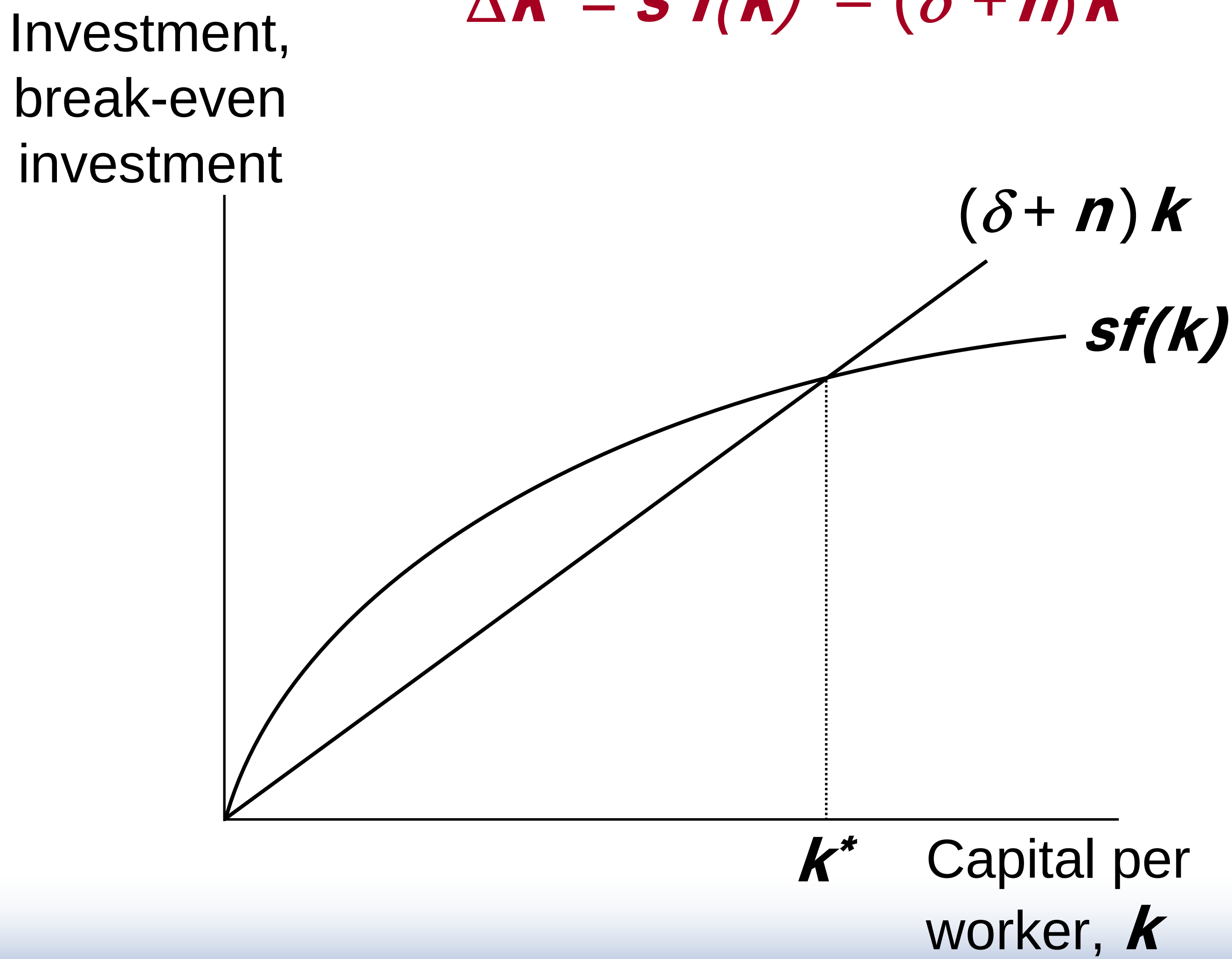
The equation of motion for *k*

- With population growth, the equation of motion for ***k*** is

$$\Delta k = \underbrace{s\,f(k)}_{\text{actual investment}} - \underbrace{(\delta + n)\,k}_{\text{break-even investment}}$$

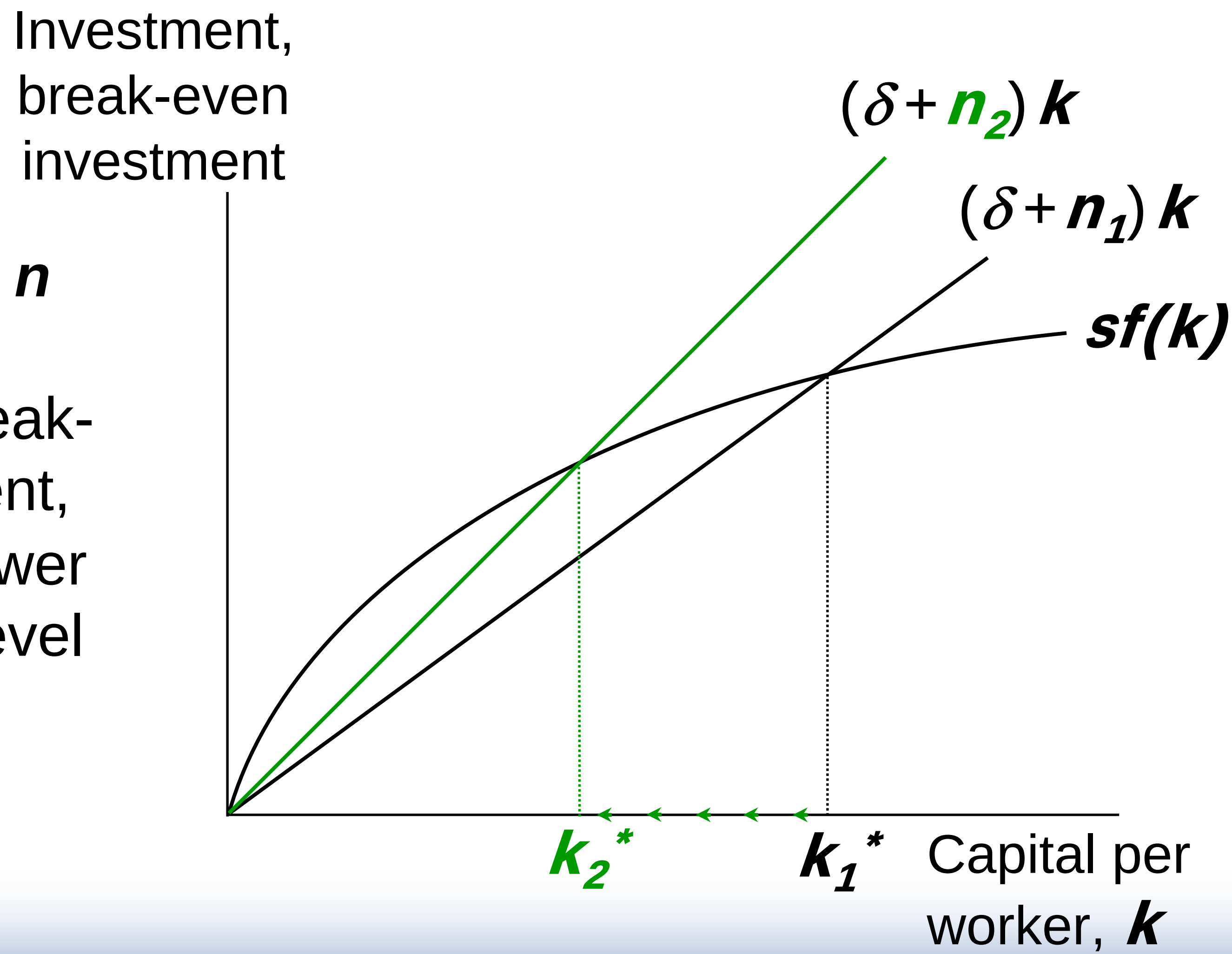
The Solow Model diagram

$$\Delta k = s\,f(k) - (\delta + n)\,k$$



The impact of population growth

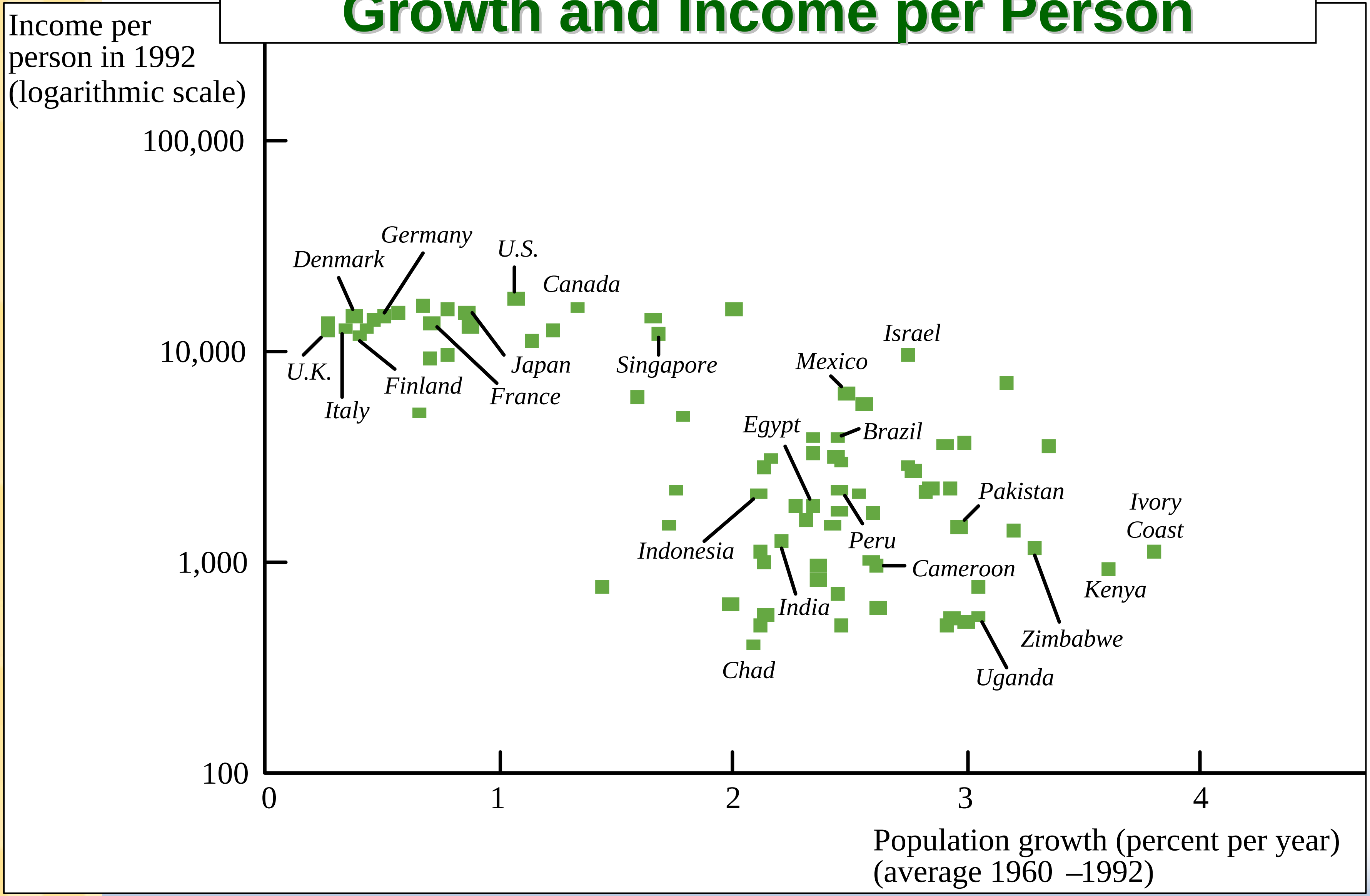
An increase in ***n*** causes an increase in break-even investment, leading to a lower steady-state level of ***k***.



Prediction:

- Higher $\boldsymbol{n} \Rightarrow$ lower $\boldsymbol{k}^*$.
- And since $\boldsymbol{y} = \boldsymbol{f(k)}$,
  lower $\boldsymbol{k}^* \Rightarrow$ lower $\boldsymbol{y}^*$.
- Thus, the Solow model predicts that countries with higher population growth rates will have lower levels of capital and income per worker in the long run.

International Evidence on Population Growth and Income per Person



The Golden Rule with Population Growth

To find the Golden Rule capital stock, we again express $\boldsymbol{c^*}$ in terms of $\boldsymbol{k^*}$:

$$\begin{aligned} \boldsymbol{c^*} &= \quad \boldsymbol{y^*} \quad - \quad \boldsymbol{i^*} \\ &= \boldsymbol{f}(\boldsymbol{k^*}) - (\delta + \boldsymbol{n})\,\boldsymbol{k^*} \end{aligned}$$

$\boldsymbol{c^*}$ is maximized when

$$\text{MPK} = \delta + \boldsymbol{n}$$

or equivalently,

$$\boxed{\text{MPK} - \delta = \boldsymbol{n}}$$

In the Golden Rule Steady State, the marginal product of capital net of depreciation equals the population growth rate.

Chapter Summary

1. The Solow growth model shows that, in the long run, a country's standard of living depends
   - positively on its saving rate.
   - negatively on its population growth rate.

2. An increase in the saving rate leads to
   - higher output in the long run
   - faster growth temporarily
   - but not faster steady state growth.

Chapter Summary

3. If the economy has more capital than the Golden Rule level, then reducing saving will increase consumption at all points in time, making all generations better off.

   If the economy has less capital than the Golden Rule level, then increasing saving will increase consumption for future generations, but reduce consumption for the present generation.

Learning objectives

- Technological progress in the Solow model
- Policies to promote growth
- Growth empirics:
  Confronting the theory with facts
- Endogenous growth:
  Two simple models in which the rate of technological progress is endogenous

Introduction

In the Solow model of Chapter 7,

- the production technology is held constant
- income per capita is constant in the steady state.

Neither point is true in the real world:

- 1929-2001: U.S. real GDP per person grew by a factor of 4.8, or 2.2% per year.
- examples of technological progress abound *(see next slide)*

Examples of technological progress

- 1970: 50,000 computers in the world
  2000: 51% of U.S. households have 1 or more computers
- The real price of computer power has fallen an average of 30% per year over the past three decades.
- The average car built in 1996 contained more computer processing power than the first lunar landing craft in 1969.
- Modems are 22 times faster today than two decades ago.
- Since 1980, semiconductor usage per unit of GDP has increased by a factor of 3500.
- 1981: 213 computers connected to the Internet
  2000: 60 million computers connected to the Internet

Tech. progress in the Solow model

- A new variable: $\boldsymbol{E}$ = labor efficiency
- Assume:
  Technological progress is **labor-augmenting**: it increases labor efficiency at the exogenous rate $\boldsymbol{g}$:

$$g = \frac{\Delta E}{E}$$

Tech. progress in the Solow model

- We now write the production function as:

$$\boldsymbol{Y} = \boldsymbol{F}(\boldsymbol{K}, \boldsymbol{L} \times \boldsymbol{E})$$

- where $\boldsymbol{L} \times \boldsymbol{E}$ = the number of effective workers.
  - Hence, increases in labor efficiency have the same effect on output as increases in the labor force.

Tech. progress in the Solow model

- Notation:

  $y = Y/LE$ = output per effective worker

  $k = K/LE$ = capital per effective worker

- Production function per effective worker:

  $$y = f(k)$$

- Saving and investment per effective worker:

  $$s\,y = s\,f(k)$$

Tech. progress in the Solow model

$(\delta + n + g)k$ = break-even investment:
the amount of investment necessary to keep k constant.

Consists of:

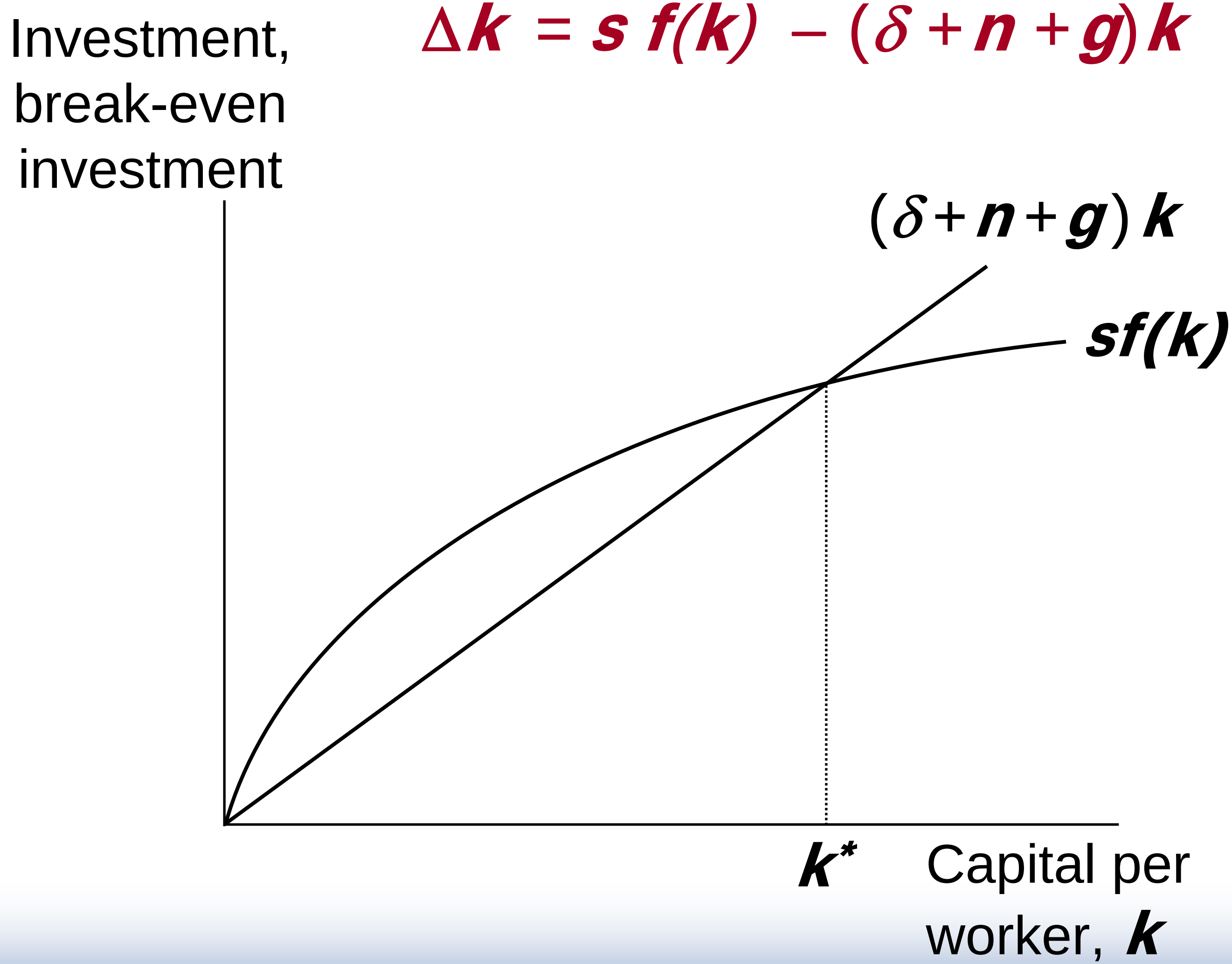
δk to replace depreciating capital

nk to provide capital for new workers

gk to provide capital for the new "effective" workers created by technological progress

Tech. progress in the Solow model

$$\Delta k = s\,f(k) - (\delta + n + g)\,k$$



Steady-State Growth Rates in the Solow Model with Tech. Progress

Variable	Symbol	Steady-state growth rate
Capital per effective worker	$\boldsymbol{k} = \boldsymbol{K}/(\boldsymbol{L} \times \boldsymbol{E})$	0
Output per effective worker	$\boldsymbol{y} = \boldsymbol{Y}/(\boldsymbol{L} \times \boldsymbol{E})$	0
Output per worker	$(\boldsymbol{Y}/\boldsymbol{L}) = \boldsymbol{y} \times \boldsymbol{E}$	$\boldsymbol{g}$
Total output	$\boldsymbol{Y} = \boldsymbol{y} \times \boldsymbol{E} \times \boldsymbol{L}$	$\boldsymbol{n} + \boldsymbol{g}$

The Golden Rule

To find the Golden Rule capital stock, express c^* in terms of k^*:

$$c^* = y^* - i^*$$
$$= f(k^*) - (\delta + n + g)\,k^*$$

c^* is maximized when

$$\text{MPK} = \delta + n + g$$

or equivalently,

$$\boxed{\text{MPK} - \delta = n + g}$$

In the Golden Rule Steady State, the marginal product of capital net of depreciation equals the pop. growth rate plus the rate of tech progress.

Policies to promote growth

Four policy questions:

1. Are we saving enough? Too much?
2. What policies might change the saving rate?
3. How should we allocate our investment between privately owned physical capital, public infrastructure, and "human capital"?
4. What policies might encourage faster technological progress?

1. Evaluating the Rate of Saving

- Use the Golden Rule to determine whether our saving rate and capital stock are too high, too low, or about right.
- To do this, we need to compare $(\text{MPK} - \delta)$ to $(\boldsymbol{n} + \boldsymbol{g})$.
- If $(\text{MPK} - \delta) > (\boldsymbol{n} + \boldsymbol{g})$, then we are below the Golden Rule steady state and should increase $\boldsymbol{s}$.
- If $(\text{MPK} - \delta) < (\boldsymbol{n} + \boldsymbol{g})$, then we are above the Golden Rule steady state and should reduce $\boldsymbol{s}$.

1. Evaluating the Rate of Saving

To estimate (MPK – δ), we use three facts about the U.S. economy:

1. $\boldsymbol{k} = 2.5\,\boldsymbol{y}$

   The capital stock is about 2.5 times one year's GDP.

2. $\delta\,\boldsymbol{k} = 0.1\,\boldsymbol{y}$

   About 10% of GDP is used to replace depreciating capital.

3. $\text{MPK} \times \boldsymbol{k} = 0.3\,\boldsymbol{y}$

   Capital income is about 30% of GDP

1. Evaluating the Rate of Saving

1. $\boldsymbol{k} = 2.5\ \boldsymbol{y}$
2. $\delta\,\boldsymbol{k} = 0.1\ \boldsymbol{y}$
3. $\text{MPK} \times \boldsymbol{k} = 0.3\ \boldsymbol{y}$

To determine δ, divided 2 by 1:

$$\frac{\delta \boldsymbol{k}}{\boldsymbol{k}} = \frac{0.1\,\boldsymbol{y}}{2.5\,\boldsymbol{y}} \quad \Rightarrow \quad \delta = \frac{0.1}{2.5} = 0.04$$

1. Evaluating the Rate of Saving

1. $\boldsymbol{k} = 2.5\ \boldsymbol{y}$
2. $\delta\,\boldsymbol{k} = 0.1\ \boldsymbol{y}$
3. $\text{MPK} \times \boldsymbol{k} = 0.3\ \boldsymbol{y}$

To determine MPK, divided 3 by 1:

$$\frac{\text{MPK} \times \boldsymbol{k}}{\boldsymbol{k}} = \frac{0.3\,\boldsymbol{y}}{2.5\,\boldsymbol{y}} \quad \Rightarrow \quad \text{MPK} = \frac{0.3}{2.5} = 0.12$$

Hence, $\text{MPK} - \delta = 0.12 - 0.04 = 0.08$

1. Evaluating the Rate of Saving

- From the last slide: MPK – δ = 0.08
- U.S. real GDP grows an average of 3%/year, so $\boldsymbol{n} + \boldsymbol{g} = 0.03$
- Thus, in the U.S.,

  $$\text{MPK} - \delta = 0.08 > 0.03 = \boldsymbol{n} + \boldsymbol{g}$$

- Conclusion:

The U.S. is below the Golden Rule steady state: if we increase our saving rate, we will have faster growth until we get to a new steady state with higher consumption per capita.

2. Policies to increase the saving rate

- Reduce the government budget deficit (or increase the budget surplus)
- Increase incentives for private saving:
  - reduce capital gains tax, corporate income tax, estate tax as they discourage saving
  - replace federal income tax with a consumption tax
  - expand tax incentives for IRAs (individual retirement accounts) and other retirement savings accounts

3. Allocating the economy's investment

- In the Solow model, there's one type of capital.
- In the real world, there are many types, which we can divide into three categories:
  – private capital stock
  – public infrastructure
  – **human capital**: the knowledge and skills that workers acquire through education
- How should we allocate investment among these types?

Allocating the economy's investment: *two viewpoints*

1. Equalize tax treatment of all types of capital in all industries, then let the market allocate investment to the type with the highest marginal product.

2. **Industrial policy**: Govt should actively encourage investment in capital of certain types or in certain industries, because they may have *positive externalities* (by-products) that private investors don't consider.

Possible problems with industrial policy

- Does the govt have the ability to “pick winners” (choose industries with the highest return to capital or biggest externalities)?
- Would politics (e.g. campaign contributions) rather than economics influence which industries get preferential treatment?

4. Encouraging technological progress

- Patent laws:
  encourage innovation by granting temporary monopolies to inventors of new products
- Tax incentives for R&D
- Grants to fund basic research at universities
- Industrial policy:
  encourage specific industries that are key for rapid tech. progress
  (subject to the concerns on the preceding slide)

CASE STUDY:
The Productivity Slowdown

	Growth in output per person (percent per year)	
	1948-72	1972-95
Canada	2.9	1.8
France	4.3	1.6
Germany	5.7	2.0
Italy	4.9	2.3
Japan	8.2	2.6
U.K.	2.4	1.8
U.S.	2.2	1.5

Explanations?

- *Measurement problems*

  Increases in productivity not fully measured.
  - But: Why would measurement problems be worse after 1972 than before?

- *Oil prices*

  Oil shocks occurred about when productivity slowdown began.
  - But: Then why didn't productivity speed up when oil prices fell in the mid-1980s?

Explanations?

- *Worker quality*

  1970s - large influx of new entrants into labor force (baby boomers, women).
  New workers are less productive than experienced workers.

- *The depletion of ideas*

  Perhaps the slow growth of 1972-1995 is normal and the true anomaly was the rapid growth from 1948-1972.

The bottom line:

We don't know which of these is the true explanation, it's probably a combination of several of them.

CASE STUDY:
I.T. and the "new economy"

	Growth in output per person (percent per year)		
	1948-72	1972-95	1995-2000
Canada	2.9	1.8	2.7
France	4.3	1.6	2.2
Germany	5.7	2.0	1.7
Italy	4.9	2.3	4.7
Japan	8.2	2.6	1.1
U.K.	2.4	1.8	2.5
U.S.	2.2	1.5	2.9

CASE STUDY:
I.T. and the "new economy"

Apparently, the computer revolution didn't affect aggregate productivity until the mid-1990s.

Two reasons:

1. Computer industry's share of GDP much bigger in late 1990s than earlier.
2. Takes time for firms to determine how to utilize new technology most effectively

The big questions:

- Will the growth spurt of the late 1990s continue?
- Will I.T. remain an engine of growth?

Growth empirics: Confronting the Solow model with the facts

Solow model's steady state exhibits **balanced growth** - many variables grow at the same rate.

- Solow model predicts ***Y/L*** and ***K/L*** grow at same rate (***g***), so that ***K/Y*** should be constant.

  This is true in the real world.
- Solow model predicts real wage grows at same rate as ***Y/L***, while real rental price is constant. Also true in the real world.

Convergence

- Solow model predicts that, other things equal, "poor" countries (with lower ***Y/L*** and ***K/L***) should grow faster than "rich" ones.
- If true, then the income gap between rich & poor countries would shrink over time, and living standards "converge."
- In real world, many poor countries do NOT grow faster than rich ones. Does this mean the Solow model fails?

Convergence

- No, because "other things" aren't equal.
  - In samples of countries with similar savings & pop. growth rates, income gaps shrink about 2%/year.
  - In larger samples, if one controls for differences in saving, population growth, and human capital, incomes converge by about 2%/year.
- What the Solow model *really* predicts is **conditional convergence** - countries converge to their own steady states, which are determined by saving, population growth, and education. And this prediction comes true in the real world.

Factor accumulation vs. Production efficiency

Two reasons why income per capita are lower in some countries than others:

1. Differences in capital (physical or human) per worker
2. Differences in the efficiency of production (the height of the production function)

Studies:

- both factors are important
- countries with higher capital (phys or human) per worker also tend to have higher production efficiency

Endogenous Growth Theory

- Solow model:
  - sustained growth in living standards is due to tech progress
  - the rate of tech progress is exogenous
- Endogenous growth theory:
  - a set of models in which the growth rate of productivity and living standards is endogenous

A basic model

- Production function: $Y = AK$
  where A is the amount of output for each unit of capital (A is exogenous & constant)
- Key difference between this model & Solow: MPK is constant here, diminishes in Solow
- Investment: sY
- Depreciation: δK
- Equation of motion for total capital:

$$\Delta K = sY - \delta K$$

A basic model

$$\Delta K = sY - \delta K$$

- Divide through by K and use $Y = AK$, get:

$$\frac{\Delta Y}{Y} = \frac{\Delta K}{K} = sA - \delta$$

- If $sA > \delta$, then income will grow forever, and investment is the "engine of growth."
- Here, the permanent growth rate depends on s. In Solow model, it does not.

Does capital have diminishing returns or not?

- Yes, if “capital” is narrowly defined (plant & equipment).
- Perhaps not, with a broad definition of “capital” (physical & human capital, knowledge).
- Some economists believe that knowledge exhibits <u>increasing</u> returns.

A two-sector model

- Two sectors:
  - manufacturing firms produce goods
  - research universities produce knowledge that increases labor efficiency in manufacturing
- $\boldsymbol{u}$ = fraction of labor in research
  ($\boldsymbol{u}$ is exogenous)
- Mfg prod func: $\boldsymbol{Y} = \boldsymbol{F}[\boldsymbol{K}, (1-\boldsymbol{u})\boldsymbol{E}\boldsymbol{L}]$
- Res prod func: $\Delta\boldsymbol{E} = \boldsymbol{g}(\boldsymbol{u})\boldsymbol{E}$
- Cap accumulation: $\Delta\boldsymbol{K} = \boldsymbol{s}\boldsymbol{Y} - \delta\boldsymbol{K}$

A two-sector model

- In the steady state, mfg output per worker and the standard of living grow at rate $\Delta \boldsymbol{E}/\boldsymbol{E} = \boldsymbol{g}(\boldsymbol{u})$.
- Key variables:

  s: affects the level of income, but not its growth rate (same as in Solow model)

  u: affects level <u>and</u> growth rate of income

- Question:
  Would an increase in ***u*** be unambiguously good for the economy?

Three facts about R&D in the real world

1. Much research is done by firms seeking profits.
2. Firms profit from research because
   - new inventions can be patented, creating a stream of monopoly profits until the patent expires
   - there is an advantage to being the first firm on the market with a new product
3. Innovation produces externalities that reduce the cost of subsequent innovation.

Much of the new endogenous growth theory attempts to incorporate these facts into models to better understand tech progress.

Is the private sector doing enough R&D?

- The existence of positive externalities in the creation of knowledge suggests that the private sector is not doing enough R&D.
- But, there is much duplication of R&D effort among competing firms.
- Estimates: The social return to R&D is at least 40% per year.
  Thus, many believe govt should encourage R&D

Chapter summary

1. Key results from Solow model with tech progress
   - steady state growth rate of income per person depends solely on the exogenous rate of tech progress
   - the U.S. has much less capital than the Golden Rule steady state

2. Ways to increase the saving rate
   - increase public saving (reduce budget deficit)
   - tax incentives for private saving

Chapter summary

3. Productivity slowdown & "new economy"
   - Early 1970s: productivity growth fell in the U.S. and other countries.
   - Mid 1990s: productivity growth increased, probably because of advances in I.T.
4. Empirical studies
   - Solow model explains balanced growth, conditional convergence
   - Cross-country variation in living standards due to differences in cap. accumulation and in production efficiency

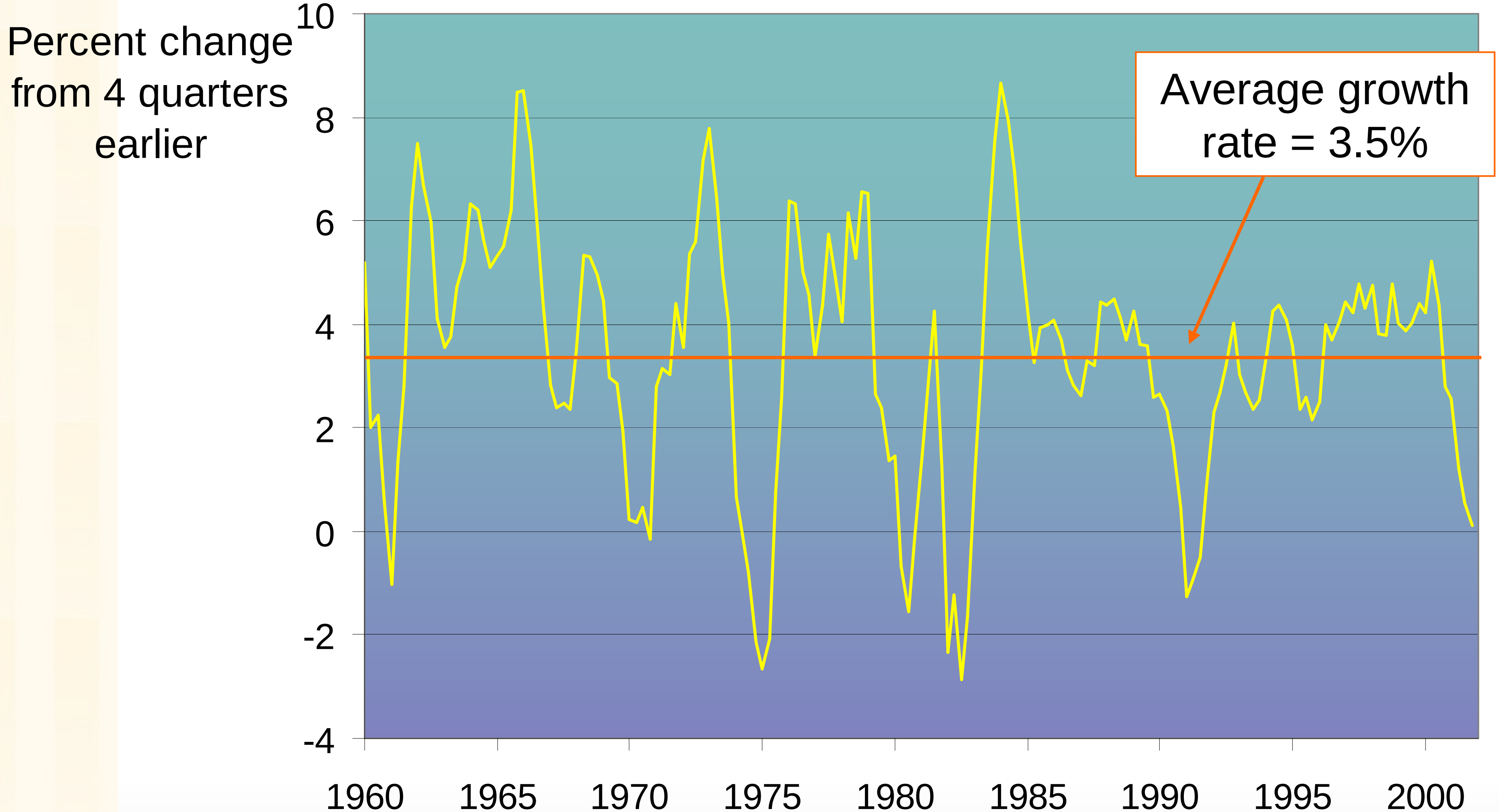
Chapter summary

5. Endogenous growth theory: models that
   - examine the determinants of the rate of tech progress, which Solow takes as given
   - explain decisions that determine the creation of knowledge through R&D

Chapter objectives

- difference between short run & long run
- introduction to aggregate demand
- aggregate supply in the short run & long run
- see how model of aggregate supply and demand can be used to analyze short-run and long-run effects of “shocks”

Real GDP Growth in the United States



Time horizons

- Long run:
  Prices are flexible, respond to changes in supply or demand
- Short run:
  many prices are “sticky” at some predetermined level

The economy behaves much differently when prices are sticky.

In Classical Macroeconomic Theory,

(what we studied in chapters 3-8)

- Output is determined by the supply side:
  - supplies of capital, labor
  - technology
- Changes in demand for goods & services (***C***, ***I***, ***G***) only affect prices, not quantities.
- Complete price flexibility is a crucial assumption,
  so classical theory applies in the long run.

When prices are sticky

...output and employment also depend on demand for goods & services,
which is affected by

- fiscal policy (***G*** and ***T***)
- monetary policy (***M***)
- other factors, like exogenous changes in ***C*** or ***I***.

The model of aggregate demand and supply

- the paradigm that most mainstream economists & policymakers use to think about economic fluctuations and policies to stabilize the economy
- shows how the price level and aggregate output are determined
- shows how the economy’s behavior is different in the short run and long run

Aggregate demand

- The aggregate demand curve shows the relationship between the price level and the quantity of output demanded.
- For this chapter's intro to the AD/AS model, we use a simple theory of aggregate demand based on the Quantity Theory of Money.
- Chapters 10-12 develop the theory of aggregate demand in more detail.

The Quantity Equation as Agg. Demand

- From Chapter 4, recall the quantity equation

$$\boldsymbol{M\,V = P\,Y}$$

and the money demand function it implies:

$$(\boldsymbol{M/P})^d = \boldsymbol{k\,Y}$$

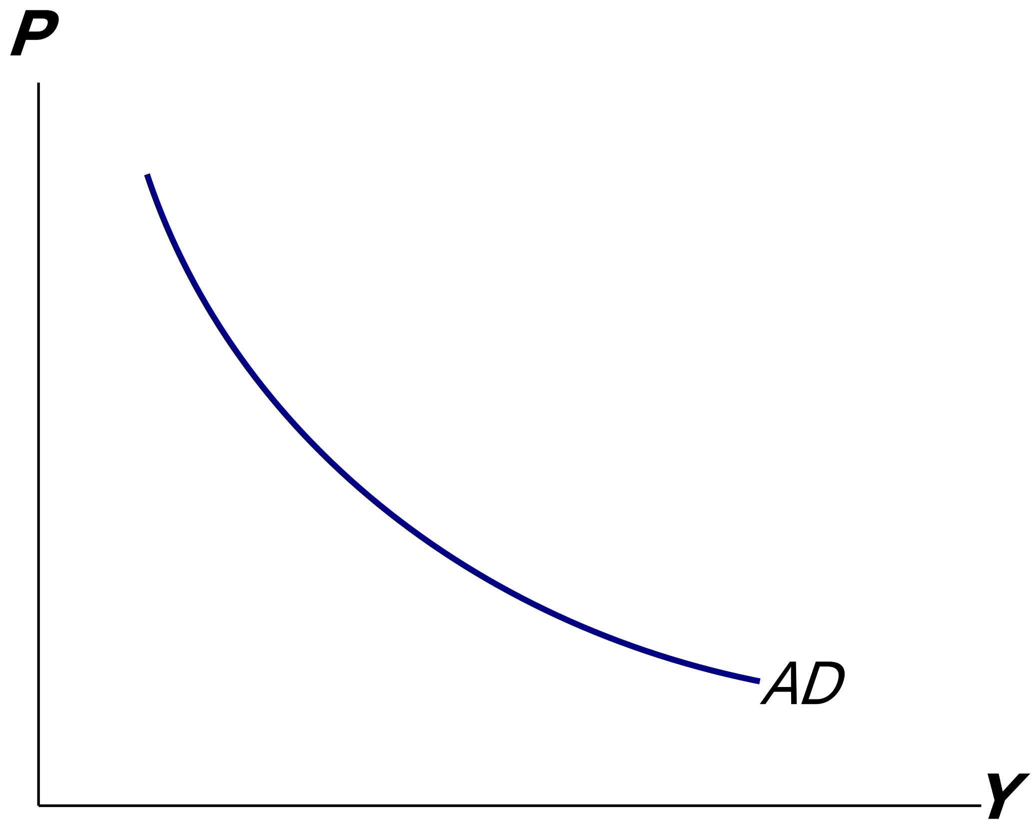
where $\boldsymbol{V} = 1/\boldsymbol{k}$ = velocity.

- For given values of ***M*** and ***V***, these equations imply an inverse relationship between ***P*** and ***Y***:

The downward-sloping *AD* curve

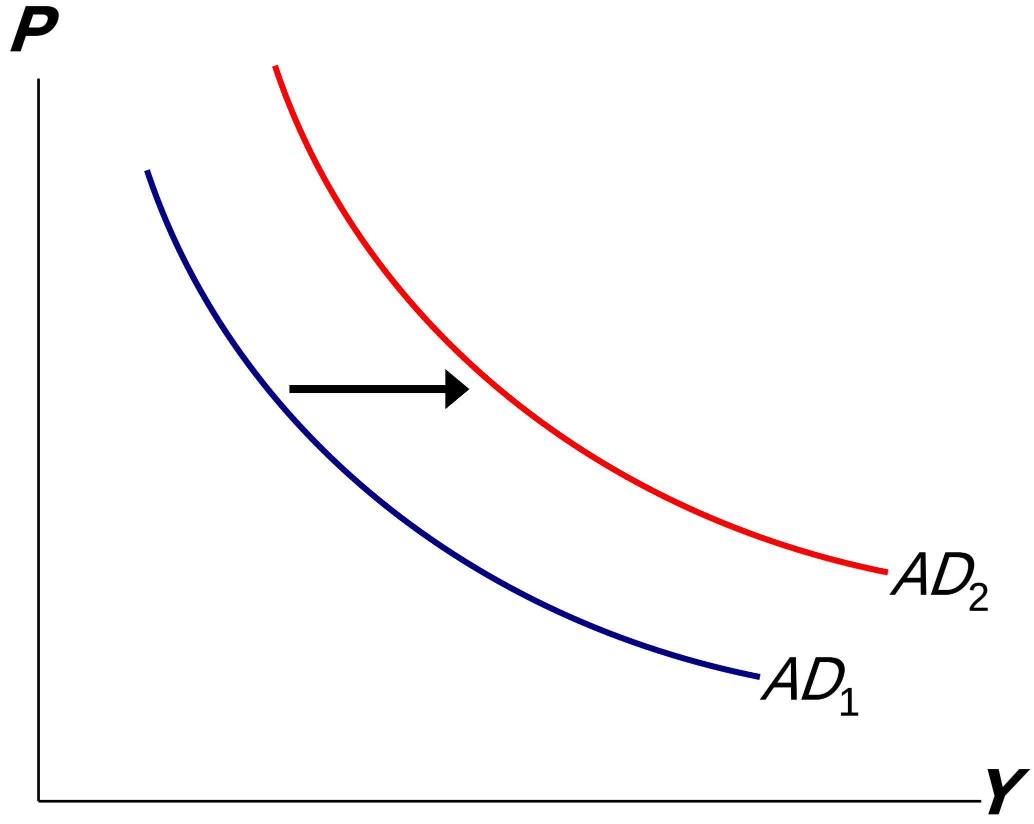
An increase in the price level causes a fall in real money balances (***M/P***),

causing a decrease in the demand for goods & services.



Shifting the *AD* curve

An increase in the money supply shifts the *AD* curve to the right.



Aggregate Supply in the Long Run

- Recall from chapter 3:
  In the long run, output is determined by factor supplies and technology

$$\overline{Y} = F(\overline{K}, \overline{L})$$

$\overline{Y}$ is the **full-employment** or **natural** level of output, the level of output at which the economy's resources are fully employed.

"Full employment" means that unemployment equals its natural rate.

Aggregate Supply in the Long Run

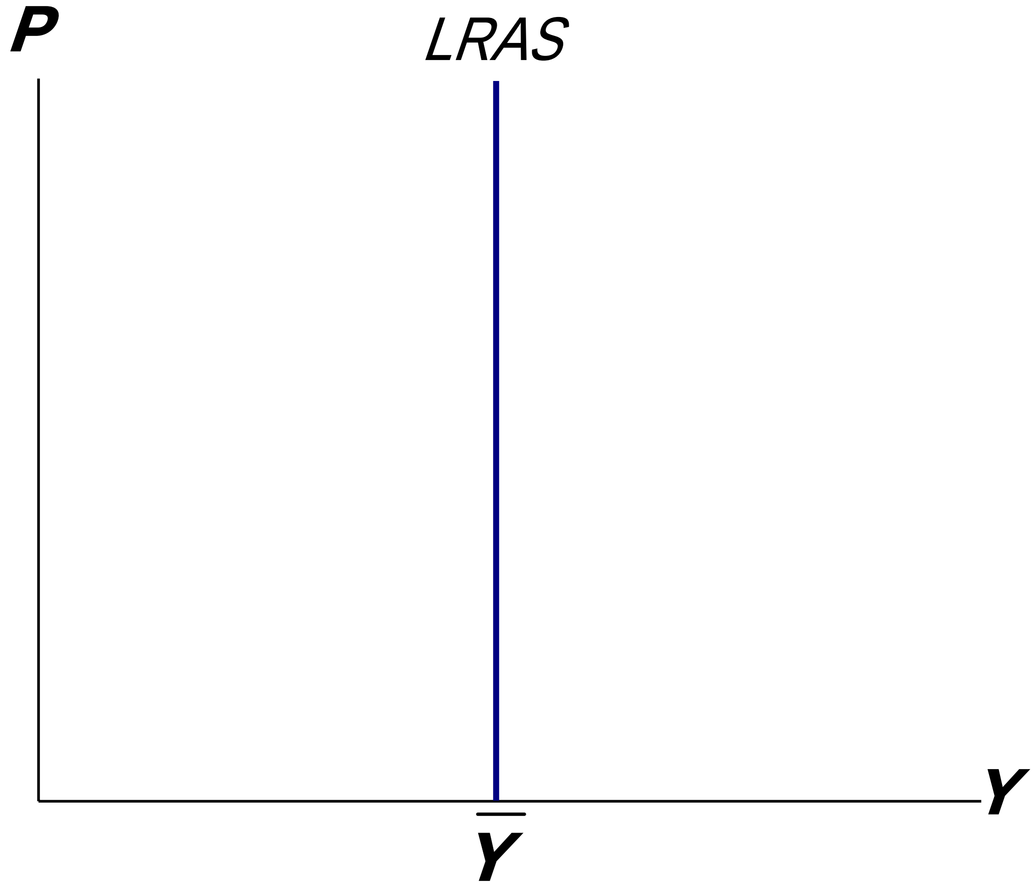
- Recall from chapter 3:
  In the long run, output is determined by factor supplies and technology

$$\overline{Y} = F(\overline{K}, \overline{L})$$

- Full-employment output does not depend on the price level,

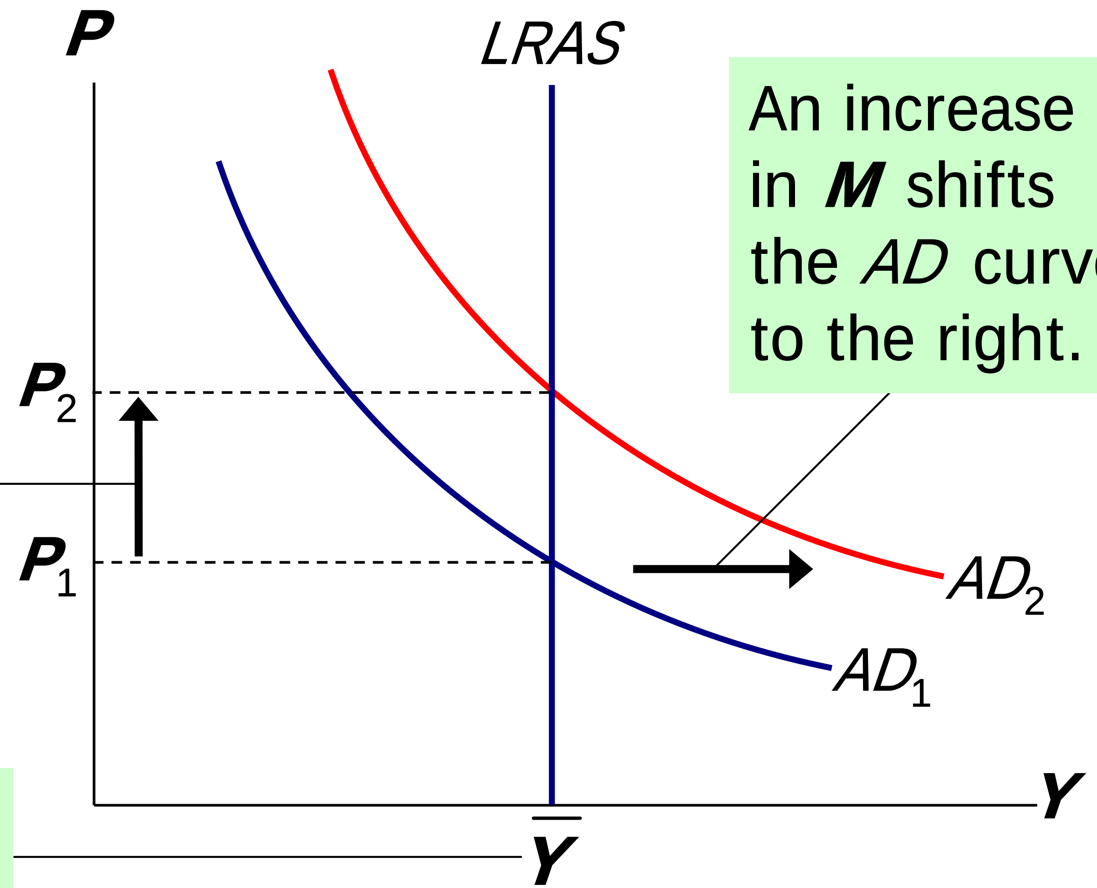
  so the long run aggregate supply (LRAS) curve is vertical:

The long-run aggregate supply curve



The LRAS curve is vertical at the full-employment level of output.

Long-run effects of an increase in *M*



An increase in ***M*** shifts the *AD* curve to the right.

In the long run, this increases the price level…

…but leaves output the same.

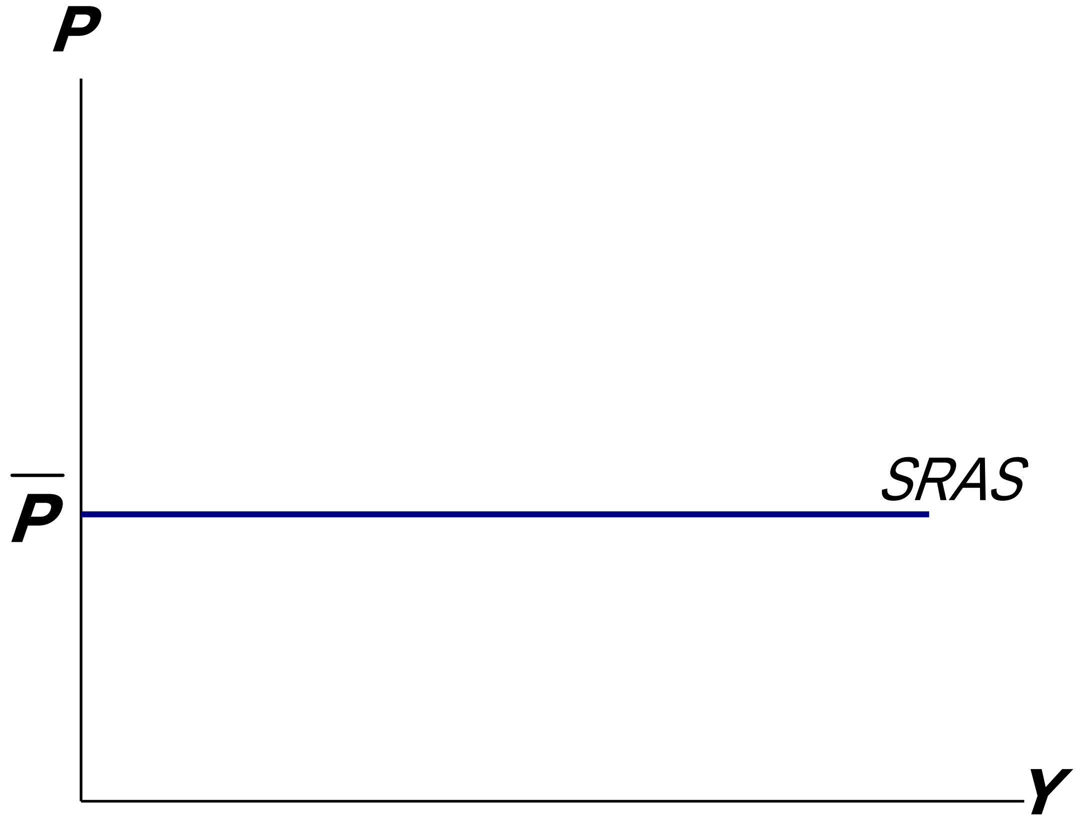
Aggregate Supply in the Short Run

- In the real world, many prices are sticky in the short run.
- For now (and throughout Chapters 9-12), we assume that all prices are stuck at a predetermined level in the short run...
- ...and that firms are willing to sell as much as their customers are willing to buy at that price level.
- Therefore, the short-run aggregate supply (SRAS) curve is horizontal:

The short run aggregate supply curve

The SRAS curve is horizontal:

The price level is fixed at a predetermined level, and firms sell as much as buyers demand.

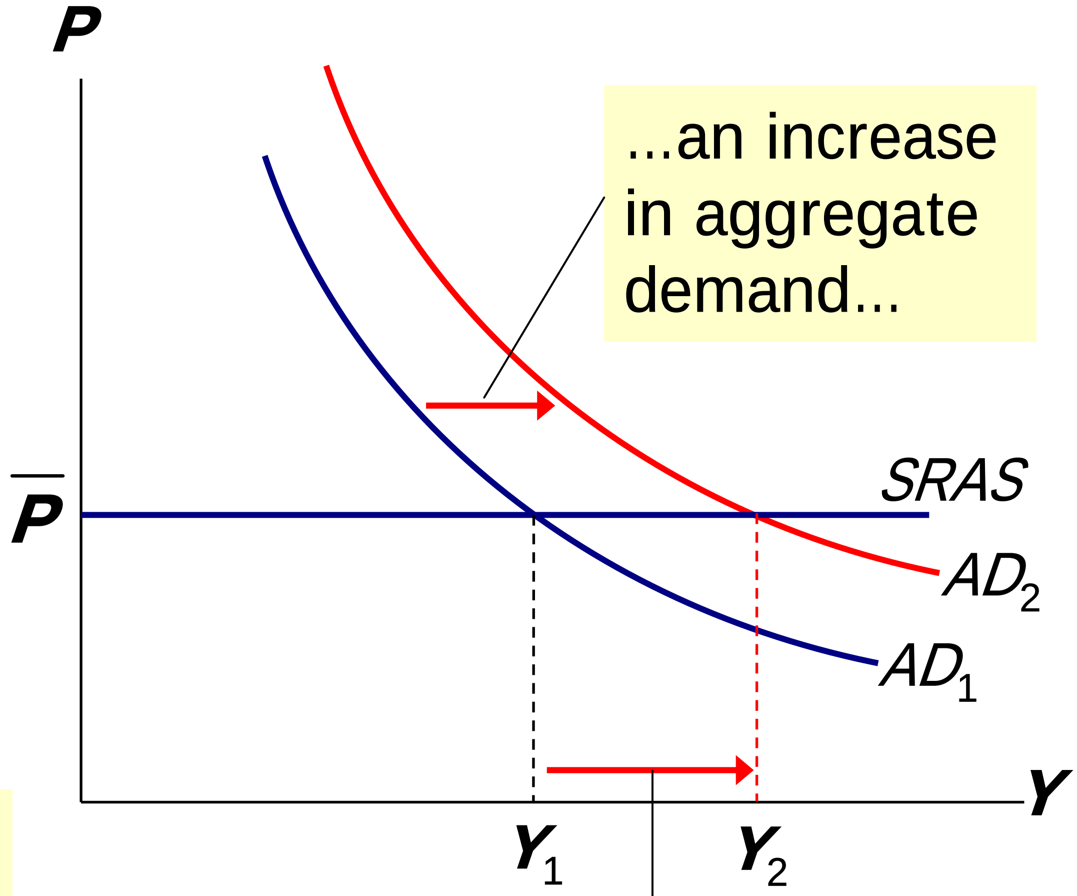


Short-run effects of an increase in *M*

In the short run when prices are sticky,...

...an increase in aggregate demand...

...causes output to rise.



From the short run to the long run

Over time, prices gradually become "unstuck." When they do, will they rise or fall?

In the short-run equilibrium, if	then over time, the price level will
$Y > \bar{Y}$	*rise*
$Y < \bar{Y}$	*fall*
$Y = \bar{Y}$	*remain constant*

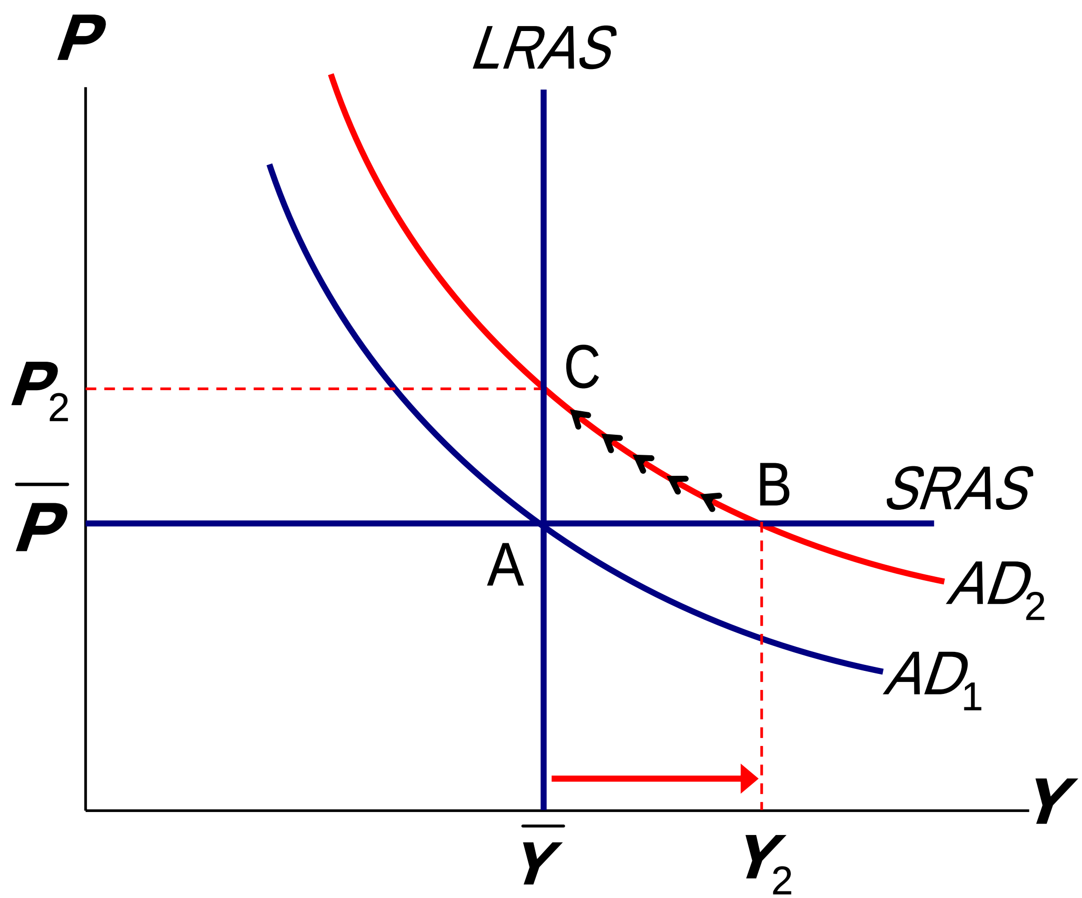
This adjustment of prices is what moves the economy to its long-run equilibrium.

The SR & LR effects of $\Delta M > 0$

A = initial equilibrium

B = new short-run eq'm after Fed increases ***M***

C = long-run equilibrium



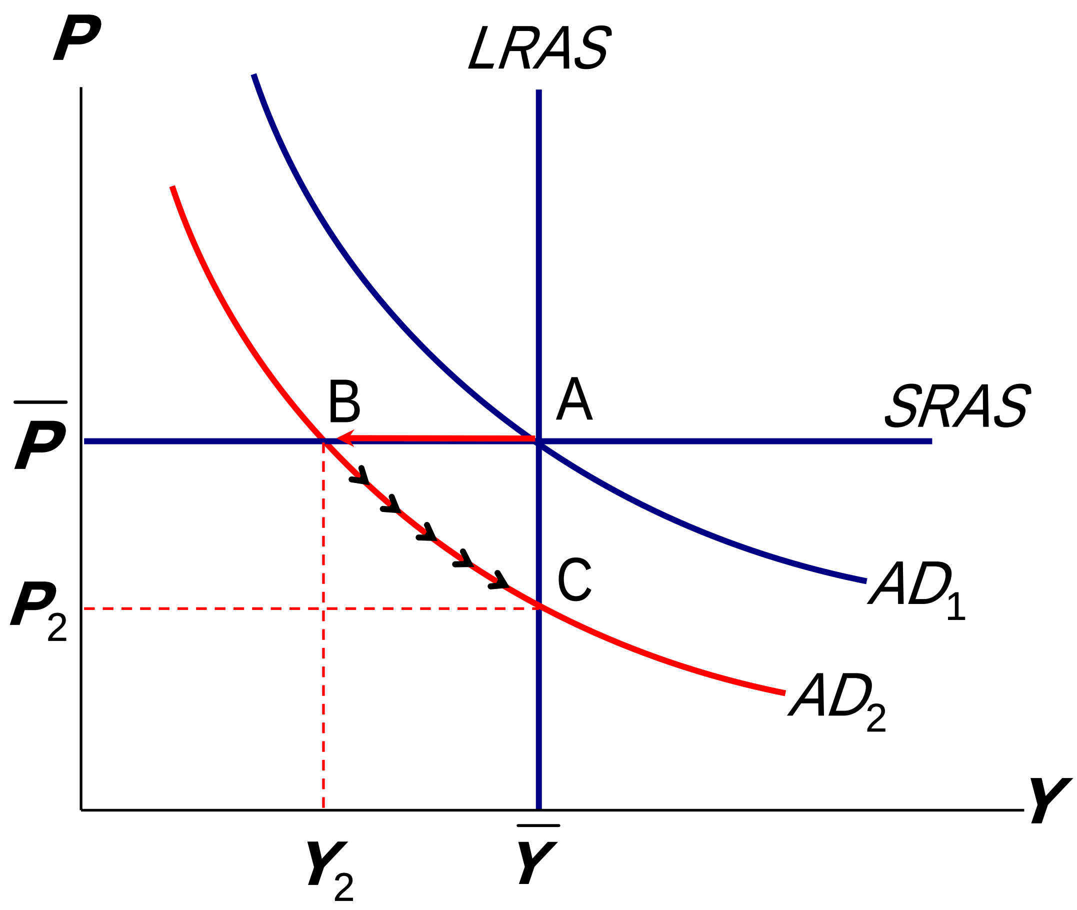
How shocking!!!

- **shocks**: exogenous changes in aggregate supply or demand
- Shocks temporarily push the economy away from full-employment.
- An example of a demand shock: exogenous decrease in velocity
- If the money supply is held constant, then a decrease in ***V*** means people will be using their money in fewer transactions, causing a decrease in demand for goods and services:

The effects of a negative demand shock

The shock shifts AD left, causing output and employment to fall in the short run

Over time, prices fall and the economy moves down its demand curve toward full-employment.



Supply shocks

A **supply shock** alters production costs, affects the prices that firms charge. (also called **price shocks**)

Examples of *adverse* supply shocks:

- Bad weather reduces crop yields, pushing up food prices.
- Workers unionize, negotiate wage increases.
- New environmental regulations require firms to reduce emissions. Firms charge higher prices to help cover the costs of compliance.

(*Favorable* supply shocks *lower* costs and prices.)

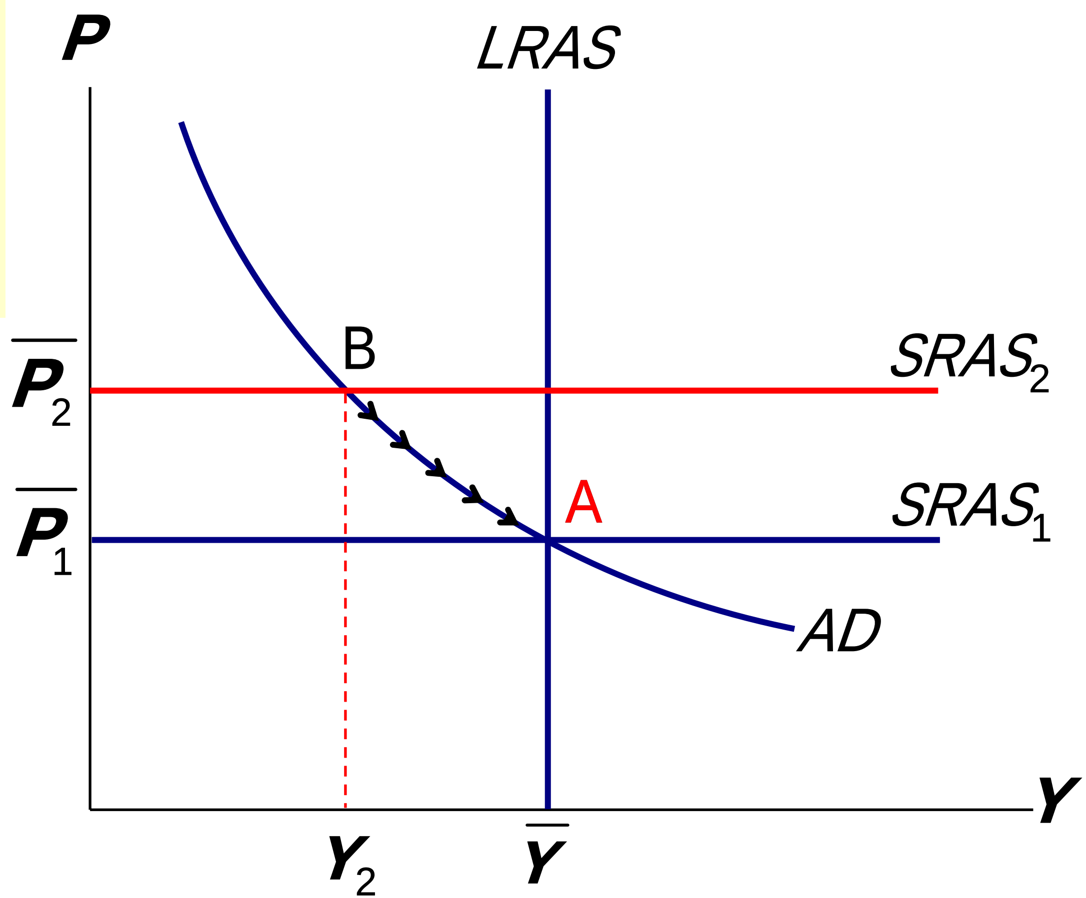
CASE STUDY:
The 1970s oil shocks

- Early 1970s: OPEC coordinates a reduction in the supply of oil.
- Oil prices rose
  11% in 1973
  68% in 1974
  16% in 1975
- Such sharp oil price increases are supply shocks because they significantly impact production costs and prices.

CASE STUDY:
The 1970s oil shocks

The oil price shock shifts SRAS up, causing output and employment to fall.

In absence of further price shocks, prices will fall over time and economy moves back toward full employment.

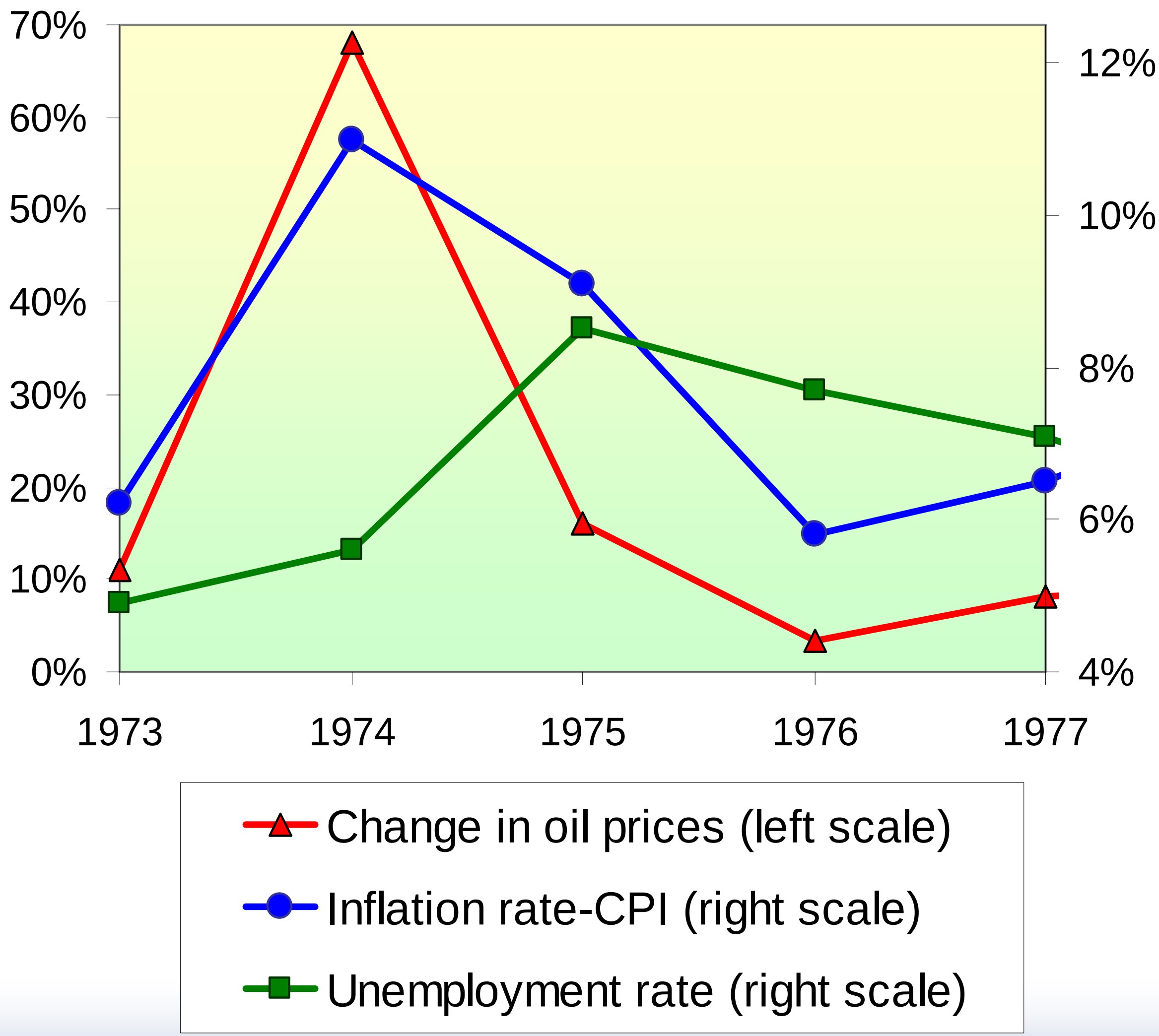


CASE STUDY:
The 1970s oil shocks

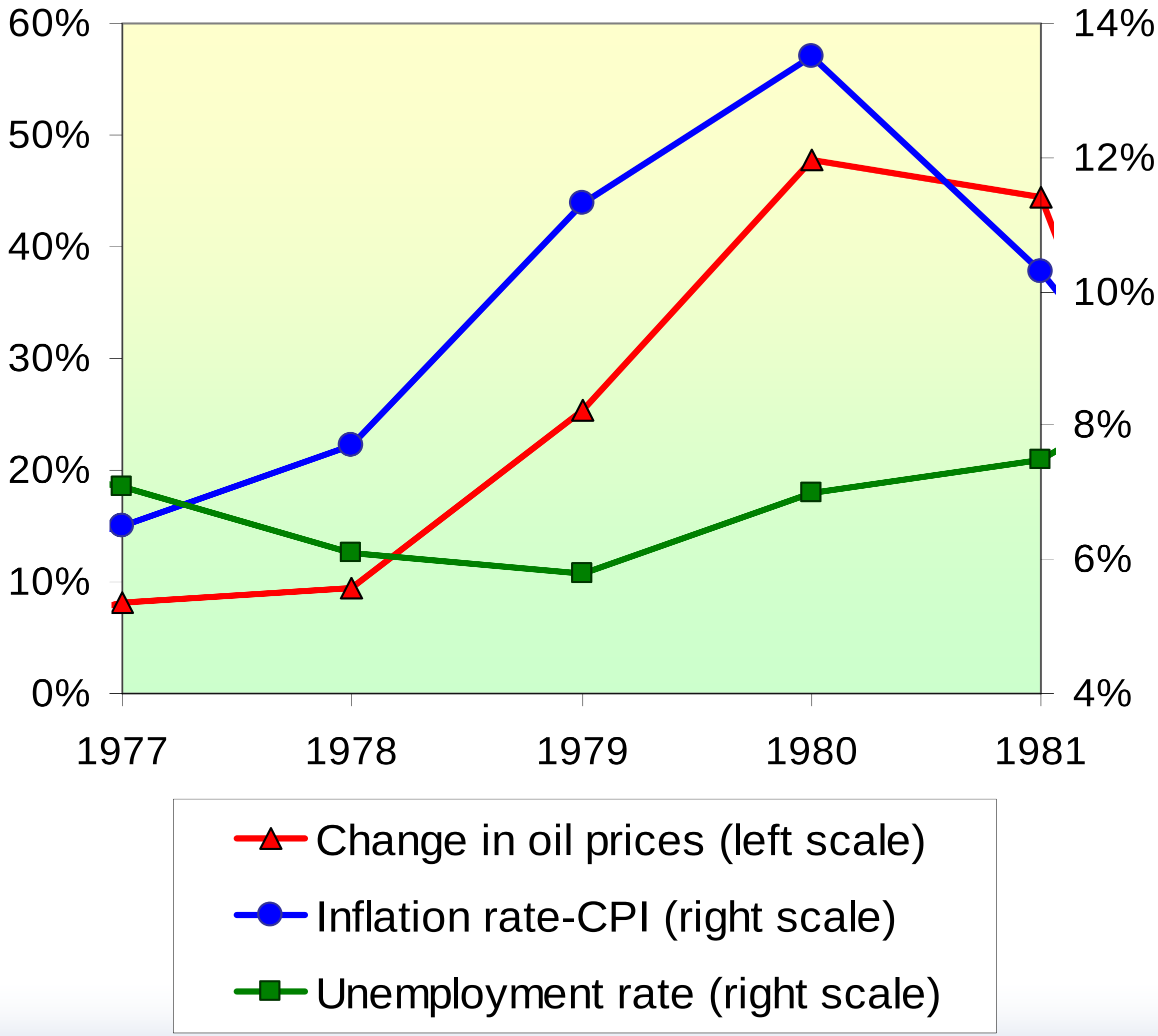
Predicted effects of the oil price shock:

- inflation ↑
- output ↓
- unemployment ↑

...and then a gradual recovery.



CASE STUDY:
The 1970s oil shocks



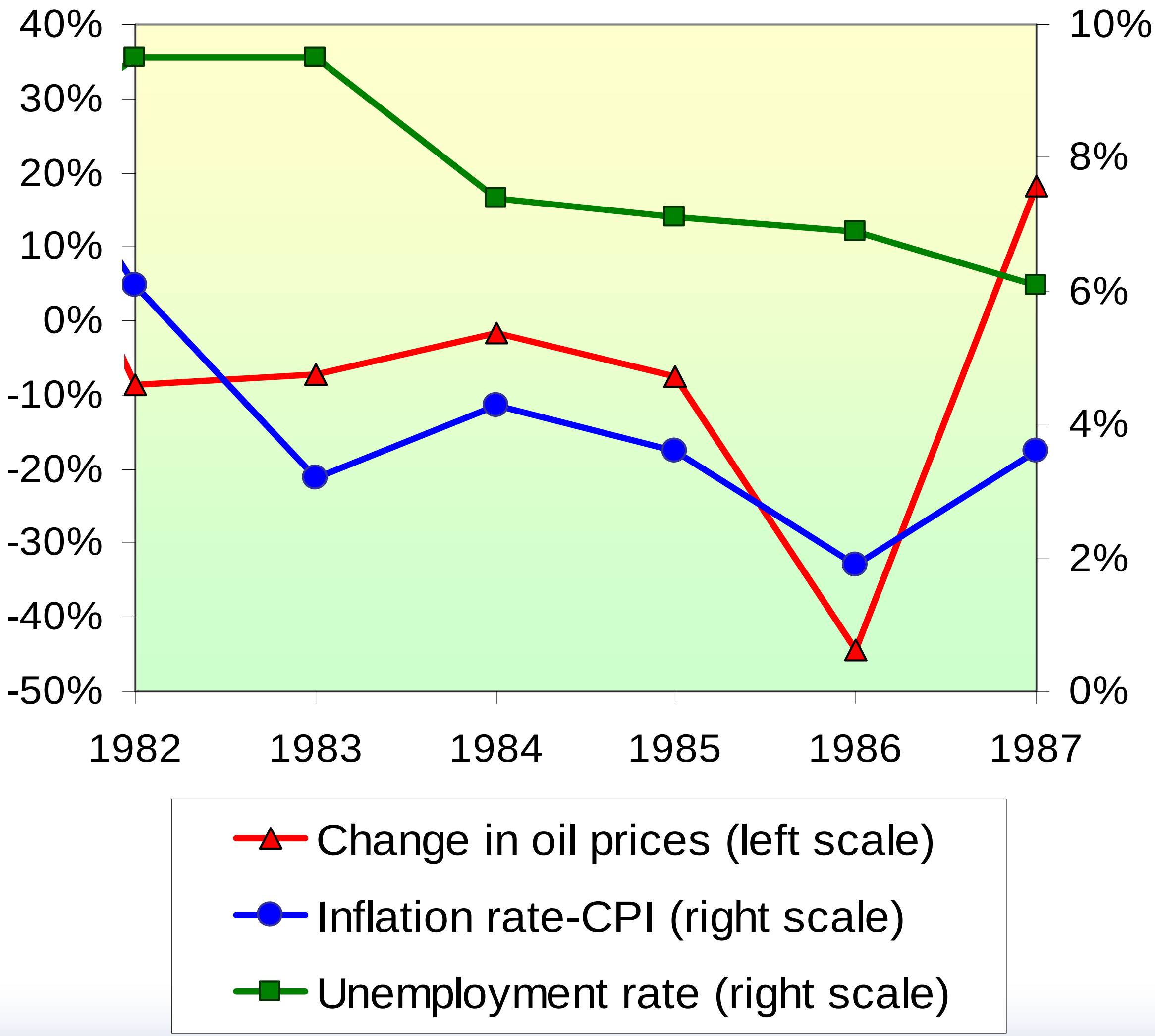
Late 1970s:

As economy was recovering, oil prices shot up again, causing another huge supply shock!!!

CASE STUDY:
The 1980s oil shocks

1980s:
A favorable supply shock--a significant fall in oil prices.

As the model would predict, inflation and unemployment fell:

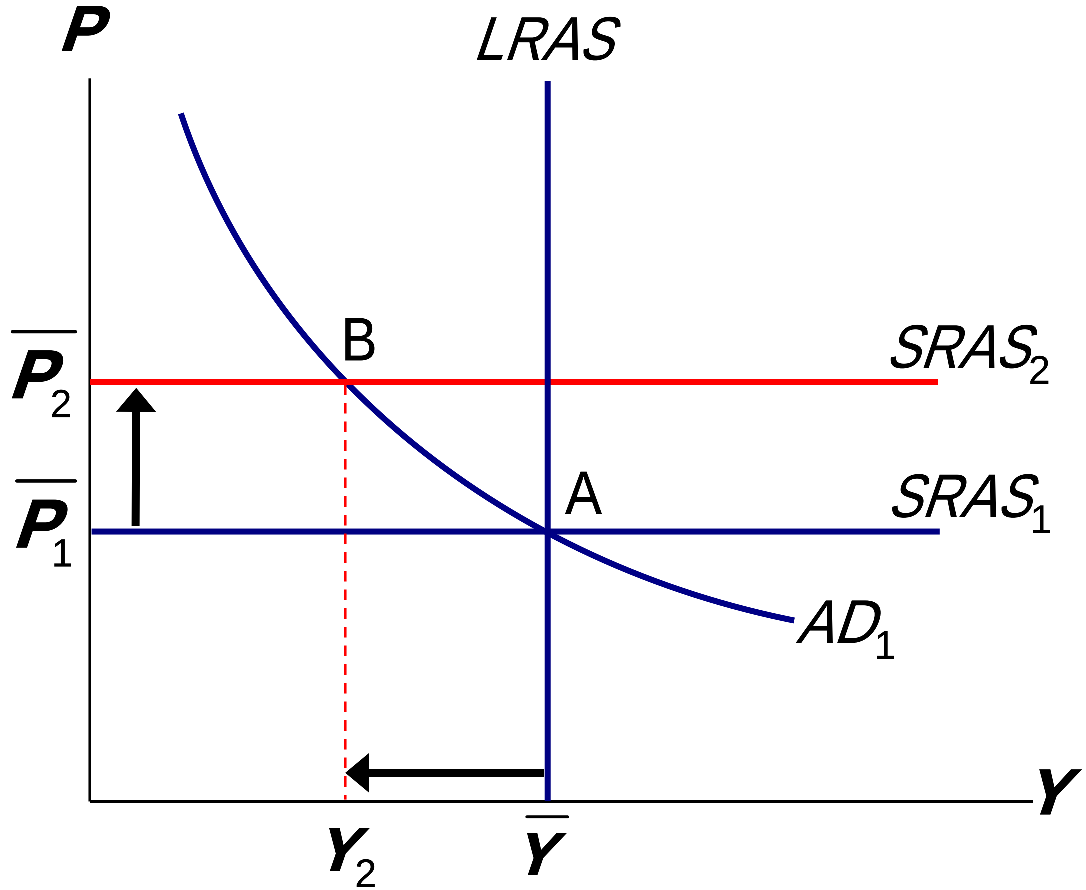


Stabilization policy

- def: policy actions aimed at reducing the severity of short-run economic fluctuations.
- Example: Using monetary policy to combat the effects of adverse supply shocks:

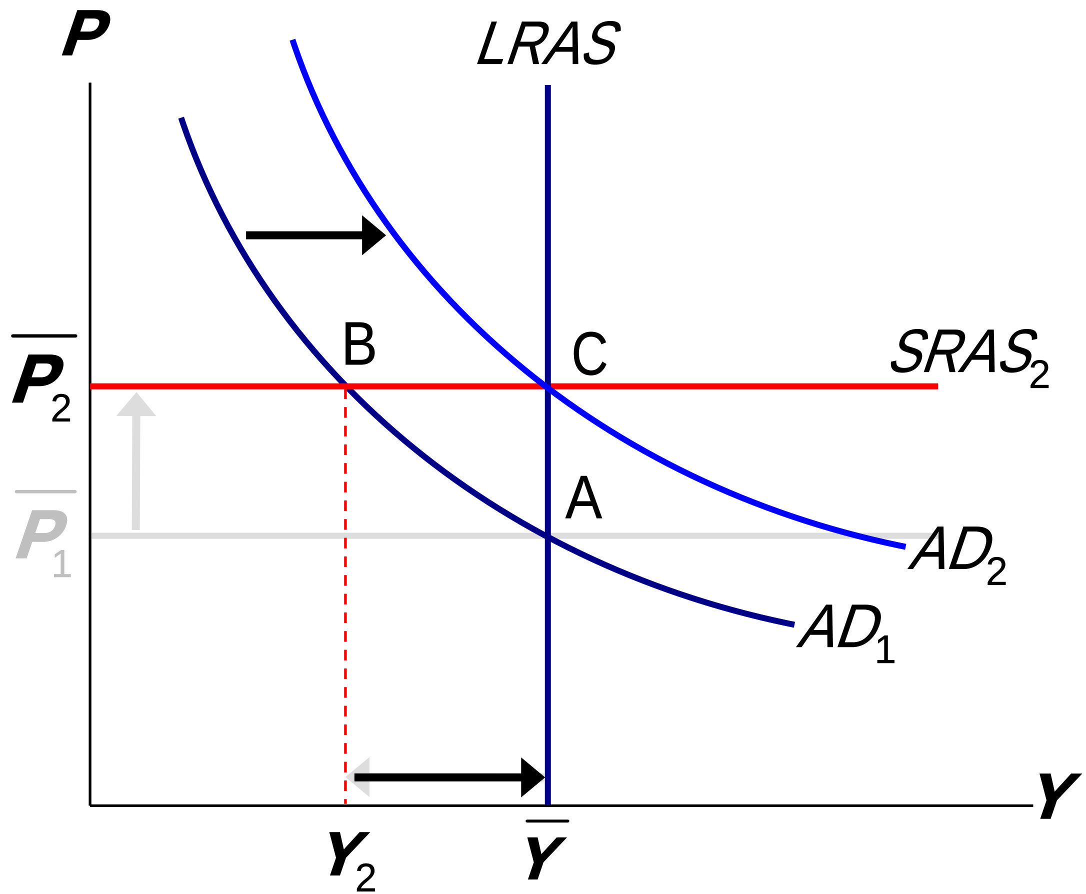
Stabilizing output with monetary policy

The adverse supply shock moves the economy to point B.



Stabilizing output with monetary policy

But the Fed accommodates the shock by raising agg. demand.



results:
P is permanently higher, but ***Y*** remains at its full-employment level.

Chapter summary

1. Long run: prices are flexible, output and employment are always at their natural rates, and the classical theory applies.

   Short run: prices are sticky, shocks can push output and employment away from their natural rates.

2. Aggregate demand and supply: a framework to analyze economic fluctuations

Chapter summary

3. The aggregate demand curve slopes downward.

4. The long-run aggregate supply curve is vertical, because output depends on technology and factor supplies, but not prices.

5. The short-run aggregate supply curve is horizontal, because prices are sticky at predetermined levels.

Chapter summary

6. Shocks to aggregate demand and supply cause fluctuations in GDP and employment in the short run.
7. The Fed can attempt to stabilize the economy with monetary policy.

Context

- Chapter 9 introduced the model of aggregate demand and aggregate supply.
- Long run
  - prices flexible
  - output determined by factors of production & technology
  - unemployment equals its natural rate
- Short run
  - prices fixed
  - output determined by aggregate demand
  - unemployment is negatively related to output

Context

- This chapter develops the *IS-LM* model, the theory that yields the aggregate demand curve.
- We focus on the short run and assume the price level is fixed.

The Keynesian Cross

- A simple closed economy model in which income is determined by expenditure.
  (due to J.M. Keynes)
- Notation:
  I = *planned* investment
  $E = C + I + G$ = planned expenditure
  Y = real GDP = actual expenditure
- Difference between actual & planned expenditure: unplanned inventory investment

Elements of the Keynesian Cross

consumption function: $C = C(Y - T)$

govt policy variables: $G = \bar{G}, \quad T = \bar{T}$

for now,
investment is exogenous: $I = \bar{I}$

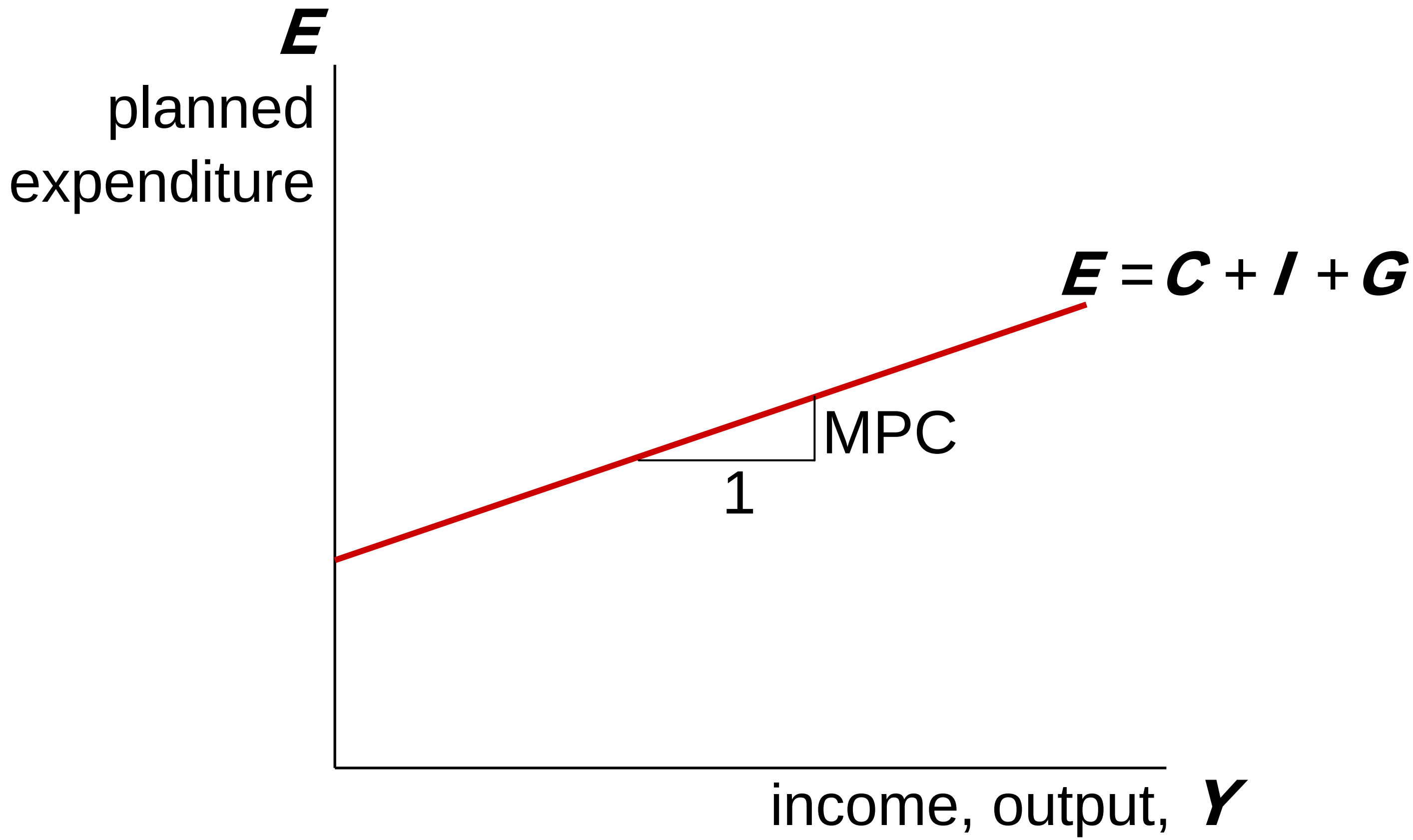
planned expenditure: $E = C(Y - \bar{T}) + \bar{I} + \bar{G}$

Equilibrium condition:

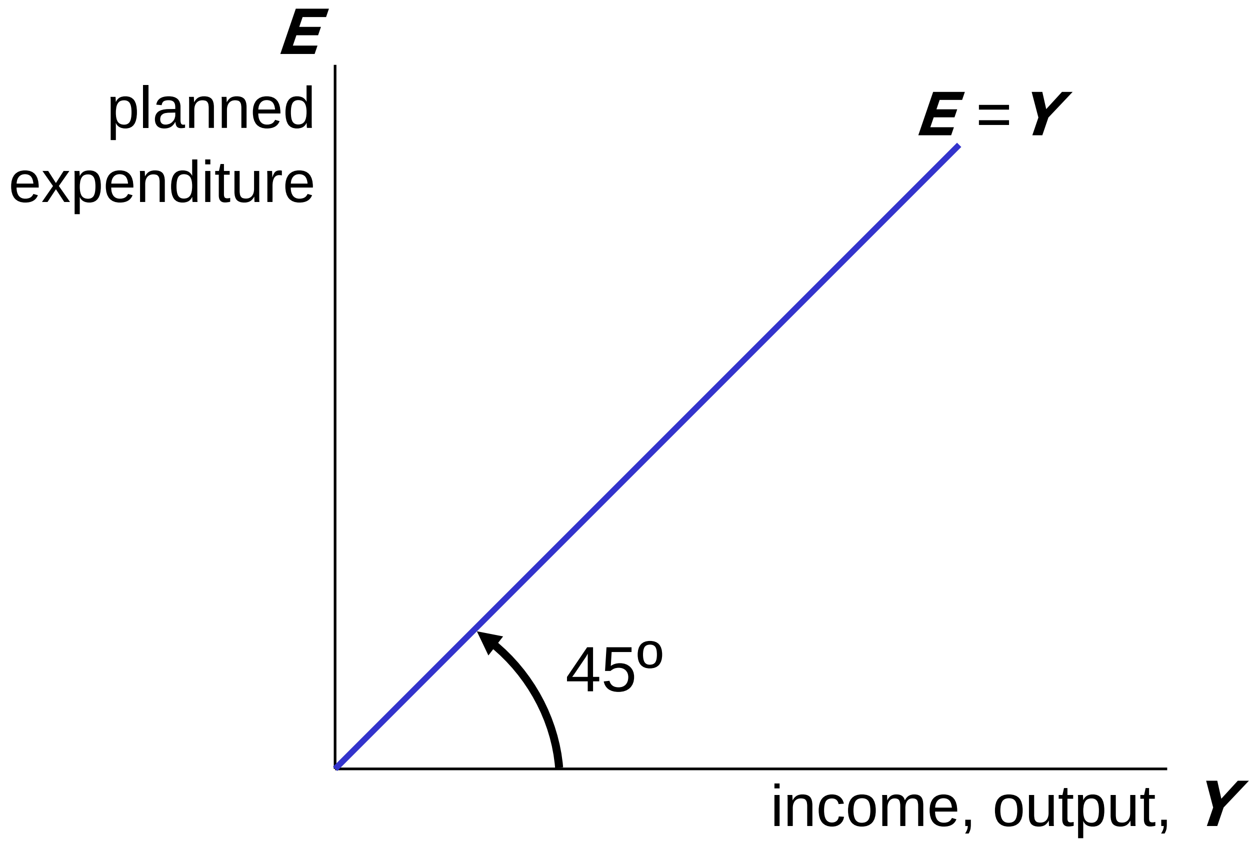
Actual expenditure $=$ Planned expenditure

$$Y = E$$

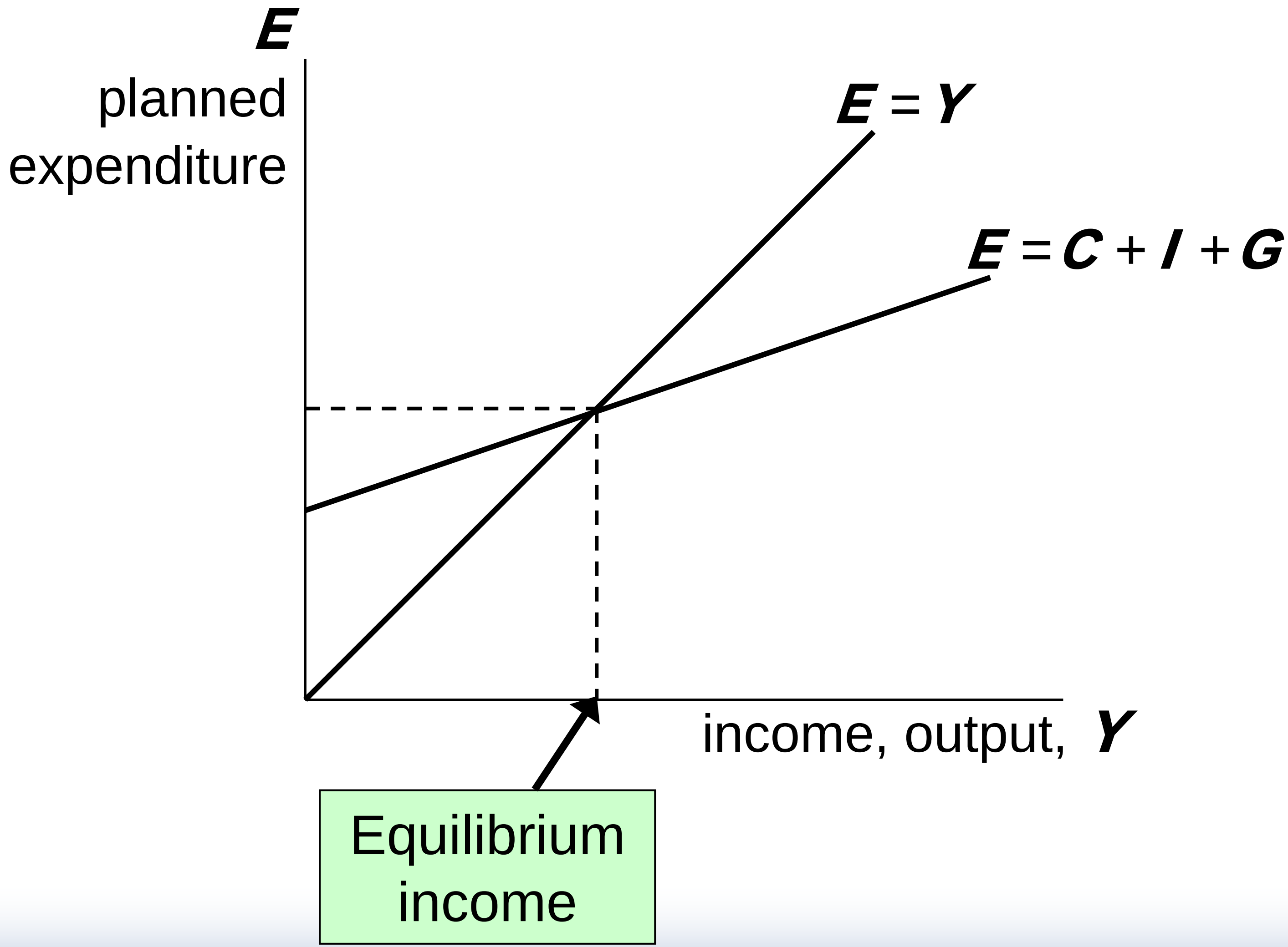
Graphing planned expenditure



Graphing the equilibrium condition



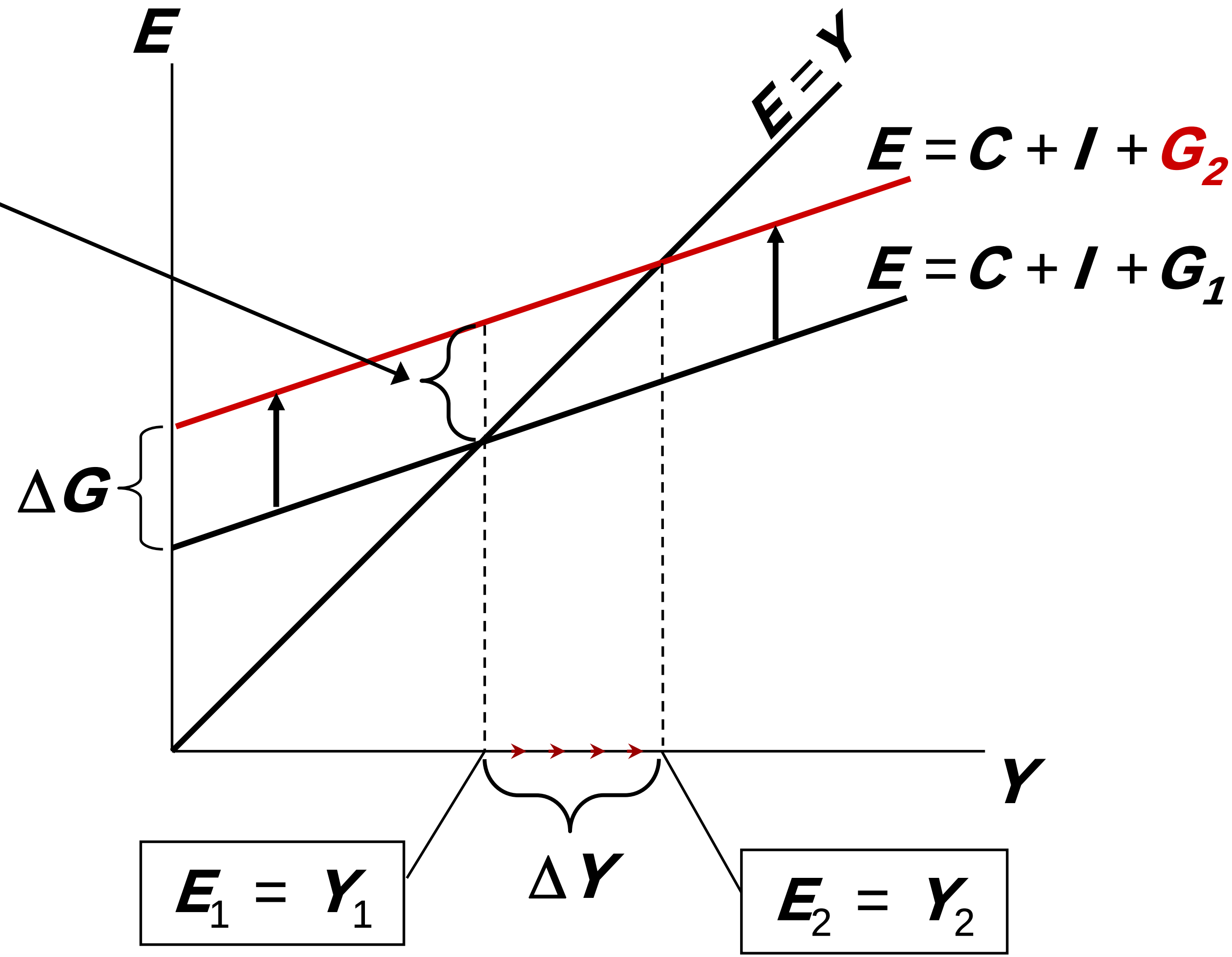
The equilibrium value of income



An increase in government purchases

At Y_1,
there is now an unplanned drop in inventory…

…so firms increase output, and income rises toward a new equilibrium



Solving for ΔY

$Y = C + I + G$ equilibrium condition

$\Delta Y = \Delta C + \Delta I + \Delta G$ in changes

$= \Delta C + \Delta G$ because I exogenous

$= \text{MPC} \times \Delta Y + \Delta G$ because $\Delta C = \text{MPC}\ \Delta Y$

Collect terms with ΔY on the left side of the equals sign:

$$(1 - \text{MPC}) \times \Delta Y = \Delta G$$

Finally, solve for ΔY:

$$\Delta Y = \left(\frac{1}{1 - \text{MPC}}\right) \times \Delta G$$

The government purchases multiplier

Example: MPC = 0.8

$$\Delta \boldsymbol{Y} = \frac{1}{1 - \text{MPC}} \Delta \boldsymbol{G}$$

$$= \frac{1}{1 - 0.8} \Delta \boldsymbol{G} = \frac{1}{0.2} \Delta \boldsymbol{G} = 5 \Delta \boldsymbol{G}$$

The increase in ***G*** causes income to increase by 5 times as much!

The government purchases multiplier

Definition: the increase in income resulting from a \$1 increase in ***G***.

In this model, the ***G*** multiplier equals

$$\frac{\Delta \boldsymbol{Y}}{\Delta \boldsymbol{G}} = \frac{1}{1 - \text{MPC}}$$

In the example with MPC = 0.8,

$$\frac{\Delta \boldsymbol{Y}}{\Delta \boldsymbol{G}} = \frac{1}{1 - 0.8} = 5$$

Why the multiplier is greater than 1

- Initially, the increase in $\boldsymbol{G}$ causes an equal increase in $\boldsymbol{Y}$: $\Delta \boldsymbol{Y} = \Delta \boldsymbol{G}$.
- But $\uparrow \boldsymbol{Y} \Rightarrow \uparrow \boldsymbol{C}$

  $\Rightarrow$ further $\uparrow \boldsymbol{Y}$

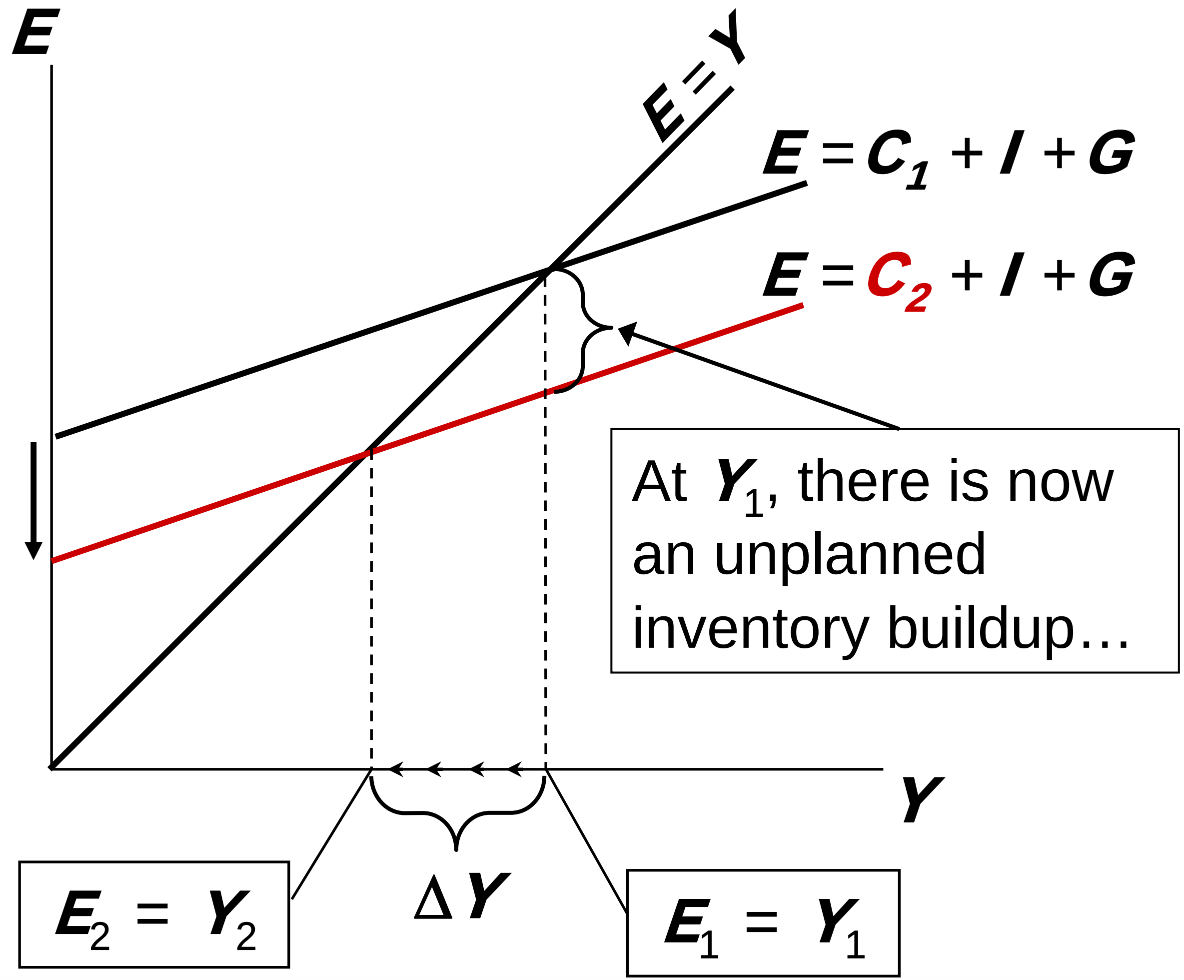
  $\Rightarrow$ further $\uparrow \boldsymbol{C}$

  $\Rightarrow$ further $\uparrow \boldsymbol{Y}$
- So the final impact on income is much bigger than the initial $\Delta \boldsymbol{G}$.

An increase in taxes

Initially, the tax increase reduces consumption, and therefore ***E***:

$\Delta C = -\text{MPC}\,\Delta T$



…so firms reduce output, and income falls toward a new equilibrium

Solving for ΔY

$$\Delta \boldsymbol{Y} = \Delta \boldsymbol{C} + \Delta \boldsymbol{I} + \Delta \boldsymbol{G}$$

eq'm condition in changes

$$= \Delta \boldsymbol{C}$$

I and ***G*** exogenous

$$= \text{MPC} \times \left(\Delta \boldsymbol{Y} - \Delta \boldsymbol{T} \right)$$

Solving for $\Delta \boldsymbol{Y}$: $(1 - \text{MPC}) \times \Delta \boldsymbol{Y} = -\text{MPC} \times \Delta \boldsymbol{T}$

Final result:

$$\boxed{\Delta \boldsymbol{Y} = \left(\frac{-\text{MPC}}{1 - \text{MPC}} \right) \times \Delta \boldsymbol{T}}$$

The Tax Multiplier

def: the change in income resulting from a \$1 increase in $\boldsymbol{T}$:

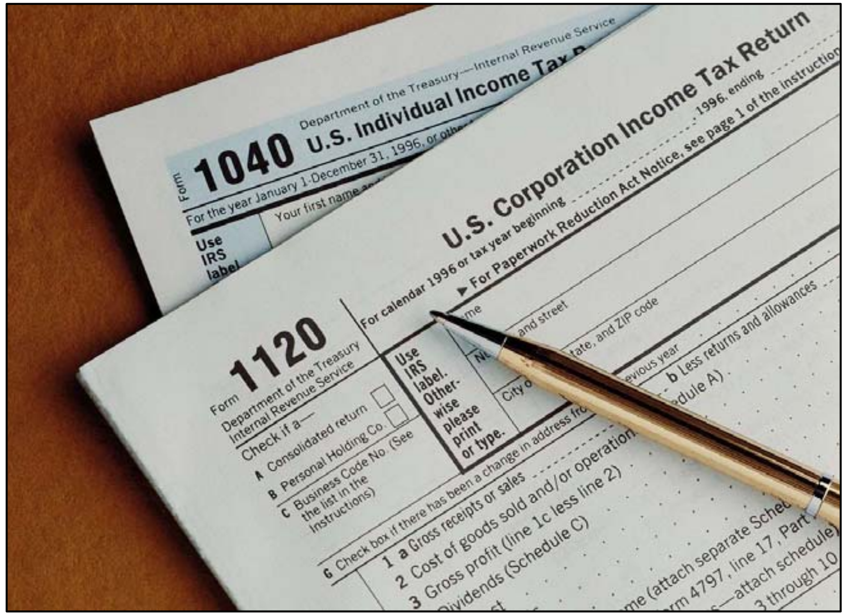
$$\frac{\Delta \boldsymbol{Y}}{\Delta \boldsymbol{T}} = \frac{-\text{MPC}}{1 - \text{MPC}}$$

If MPC = 0.8, then the tax multiplier equals

$$\frac{\Delta \boldsymbol{Y}}{\Delta \boldsymbol{T}} = \frac{-0.8}{1 - 0.8} = \frac{-0.8}{0.2} = -4$$

The Tax Multiplier

...is *negative:*
A tax hike reduces consumer spending, which reduces income.



...is *greater than one*
(*in absolute value*):
A change in taxes has a multiplier effect on income.

...is *smaller than the govt spending multiplier:*
Consumers save the fraction (1-MPC) of a tax cut, so the initial boost in spending from a tax cut is smaller than from an equal increase in ***G***.

The Tax Multiplier

...is *negative:*
An increase in taxes reduces consumer spending, which reduces equilibrium income.

...is *greater than one* (*in absolute value*):
A change in taxes has a multiplier effect on income.

...is *smaller than the govt spending multiplier:*
Consumers save the fraction (1-MPC) of a tax cut, so the initial boost in spending from a tax cut is smaller than from an equal increase in ***G***.

Exercise:

- Use a graph of the Keynesian Cross to show the impact of an increase in investment on the equilibrium level of income/output.

The *IS* curve

def: a graph of all combinations of ***r*** and ***Y*** that result in goods market equilibrium,

i.e. actual expenditure (output)
= planned expenditure

The equation for the *IS* curve is:

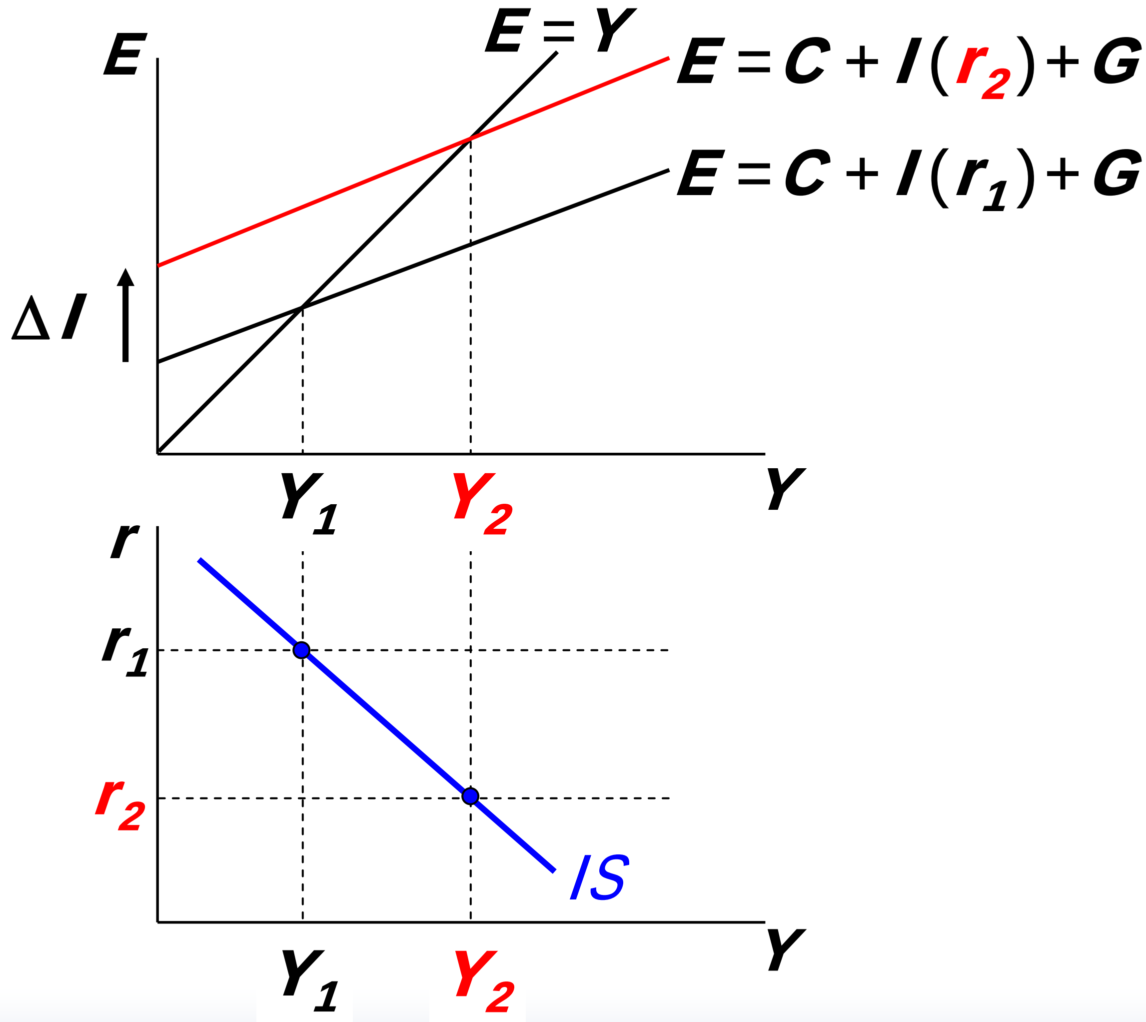
$$Y = C(Y - \bar{T}) + I(r) + \bar{G}$$

Deriving the *IS* curve

$\downarrow r \;\Rightarrow\; \uparrow I$

$\Rightarrow\; \uparrow E$

$\Rightarrow\; \uparrow Y$



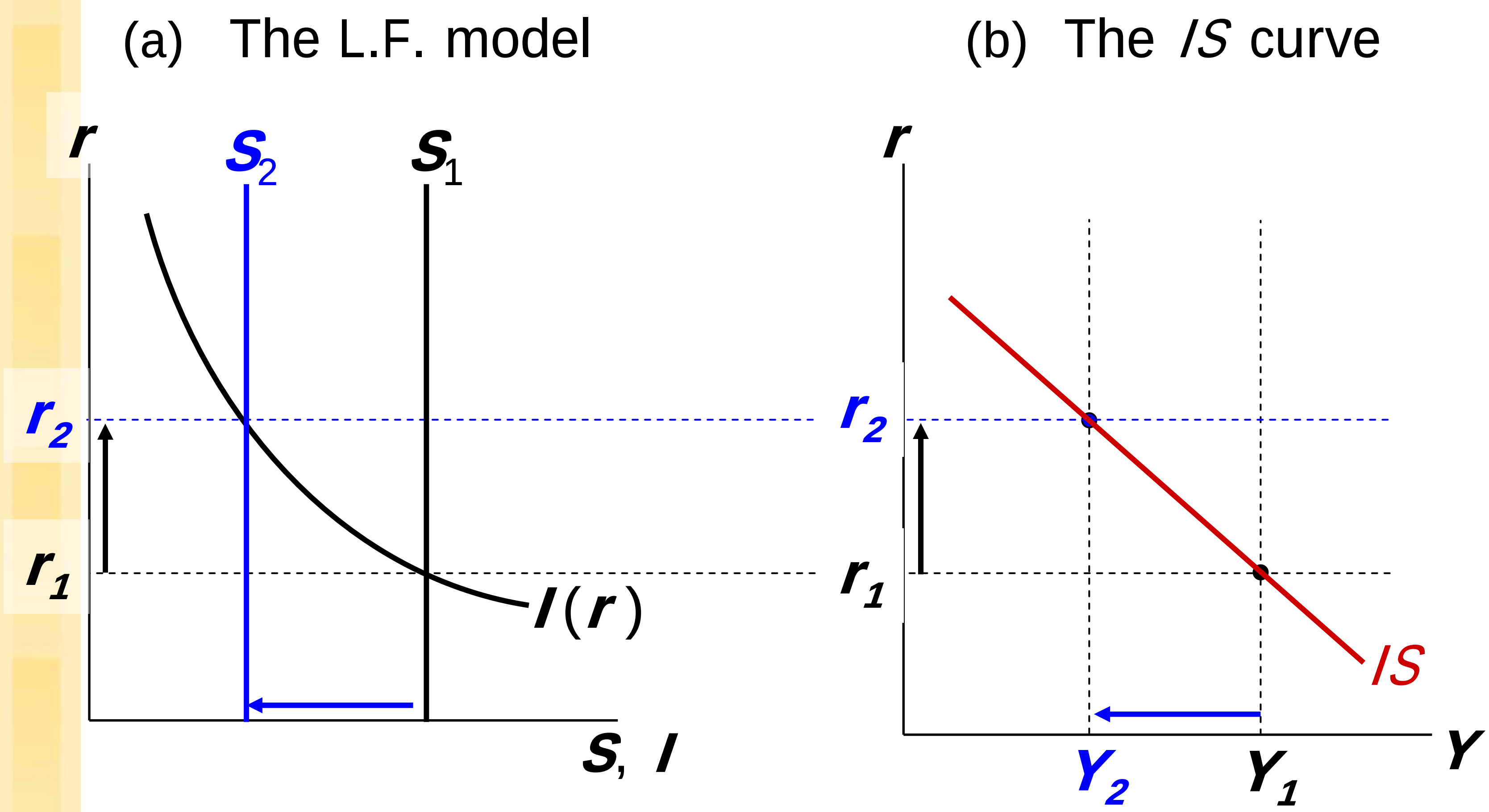
Understanding the *IS* curve's slope

- The *IS* curve is negatively sloped.
- Intuition:

  A fall in the interest rate motivates firms to increase investment spending, which drives up total planned spending (***E***).

  To restore equilibrium in the goods market, output (a.k.a. actual expenditure, ***Y***) must increase.

The IS curve and the Loanable Funds model



Fiscal Policy and the *IS* curve

- We can use the *IS-LM* model to see how fiscal policy (***G*** and ***T***) can affect aggregate demand and output.

- Let's start by using the Keynesian Cross to see how fiscal policy shifts the *IS* curve...

Shifting the *IS* curve: ΔG

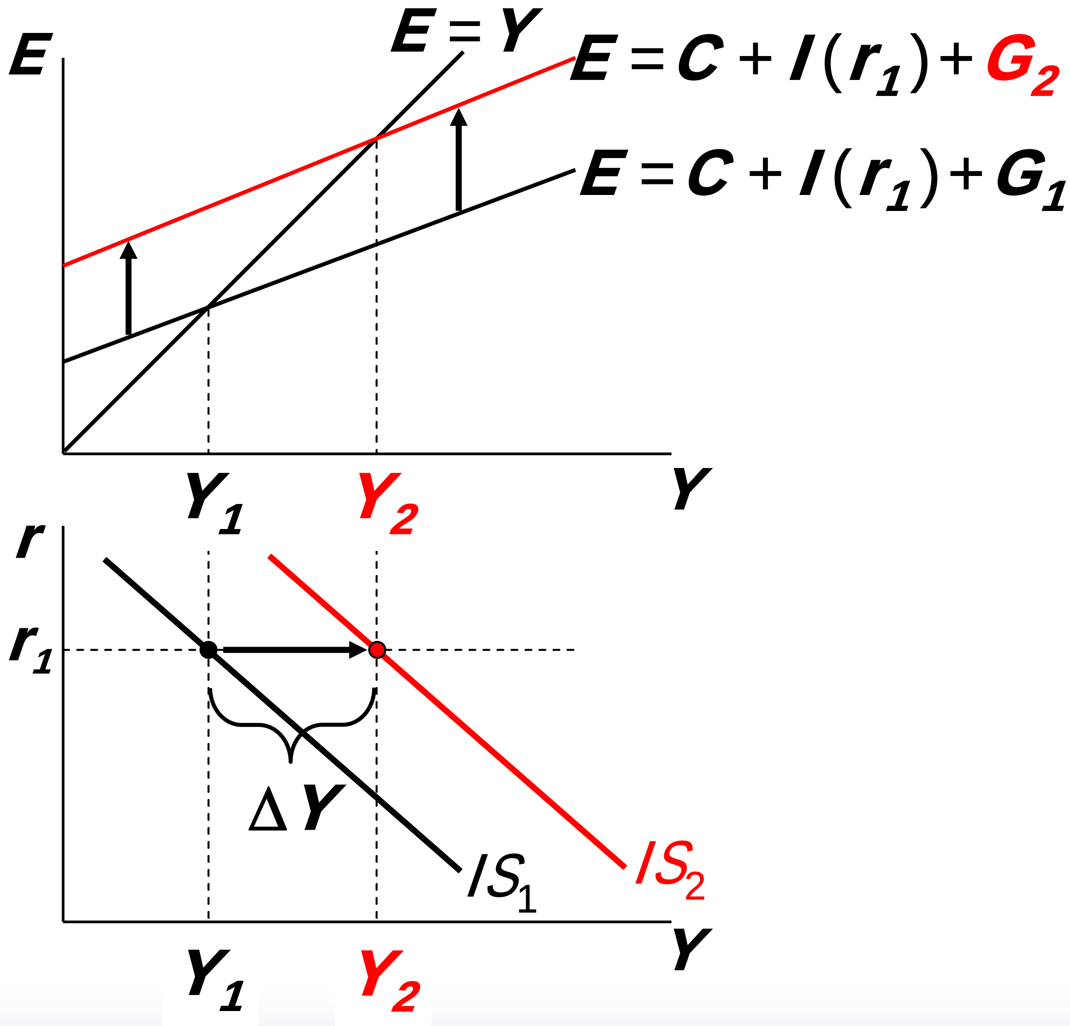
At any value of r,

$\uparrow G \Rightarrow \uparrow E \Rightarrow \uparrow Y$

...so the IS curve shifts to the right.

The horizontal distance of the IS shift equals

$$\Delta Y = \frac{1}{1-\text{MPC}}\Delta G$$



Exercise: Shifting the IS curve

- Use the diagram of the Keynesian Cross or Loanable Funds model to show how an increase in taxes shifts the *IS* curve.

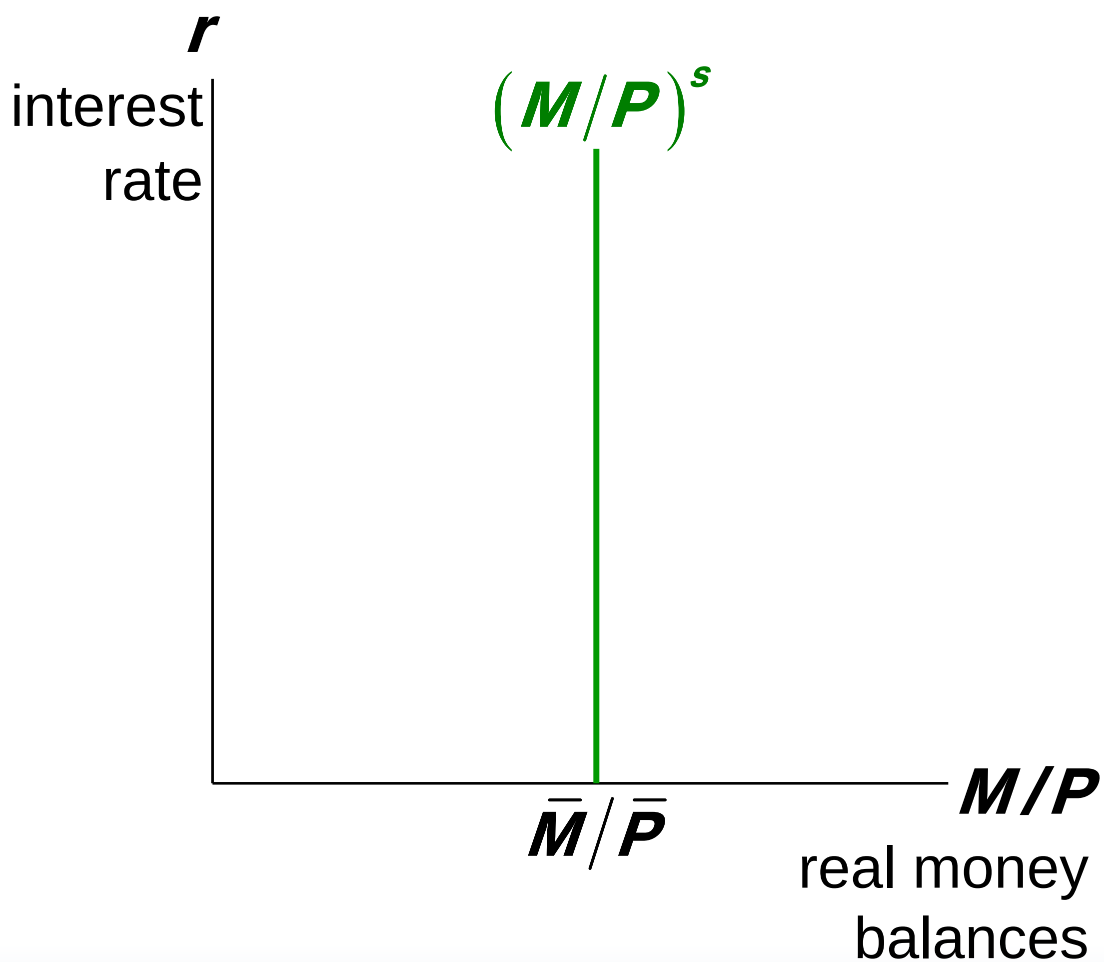
The Theory of Liquidity Preference

- due to John Maynard Keynes.
- A simple theory in which the interest rate is determined by money supply and money demand.

Money Supply

The supply of real money balances is fixed:

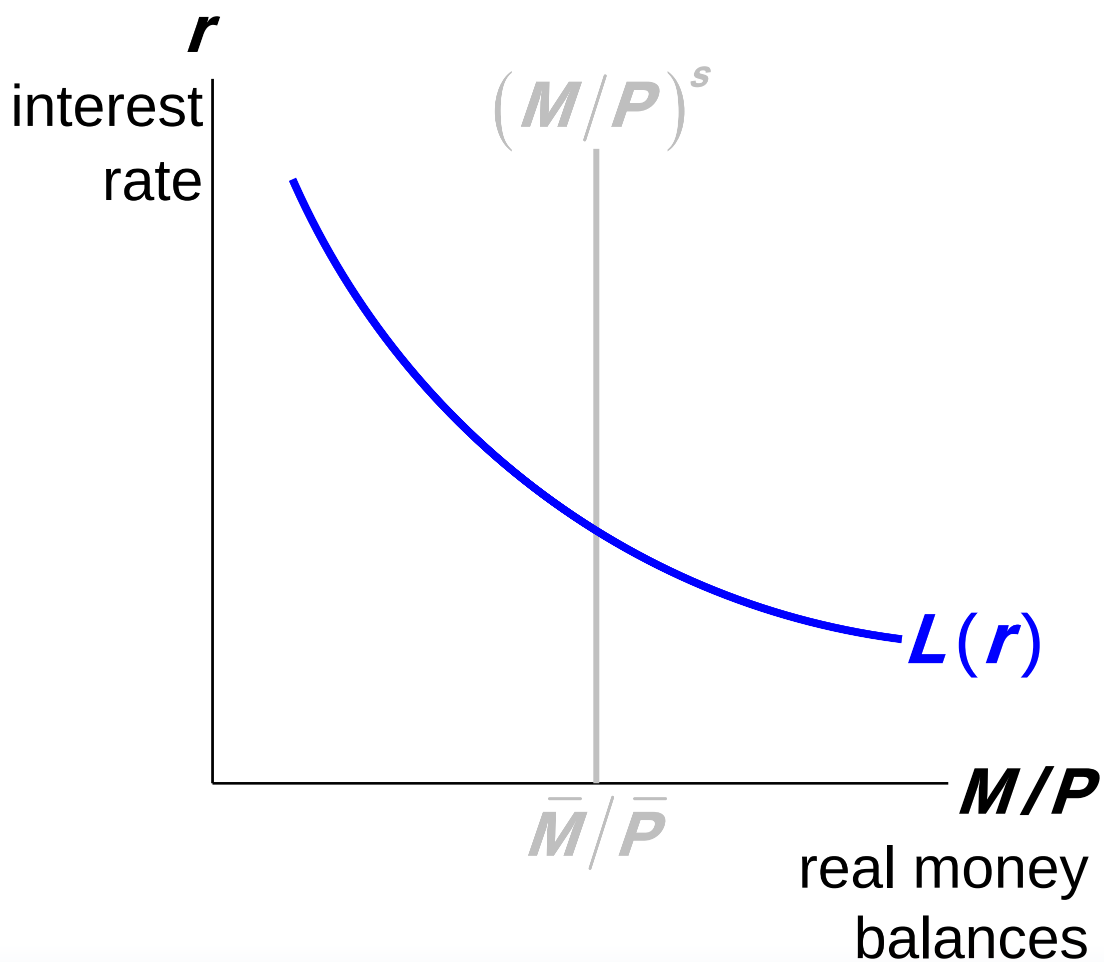
$$\left(M/P\right)^s = \bar{M}/\bar{P}$$



Money Demand

Demand for real money balances:

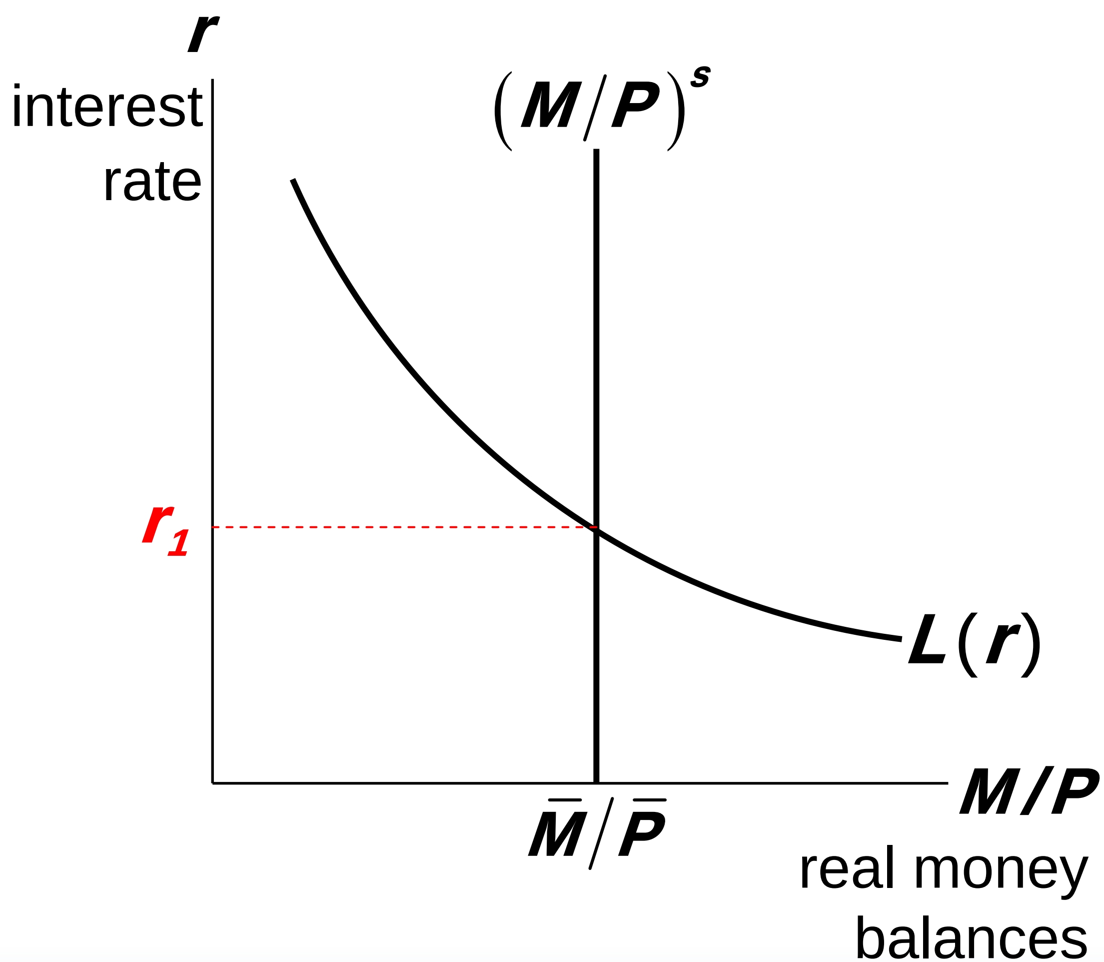
$$\left(M/P\right)^d = L(r)$$



Equilibrium

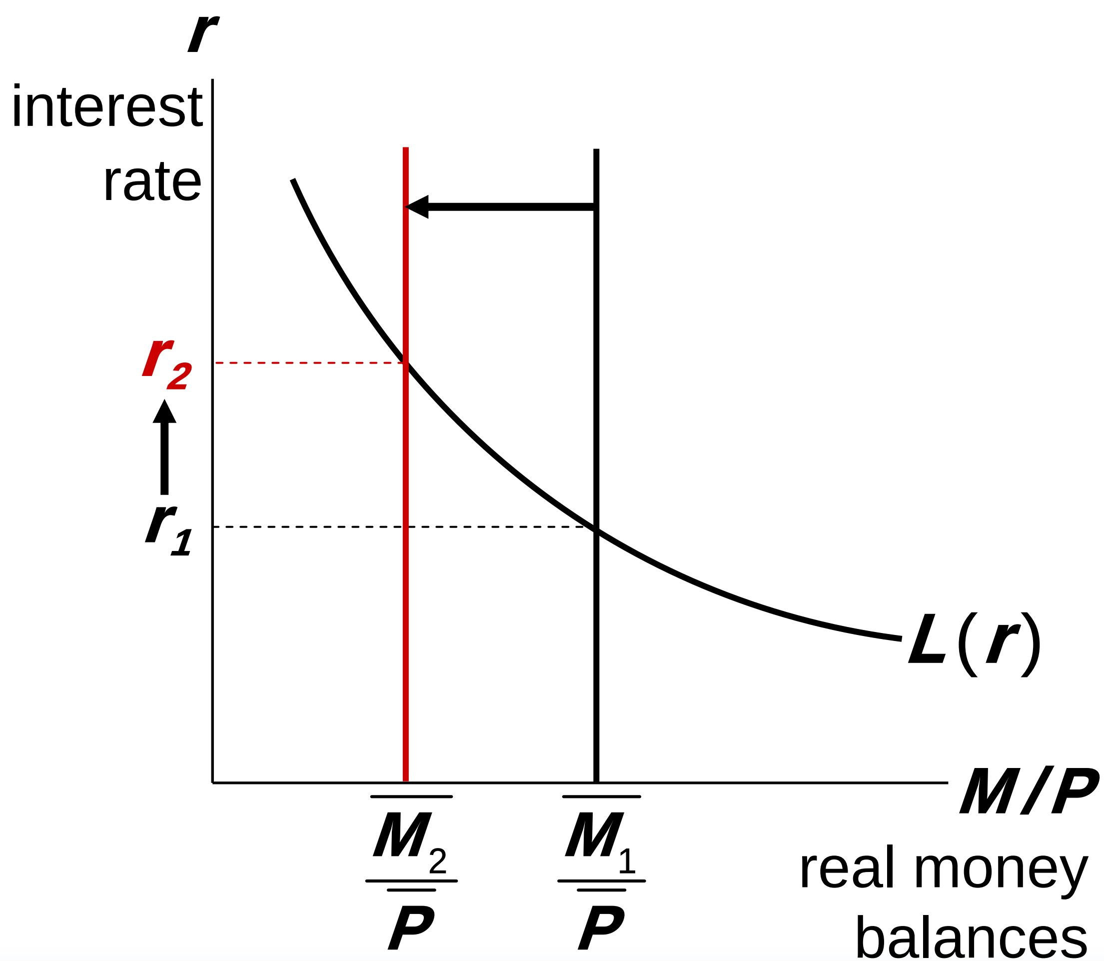
The interest rate adjusts to equate the supply and demand for money:

$$\overline{M}/\overline{P} = L(r)$$



How the Fed raises the interest rate

To increase ***r***,
Fed reduces ***M***



CASE STUDY
Volcker's Monetary Tightening

- Late 1970s: $\pi > 10\%$
- Oct 1979: Fed Chairman Paul Volcker announced that monetary policy would aim to reduce inflation.
- Aug 1979-April 1980:
  Fed reduces ***M/P*** 8.0%
- Jan 1983: $\pi = 3.7\%$

How do you think this policy change would affect interest rates?

Volcker's Monetary Tightening, *cont.*

The effects of a monetary tightening on nominal interest rates

	short run	long run
model	Liquidity Preference *(Keynesian)*	Quantity Theory, Fisher Effect *(Classical)*
prices	sticky	flexible
prediction	$\Delta \boldsymbol{i} > 0$	$\Delta \boldsymbol{i} < 0$
actual outcome	8/1979: $\boldsymbol{i}$ = 10.4% 4/1980: $\boldsymbol{i}$ = 15.8%	1/1983: $\boldsymbol{i}$ = 8.2%

The LM curve

Now let's put $\boldsymbol{Y}$ back into the money demand function:

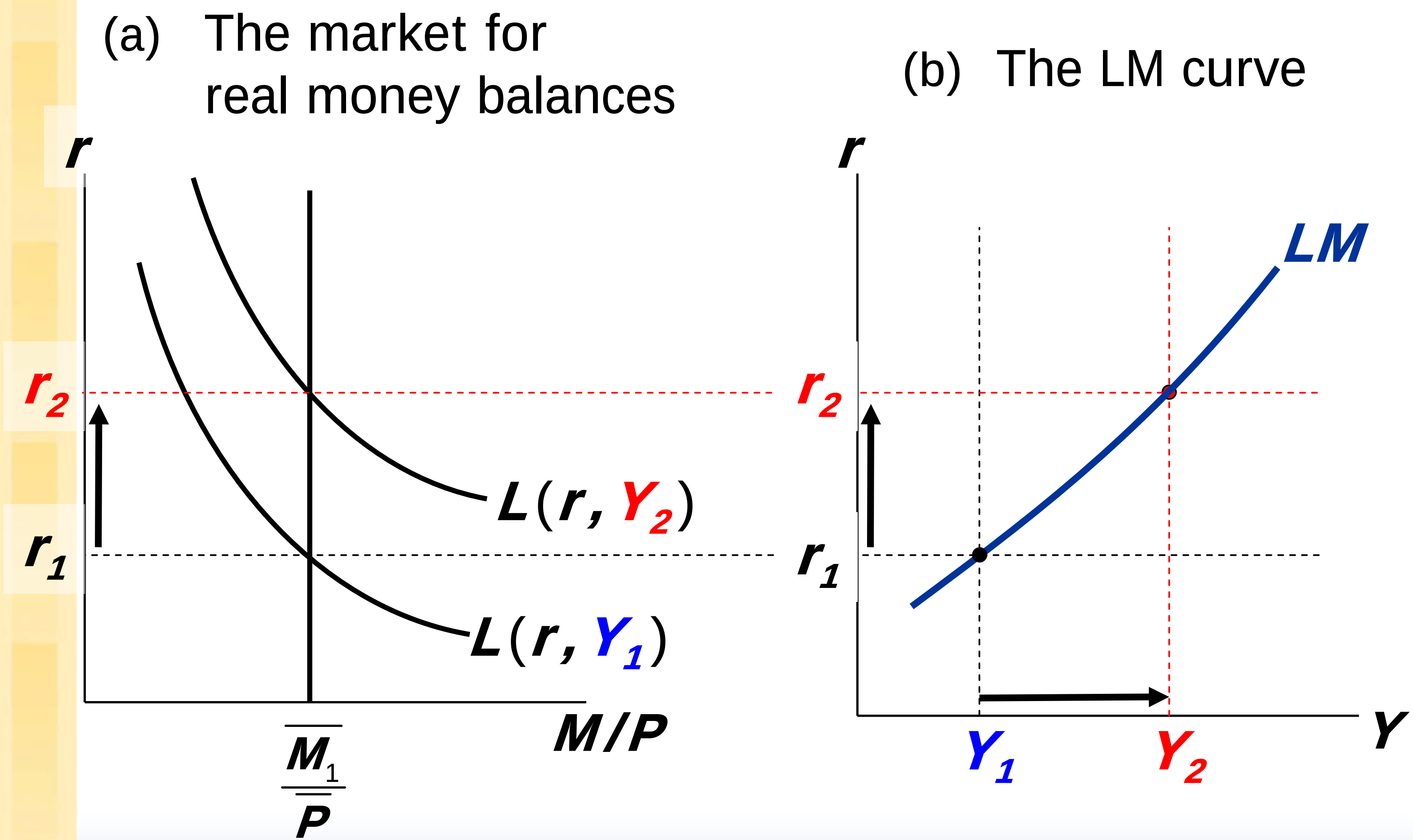
$$\left(M/P\right)^d = L(r, Y)$$

The ***LM* curve** is a graph of all combinations of $\boldsymbol{r}$ and $\boldsymbol{Y}$ that equate the supply and demand for real money balances.

The equation for the *LM* curve is:

$$\bar{M}/\bar{P} = L(r, Y)$$

Deriving the LM curve



Understanding the *LM* curve's slope

- The *LM* curve is positively sloped.
- Intuition:

  An increase in income raises money demand.

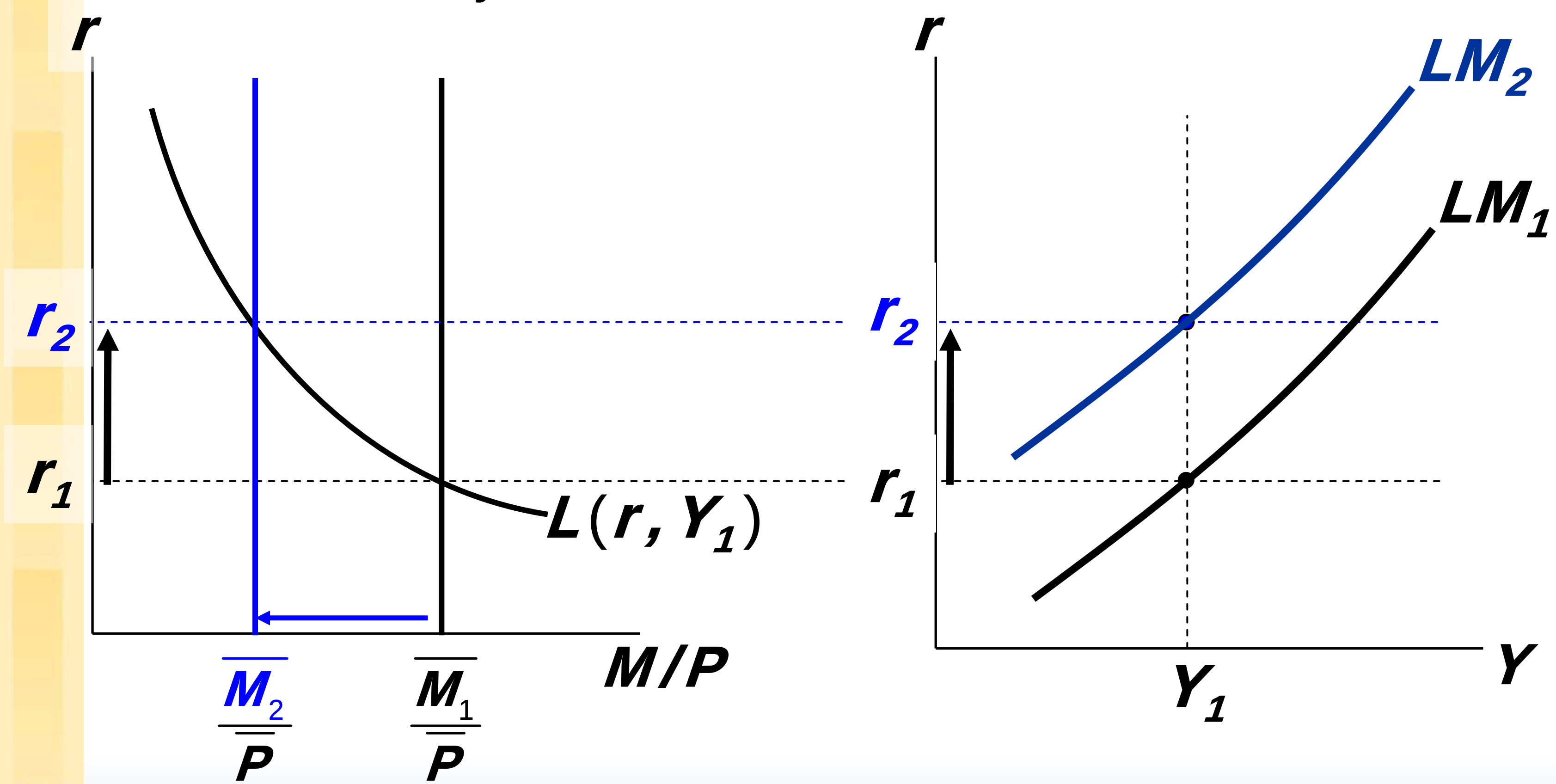
  Since the supply of real balances is fixed, there is now excess demand in the money market at the initial interest rate.

  The interest rate must rise to restore equilibrium in the money market.

How ΔM shifts the LM curve

(a) The market for real money balances

(b) The LM curve



Exercise: Shifting the LM curve

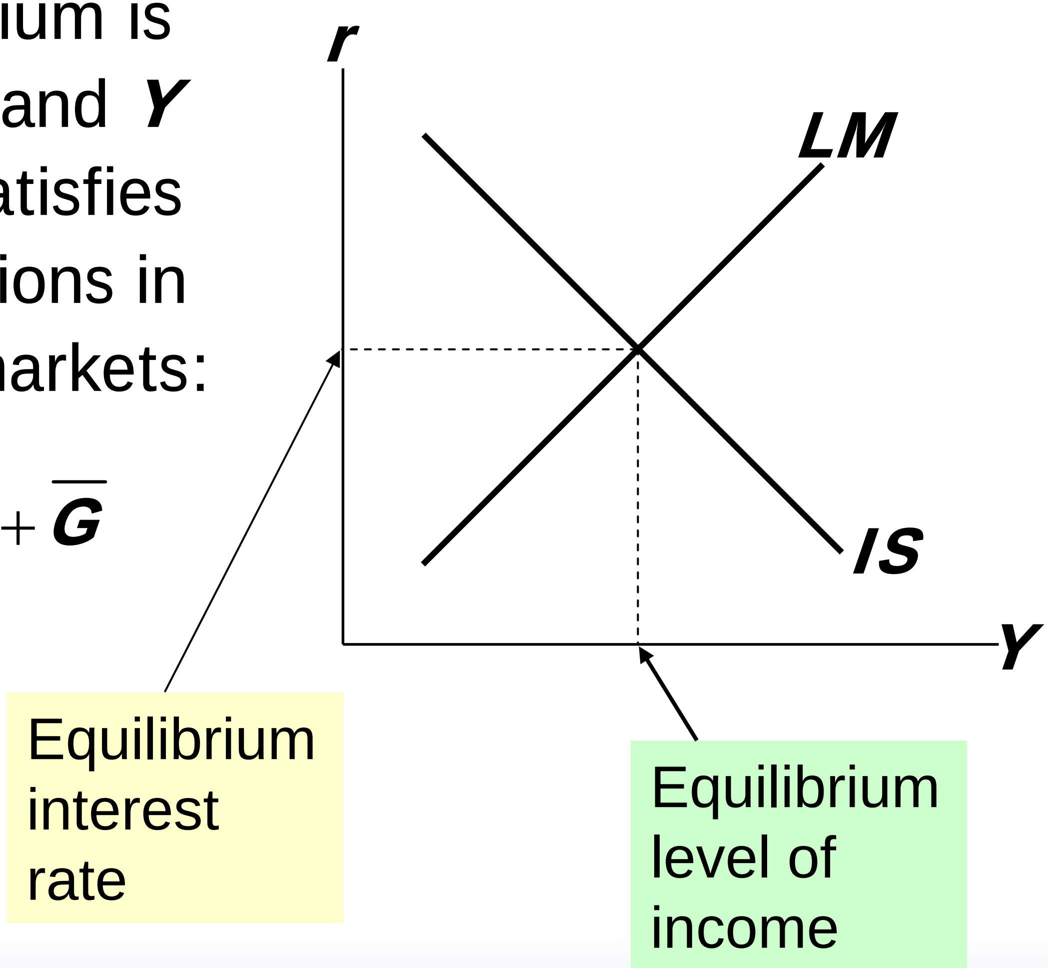
- Suppose a wave of credit card fraud causes consumers to use cash more frequently in transactions.
- Use the Liquidity Preference model to show how these events shift the *LM* curve.

The short-run equilibrium

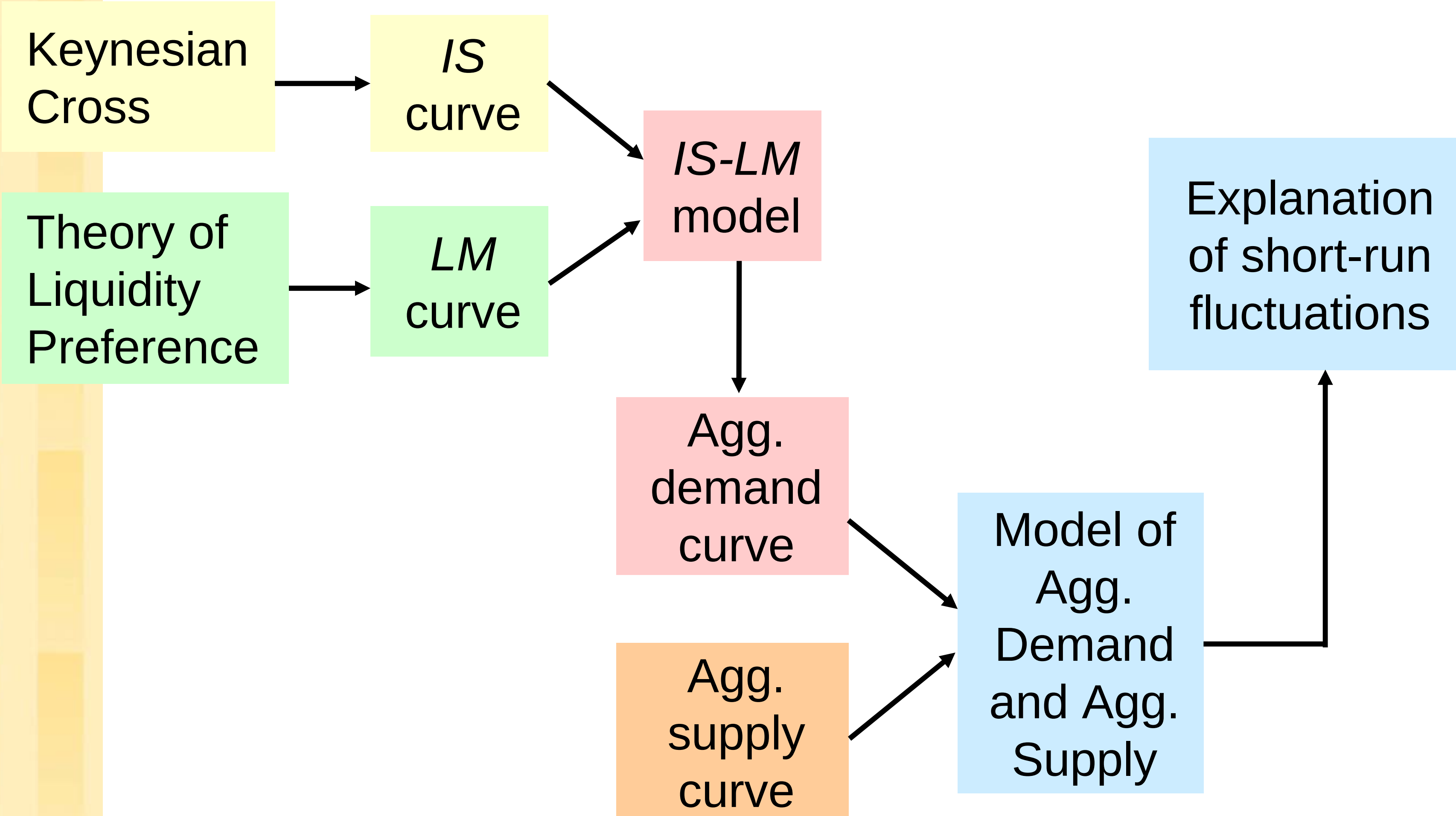
The short-run equilibrium is the combination of r and Y that simultaneously satisfies the equilibrium conditions in the goods & money markets:

$$Y = C(Y - \bar{T}) + I(r) + \bar{G}$$

$$\bar{M}/\bar{P} = L(r, Y)$$



The Big Picture



Chapter summary

1. Keynesian Cross
   - basic model of income determination
   - takes fiscal policy & investment as exogenous
   - fiscal policy has a multiplied impact on income.
2. *IS* curve
   - comes from Keynesian Cross when planned investment depends negatively on interest rate
   - shows all combinations of ***r*** and ***Y*** that equate planned expenditure with actual expenditure on goods & services

Chapter summary

3. Theory of Liquidity Preference
   - basic model of interest rate determination
   - takes money supply & price level as exogenous
   - an increase in the money supply lowers the interest rate

4. *LM* curve
   - comes from Liquidity Preference Theory when money demand depends positively on income
   - shows all combinations of ***r*** and ***Y*** that equate demand for real money balances with supply

Chapter summary

5. *IS-LM* model
   - Intersection of *IS* and *LM* curves shows the unique point (***Y***, ***r***) that satisfies equilibrium in both the goods and money markets.

Preview of Chapter 11

In Chapter 11, we will

- use the *IS-LM* model to analyze the impact of policies and shocks
- learn how the aggregate demand curve comes from *IS-LM*
- use the *IS-LM* and *AD-AS* models together to analyze the short-run and long-run effects of shocks
- learn about the Great Depression using our models

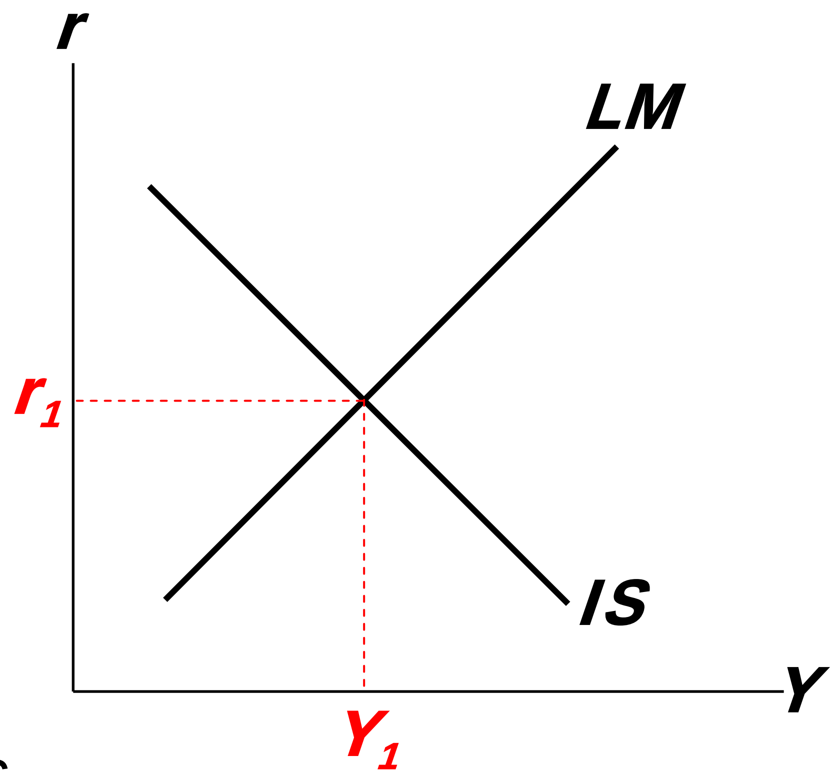
Context

- Chapter 9 introduced the model of aggregate demand and supply.
- Chapter 10 developed the IS-LM model, the basis of the aggregate demand curve.
- In Chapter 11, we will use the IS-LM model to
  - see how policies and shocks affect income and the interest rate in the short run when prices are fixed
  - derive the aggregate demand curve
  - explore various explanations for the Great Depression

Equilibrium in the *IS*-*LM* Model

The *IS* curve represents equilibrium in the goods market.

$$Y = C(Y - \overline{T}) + I(r) + \overline{G}$$



The *LM* curve represents money market equilibrium.

$$\overline{M}/\overline{P} = L(r, Y)$$

The intersection determines the unique combination of ***Y*** and ***r*** that satisfies equilibrium in both markets.

Policy analysis with the *IS*-*LM* Model

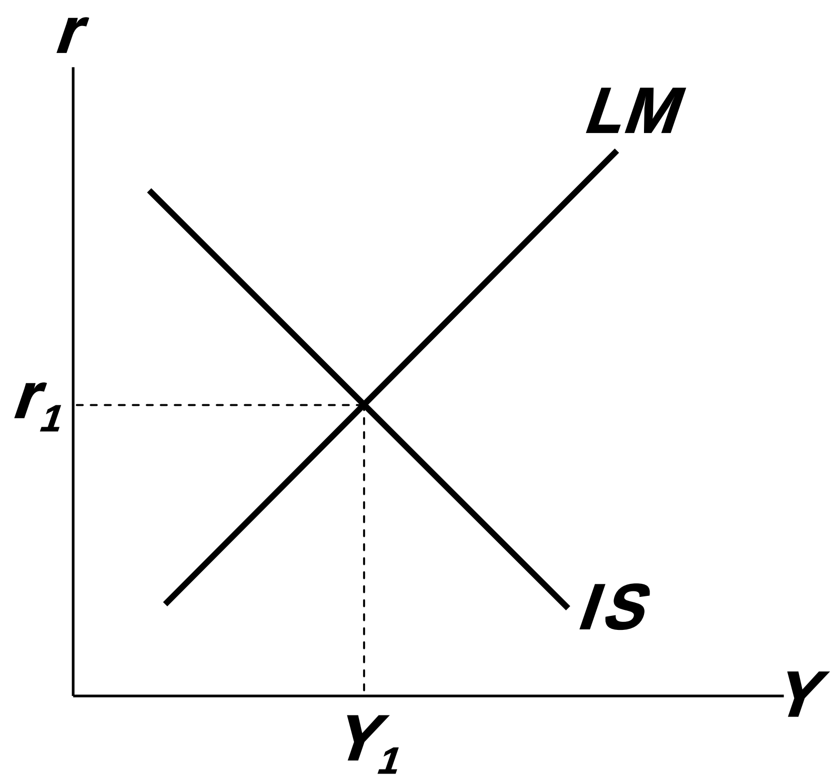
$$Y = C(Y - \bar{T}) + I(r) + \bar{G}$$

$$\bar{M}/\bar{P} = L(r, Y)$$

Policymakers can affect macroeconomic variables with

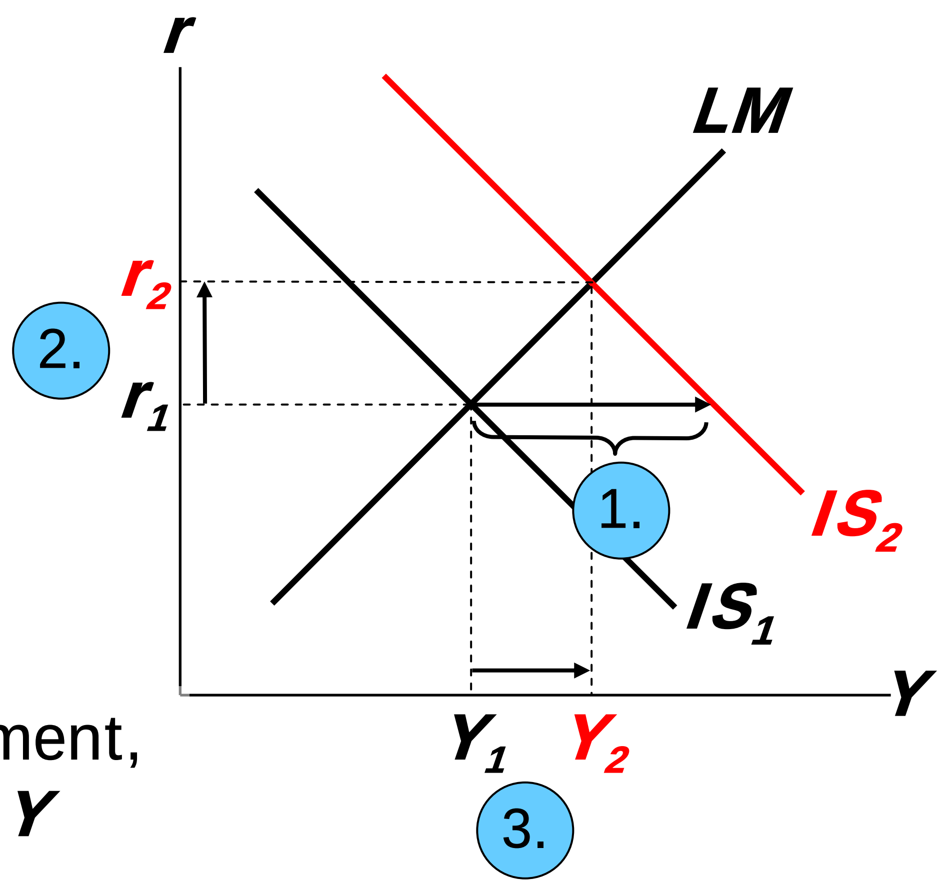
- fiscal policy: G and/or T
- monetary policy: M

We can use the *IS*-*LM* model to analyze the effects of these policies.



An increase in government purchases

1. *IS* curve shifts right by $\dfrac{1}{1-\text{MPC}}\Delta \boldsymbol{G}$ causing output & income to rise.
2. This raises money demand, causing the interest rate to rise…
3. …which reduces investment, so the final increase in ***Y*** is smaller than $\dfrac{1}{1-\text{MPC}}\Delta \boldsymbol{G}$



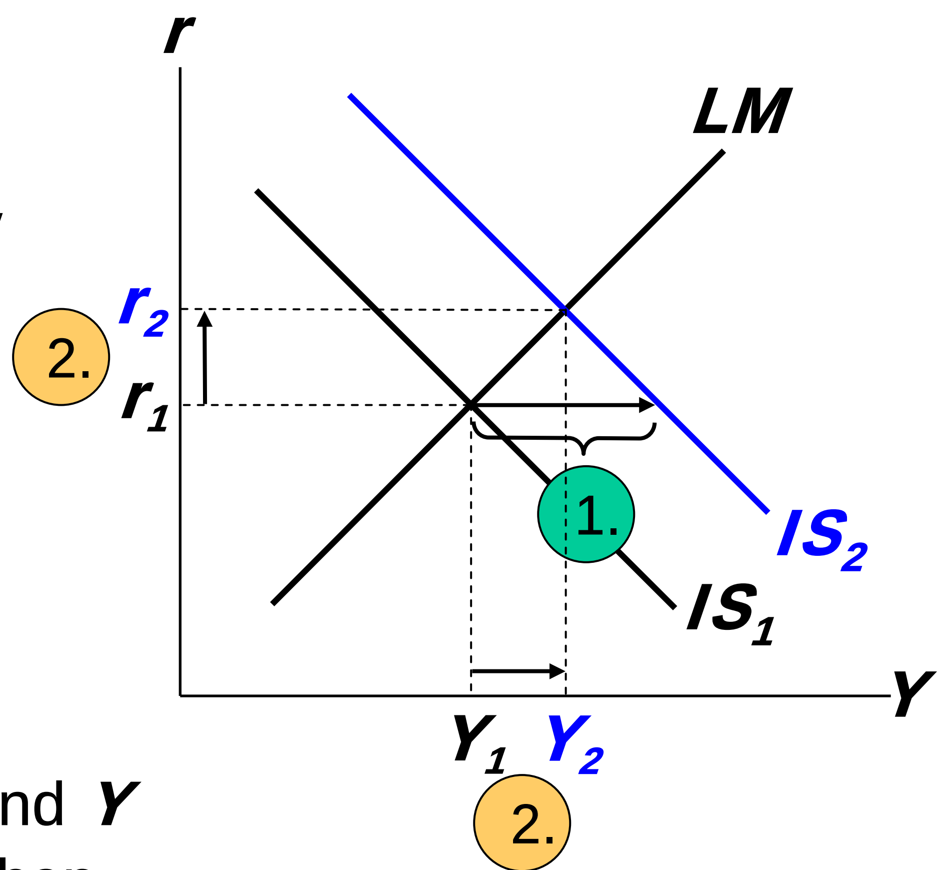
A tax cut

Because consumers save (1–MPC) of the tax cut, the initial boost in spending is smaller for ΔT than for an equal ΔG...

and the *IS* curve shifts by

1. $$\frac{-\text{MPC}}{1-\text{MPC}}\Delta T$$

2. ...so the effects on r and Y are smaller for a ΔT than for an equal ΔG.

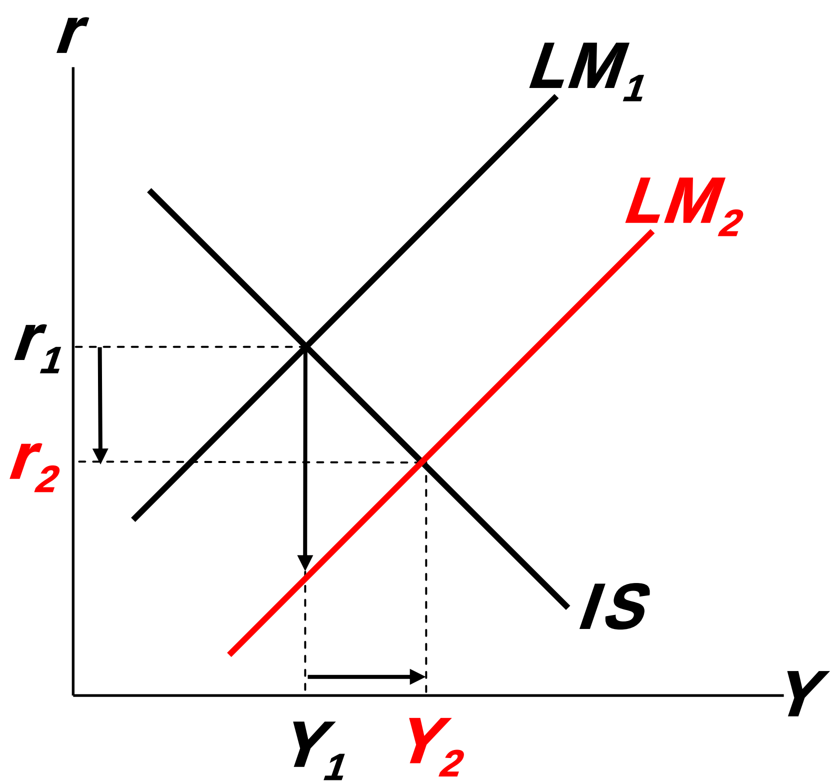


Monetary Policy: an increase in *M*

1. $\Delta M > 0$ shifts the *LM* curve down (or to the right)

2. ...causing the interest rate to fall

3. ...which increases investment, causing output & income to rise.



Interaction between monetary & fiscal policy

- Model:
  monetary & fiscal policy variables
  (***M***, ***G*** and ***T***) are exogenous
- Real world:
  Monetary policymakers may adjust ***M***
  in response to changes in fiscal policy,
  or vice versa.
- Such interaction may alter the impact of the original policy change.

The Fed's response to $\Delta G > 0$

- Suppose Congress increases G.
- Possible Fed responses:
  1. hold M constant
  2. hold r constant
  3. hold Y constant
- In each case, the effects of the ΔG are different:

Response 1: hold *M* constant

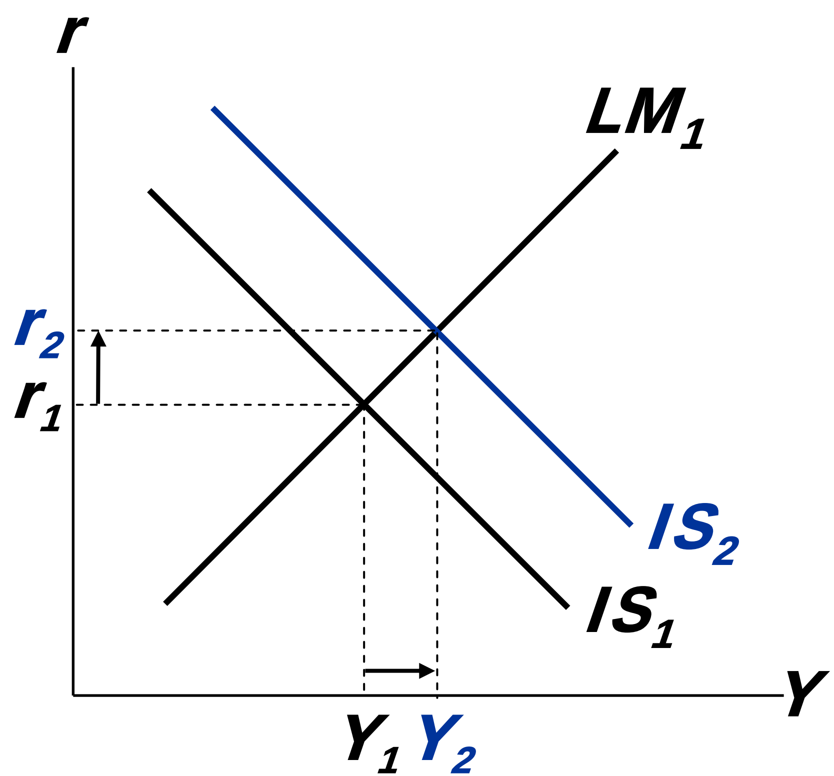
If Congress raises ***G***, the *IS* curve shifts right

If Fed holds ***M*** constant, then *LM* curve doesn't shift.

Results:

$$\Delta \boldsymbol{Y} = \boldsymbol{Y}_2 - \boldsymbol{Y}_1$$

$$\Delta \boldsymbol{r} = \boldsymbol{r}_2 - \boldsymbol{r}_1$$



Response 2: hold *r* constant

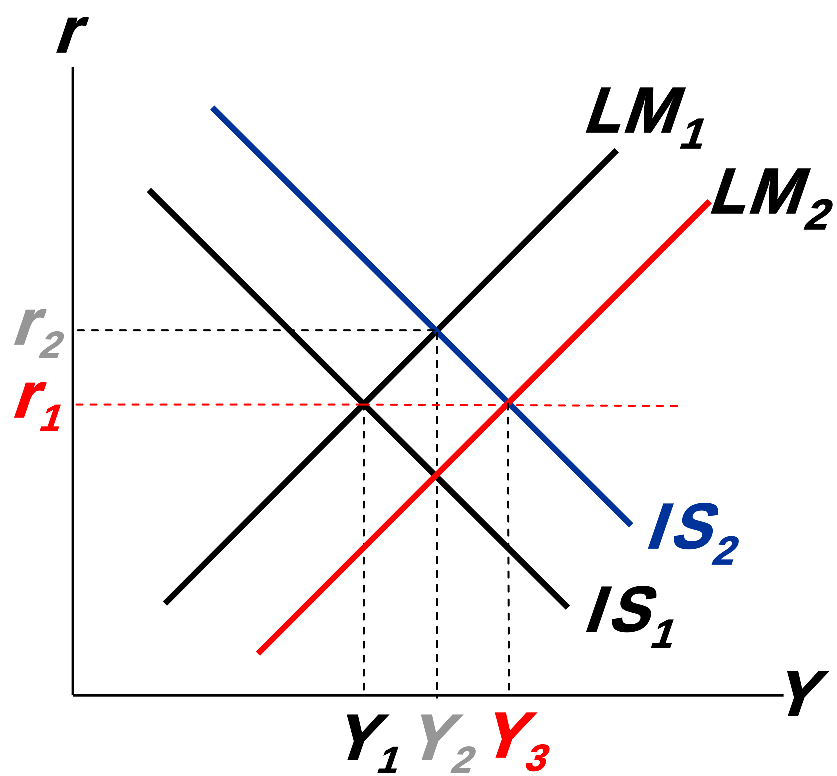
If Congress raises ***G***, the *IS* curve shifts right

To keep ***r*** constant, Fed increases ***M*** to shift *LM* curve right.

Results:

$$\Delta \boldsymbol{Y} = \boldsymbol{Y}_3 - \boldsymbol{Y}_1$$

$$\Delta \boldsymbol{r} = 0$$



Response 3: hold *Y* constant

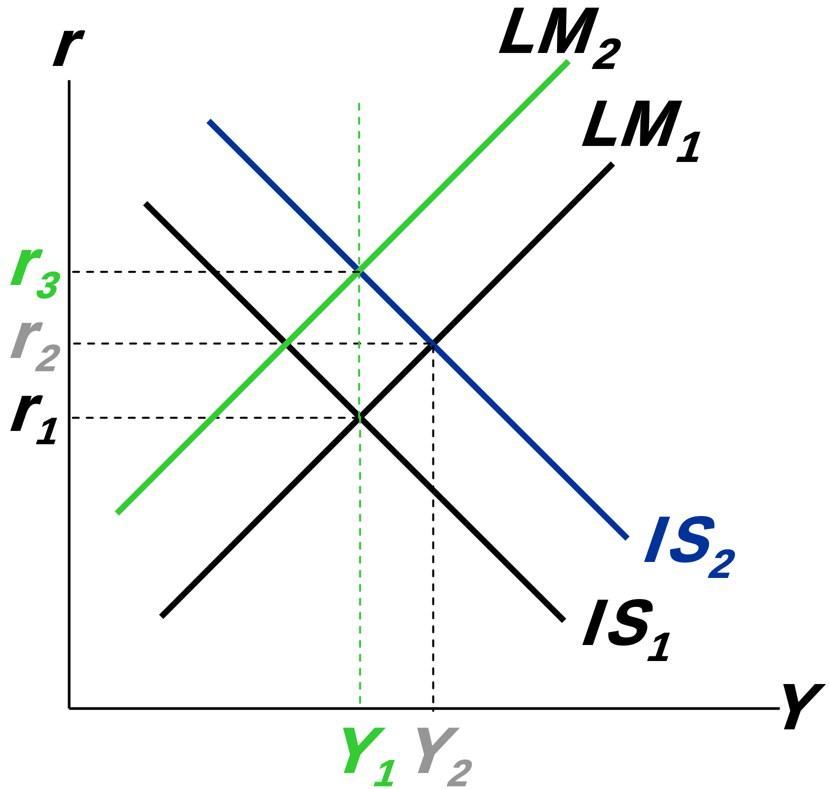
If Congress raises *G*, the *IS* curve shifts right

To keep ***Y*** constant, Fed reduces ***M*** to shift *LM* curve left.

Results:

$$\Delta \boldsymbol{Y} = 0$$

$$\Delta \boldsymbol{r} = \boldsymbol{r}_3 - \boldsymbol{r}_1$$



Estimates of fiscal policy multipliers

from the DRI macroeconometric model

Assumption about monetary policy	**Estimated value of $\Delta Y/\Delta G$**	**Estimated value of $\Delta Y/\Delta T$**
Fed holds money supply constant	0.60	–0.26
Fed holds nominal interest rate constant	1.93	–1.19

Shocks in the *IS*-*LM* Model

***IS* shocks**: exogenous changes in the demand for goods & services.

Examples:

- stock market boom or crash
  $\Rightarrow$ change in households' wealth
  $\Rightarrow \Delta \boldsymbol{C}$
- change in business or consumer confidence or expectations
  $\Rightarrow \Delta \boldsymbol{I}$ and/or $\Delta \boldsymbol{C}$

Shocks in the *IS*-*LM* Model

***LM* shocks**: exogenous changes in the demand for money.

Examples:

- a wave of credit card fraud increases demand for money
- more ATMs or the Internet reduce money demand

EXERCISE:

Analyze shocks with the IS-LM model

Use the *IS-LM* model to analyze the effects of

1. A boom in the stock market makes consumers wealthier.
2. After a wave of credit card fraud, consumers use cash more frequently in transactions.

For each shock,

a. use the *IS-LM* diagram to show the effects of the shock on ***Y*** and ***r***.

b. determine what happens to ***C***, ***I***, and the unemployment rate.

CASE STUDY

The U.S. economic slowdown of 2001

~*What happened*~

1. Real GDP growth rate

1994-2000: 3.9% (average annual)

2001: 1.2%

2. Unemployment rate

Dec 2000: 4.0%

Dec 2001: 5.8%

CASE STUDY

The U.S. economic slowdown of 2001

~Shocks that contributed to the slowdown~

1. Falling stock prices

   From Aug 2000 to Aug 2001: -25%

   Week after 9/11: -12%

2. The terrorist attacks on 9/11
   - increased uncertainty
   - fall in consumer & business confidence

Both shocks reduced spending and shifted the IS curve left.

CASE STUDY

The U.S. economic slowdown of 2001

~The policy response~

1. Fiscal policy
   - large long-term tax cut, immediate $300 rebate checks
   - spending increases: aid to New York City & the airline industry, war on terrorism
2. Monetary policy
   - Fed lowered its Fed Funds rate target 11 times during 2001, from 6.5% to 1.75%
   - Money growth increased, interest rates fell

CASE STUDY

The U.S. economic slowdown of 2001

~*What's happening now*~

- In the first quarter of 2002, Real GDP grew at an annual rate of 6.1%, according to final figures released by the Bureau of Economic Analysis on June 27, 2002.
- However, in its news release of June 7, 2002, the NBER Business Cycle Dating Committee had not yet determined the date of the trough in economic activity, though it acknowledges that the economy seems to be picking up.

What is the Fed's policy instrument?

What the newspaper says:

"the Fed lowered interest rates by one-half point today"

What actually happened:

The Fed conducted expansionary monetary policy to shift the LM curve to the right until the interest rate fell 0.5 points.

The Fed targets the Federal Funds rate:
it announces a target value,
and uses monetary policy to shift the LM curve
as needed to attain its target rate.

What is the Fed's policy instrument?

Why does the Fed target interest rates instead of the money supply?

1) They are easier to measure than the money supply
2) The Fed might believe that *LM* shocks are more prevalent than *IS* shocks. If so, then targeting the interest rate stabilizes income better than targeting the money supply.
   (See Problem 7 on p.306)

IS-LM and Aggregate Demand

- So far, we've been using the *IS-LM* model to analyze the short run, when the price level is assumed fixed.
- However, a change in ***P*** would shift the *LM* curve and therefore affect ***Y***.
- The **aggregate demand curve** (*introduced in chap. 9*) captures this relationship between ***P*** and ***Y***

Deriving the *AD* curve

Intuition for slope of *AD* curve:

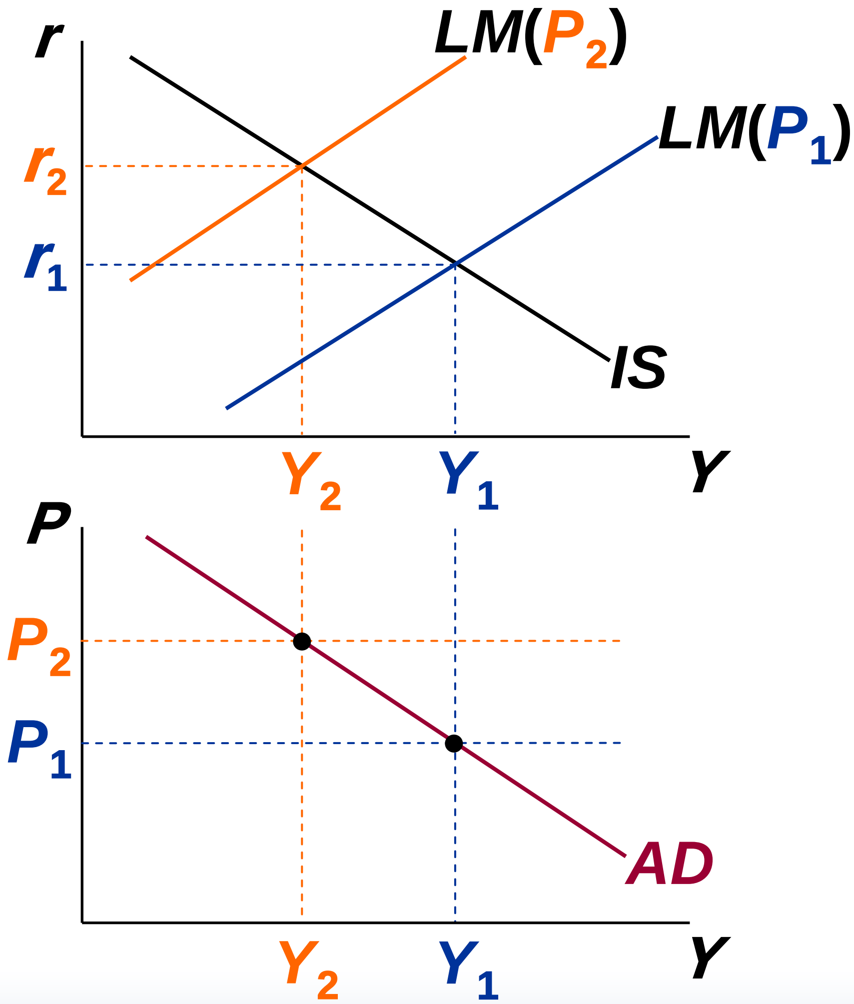
$\uparrow P \Rightarrow \downarrow(M/P)$

$\Rightarrow LM$ shifts left

$\Rightarrow \uparrow r$

$\Rightarrow \downarrow I$

$\Rightarrow \downarrow Y$



Monetary policy and the *AD* curve

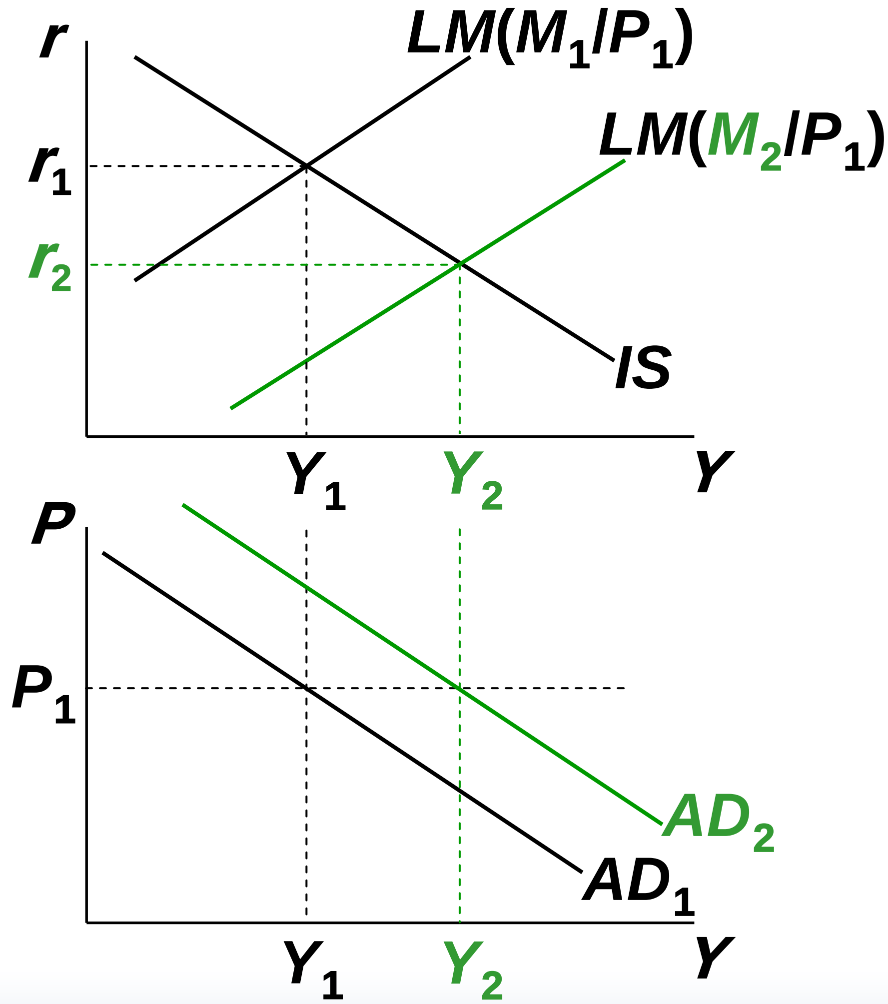
The Fed can increase aggregate demand:

$\uparrow M \Rightarrow LM$ shifts right

$\Rightarrow \downarrow r$

$\Rightarrow \uparrow I$

$\Rightarrow \uparrow Y$ at each value of P



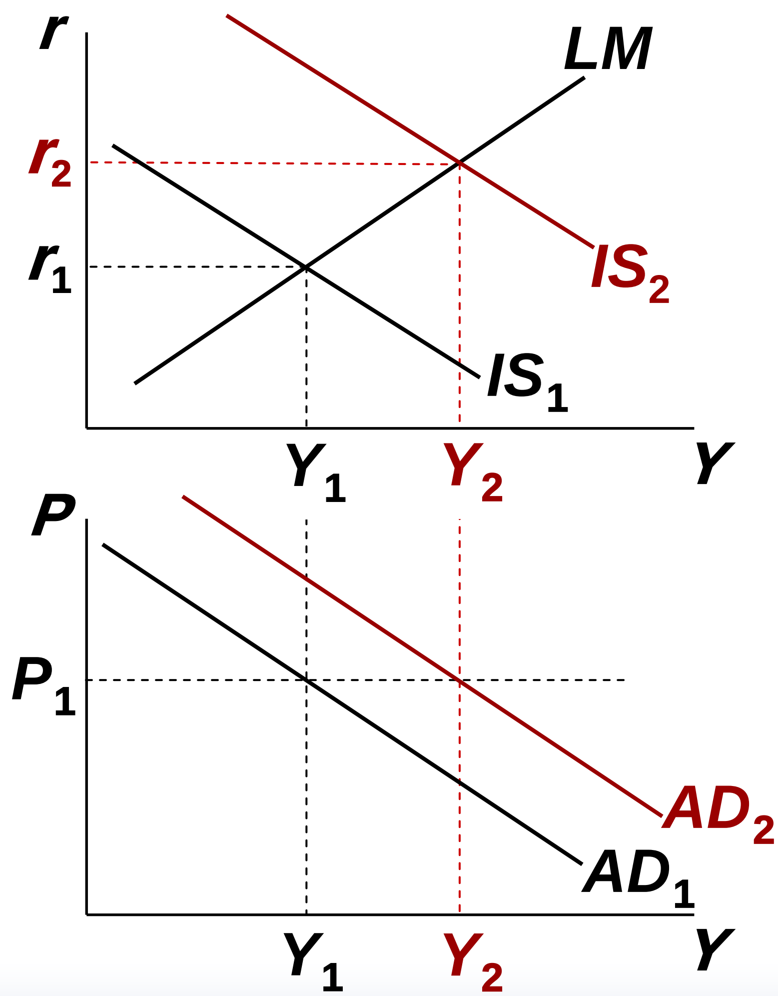
Fiscal policy and the *AD* curve

Expansionary fiscal policy ($\uparrow$***G*** and/or $\downarrow$***T***) increases agg. demand:

$\downarrow T \Rightarrow \uparrow C$

$\Rightarrow$ IS shifts right

$\Rightarrow \uparrow Y$ at each value of ***P***



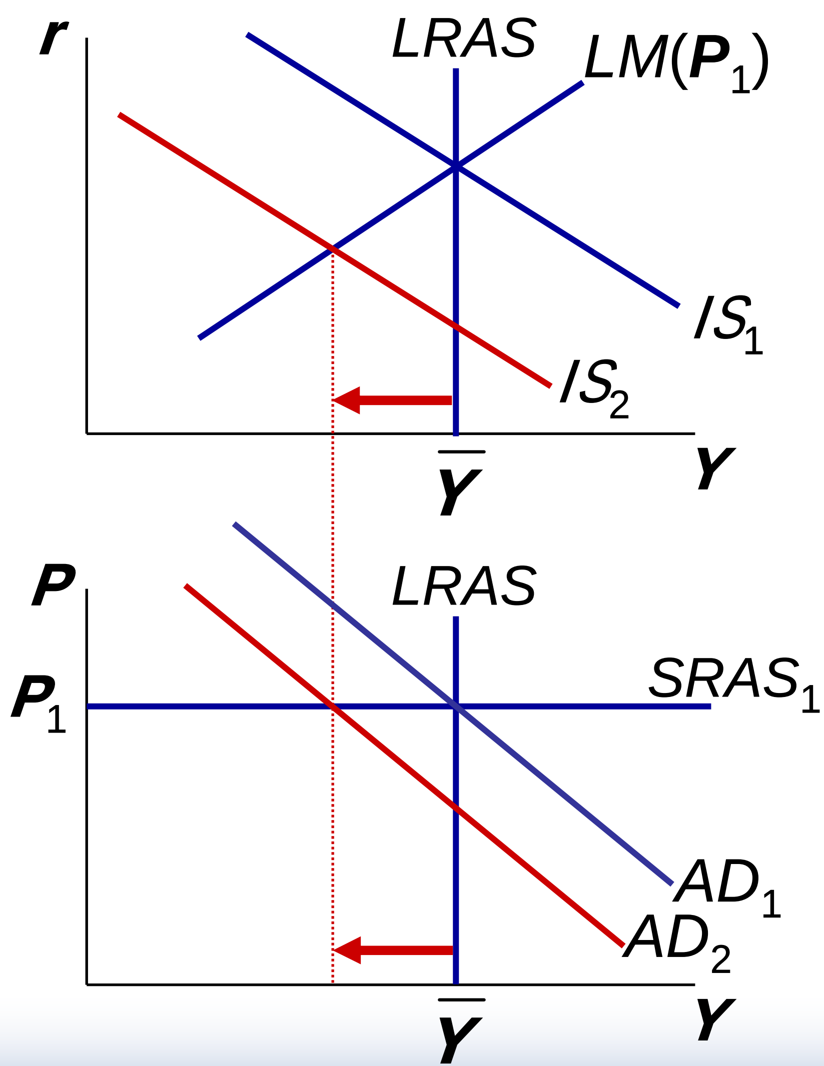
IS-LM and *AD-AS* in the short run & long run

Recall from Chapter 9: The force that moves the economy from the short run to the long run is the gradual adjustment of prices.

In the short-run equilibrium, if	then over time, the price level will
$Y > \bar{Y}$	rise
$Y < \bar{Y}$	fall
$Y = \bar{Y}$	remain constant

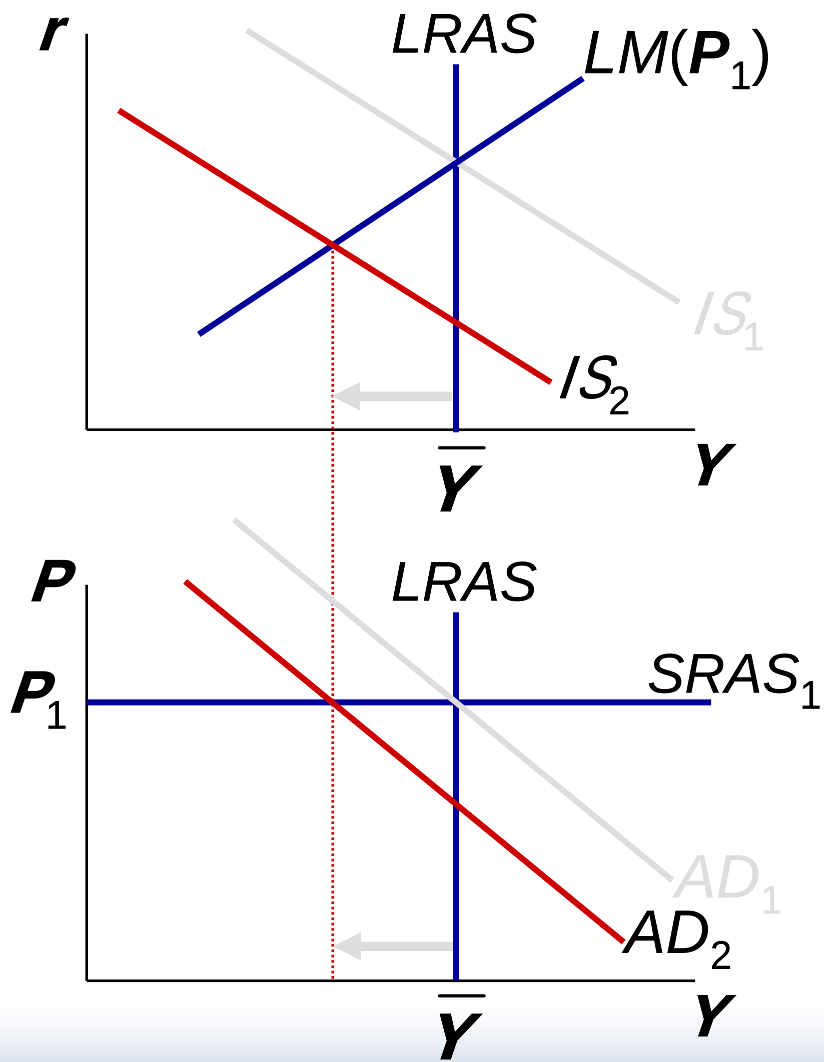
The SR and LR effects of an *IS* shock

A negative *IS* shock shifts *IS* and *AD* left, causing ***Y*** to fall.



The SR and LR effects of an *IS* shock

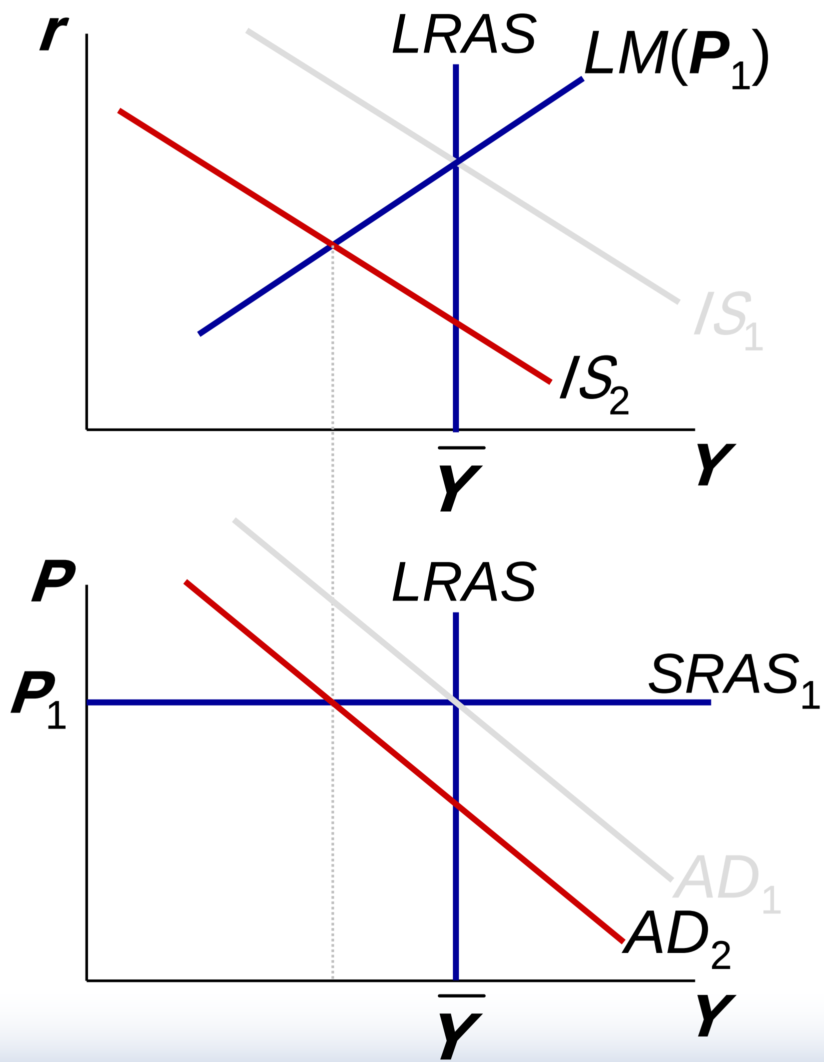
In the new short-run equilibrium, $Y < \overline{Y}$



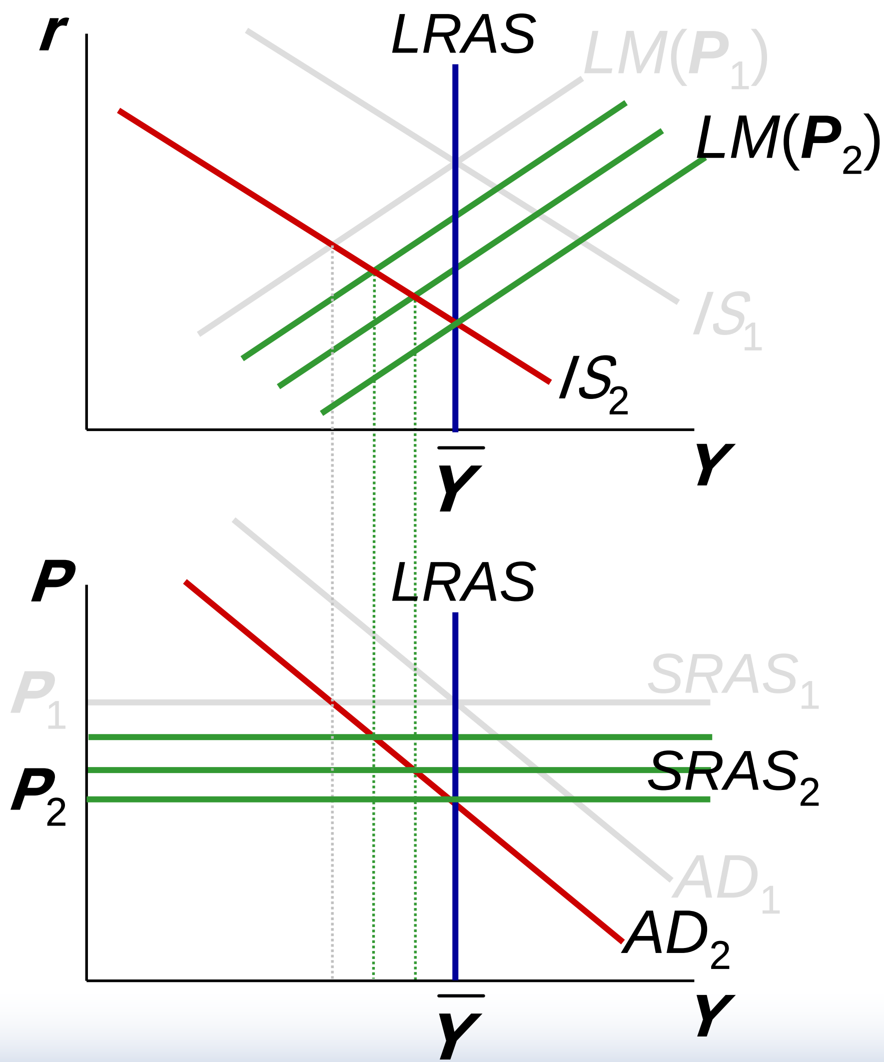
The SR and LR effects of an *IS* shock

In the new short-run equilibrium, $Y < \bar{Y}$

Over time,
P gradually falls,
which causes
- *SRAS* to move down
- M/P to increase, which causes *LM* to move down



The SR and LR effects of an *IS* shock

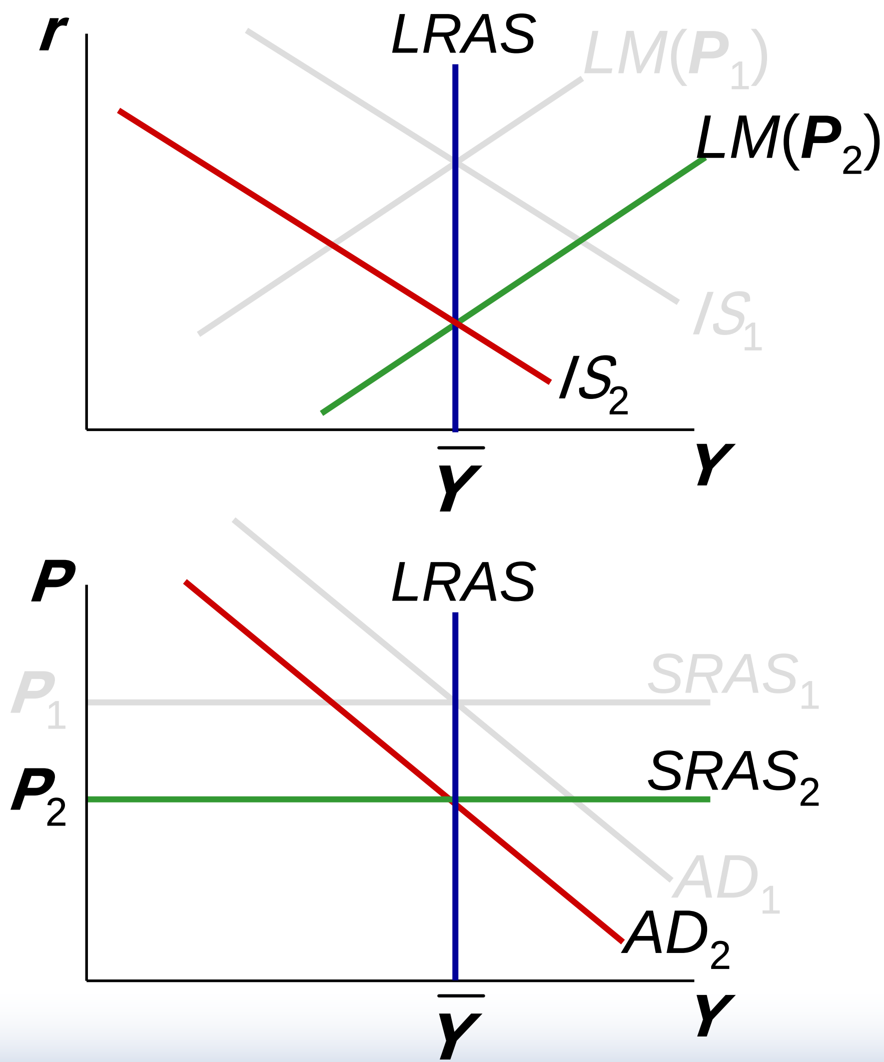


Over time,
P gradually falls,
which causes

- *SRAS* to move down
- ***M/P*** to increase, which causes *LM* to move down

The SR and LR effects of an *IS* shock

This process continues until economy reaches a long-run equilibrium with $Y = \bar{Y}$



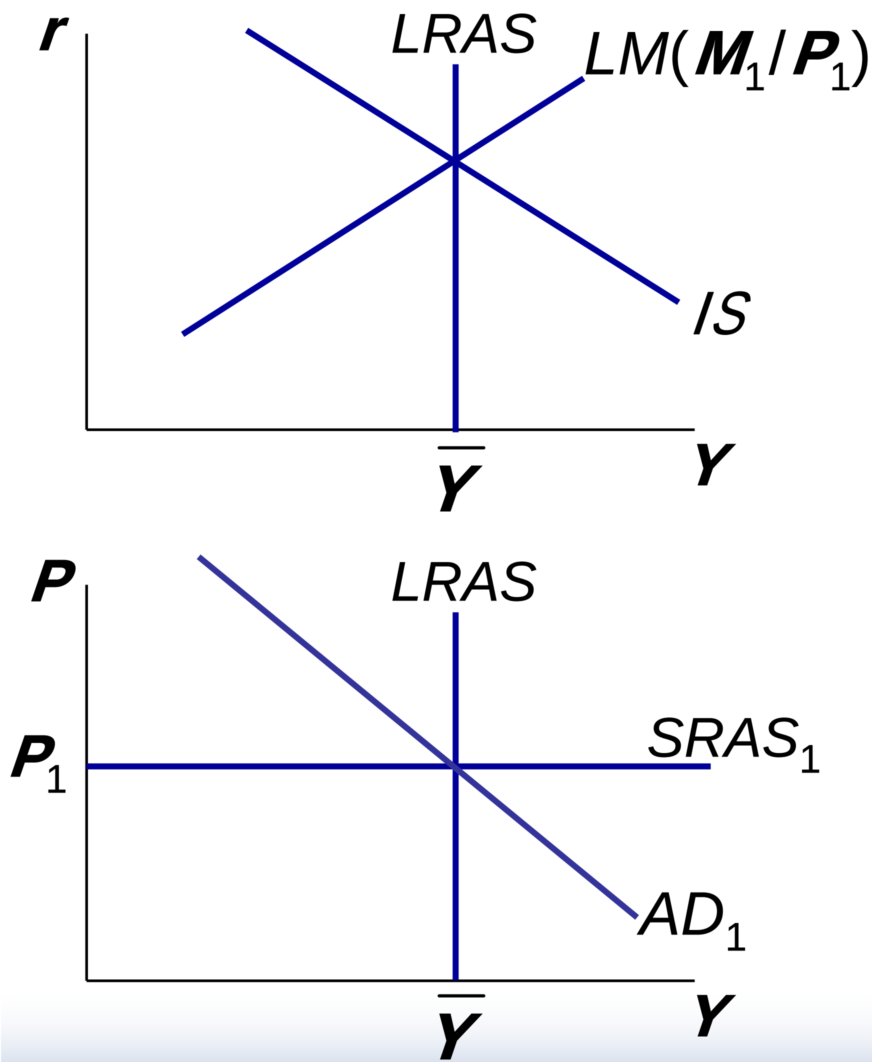
EXERCISE:
Analyze SR & LR effects of ΔM

a. Draw the *IS-LM* and *AD-AS* diagrams as shown here.

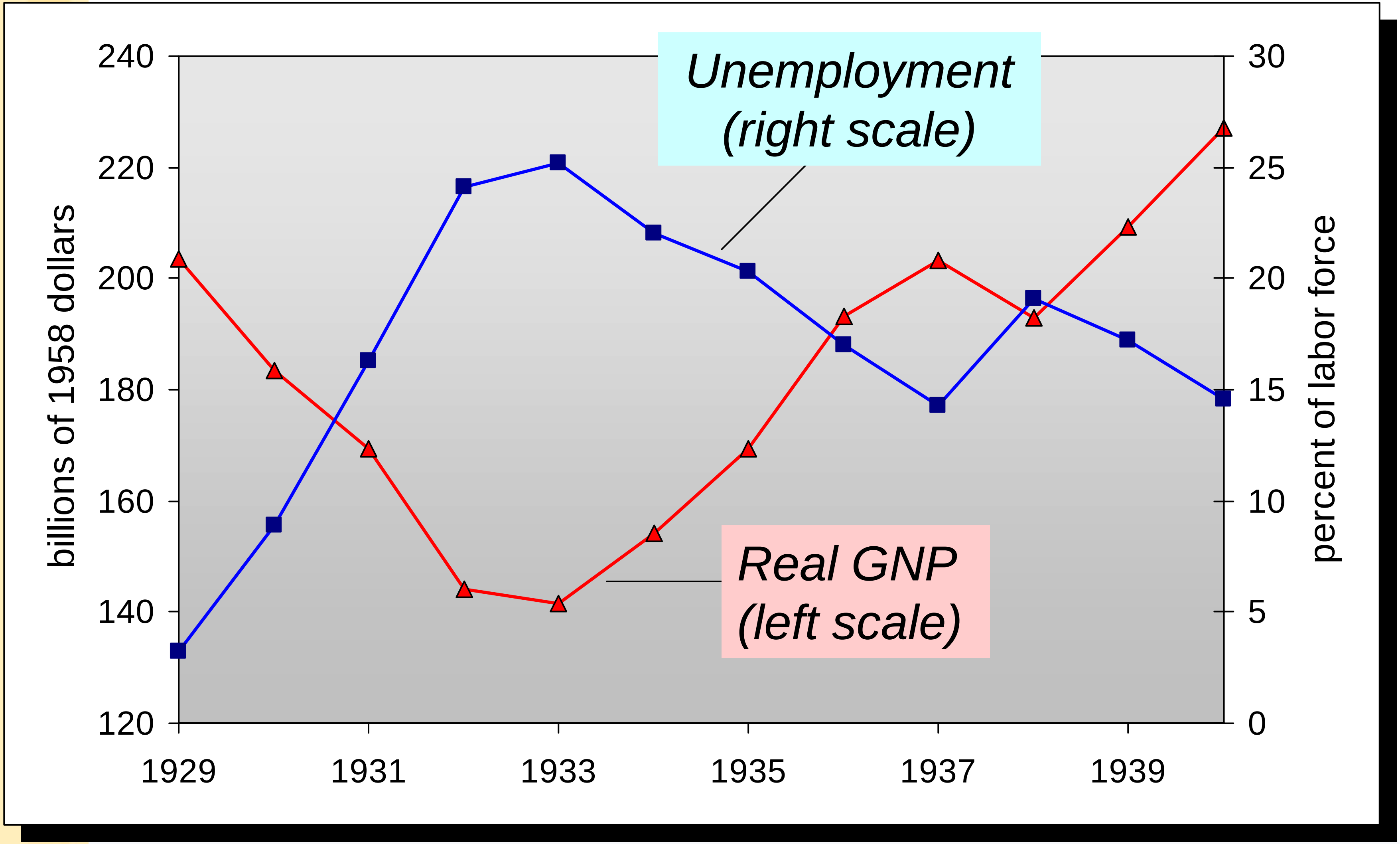
b. Suppose Fed increases ***M***. Show the short-run effects on your graphs.

c. Show what happens in the transition from the short run to the long run.

d. How do the new long-run equilibrium values of the endogenous variables compare to their initial values?



The Great Depression



The Spending Hypothesis: *Shocks to the IS Curve*

- asserts that the Depression was largely due to an exogenous fall in the demand for goods & services -- a leftward shift of the *IS* curve

- evidence:
  output and interest rates both fell, which is what a leftward *IS* shift would cause

The Spending Hypothesis: *Reasons for the IS shift*

1. Stock market crash ⇒ exogenous ↓***C***
   - Oct-Dec 1929: S&P 500 fell 17%
   - Oct 1929-Dec 1933: S&P 500 fell 71%
2. Drop in investment
   - "correction" after overbuilding in the 1920s
   - widespread bank failures made it harder to obtain financing for investment
3. Contractionary fiscal policy
   - in the face of falling tax revenues and increasing deficits, politicians raised tax rates and cut spending

The Money Hypothesis:
A Shock to the LM Curve

- asserts that the Depression was largely due to huge fall in the money supply
- evidence:
  M1 fell 25% during 1929-33.

But, two problems with this hypothesis:

1. ***P*** fell even more, so ***M/P*** actually rose slightly during 1929-31.
2. nominal interest rates fell, which is the opposite of what would result from a leftward *LM* shift.

The Money Hypothesis Again: *The Effects of Falling Prices*

- asserts that the severity of the Depression was due to a huge deflation:

  P fell 25% during 1929-33.

- This deflation was probably caused by the fall in ***M***, so perhaps money played an important role after all.

- In what ways does a deflation affect the economy?

The Money Hypothesis Again: *The Effects of Falling Prices*

The stabilizing effects of deflation:

- $\downarrow \boldsymbol{P} \Rightarrow \uparrow(\boldsymbol{M/P}) \Rightarrow$ *LM* shifts right $\Rightarrow \uparrow \boldsymbol{Y}$
- **Pigou effect**:

  $\downarrow \boldsymbol{P} \Rightarrow \uparrow(\boldsymbol{M/P})$

  $\Rightarrow$ consumers' wealth $\uparrow$

  $\Rightarrow \uparrow \boldsymbol{C}$

  $\Rightarrow$ *IS* shifts right

  $\Rightarrow \uparrow \boldsymbol{Y}$

The Money Hypothesis Again:
The Effects of Falling Prices

The destabilizing effects of <u>unexpected</u> deflation:
debt-deflation theory

$\downarrow$***P*** (if unexpected)

$\Rightarrow$ transfers purchasing power from borrowers to lenders

$\Rightarrow$ borrowers spend less,
lenders spend more

$\Rightarrow$ if borrowers' propensity to spend is larger than lenders, then aggregate spending falls, the *IS* curve shifts left, and ***Y*** falls

The Money Hypothesis Again: *The Effects of Falling Prices*

The destabilizing effects of <u>expected</u> deflation:

$\downarrow \pi^e$

$\Rightarrow$ $\boldsymbol{r}\uparrow$ for each value of $\boldsymbol{i}$

$\Rightarrow$ $\boldsymbol{I}\downarrow$ because $\boldsymbol{I} = \boldsymbol{I}(\boldsymbol{r})$

$\Rightarrow$ planned expenditure & agg. demand $\downarrow$

$\Rightarrow$ income & output $\downarrow$

Why another Depression is unlikely

- Policymakers (or their advisors) now know much more about macroeconomics:
  - The Fed knows better than to let ***M*** fall so much, especially during a contraction.
  - Fiscal policymakers know better than to raise taxes or cut spending during a contraction.
- Federal deposit insurance makes widespread bank failures very unlikely.
- **Automatic stabilizers** make fiscal policy expansionary during an economic downturn.

Chapter summary

1. *IS-LM* model
   - a theory of aggregate demand
   - exogenous: ***M***, ***G***, ***T***,
     P exogenous in short run, ***Y*** in long run
   - endogenous: ***r***,
     Y endogenous in short run, ***P*** in long run
   - *IS* curve: goods market equilibrium
   - *LM* curve: money market equilibrium

Chapter summary

2. AD curve

- shows relation between $\boldsymbol{P}$ and the *IS-LM* model's equilibrium $\boldsymbol{Y}$.
- negative slope because
  $\uparrow \boldsymbol{P} \Rightarrow \downarrow(\boldsymbol{M/P}) \Rightarrow \uparrow \boldsymbol{r} \Rightarrow \downarrow \boldsymbol{I} \Rightarrow \downarrow \boldsymbol{Y}$
- expansionary fiscal policy shifts *IS* curve right, raises income, and shifts *AD* curve right
- expansionary monetary policy shifts *LM* curve right, raises income, and shifts *AD* curve right
- *IS* or *LM* shocks shift the *AD* curve

Learning objectives

- The Mundell-Fleming model: *IS-LM* for the small open economy
- Causes and effects of interest rate differentials
- Arguments for fixed vs. floating exchange rates
- The aggregate demand curve for the small open economy

The Mundell-Fleming Model

- *Key assumption:*
  Small open economy with perfect capital mobility.

  $$r = r^*$$

- Goods market equilibrium---the *IS** curve:

$$Y = C(Y - T) + I(r^*) + G + NX(e)$$

where

e = nominal exchange rate

= foreign currency per unit of domestic currency

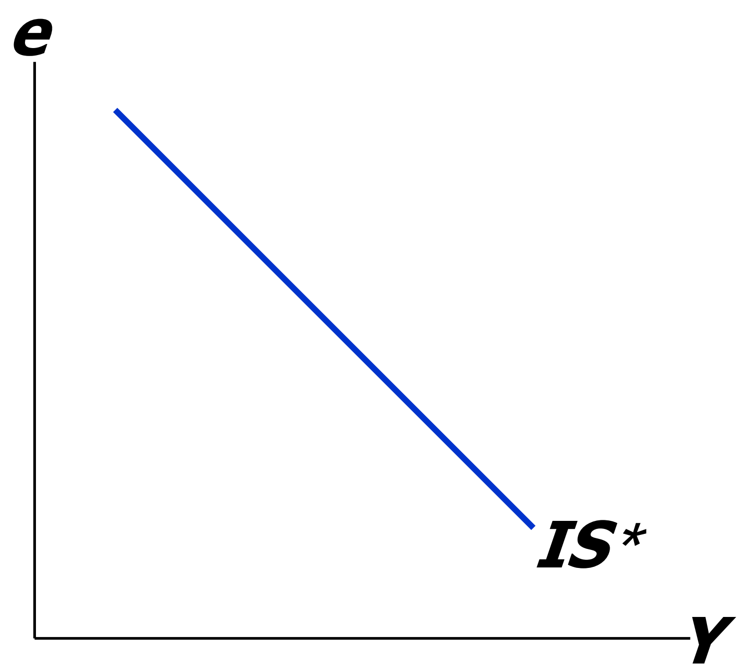
The *IS** curve: Goods Market Eq'm

$$Y = C(Y - T) + I(r^*) + G + NX(e)$$

The *IS** curve is drawn for a given value of r^*.

Intuition for the slope:

$$\downarrow e \Rightarrow \uparrow NX \Rightarrow \uparrow Y$$

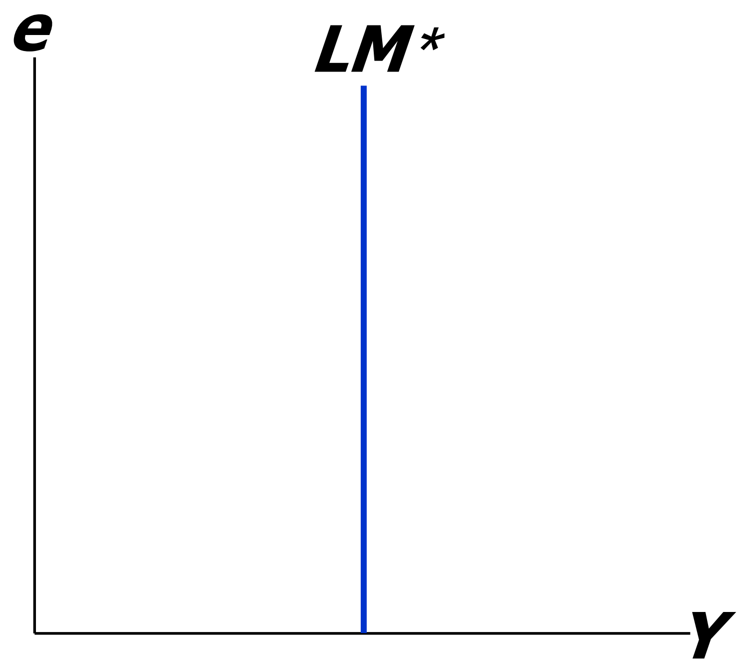


The *LM** curve: Money Market Eq'm

$$M/P = L(r^*, Y)$$

The *LM** curve

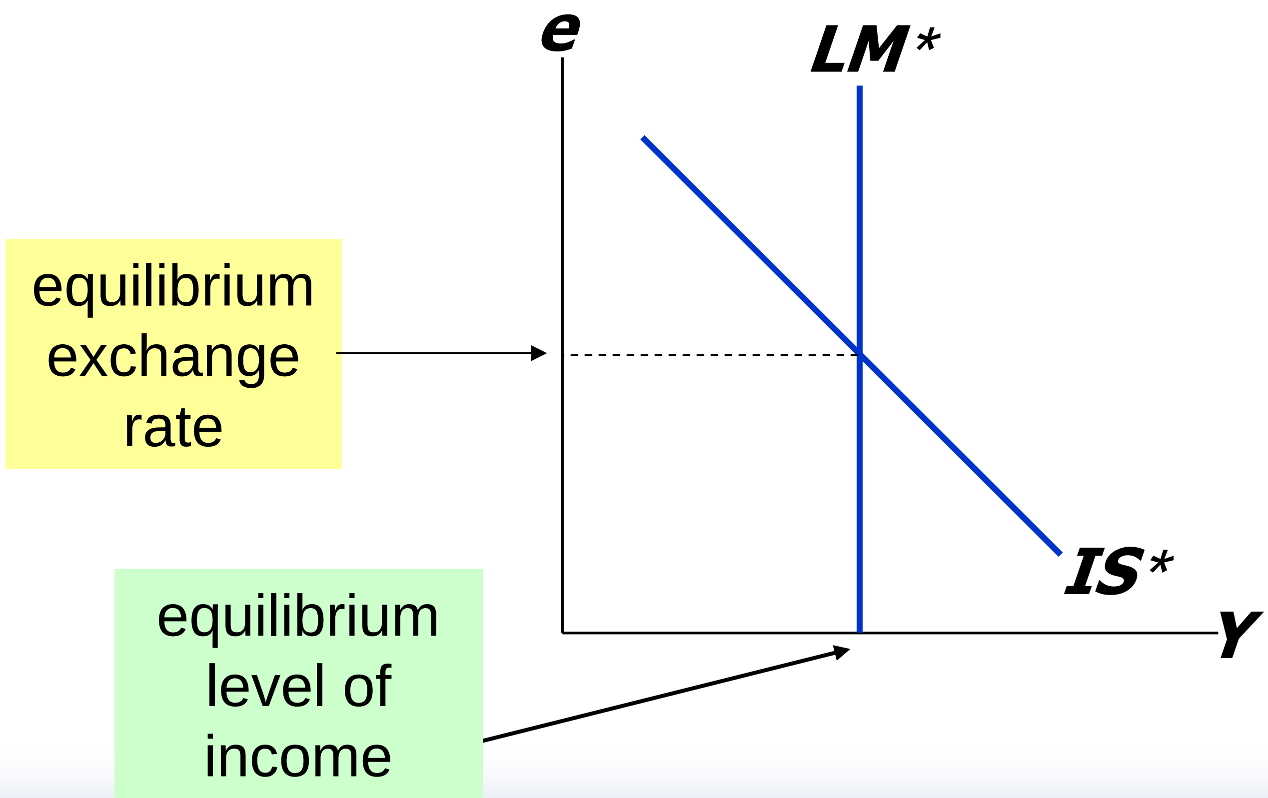
- is drawn for a given value of r^*
- is vertical because: given r^*, there is only one value of Y that equates money demand with supply, regardless of e.



Equilibrium in the Mundell-Fleming model

$$Y = C(Y - T) + I(r^*) + G + NX(e)$$

$$M/P = L(r^*, Y)$$



Floating & fixed exchange rates

- In a system of **floating exchange rates**, ***e*** is allowed to fluctuate in response to changing economic conditions.
- In contrast, under **fixed exchange rates**, the central bank trades domestic for foreign currency at a predetermined price.
- We now consider fiscal, monetary, and trade policy: first in a floating exchange rate system, then in a fixed exchange rate system.

Fiscal policy under floating exchange rates

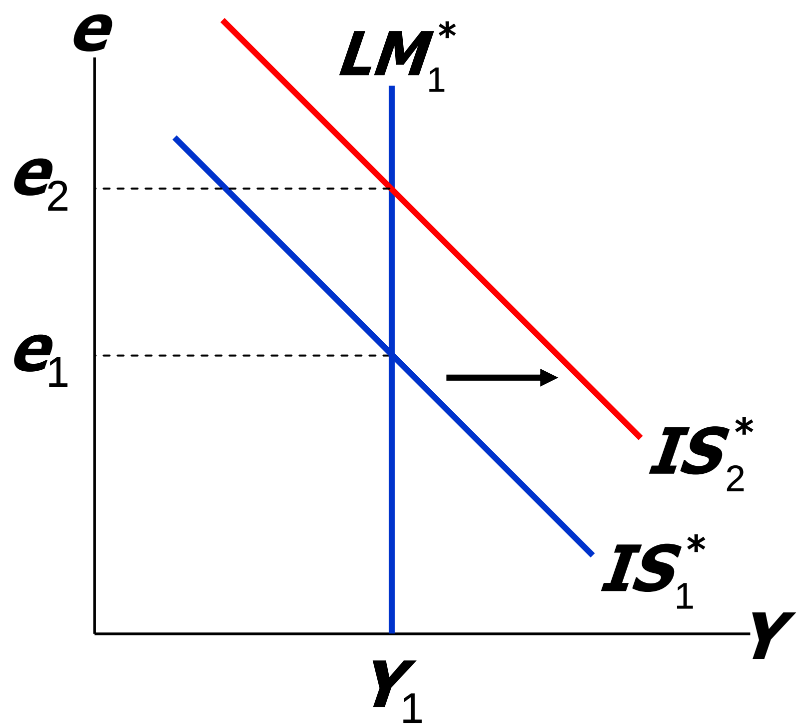
$$\boldsymbol{Y} = \boldsymbol{C}(\boldsymbol{Y}-\boldsymbol{T}) + \boldsymbol{I}(\boldsymbol{r}^*) + \boldsymbol{G} + \boldsymbol{NX}(\boldsymbol{e})$$

$$\boldsymbol{M}/\boldsymbol{P} = \boldsymbol{L}(\boldsymbol{r}^*, \boldsymbol{Y})$$

At any given value of ***e***, a fiscal expansion increases ***Y***, shifting *IS** to the right.

Results:

$\Delta \boldsymbol{e} > 0, \ \Delta \boldsymbol{Y} = 0$



Lessons about fiscal policy

- In a small open economy with perfect capital mobility, fiscal policy is utterly incapable of affecting real GDP.
- "Crowding out"
  - *closed economy:*
    Fiscal policy crowds out investment by causing the interest rate to rise.
  - *small open economy:*
    Fiscal policy crowds out net exports by causing the exchange rate to appreciate.

Mon. policy under floating exchange rates

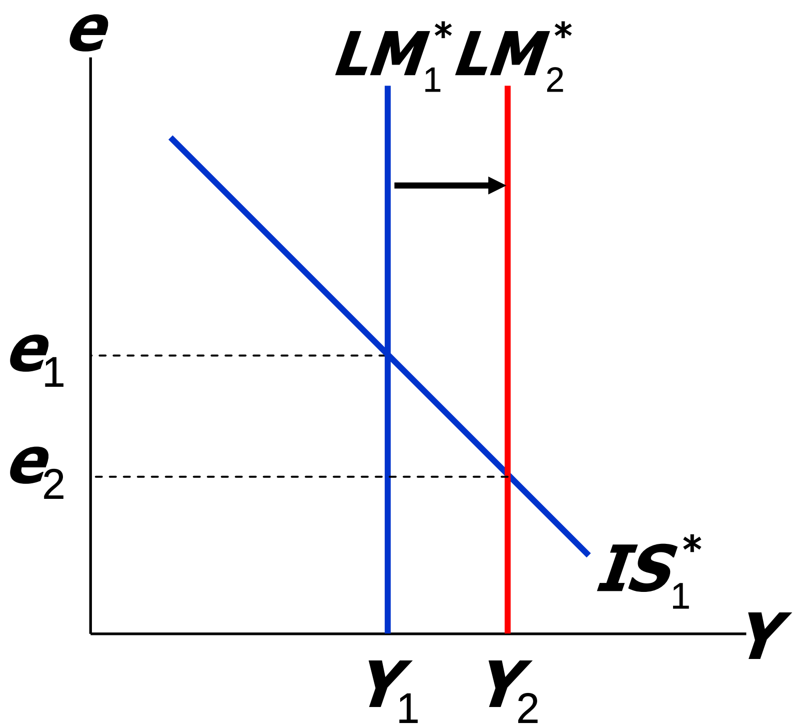
$$Y = C(Y - T) + I(r^*) + G + NX(e)$$

$$M/P = L(r^*, Y)$$

An increase in M shifts LM^* right because Y must rise to restore eq'm in the money market.

Results:

$\Delta e < 0, \ \Delta Y > 0$



Lessons about monetary policy

- Monetary policy affects output by affecting one (or more) of the components of aggregate demand:

closed economy: $\uparrow \boldsymbol{M} \Rightarrow \downarrow \boldsymbol{r} \Rightarrow \uparrow \boldsymbol{I} \Rightarrow \uparrow \boldsymbol{Y}$

small open economy: $\uparrow \boldsymbol{M} \Rightarrow \downarrow \boldsymbol{e} \Rightarrow \uparrow \boldsymbol{NX} \Rightarrow \uparrow \boldsymbol{Y}$

- Expansionary mon. policy does not raise world aggregate demand, it shifts demand from foreign to domestic products.

  Thus, the increases in income and employment at home come at the expense of losses abroad.

Trade policy under floating exchange rates

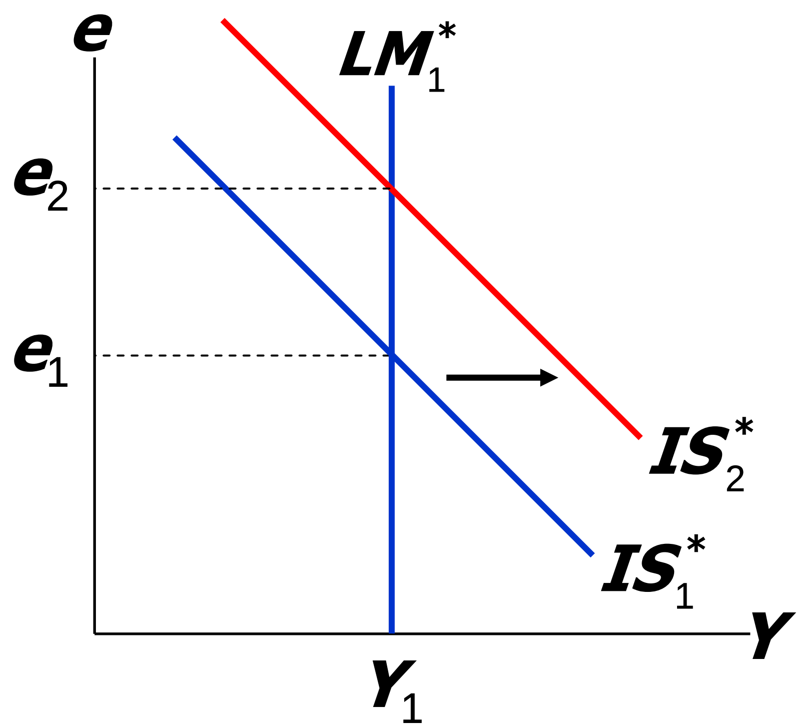
$$Y = C(Y - T) + I(r^*) + G + NX(e)$$

$$M/P = L(r^*, Y)$$

At any given value of e, a tariff or quota reduces imports, increases NX, and shifts IS^* to the right.

Results:

$\Delta e > 0, \ \Delta Y = 0$



Lessons about trade policy

- Import restrictions cannot reduce a trade deficit.
- Even though ***NX*** is unchanged, there is less trade:
  - the trade restriction reduces imports
  - the exchange rate appreciation reduces exports

  Less trade means fewer 'gains from trade.'
- Import restrictions on specific products save jobs in the domestic industries that produce those products, but destroy jobs in export-producing sectors.

  Hence, import restrictions fail to increase total employment.

  Worse yet, import restrictions create "sectoral shifts," which cause frictional unemployment.

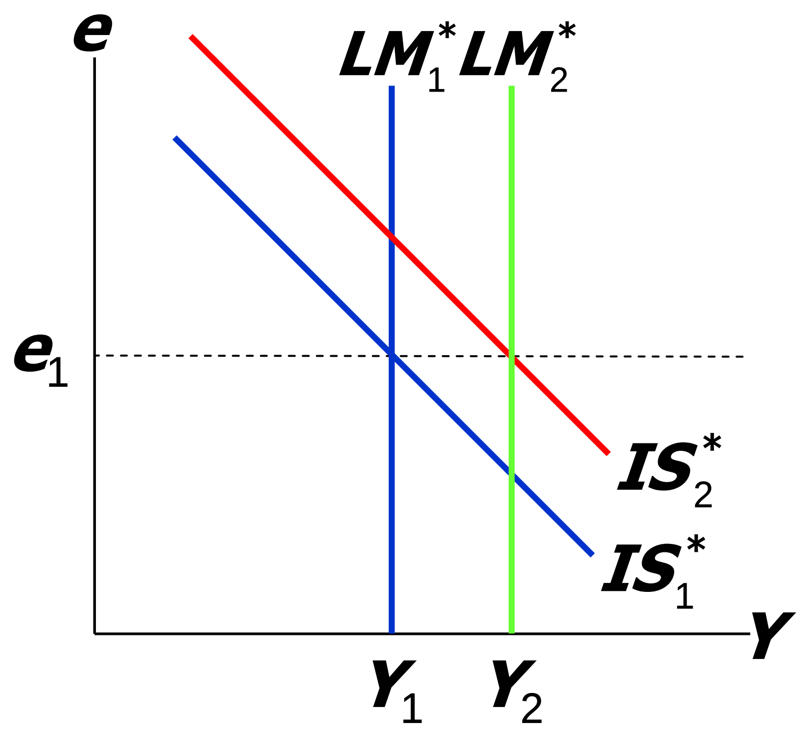
Fixed exchange rates

- Under a system of fixed exchange rates, the country's central bank stands ready to buy or sell the domestic currency for foreign currency at a predetermined rate.
- In the context of the Mundell-Fleming model, the central bank shifts the LM^* curve as required to keep ***e*** at its preannounced rate.
- This system fixes the nominal exchange rate. In the long run, when prices are flexible, the real exchange rate can move even if the nominal rate is fixed.

Fiscal policy under fixed exchange rates

Under floating rates, fiscal policy ineffective at changing output.

Under fixed rates, fiscal policy is very effective at changing output.



Results:

$$\Delta e = 0, \quad \Delta Y > 0$$

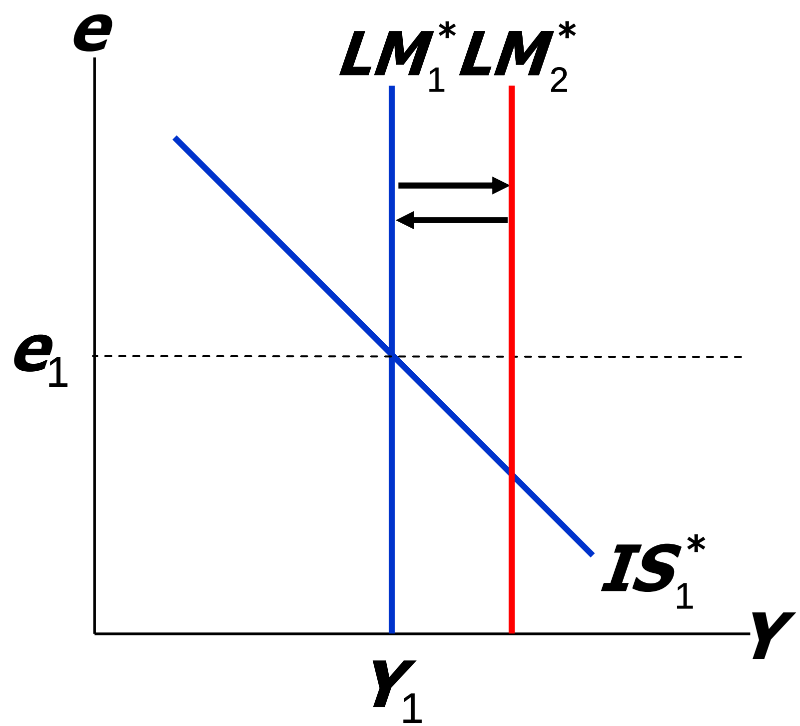
Mon. policy under fixed exchange rates

Under floating rates, monetary policy is very effective at changing output.

Under fixed rates, monetary policy cannot be used to affect output.

Results:

$$\Delta \boldsymbol{e} = 0, \quad \Delta \boldsymbol{Y} = 0$$

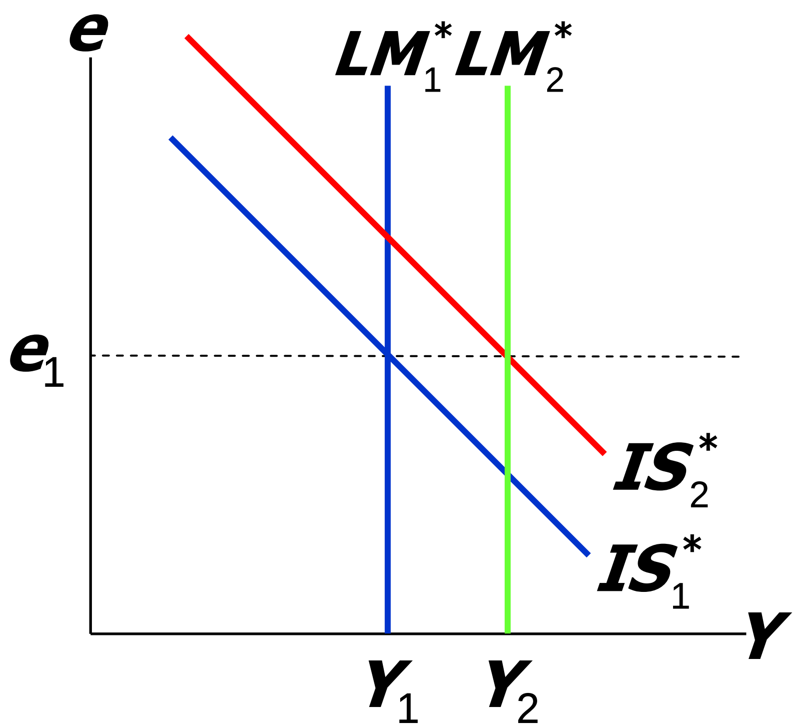


Trade policy under fixed exchange rates

Under floating rates, import restrictions do not affect ***Y*** or ***NX***.

Under fixed rates, import restrictions increase ***Y*** and ***NX***.

But, these gains come at the expense of other countries, as the policy merely shifts demand from foreign to domestic goods.



M-F: summary of policy effects

	type of exchange rate regime:					
	floating			fixed		
	impact on:					
Policy	***Y***	***e***	***NX***	***Y***	***e***	***NX***
fiscal expansion	0	↑	↓	↑	0	0
mon. expansion	↑	↓	↑	0	0	0
import restriction	0	↑	0	↑	0	↑

Interest-rate differentials

Two reasons why ***r*** may differ from ***r****

- *country risk:*
  The risk that the country's borrowers will default on their loan repayments because of political or economic turmoil.
  Lenders require a higher interest rate to compensate them for this risk.
- *expected exchange rate changes:*
  If a country's exchange rate is expected to fall, then its borrowers must pay a higher interest rate to compensate lenders for the expected currency depreciation.

Differentials in the M-F model

$$r = r^* + \theta$$

where θ is a risk premium.

Substitute the expression for r into the *IS** and *LM** equations:

$$Y = C(Y - T) + I(r^* + \theta) + G + NX(e)$$

$$M/P = L(r^* + \theta, Y)$$

The effects of an increase in θ

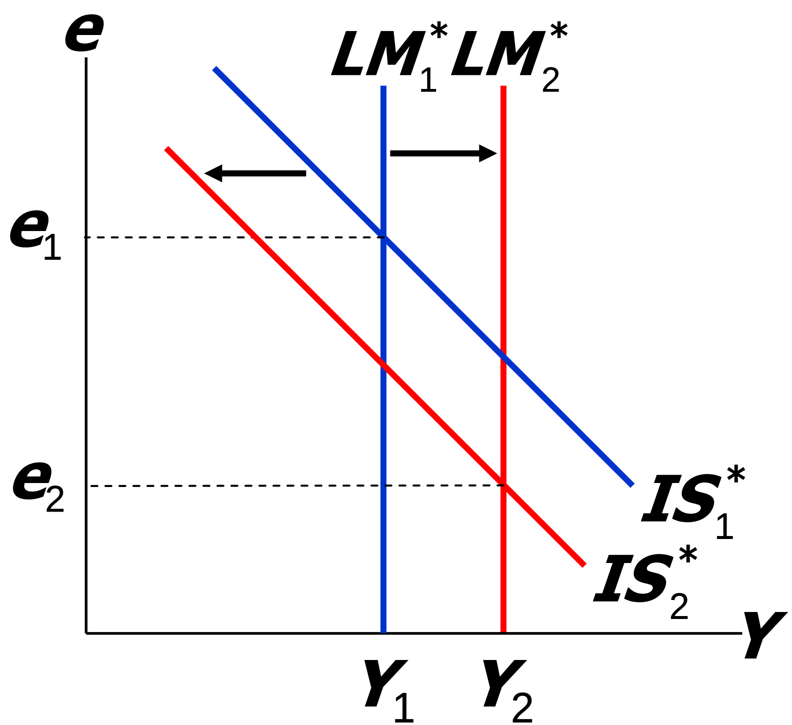
IS^* shifts left, because

$\uparrow \theta \Rightarrow \uparrow \boldsymbol{r} \Rightarrow \downarrow \boldsymbol{I}$

LM^* shifts right, because

$\uparrow \theta \Rightarrow \uparrow \boldsymbol{r} \Rightarrow \downarrow (\boldsymbol{M/P})^d$,

so $\boldsymbol{Y}$ must rise to restore money market eq'm.



Results:

$\Delta \boldsymbol{e} < 0, \ \Delta \boldsymbol{Y} > 0$

The effects of an increase in θ

- The fall in ***e*** is intuitive:
  An increase in country risk or an expected depreciation makes holding the country's currency less attractive.

  Note: an expected depreciation is a self-fulfilling prophecy.

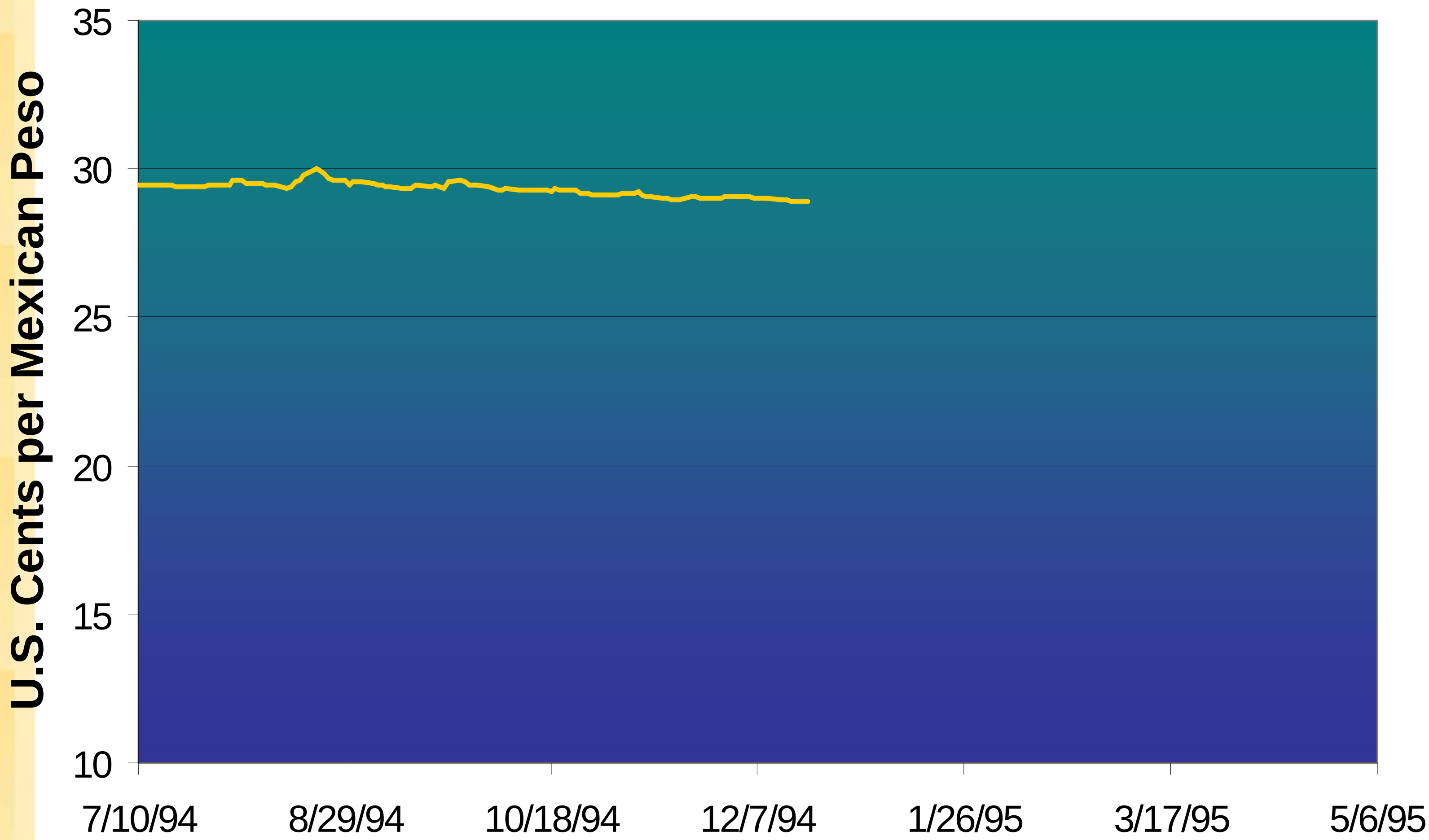
- The increase in ***Y*** occurs because
  the boost in ***NX***
  (from the depreciation)
  is even greater than the fall in ***I***
  (from the rise in ***r***).

Why income might not rise

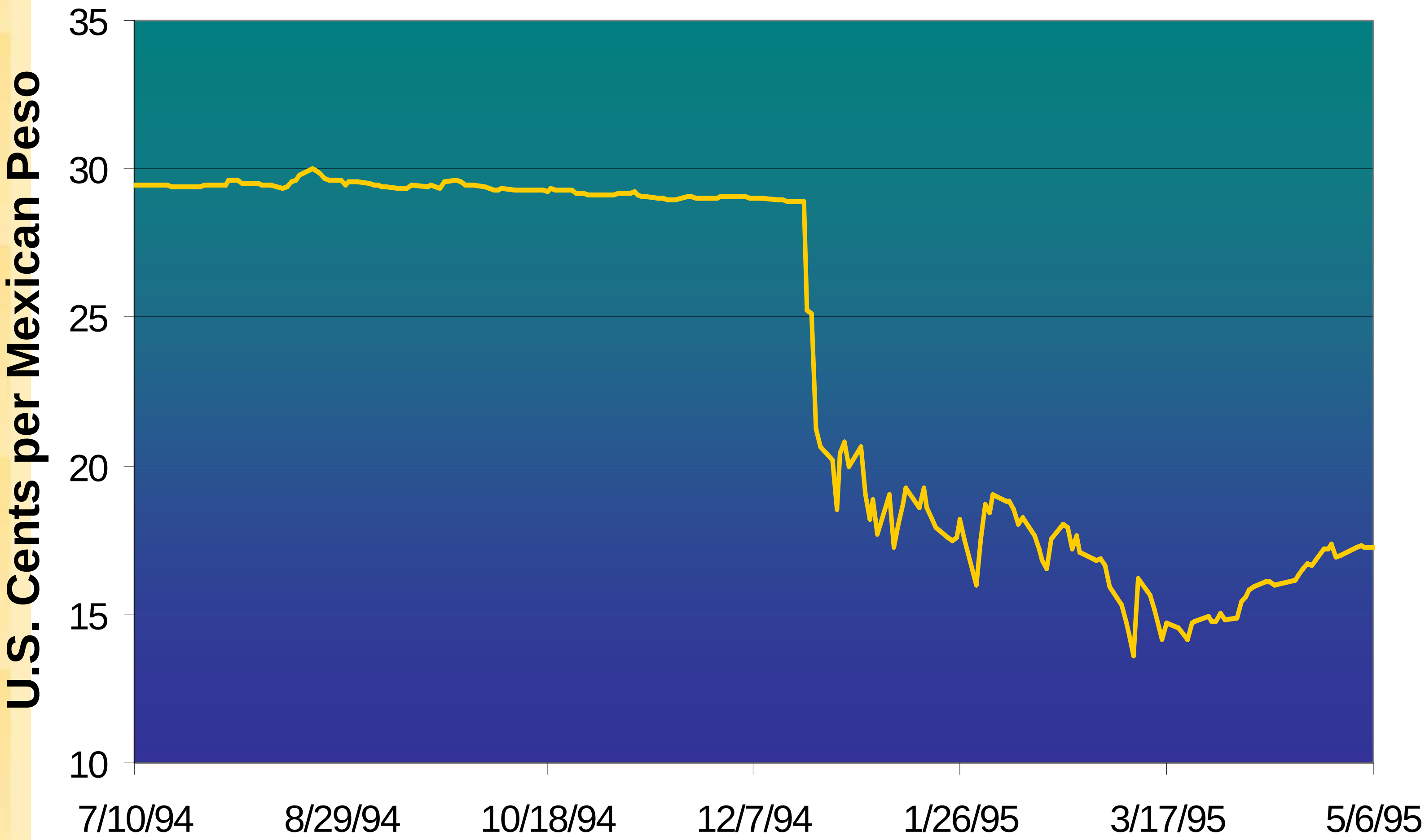
- The central bank may try to prevent the depreciation by reducing the money supply
- The depreciation might boost the price of imports enough to increase the price level (which would reduce the real money supply)
- Consumers might respond to the increased risk by holding more money.

Each of the above would shift *LM** leftward.

CASE STUDY:
The Mexican Peso Crisis



CASE STUDY:
The Mexican Peso Crisis



The Peso Crisis didn't just hurt Mexico

- U.S. goods more expensive to Mexicans
  - U.S. firms lost revenue
  - Hundreds of bankruptcies along U.S.-Mex border
- Mexican assets worth less in dollars
  - Affected retirement savings of millions of U.S. citizens

Understanding the crisis

In the early 1990s, Mexico was an attractive place for foreign investment.

During 1994, political developments caused an increase in Mexico's risk premium (θ):

- peasant uprising in Chiapas
- assassination of leading presidential candidate

Another factor:
The Federal Reserve raised U.S. interest rates several times during 1994 to prevent U.S. inflation. (So, $\Delta \boldsymbol{r}^* > 0$)

Understanding the crisis

- These events put downward pressure on the peso.
- Mexico's central bank had repeatedly promised foreign investors that it would not allow the peso's value to fall, so it bought pesos and sold dollars to "prop up" the peso exchange rate.
- Doing this requires that Mexico's central bank have adequate reserves of dollars. Did it?

Dollar reserves of Mexico's central bank

December 1993	$28 billion
August 17, 1994	$17 billion
December 1, 1994	$ 9 billion
December 15, 1994	$ 7 billion

During 1994, Mexico's central bank hid the fact that its reserves were being depleted.

the disaster

- Dec. 20: Mexico devalues the peso by 13% (fixes ***e*** at 25 cents instead of 29 cents)
- Investors are *shocked* ***! ! !***

  ...and realize the central bank must be running out of reserves...
- $\uparrow\theta$, Investors dump their Mexican assets and pull their capital out of Mexico.
- Dec. 22: central bank's reserves nearly gone. It abandons the fixed rate and lets ***e*** float.
- In a week, ***e*** falls another 30%.

The rescue package

- 1995: U.S. & IMF set up $50b line of credit to provide loan guarantees to Mexico's govt.
- This helped restore confidence in Mexico, reduced the risk premium.
- After a hard recession in 1995, Mexico began a strong recovery from the crisis.

Floating vs. Fixed Exchange Rates

Argument for floating rates:

- allows monetary policy to be used to pursue other goals (stable growth, low inflation)

Arguments for fixed rates:

- avoids uncertainty and volatility, making international transactions easier
- disciplines monetary policy to prevent excessive money growth & hyperinflation

Mundell-Fleming and the *AD* curve

- Previously, we examined the M-F model with a fixed price level. To derive the *AD* curve, we now consider the impact of a change in ***P*** in the M-F model.
- We now write the M-F equations as:

$$(IS^*) \qquad \boldsymbol{Y} = \boldsymbol{C}(\boldsymbol{Y} - \boldsymbol{T}) + \boldsymbol{I}(\boldsymbol{r^*}) + \boldsymbol{G} + \boldsymbol{NX}(\boldsymbol{\varepsilon})$$

$$(LM^*) \qquad \boldsymbol{M}/\boldsymbol{P} = \boldsymbol{L}(\boldsymbol{r^*}, \boldsymbol{Y})$$

*(Earlier in this chapter, we could write **NX** as a function of **e** because **e** and ε move in the same direction when **P** is fixed.)*

Deriving the *AD* curve

Why *AD* curve has negative slope:

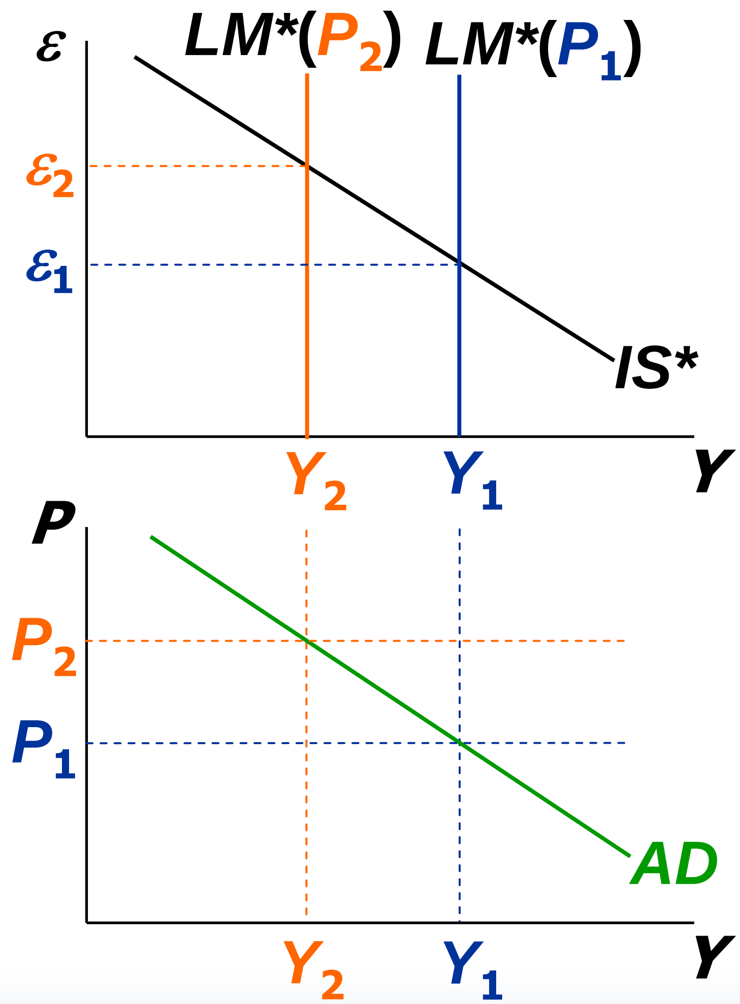
$\uparrow \boldsymbol{P} \;\Rightarrow \downarrow(\boldsymbol{M/P})$

$\Rightarrow$ *LM* shifts left

$\Rightarrow \uparrow \varepsilon$

$\Rightarrow \downarrow \boldsymbol{NX}$

$\Rightarrow \downarrow \boldsymbol{Y}$



From the short run to the long run

If $Y_1 < \bar{Y}$,

then there is downward pressure on prices.

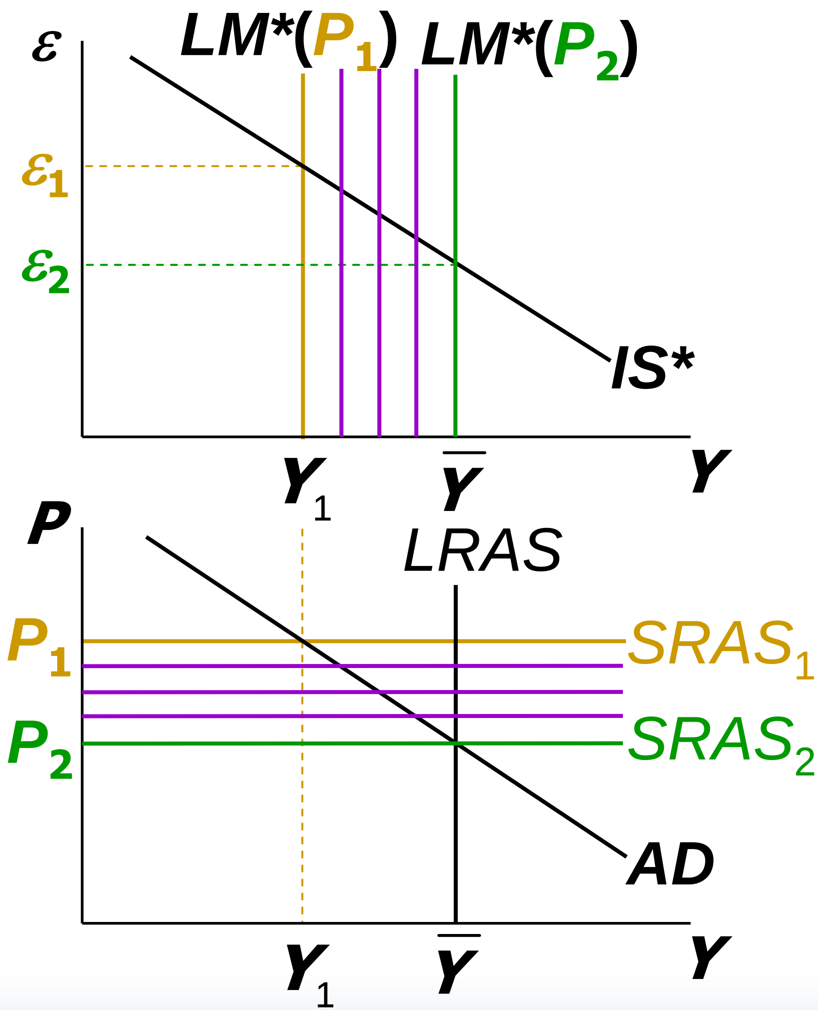
Over time, P will move down, causing

$(M/P)\uparrow$

$\varepsilon\downarrow$

$NX\uparrow$

$Y\uparrow$



Large: between small and closed

- Many countries - including the U.S. - are neither closed nor small open economies.
- A large open economy is in between the polar cases of closed & small open.
- Consider a monetary expansion:
  - Like in a closed economy,
    $\Delta \boldsymbol{M} > 0 \Rightarrow \downarrow \boldsymbol{r} \Rightarrow \uparrow \boldsymbol{I}$ (though not as much)
  - Like in a small open economy,
    $\Delta \boldsymbol{M} > 0 \Rightarrow \downarrow \varepsilon \Rightarrow \uparrow \boldsymbol{NX}$ (though not as much)

Chapter summary

1. Mundell-Fleming model
   - the IS-LM model for a small open economy.
   - takes ***P*** as given
   - can show how policies and shocks affect income and the exchange rate
2. Fiscal policy
   - affects income under fixed exchange rates, but not under floating exchange rates.

Chapter summary

3. Monetary policy
   - affects income under floating exchange rates.
   - Under fixed exchange rates, monetary policy is not available to affect output.
4. Interest rate differentials
   - exist if investors require a risk premium to hold a country's assets.
   - An increase in this risk premium raises domestic interest rates and causes the country's exchange rate to depreciate.

Chapter summary

5. Fixed vs. floating exchange rates
   - Under floating rates, monetary policy is available for can purposes other than maintaining exchange rate stability.
   - Fixed exchange rates reduce some of the uncertainty in international transactions.

Learning objectives

- three models of aggregate supply in which output depends positively on the price level in the short run
- the short-run tradeoff between inflation and unemployment known as the Phillips curve

Three models of aggregate supply

1. The sticky-wage model
2. The imperfect-information model
3. The sticky-price model

All three models imply:

$$Y = \bar{Y} + \alpha\,(P - P^e)$$

agg. output

natural rate of output

a positive parameter

the actual price level

the expected price level

The sticky-wage model

- Assumes that firms and workers negotiate contracts and fix the nominal wage before they know what the price level will turn out to be.
- The nominal wage, W, they set is the product of a target real wage, ω, and the expected price level:

$$W = \omega \times P^e$$

$$\Rightarrow \quad \frac{W}{P} = \omega \times \frac{P^e}{P}$$

The sticky-wage model

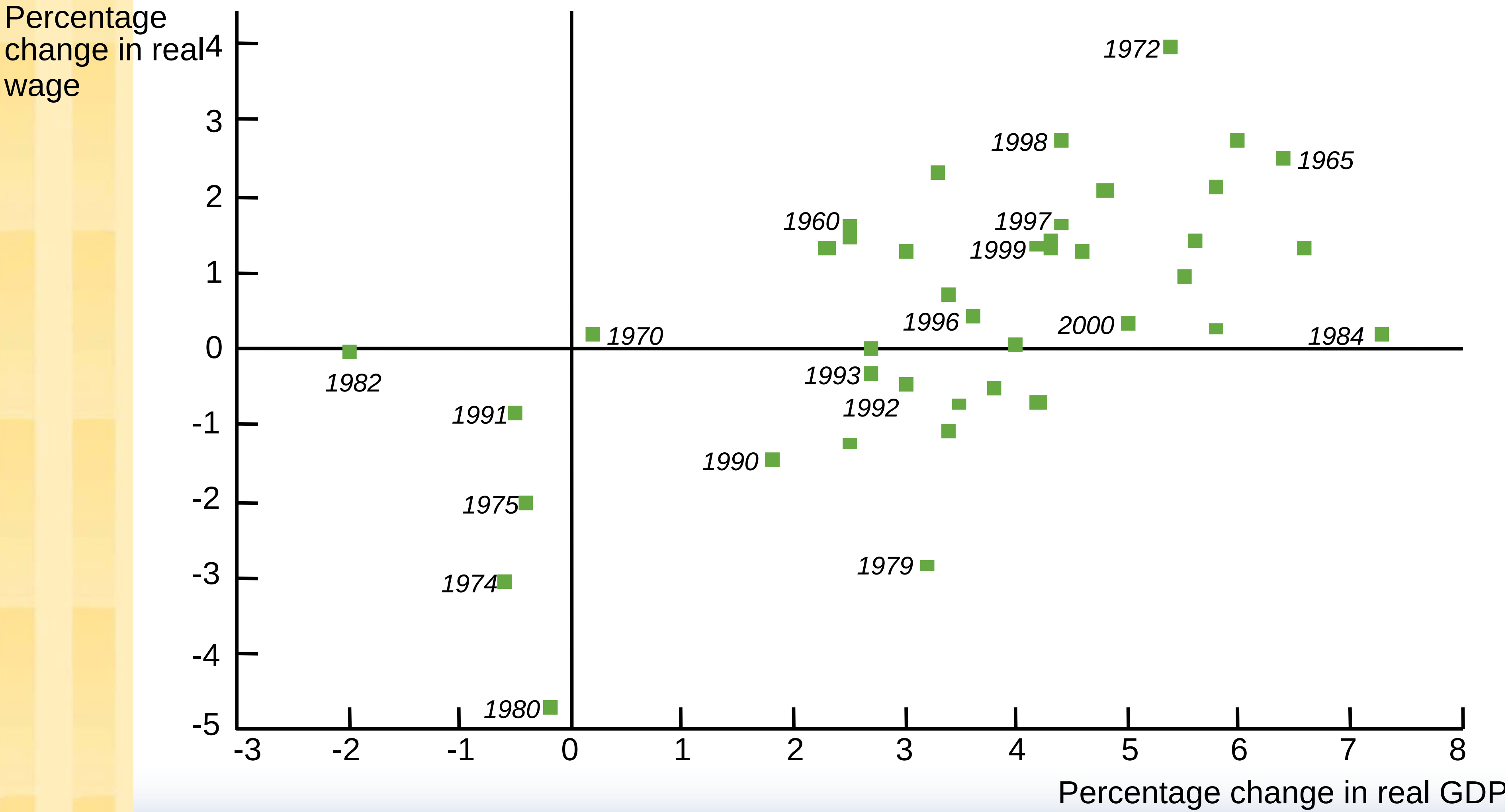
$$\frac{W}{P} = \omega \times \frac{P^e}{P}$$

If it turns out that	then
$P = P^e$	unemployment and output are at their natural rates
$P > P^e$	Real wage is less than its target, so firms hire more workers and output rises above its natural rate
$P < P^e$	Real wage exceeds its target, so firms hire fewer workers and output falls below its natural rate

The sticky-wage model

- Implies that the real wage should be *counter-cyclical* , it should move in the opposite direction as output over the course of business cycles:
  - In booms, when ***P*** typically rises, the real wage should fall.
  - In recessions, when ***P*** typically falls, the real wage should rise.
- This prediction does not come true in the real world:

The cyclical behavior of the real wage



The imperfect-information model

Assumptions:

- all wages and prices perfectly flexible, all markets clear
- each supplier produces one good, consumes many goods
- each supplier knows the nominal price of the good she produces, but does not know the overall price level

The imperfect-information model

- Supply of each good depends on its relative price: the nominal price of the good divided by the overall price level.
- Supplier doesn't know price level at the time she makes her production decision, so uses the expected price level, P^e.
- Suppose P rises but P^e does not.

  Then supplier thinks her relative price has risen, so she produces more.

  With many producers thinking this way, Y will rise whenever P rises above P^e.

The sticky-price model

- Reasons for sticky prices:
  – long-term contracts between firms and customers
  – menu costs
  – firms do not wish to annoy customers with frequent price changes
- Assumption:
  – Firms set their own prices
  (e.g. as in monopolistic competition)

The sticky-price model

- An individual firm's desired price is

$$p = P + a(Y - \bar{Y})$$

where $a > 0$.

Suppose two types of firms:

- firms with flexible prices, set prices as above
- firms with sticky prices, must set their price before they know how P and Y will turn out:

$$p = P^e + a(Y^e - \bar{Y}^e)$$

The sticky-price model

$$p = P^e + a(Y^e - \bar{Y}^e)$$

- Assume firms w/ sticky prices expect that output will equal its natural rate. Then,

$$p = P^e$$

- To derive the aggregate supply curve, we first find an expression for the overall price level.
- Let s denote the fraction of firms with sticky prices. Then, we can write the overall price level as

The sticky-price model

$$P = \underbrace{s P^e}_{\text{price set by sticky price firms}} + (1 - s)\underbrace{[P + a(Y - \bar{Y})]}_{\text{price set by flexible price firms}}$$

- Subtract $(1 - s)P$ from both sides:

$$sP = s P^e + (1 - s)[a(Y - \bar{Y})]$$

- Divide both sides by s:

$$P = P^e + \left[\frac{(1 - s)a}{s}\right](Y - \bar{Y})$$

The sticky-price model

$$P = P^e + \left[\frac{(1-s)a}{s}\right](Y - \bar{Y})$$

- High $P^e \Rightarrow$ High P
  If firms expect high prices, then firms who must set prices in advance will set them high.
  Other firms respond by setting high prices.
- High $Y \Rightarrow$ High P
  When income is high, the demand for goods is high. Firms with flexible prices set high prices.
  The greater the fraction of flexible price firms, the smaller is s and the bigger is the effect of ΔY on P.

The sticky-price model

$$\boldsymbol{P} = \boldsymbol{P}^e + \left[\frac{(1-\boldsymbol{s})a}{\boldsymbol{s}}\right](\boldsymbol{Y} - \overline{\boldsymbol{Y}})$$

- Finally, derive *AS* equation by solving for $\boldsymbol{Y}$:

$$\boldsymbol{Y} = \overline{\boldsymbol{Y}} + \alpha(\boldsymbol{P} - \boldsymbol{P}^e),$$

$$\text{where} \quad \alpha = \frac{\boldsymbol{s}}{(1-\boldsymbol{s})a}$$

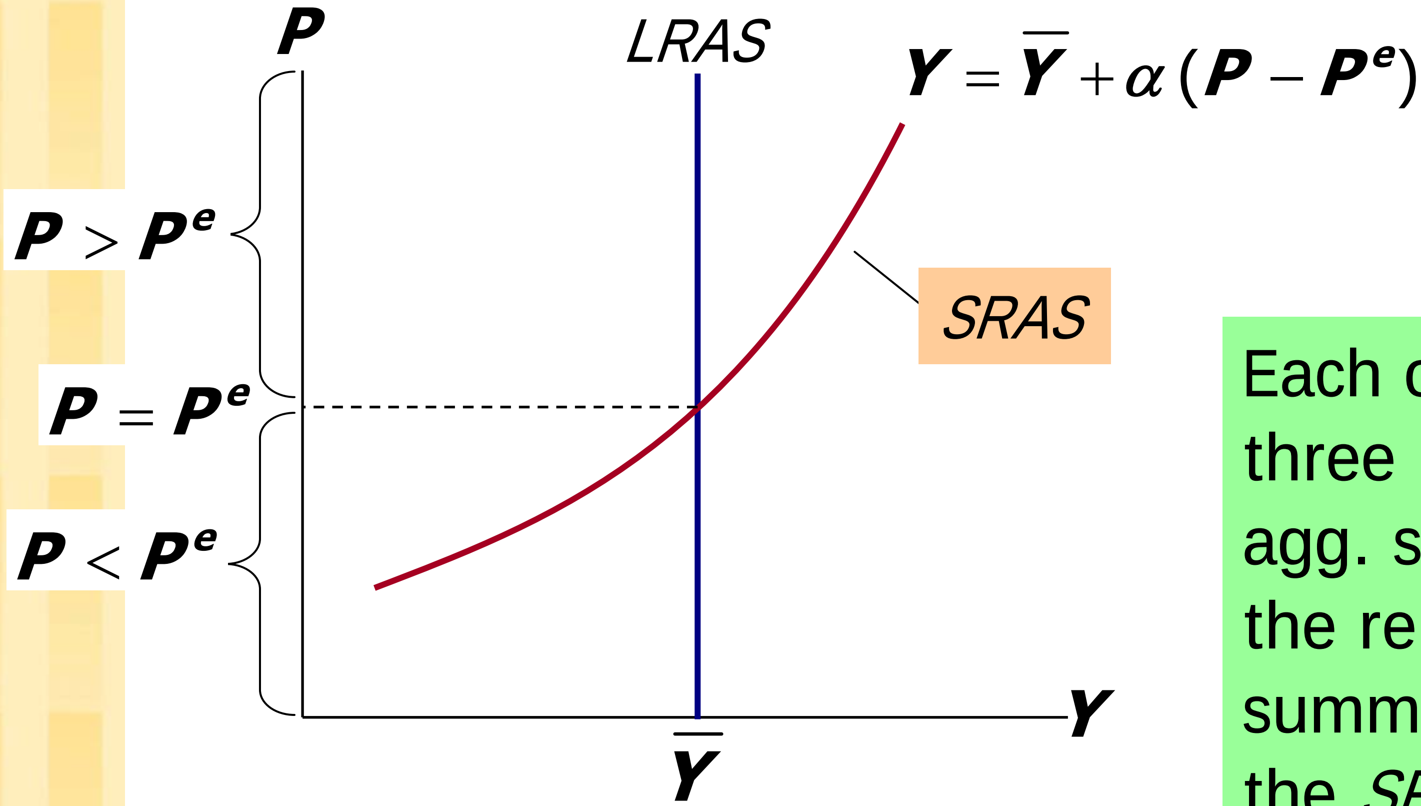
The sticky-price model

In contrast to the sticky-wage model, the sticky-price model implies a procyclical real wage:

Suppose aggregate output/income falls. Then,

- Firms see a fall in demand for their products.
- Firms with sticky prices reduce production, and hence reduce their demand for labor.
- The leftward shift in labor demand causes the real wage to fall.

Summary & implications

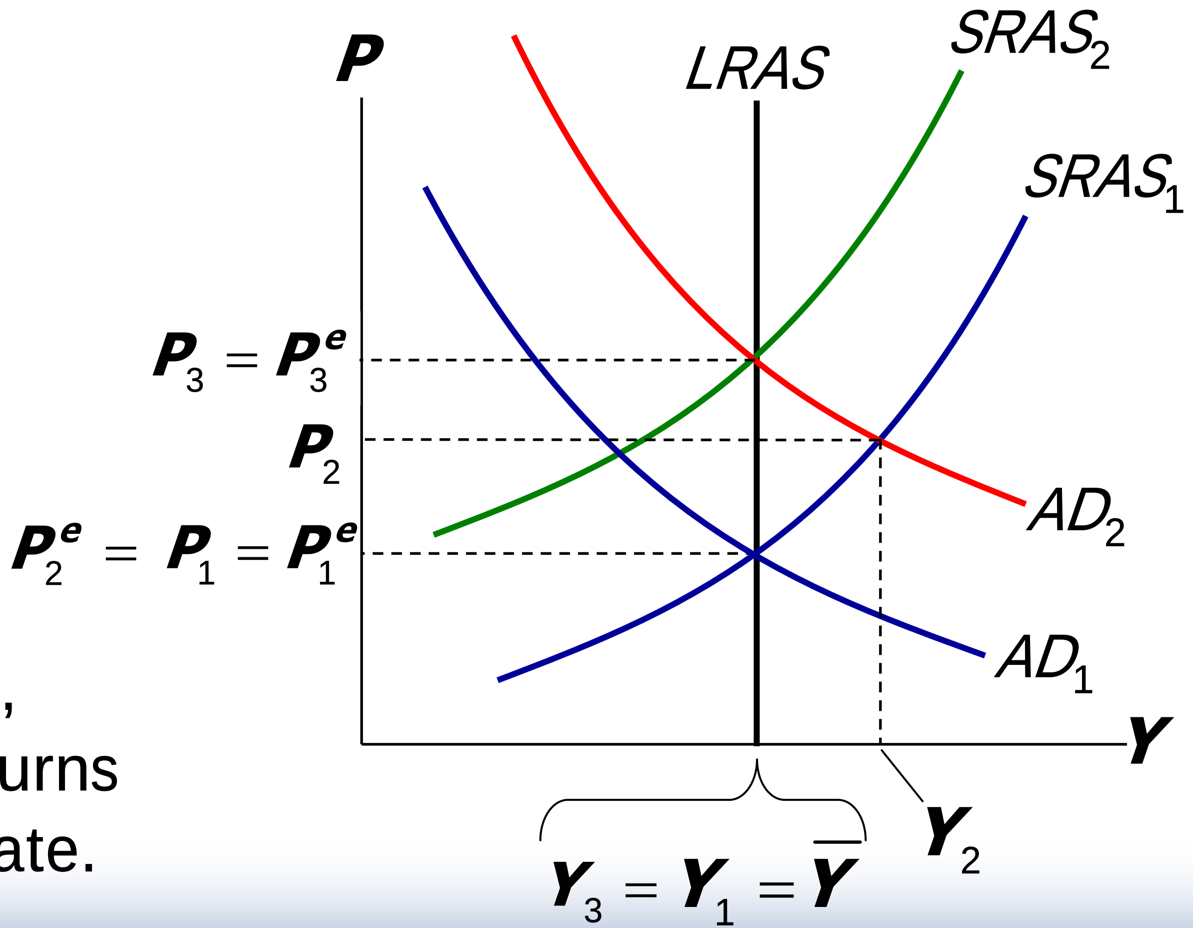


Each of the three models of agg. supply imply the relationship summarized by the *SRAS* curve & equation

Summary & implications

SRAS equation: $Y = \overline{Y} + \alpha\,(P - P^e)$

Suppose a positive *AD* shock moves output above its natural rate and P above the level people had expected.



Over time, P^e rises, *SRAS* shifts up, and output returns to its natural rate.

Inflation, Unemployment, and the Phillips Curve

The **Phillips curve** states that π depends on

- expected inflation, π^e
- **cyclical unemployment**: the deviation of the actual rate of unemployment from the natural rate
- supply shocks, ν

$$\boxed{\pi = \pi^e - \beta(u - u^n) + \nu}$$

where $\beta > 0$ is an exogenous constant.

Deriving the Phillips Curve from *SRAS*

(1) $$Y = \overline{Y} + \alpha(P - P^e)$$

(2) $$P = P^e + (1/\alpha)(Y - \overline{Y})$$

(3) $$P = P^e + (1/\alpha)(Y - \overline{Y}) + \nu$$

(4) $$(P - P_{-1}) = (P^e - P_{-1}) + (1/\alpha)(Y - \overline{Y}) + \nu$$

(5) $$\pi = \pi^e + (1/\alpha)(Y - \overline{Y}) + \nu$$

(6) $$(1/\alpha)(Y - \overline{Y}) = -\beta(u - u^n)$$

(7) $$\pi = \pi^e - \beta(u - u^n) + \nu$$

The Phillips Curve and *SRAS*

$$\text{SRAS:} \qquad \boldsymbol{Y} = \overline{\boldsymbol{Y}} + \alpha(\boldsymbol{P} - \boldsymbol{P}^{e})$$

$$\text{Phillips curve:} \qquad \pi = \pi^{e} - \beta(\boldsymbol{u} - \boldsymbol{u}^{n}) + \nu$$

- *SRAS* curve:
  output is related to unexpected movements in the price level
- Phillips curve:
  unemployment is related to unexpected movements in the inflation rate

Adaptive expectations

- **Adaptive expectations**: an approach that assumes people form their expectations of future inflation based on recently observed inflation.
- A simple example:
  Expected inflation = last year's actual inflation

$$\pi^e = \pi_{-1}$$

- Then, the P.C. becomes

$$\pi = \pi_{-1} - \beta(u - u^n) + v$$

Inflation inertia

$$\pi = \pi_{-1} - \beta(\boldsymbol{u} - \boldsymbol{u}^n) + \nu$$

- In this form, the Phillips curve implies that inflation has inertia:
  - In the absence of supply shocks or cyclical unemployment, inflation will continue indefinitely at its current rate.
  - Past inflation influences expectations of current inflation, which in turn influences the wages & prices that people set.

Two causes of rising & falling inflation

$$\pi = \pi_{-1} - \beta(\boldsymbol{u} - \boldsymbol{u}^n) + \nu$$

- **cost-push inflation**: inflation resulting from supply shocks.

  Adverse supply shocks typically raise production costs and induce firms to raise prices, "pushing" inflation up.

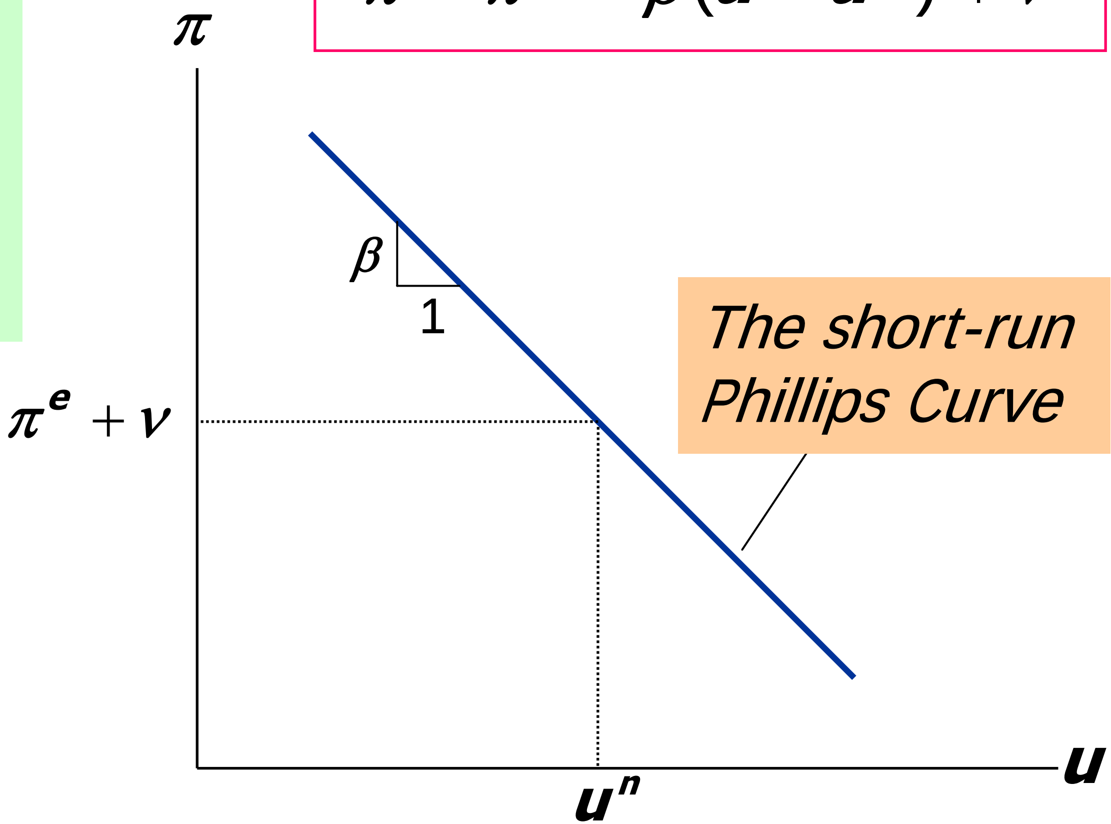
- **demand-pull inflation**: inflation resulting from demand shocks.

  Positive shocks to aggregate demand cause unemployment to fall below its natural rate, which "pulls" the inflation rate up.

Graphing the Phillips curve

In the short run, policymakers face a trade-off between π and u.

$$\pi = \pi^e - \beta(u - u^n) + \nu$$

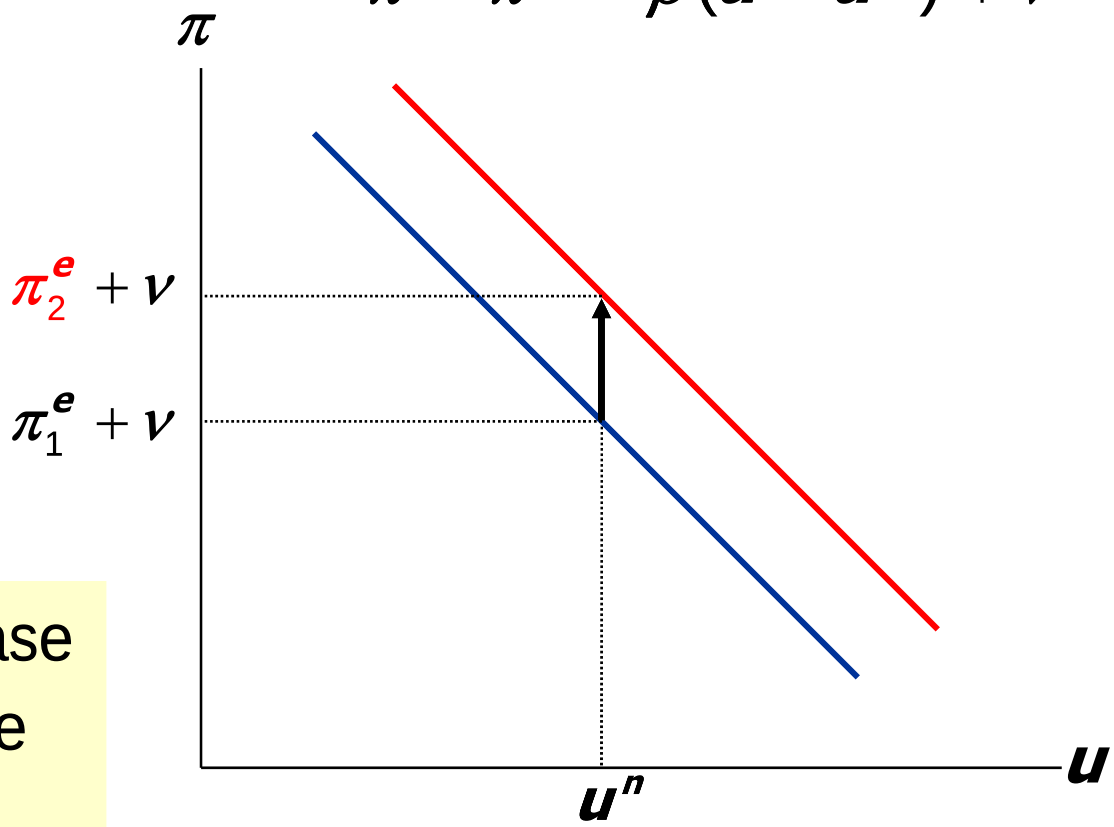


Shifting the Phillips curve

People adjust their expectations over time, so the tradeoff only holds in the short run.

E.g., an increase in π^e shifts the short-run P.C. upward.

$$\pi = \pi^e - \beta(u - u^n) + v$$



The sacrifice ratio

- To reduce inflation, policymakers can contract agg. demand, causing unemployment to rise above the natural rate.
- The **sacrifice ratio** measures the percentage of a year's real GDP that must be foregone to reduce inflation by 1 percentage point.
- Estimates vary, but a typical one is 5.

The sacrifice ratio

- Suppose policymakers wish to reduce inflation from 6 to 2 percent.

  If the sacrifice ratio is 5, then reducing inflation by 4 points requires a loss of $4 \times 5 = 20$ percent of one year's GDP.
- This could be achieved several ways, e.g.
  - reduce GDP by 20% for one year
  - reduce GDP by 10% for each of two years
  - reduce GDP by 5% for each of four years
- The cost of disinflation is lost GDP. One could use Okun's law to translate this cost into unemployment.

Rational expectations

Ways of modeling the formation of expectations:

- **adaptive expectations**:
  People base their expectations of future inflation on recently observed inflation.
- **rational expectations**:
  People base their expectations on all available information, including information about current and prospective future policies.

Painless disinflation?

- Proponents of rational expectations believe that the sacrifice ratio may be very small:
- Suppose $\boldsymbol{u} = \boldsymbol{u^n}$ and $\pi = \pi^{\boldsymbol{e}} = 6\%$,
  and suppose the Fed announces that it will do whatever is necessary to reduce inflation from 6 to 2 percent as soon as possible.
- If the announcement is credible, then $\pi^{\boldsymbol{e}}$ will fall, perhaps by the full 4 points.
- Then, π can fall without an increase in $\boldsymbol{u}$.

The sacrifice ratio for the Volcker disinflation

- 1981: π = 9.7%
  1985: π = 3.0%

Total disinflation = 6.7%

year	u	u^n	$u - u^n$
1982	9.5%	6.0%	3.5%
1983	9.5	6.0	3.5
1984	7.4	6.0	1.4
1985	7.1	6.0	1.1
		Total	9.5%

The sacrifice ratio for the Volcker disinflation

- Previous slide:
  - inflation fell by 6.7%
  - total of 9.5% of cyclical unemployment
- Okun's law:
  each 1 percentage point of unemployment implies lost output of 2 percentage points.
  So, the 9.5% cyclical unemployment translates to 19.0% of a year's real GDP.
- Sacrifice ratio = (lost GDP)/(total disinflation)
  = 19/6.7 = 2.8 percentage points of GDP were lost for each 1 percentage point reduction in inflation.

The natural rate hypothesis

Our analysis of the costs of disinflation, and of economic fluctuations in the preceding chapters, is based on the **natural rate hypothesis**:

> Changes in aggregate demand affect output and employment only in the short run.
>
> In the long run, the economy returns to the levels of output, employment, and unemployment described by the classical model (chapters 3-8).

An alternative hypothesis: hysteresis

- **Hysteresis**: the long-lasting influence of history on variables such as the natural rate of unemployment.
- Negative shocks may increase u^n, so economy may not fully recover:
  - The skills of cyclically unemployed workers deteriorate while unemployed, and they cannot find a job when the recession ends.
  - Cyclically unemployed workers may lose their influence on wage-setting; insiders (employed workers) may then bargain for higher wages for themselves. Then, the cyclically unemployed "outsiders" may become structurally unemployed when the recession ends.

Chapter summary

1. Three models of aggregate supply in the short run:
   - sticky-wage model
   - imperfect-information model
   - sticky-price model

   All three models imply that output rises above its natural rate when the price level falls below the expected price level.

Chapter summary

2. Phillips curve
   - derived from the SRAS curve
   - states that inflation depends on
     - expected inflation
     - cyclical unemployment
     - supply shocks
   - presents policymakers with a short-run tradeoff between inflation and unemployment

Chapter summary

3. How people form expectations of inflation
   - adaptive expectations
     - based on recently observed inflation
     - implies “inertia”
   - rational expectations
     - based on all available information
     - implies that disinflation may be painless

Chapter summary

4. The natural rate hypothesis and hysteresis
   - the natural rate hypotheses
     - states that changes in aggregate demand can only affect output and employment in the short run
   - hysteresis
     - states that agg. demand can have permanent effects on output and employment

Learning objectives

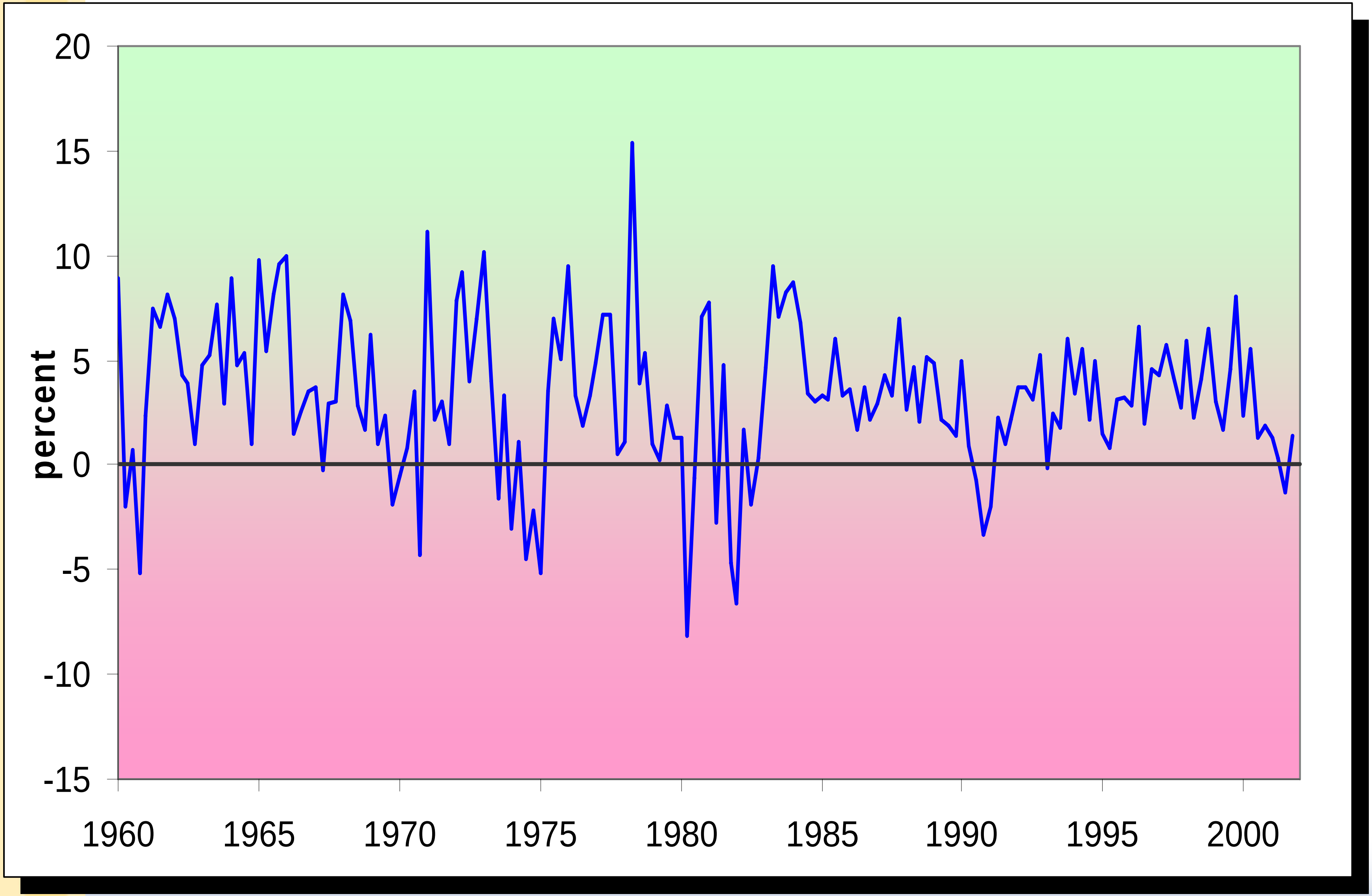
In this chapter, you will learn about two policy debates:

1. Should policy be active or passive?
2. Should policy be by rule or discretion?

Question 1:

Should policy be active or passive?

U.S. Real GDP Growth Rate, 1960:1-2001:4



Arguments for active policy

- Recessions cause economic hardship for millions of people.
- The Employment Act of 1946:
  "it is the continuing policy and responsibility of the Federal Government to...promote full employment and production."
- The model of aggregate demand and supply (Chapters 9-13) shows how fiscal and monetary policy can respond to shocks and stabilize the economy.

Change in unemployment during recessions

peak	trough	increase in no. of unemployed persons (millions)
July 1953	May 1954	2.11
Aug 1957	April 1958	2.27
April 1960	February 1961	1.21
December 1969	November 1970	2.01
November 1973	March 1975	3.58
January 1980	July 1980	1.68
July 1981	November 1982	4.08
July 1990	March 1991	1.67

Arguments against active policy

1. Long & variable lags

inside lag:

the time between the shock and the policy response

- takes time to recognize shock
- takes time to implement policy, especially fiscal policy

outside lag:

the time it takes for policy to affect economy

If conditions change before policy's impact is felt, then policy may end up destabilizing the economy.

Automatic stabilizers

- definition:
  policies that stimulate or depress the economy when necessary without any deliberate policy change.
- They are designed to reduce the lags associated with stabilization policy.
- Examples:
  – income tax
  – unemployment insurance
  – welfare

Forecasting the macroeconomy

Because policies act with lags, policymakers must predict future conditions.

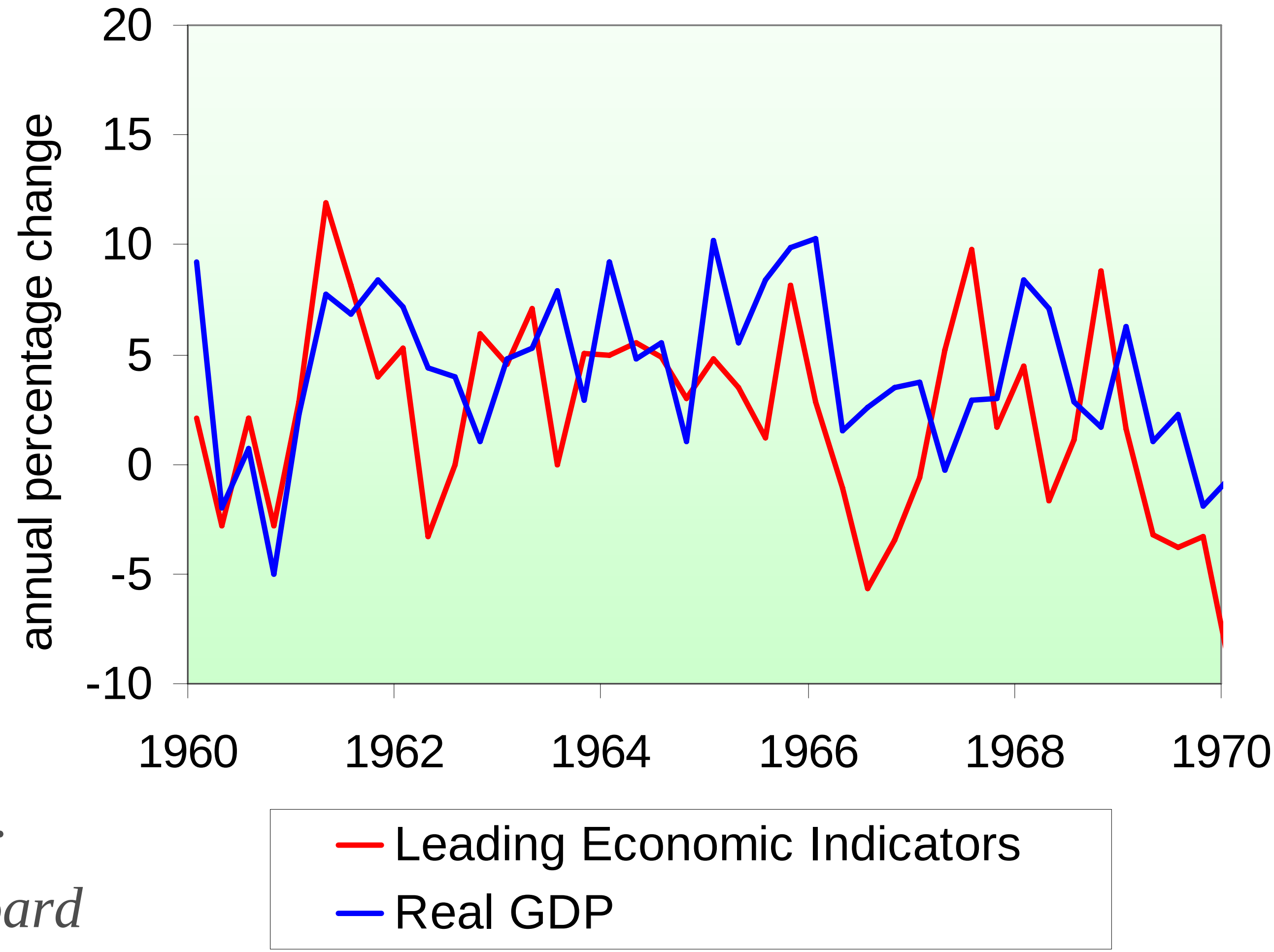
Ways to generate forecasts:

- *Leading economic indicators:*
  data series that fluctuate in advance of the economy
- *Macroeconometric models:*
  Large-scale models with estimated parameters that can be used to forecast the response of endogenous variables to shocks and policies

The LEI index and Real GDP, 1960s

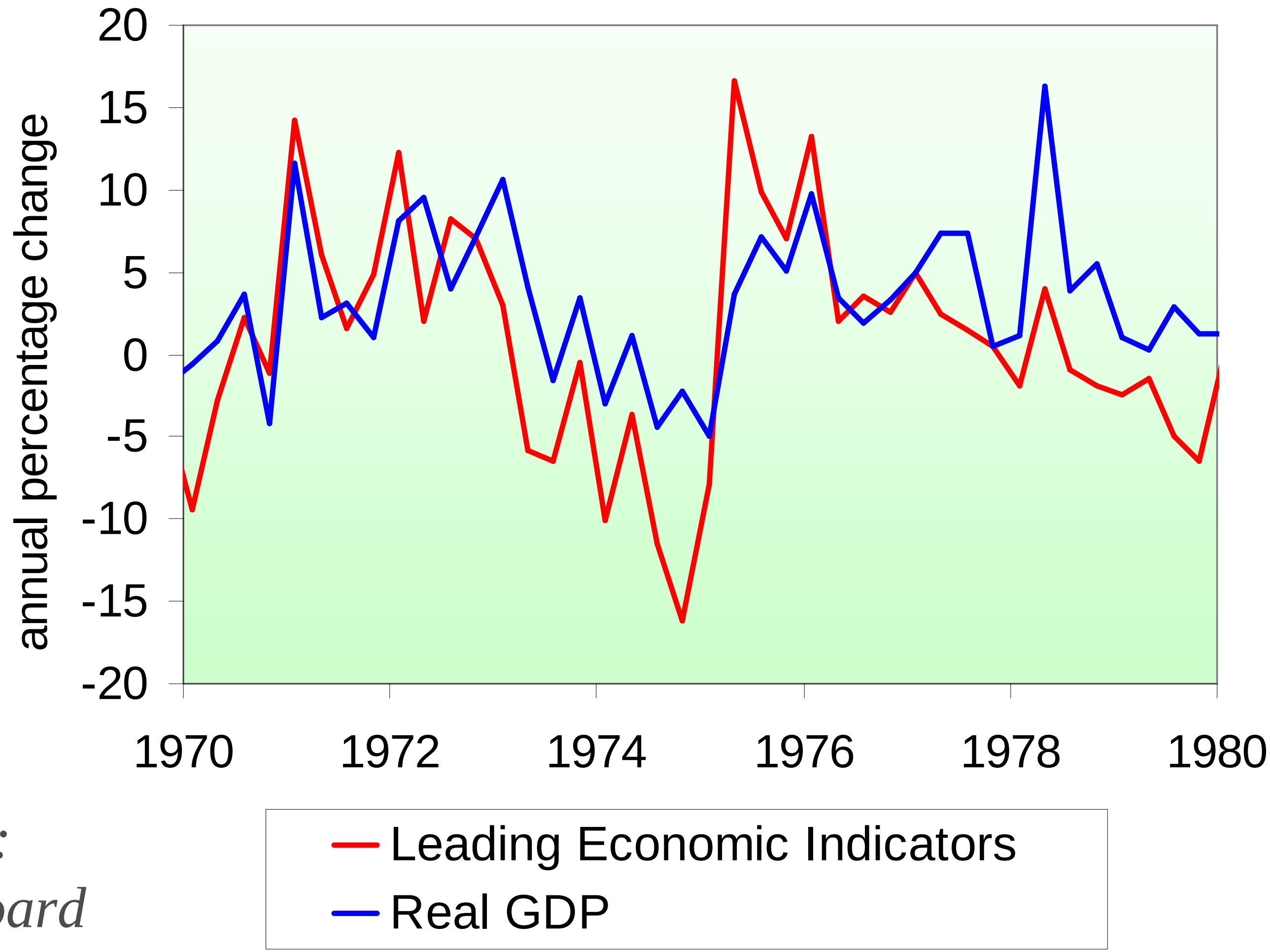
The *Index of Leading Economic Indicators* includes 10 data series

(*see FYI box on p.383*).



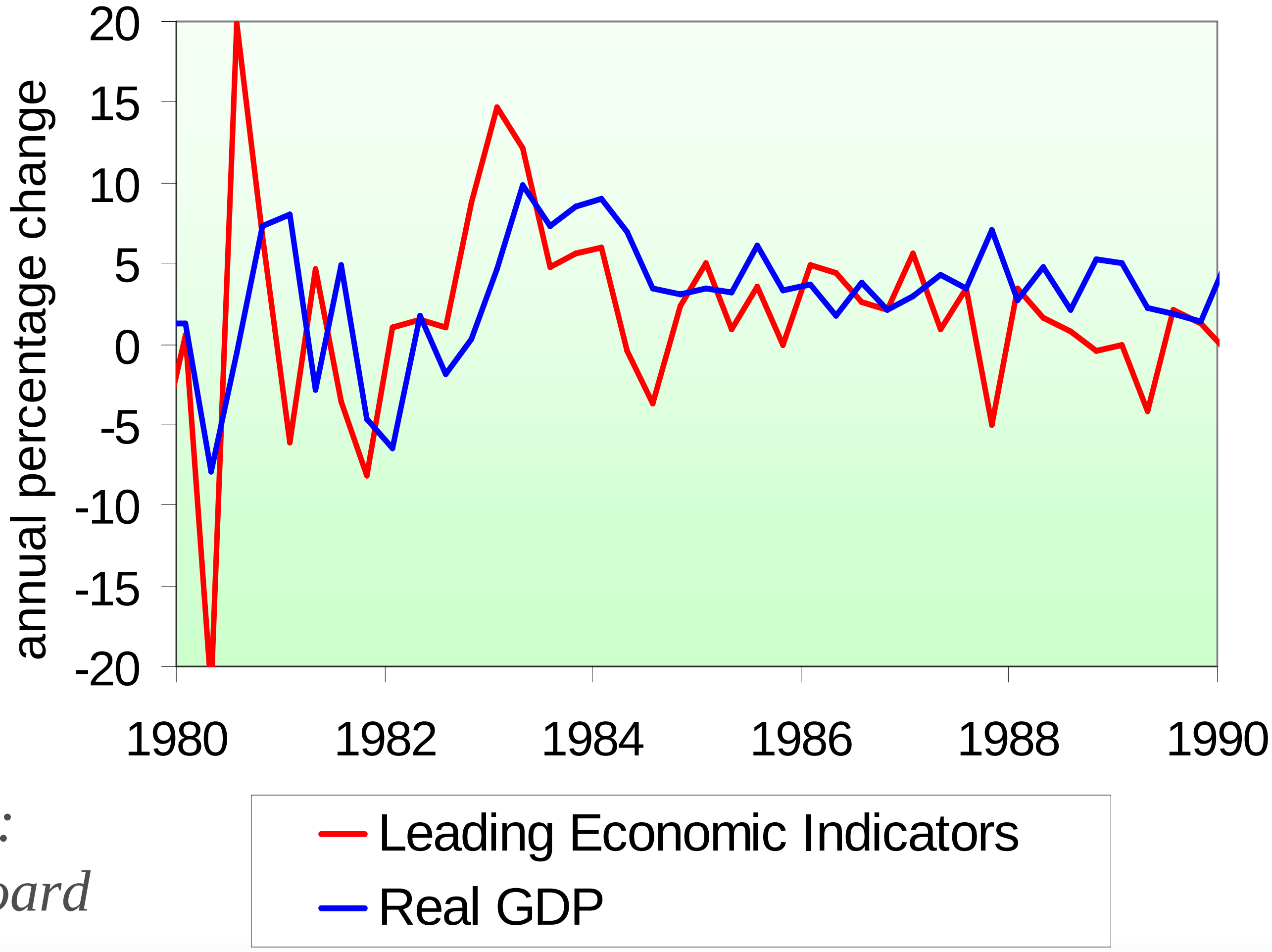
source of LEI data:
The Conference Board

The LEI index and Real GDP, 1970s



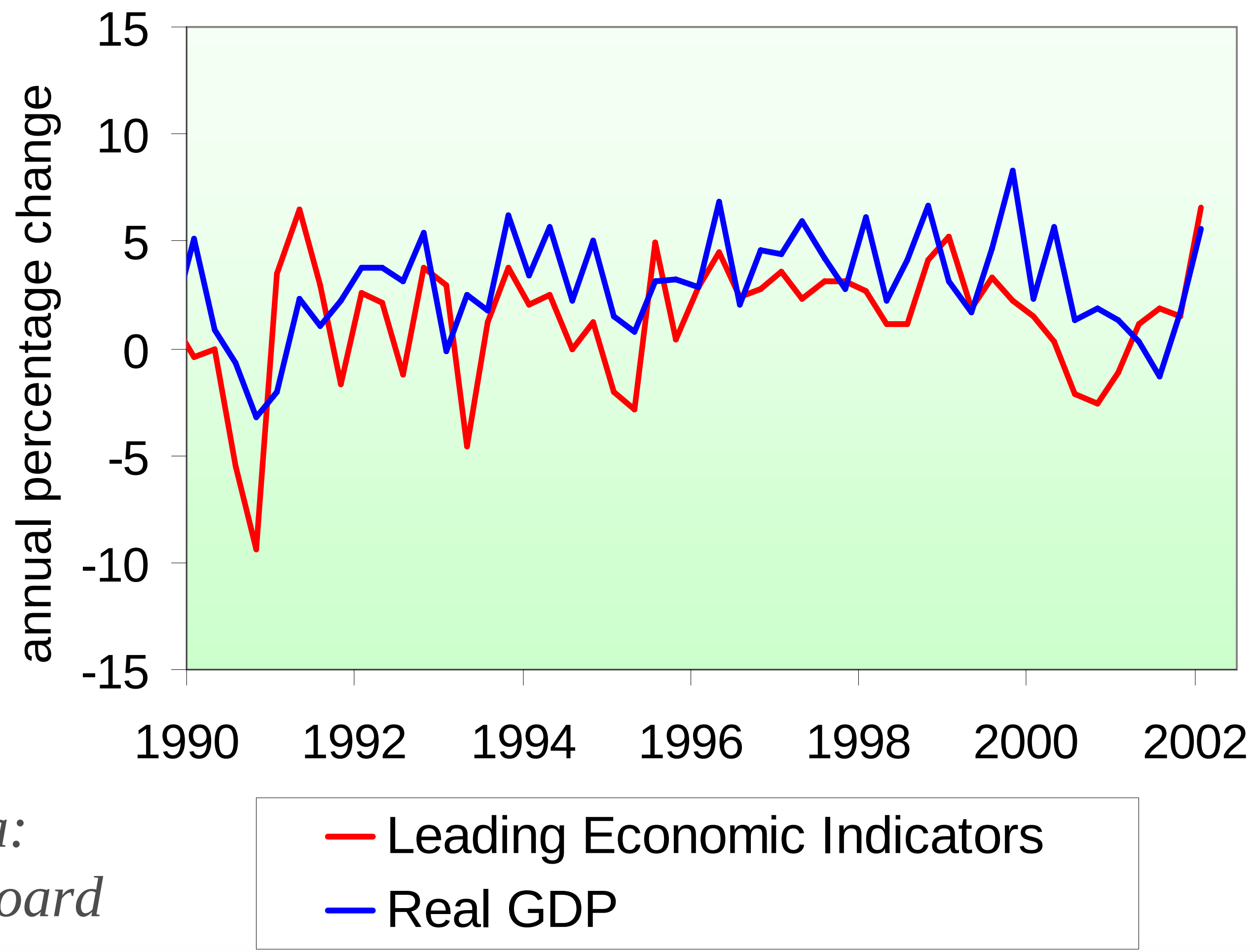
source of LEI data:
The Conference Board

The LEI index and Real GDP, 1980s



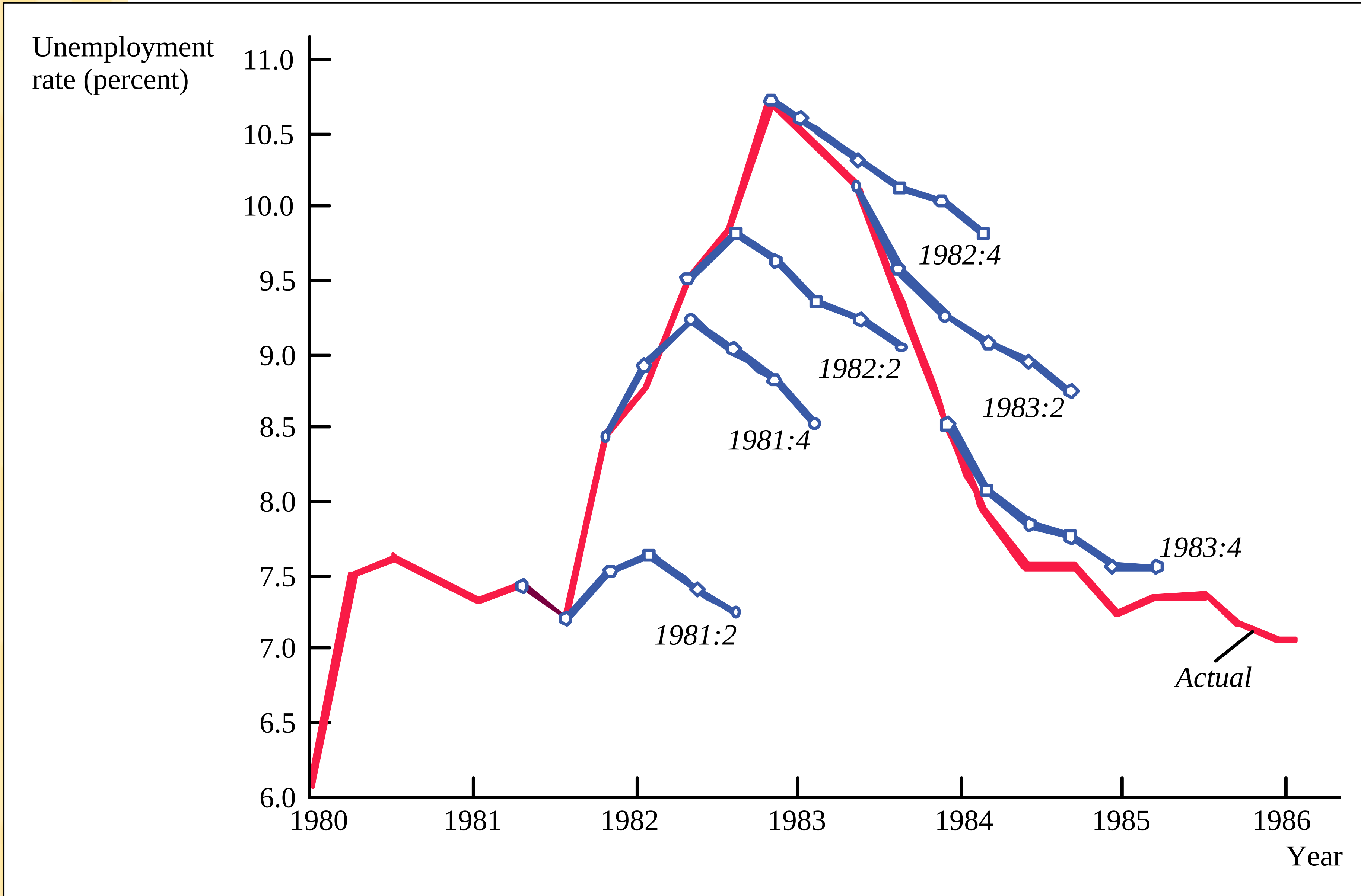
source of LEI data:
The Conference Board

The LEI index and Real GDP, 1990s



source of LEI data:
The Conference Board

Mistakes Forecasting the Recession of 1982



Forecasting the macroeconomy

Because policies act with lags, policymakers must predict future conditions.

The preceding slides show that the forecasts are often wrong.

This is one reason why some economists oppose policy activism.

The Lucas Critique

- Due to Robert Lucas
  won Nobel Prize in 1995 for "rational expectations"
- Forecasting the effects of policy changes has often been done using models estimated with historical data.
- Lucas pointed out that such predictions would not be valid if the policy change alters expectations in a way that changes the fundamental relationships between variables.

An example of the Lucas Critique

- Prediction (based on past experience): an increase in the money growth rate will reduce unemployment
- The Lucas Critique points out that increasing the money growth rate may raise expected inflation, in which case unemployment would not necessarily fall.

The Jury's Out…

Looking at recent history does not clearly answer Question 1:

- It's hard to identify shocks in the data,
- and it's hard to tell how things would have been different had actual policies not been used.

Question 2:

Should policy
be conducted by
rule or discretion?

Rules and Discretion: basic concepts

- **Policy conducted by rule**:
  Policymakers announce in advance how policy will respond in various situations, and commit themselves to following through.
- **Policy conducted by discretion**:
  As events occur and circumstances change, policymakers use their judgment and apply whatever policies seem appropriate at the time.

Arguments for Rules

1. Distrust of policymakers and the political process
   - misinformed politicians
   - politicians' interests sometimes not the same as the interests of society

Arguments for Rules

2. The **Time Inconsistency of Discretionary Policy**
   - def: A scenario in which policymakers have an incentive to renege on a previously announced policy once others have acted on that announcement.
   - Destroys policymakers' credibility, thereby reducing effectiveness of their policies.

Examples of Time-Inconsistent Policies

To encourage investment, government announces it won't tax income from capital.

But once the factories are built, the govt reneges in order to raise more tax revenue.

Examples of Time-Inconsistent Policies

To reduce expected inflation,
the Central Bank announces
it will tighten monetary policy.

But faced with high unemployment,
Central Bank may be tempted
to cut interest rates.

Examples of Time-Inconsistent Policies

Aid to poor countries is contingent on fiscal reforms.

The reforms don't occur, but aid is given anyway, because the donor countries don't want the poor countries' citizens to starve.

Monetary Policy Rules

a. Constant money supply growth rate
   - advocated by *Monetarists*
   - stabilizes aggregate demand only if velocity is stable

Monetary Policy Rules

a. Constant money supply growth rate

b. Target growth rate of nominal GDP
   - automatically increase money growth whenever nominal GDP grows slower than targeted; decrease money growth when nominal GDP growth exceeds target.

Monetary Policy Rules

a. Constant money supply growth rate

b. Target growth rate of nominal GDP

c. Target the inflation rate
   - automatically reduce money growth whenever inflation rises above the target rate.
   - Many countries' central banks now practice inflation targeting, but allow themselves a little discretion.

Monetary Policy Rules

a. Constant money supply growth rate

b. Target growth rate of nominal GDP

c. Target the inflation rate

d. The "Taylor Rule"

   Target Federal Funds rate based on

   - inflation rate
   - gap between actual & full-employment GDP

The Taylor Rule

$$r_{ff} = 2 + 0.5(\pi - 2) - 0.5(\text{GDP Gap})$$

where:

i_{ff} = nominal federal funds rate

$r_{ff} = i_{ff} - \pi$ = real federal funds rate

$$\text{GDP Gap} = 100 \times \frac{\bar{Y} - Y}{\bar{Y}}$$

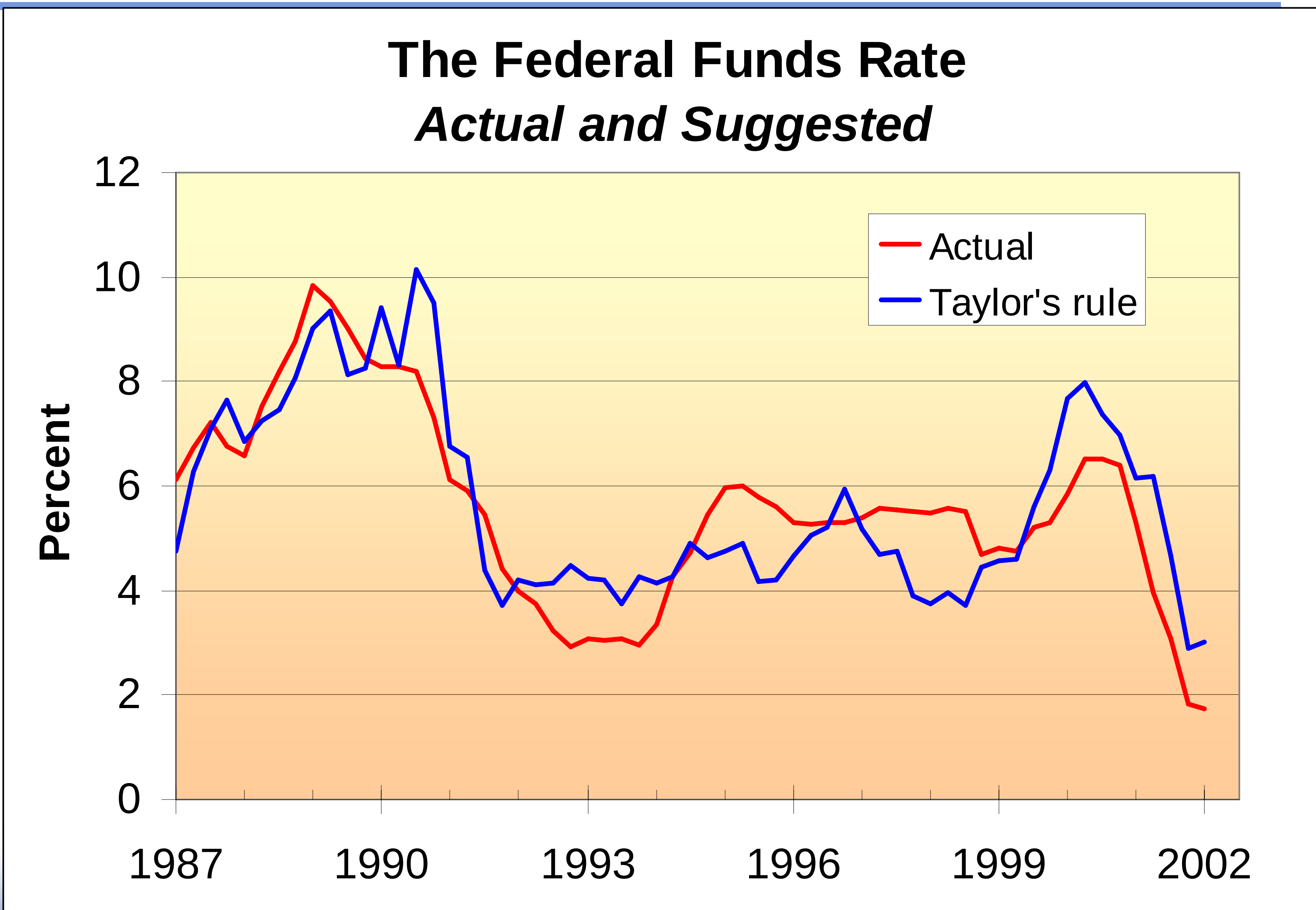
= the percent by which real GDP is below its natural rate

The Taylor Rule

$$r_{ff} = 2 + 0.5(\pi - 2) - 0.5(\text{GDP Gap})$$

- If π = 2 and output is at its natural rate, then monetary policy targets the real Fed Funds rate at 2% (and the nominal rate at 4%).
- For each one-point increase in π, mon. policy is automatically tightened to raise the real Fed Funds rate by 0.5
- For each one percentage point that GDP falls below its natural rate, mon. policy automatically eases to reduce the Fed Funds Rate by 0.5.

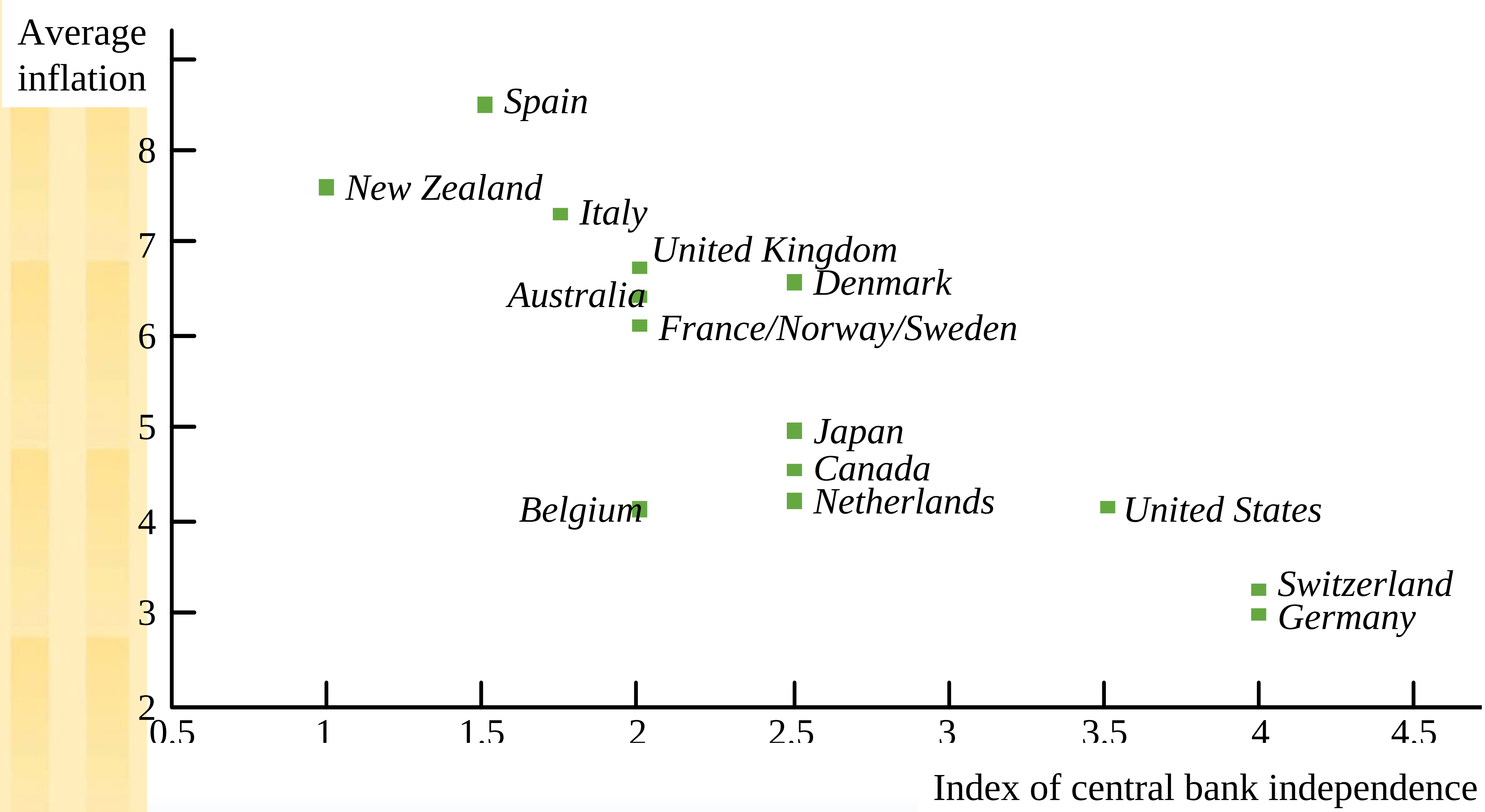
Does Greenspan follow the Taylor Rule?



Central Bank Independence

- A policy rule announced by Central Bank will work only if the announcement is credible.
- Credibility depends in part on degree of independence of central bank.

Inflation and Central Bank Independence



Chapter summary

1. Advocates of active policy believe:
   - frequent shocks lead to unnecessary fluctuations in output and employment
   - fiscal and monetary policy can stabilize the economy
2. Advocates of passive policy believe:
   - the long & variable lags associated with monetary and fiscal policy render them ineffective and possibly destabilizing
   - inept policy increases volatility in output, employment

Chapter summary

3. Advocates of discretionary policy believe:
   - discretion gives more flexibility to policymakers in responding to the unexpected
4. Advocates of policy rules believe:
   - the political process cannot be trusted: politicians make policy mistakes or use policy for their own interests
   - commitment to a fixed policy is necessary to avoid time inconsistency and maintain credibility

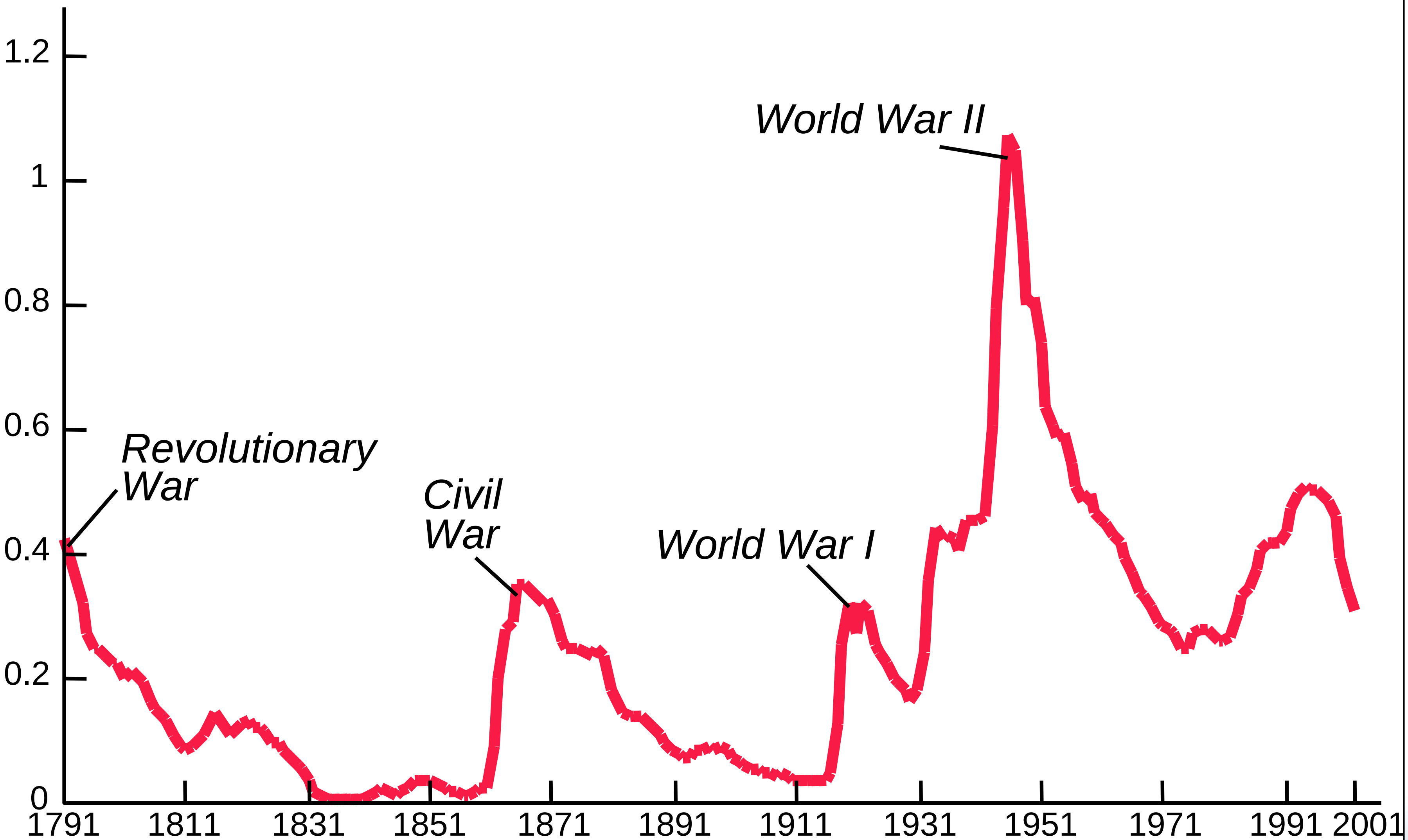
In this chapter you will learn about

- the size of the U.S. government's debt, and how it compares to that of other countries
- problems measuring the budget deficit
- the traditional and Ricardian views of the government debt
- other perspectives on the debt

Indebtedness of the World's Governments

Country	***Gov Debt*** (% of GDP)	***Country***	***Gov Debt*** (% of GDP)
Japan	119	Ireland	54
Italy	108	Spain	53
Belgium	105	Finland	51
Canada	101	Sweden	49
Greece	100	Germany	46
Denmark	67	Austria	40
U.K.	64	Netherlands	27
U.S.A.	62	Australia	26
France	58	Norway	24
Portugal	55		

The U.S. Government Debt-GDP ratio



The U.S. experience in recent years

Early 1980s through early 1990s

- Debt-GDP ratio: 25.5% in 1980, 48.9% in 1993
- Due to Reagan tax cuts, increases in defense spending & entitlements

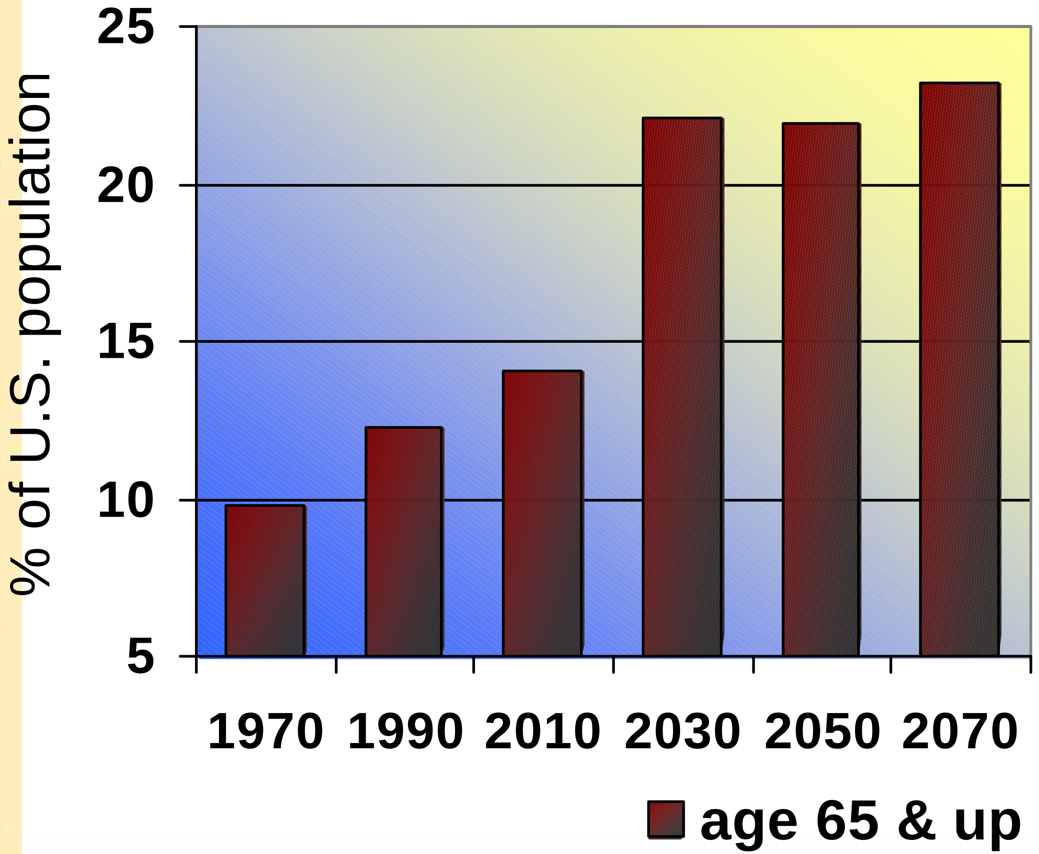
Early 1990s through 2000

- $290b deficit in 1992, $236b surplus in 2000
- debt-GDP ratio fell to 32.5% in 2000
- Due to rapid growth, stock market boom, tax hikes

2001

- The return of deficits, due to Bush tax cut and economic slowdown

The Fiscal Future



The aging population:

- lower birth rates
- increased life expectancy
- retirement of Baby Boomers

The Fiscal Future

- The number of people receiving Social Security, Medicare is growing faster than the number working, paying taxes
- Congressional Budget Office projections:

year	debt-GDP ratio
2030	40%
2040	93%
2050	206%

Problems Measuring the Deficit

1. Inflation
2. Capital assets
3. Uncounted liabilities
4. The business cycle

Measurement problem 1: Inflation

- To see why inflation is a problem, suppose the real debt is constant, which implies a zero real deficit.
- In this case, the nominal debt $\boldsymbol{D}$ grows at the rate of inflation:

$$\Delta \boldsymbol{D}/\boldsymbol{D} = \pi \quad \text{or} \quad \Delta \boldsymbol{D} = \pi \boldsymbol{D}$$

- The reported deficit (nominal) is $\pi \boldsymbol{D}$ even though the real deficit is zero.
- Hence, should subtract $\pi \boldsymbol{D}$ from the reported deficit to correct for inflation.

Measurement problem 1: Inflation

- Correcting the deficit for inflation can make a huge difference, especially when inflation is high.
- Example: In 1979,

  nominal deficit = \$28 billion

  inflation = 8.6%

  debt = \$495 billion

  $\pi \boldsymbol{D} = 0.086 \times \$495\text{b} = \$43\text{b}$

  real deficit = \$28b – \$43b = \$15b surplus

Measurement problem 2: Capital Assets

- Currently:
  deficit = change in debt
- Better: **Capital budgeting**
  deficit = (change in debt) – (change in assets)
- EX: Suppose govt sells an office building and uses the proceeds to pay down the debt.
  - Under current system, deficit would fall
  - Under capital budgeting, deficit unchanged, because fall in debt is offset by a fall in assets
- Problem w/ cap budgeting: determining which govt expenditures count as capital expenditures.

Measurement problem 3: Uncounted liabilities

Current measure of deficit omits important liabilities of the government:

- future pension payments owed to current govt workers
- future Social Security payments
- contingent liabilities (though hard to attach a dollar value when the outcome is uncertain)

Measurement problem 4: The business cycle

- The deficit varies over the business cycle due to automatic stabilizers (unemployment insurance, the income tax system).
- These are not measurement errors, but do make it harder to judge fiscal policy stance.

  EX: Is an observed increase in deficit due to a downturn or expansionary shift in fiscal policy?
- Solution: **cyclically adjusted budget deficit** (aka “full-employment deficit”) - based on estimates of what govt spending & revenues would be if economy were at the natural rates of output & unemployment.

The bottom line

We must exercise care
when interpreting
the reported deficit figures.

Is the govt debt really a problem?

Two viewpoints:

1. Traditional view
2. Ricardian view

The traditional view of a tax cut & corresponding increase in govt debt

- Short run: ↑***Y***, ↓ ***u***
- Long run:
  - ***Y*** and ***u*** back at their natural rates
  - closed economy: ↑***r***, ↓ ***I***
  - open economy: ↑ε, ↓***NX***
    (or higher trade deficit)
- Very long run:
  - slower growth until economy reaches new steady state with lower income per capita

The Ricardian View

- due to David Ricardo (1820),
  more recently advanced by Robert Barro
- According to **Ricardian equivalence**,
  a debt-financed tax cut has no effect on consumption, national saving, the real interest rate, investment, net exports, or real GDP, <u>even in the short run</u>.

The logic of Ricardian Equivalence

- Consumers are forward-looking, know that a debt-financed tax cut today implies an increase in future taxes that is equal---in present value---to the tax cut.
- Thus, the tax cut does not make consumers better off, so they do not raise consumption.
- They save the full tax cut in order to repay the future tax liability.
- Result: Private saving rises by the amount public saving falls, leaving national saving unchanged.

Problems with Ricardian Equivalence

- Myopia:
  Not all consumers think that far ahead,
  so they see the tax cut as a windfall.
- Borrowing constraints:
  Some consumers are not able to borrow enough to achieve their optimal consumption, and would therefore spend a tax cut.
- Future generations:
  If consumers expect that the burden of repaying a tax cut will fall on future generations, then a tax cut now makes them feel better off, so they increase spending.

Evidence against Ricardian Equivalence?

- Early 1980s:
  Huge Reagan tax cuts caused deficit to rise.
  National saving fell, the real interest rate rose, the exchange rate appreciated, and ***NX*** fell.
- 1992:
  President George H.W. Bush reduced income tax withholding to stimulate economy.
  This merely delayed taxes but didn't make consumers better off.
  Yet, almost half of consumers used part of this extra take-home pay for consumption.

Evidence against Ricardian Equivalence?

- Proponents of R.E. argue that the Reagan tax cuts did not provide a fair test of R.E.
  - Consumers may have expected the debt to be repaid with future spending cuts instead of future tax hikes.
  - Private saving may have fallen for reasons other than the tax cut, such as optimism about the economy.
- Because the data is subject to different interpretations, both views of govt debt survive.

Other perspectives on govt debt

1. Balanced budgets vs. optimal fiscal policy

Some politicians have proposed amending the U.S. Constitution to require balanced federal govt budget every year.

Many economists reject this proposal, arguing that deficit should be used to

- stabilize output & employment
- smooth taxes in the face of fluctuating income
- redistribute income across generations when appropriate

Other perspectives on govt debt

2. Fiscal effects on monetary policy

- govt deficits may be financed by printing money
- a high govt debt may be an incentive for policymakers to create inflation (to reduce real value of debt at expense of bond holders)

Fortunately:

- little evidence that the link between fiscal and monetary policy is important
- most governments know the folly of creating inflation
- most central banks have (at least some) political independence from fiscal policymakers

Other perspectives on govt debt

3. Debt and politics

"Fiscal policy is not made by angels..."
- Greg Mankiw, p.424

Some do not trust policymakers with deficit spending. They argue that

- policymakers do not worry about the true costs of their spending, since the burden falls on future taxpayers
- future taxpayers cannot participate in the decision process, and their interests may not be taken into account

This is another reason for the proposals for a balanced budget amendment, discussed above.

Other perspectives on govt debt

4. International dimensions

- Govt budget deficits can lead to trade deficits, which must be financed by borrowing from abroad.
- Large govt debt may increase the risk of capital flight, as foreign investors may perceive a greater risk of default.
- Large debt may reduce a country's political clout in international affairs.

Chapter summary

1. Relative to GDP, the U.S. government's debt is moderate compared to other countries

2. Standard figures on the deficit are imperfect measures of fiscal policy because they
   - are not corrected for inflation
   - do not account for changes in govt assets
   - omit some liabilities (e.g. future pension payments to current workers)
   - do not account for effects of business cycles

Chapter summary

3. In the traditional view, a debt-financed tax cut increases consumption and reduces national saving. In a closed economy, this leads to higher interest rates, lower investment, and a lower long-run standard of living. In an open economy, it causes an exchange rate appreciation, a fall in net exports (or increase in the trade deficit).
4. The Ricardian view holds that debt-financed tax cuts do not affect consumption or national saving, and therefore do not affect interest rates, investment, or net exports.

Chapter summary

5. Most economists oppose a strict balanced budget rule, as it would hinder the use of fiscal policy to stabilize output, smooth taxes, or redistribute the tax burden across generations.

6. Government debt can have other effects:
   - may lead to inflation
   - politicians can shift burden of taxes from current to future generations
   - may reduce country's political clout in international affairs or scare foreign investors into pulling their capital out of the country

Chapter overview

This chapter surveys the most prominent work on consumption:

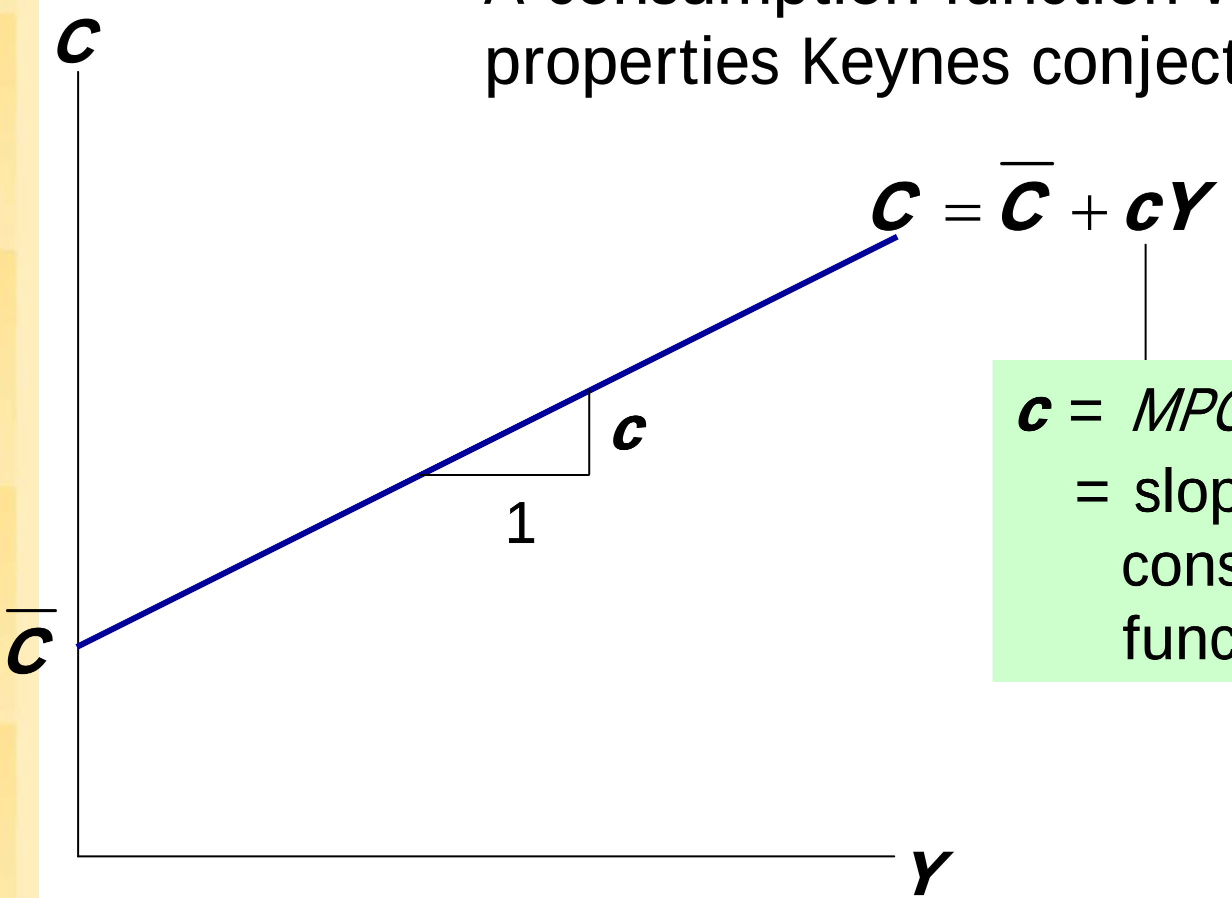
- John Maynard Keynes: consumption and current income
- Irving Fisher and Intertemporal Choice
- Franco Modigliani: the Life-Cycle Hypothesis
- Milton Friedman: the Permanent Income Hypothesis
- Robert Hall: the Random-Walk Hypothesis
- David Laibson: the pull of instant gratification

Keynes's Conjectures

1. $0 < MPC < 1$
2. *APC* falls as income rises
   where *APC*
   = **average propensity to consume**
   = $\boldsymbol{C/Y}$
3. Income is the main determinant of consumption.

The Keynesian Consumption Function

A consumption function with the properties Keynes conjectured:

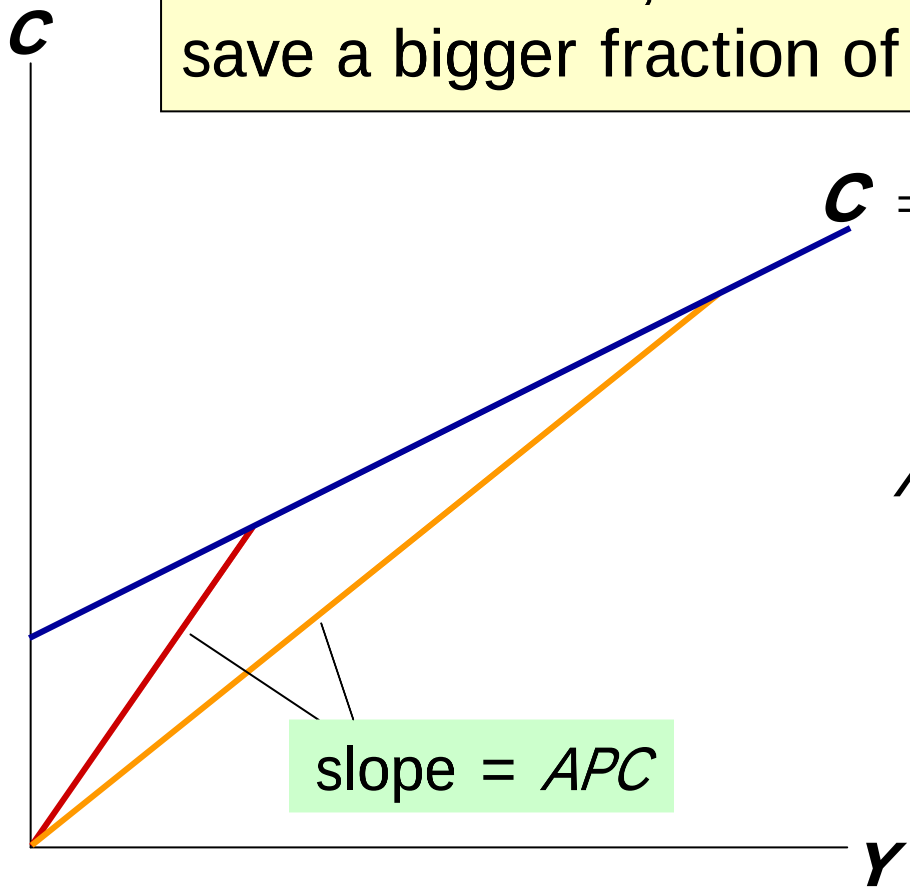


c = *MPC*

= slope of the consumption function

The Keynesian Consumption Function

As income rises, the APC falls (consumers save a bigger fraction of their income).



$$\boldsymbol{C} = \overline{\boldsymbol{C}} + \boldsymbol{cY}$$

$$APC = \frac{\boldsymbol{C}}{\boldsymbol{Y}} = \frac{\overline{\boldsymbol{C}}}{\boldsymbol{Y}} + \boldsymbol{c}$$

Early Empirical Successes: Results from Early Studies

- Households with higher incomes:
  - consume more

    $\Rightarrow$ $MPC > 0$
  - save more

    $\Rightarrow$ $MPC < 1$
  - save a larger fraction of their income

    $\Rightarrow$ $APC\downarrow$ as $\boldsymbol{Y}\uparrow$
- Very strong correlation between income and consumption

  $\Rightarrow$ income seemed to be the main determinant of consumption

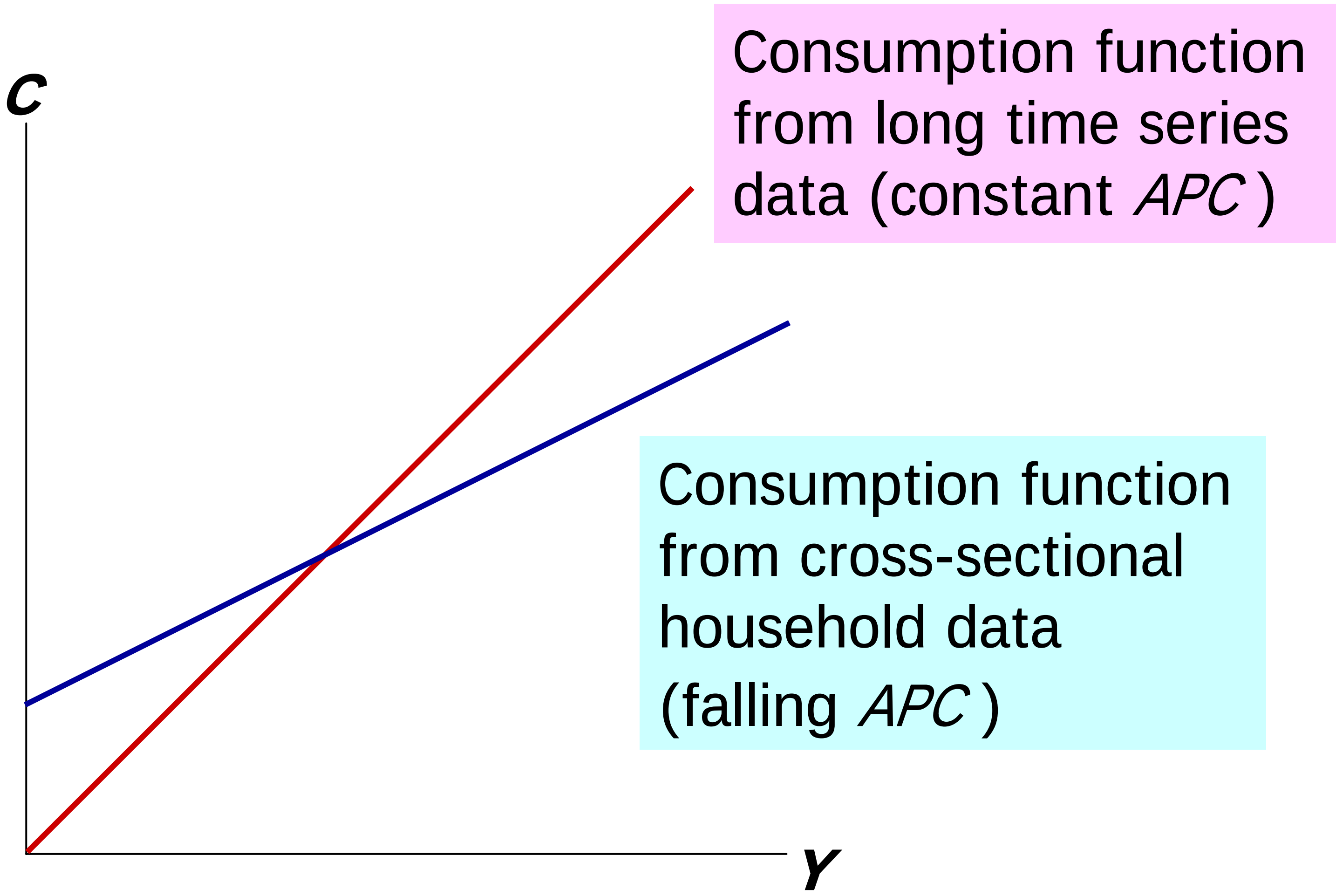
Problems for the Keynesian Consumption Function

Based on the Keynesian consumption function, economists predicted that ***C*** would grow more slowly than ***Y*** over time.

This prediction did not come true:

- As incomes grew, the APC did not fall, and ***C*** grew just as fast.
- Simon Kuznets showed that ***C/Y*** was very stable in long time series data.

The Consumption Puzzle



Irving Fisher and Intertemporal Choice

- The basis for much subsequent work on consumption.
- Assumes consumer is forward-looking and chooses consumption for the present and future to maximize lifetime satisfaction.
- Consumer's choices are subject to an **intertemporal budget constraint**, a measure of the total resources available for present and future consumption

The basic two-period model

- Period 1: the present
- Period 2: the future
- Notation

  Y_1 is income in period 1

  Y_2 is income in period 2

  C_1 is consumption in period 1

  C_2 is consumption in period 2

  $S = Y_1 - C_1$ is saving in period 1

  ($S < 0$ if the consumer borrows in period 1)

Deriving the intertemporal budget constraint

- Period 2 budget constraint:

$$\begin{aligned} C_2 &= Y_2 + (1+r)S \\ &= Y_2 + (1+r)(Y_1 - C_1) \end{aligned}$$

- Rearrange to put C terms on one side and Y terms on the other:

$$(1+r)C_1 + C_2 = Y_2 + (1+r)Y_1$$

- Finally, divide through by $(1+r)$:

The intertemporal budget constraint

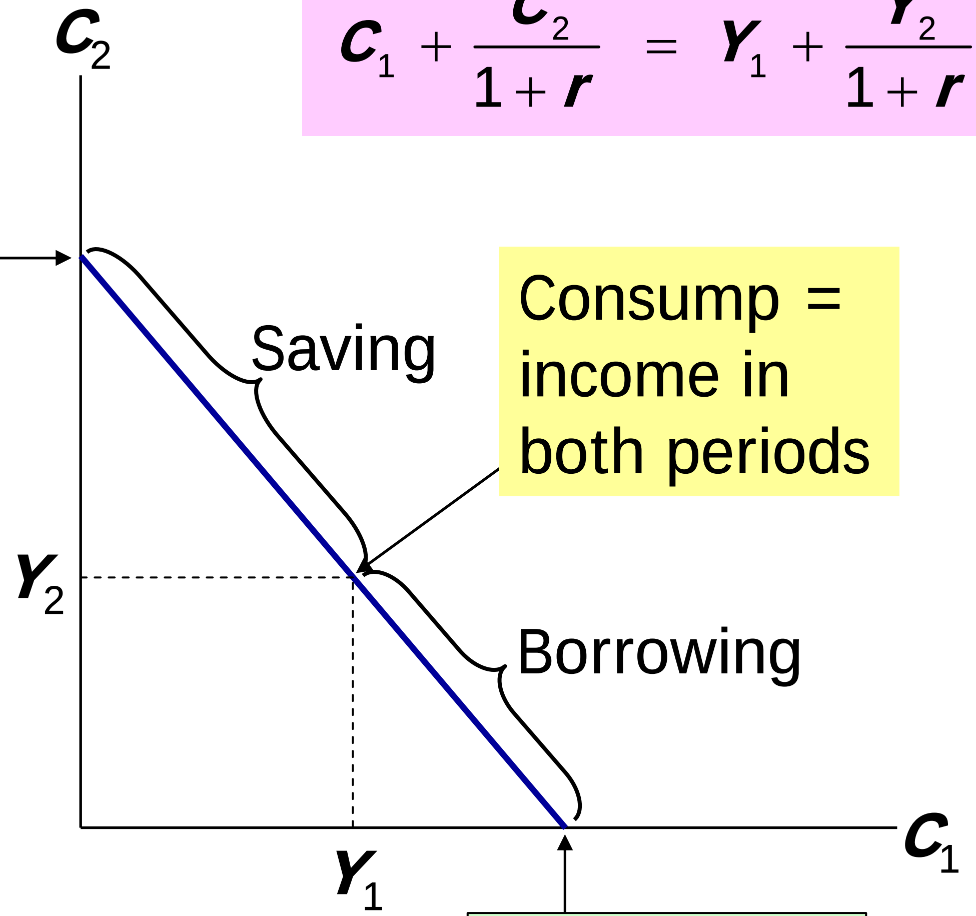
$$\underbrace{C_1 + \frac{C_2}{1+r}}_{\text{present value of lifetime consumption}} = \underbrace{Y_1 + \frac{Y_2}{1+r}}_{\text{present value of lifetime income}}$$

The intertemporal budget constraint

$$C_1 + \frac{C_2}{1+r} = Y_1 + \frac{Y_2}{1+r}$$

The budget constraint shows all combinations of C_1 and C_2 that just exhaust the consumer's resources.

$(1+r)Y_1 + Y_2$



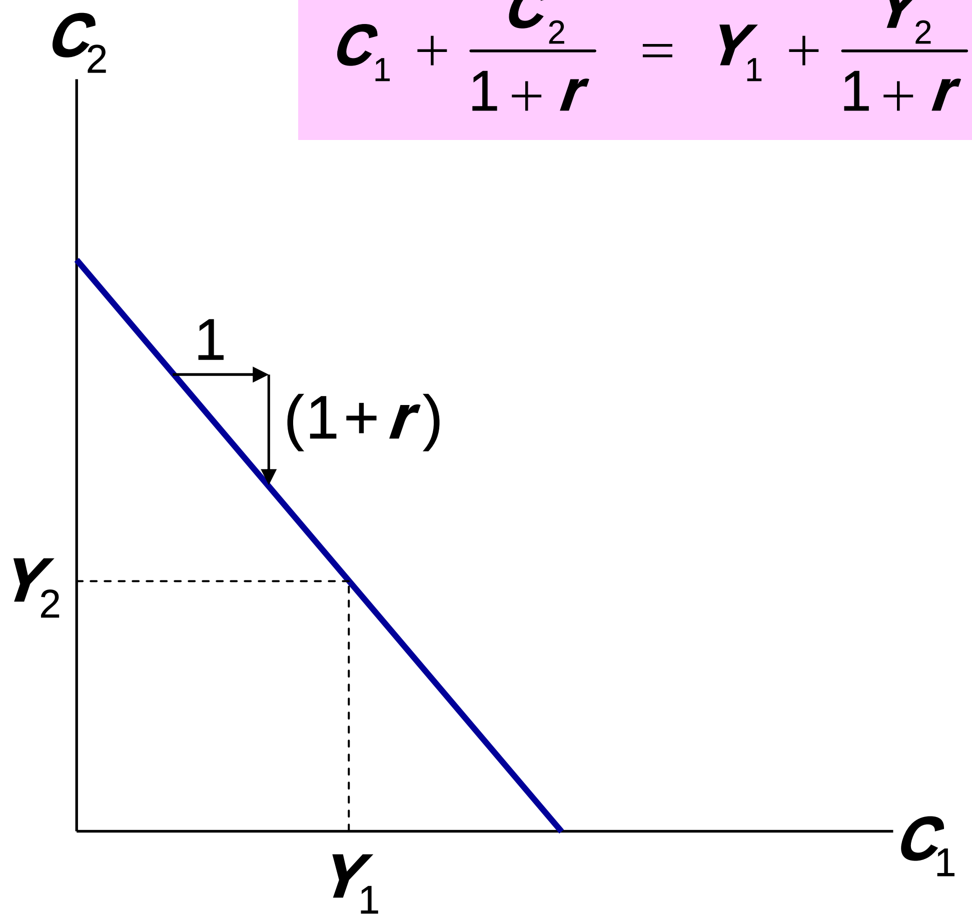
Consump = income in both periods

$Y_1 + Y_2/(1+r)$

The intertemporal budget constraint

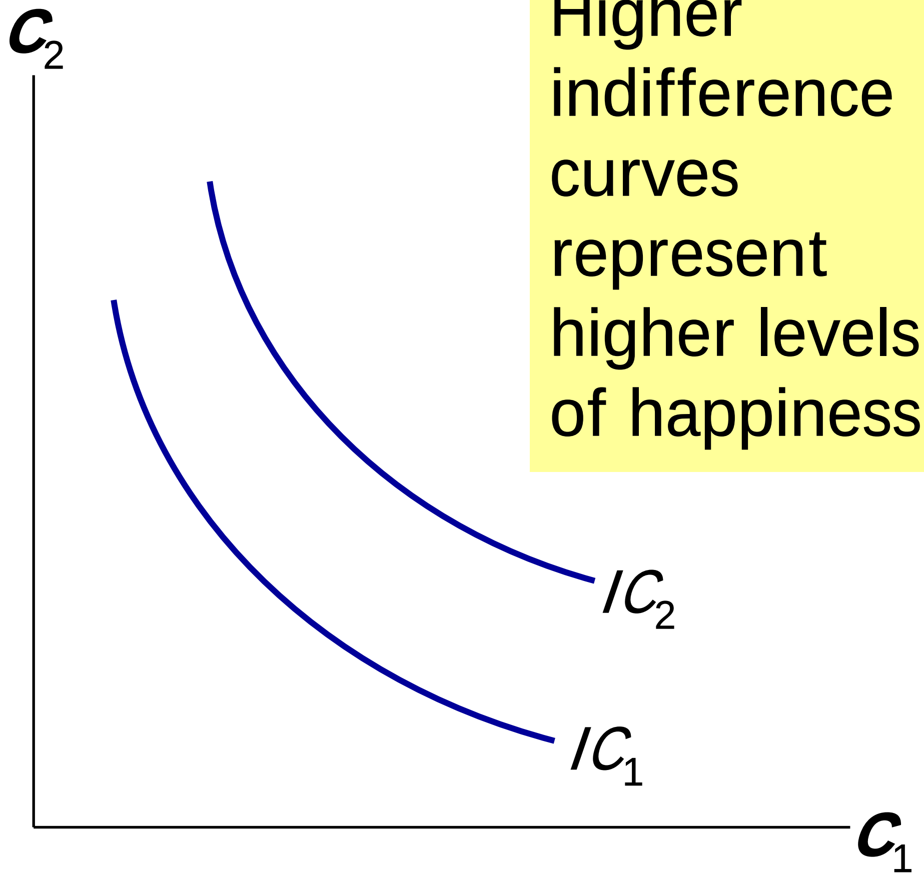
$$C_1 + \frac{C_2}{1+r} = Y_1 + \frac{Y_2}{1+r}$$

The slope of the budget line equals $-(1+r)$



Consumer preferences

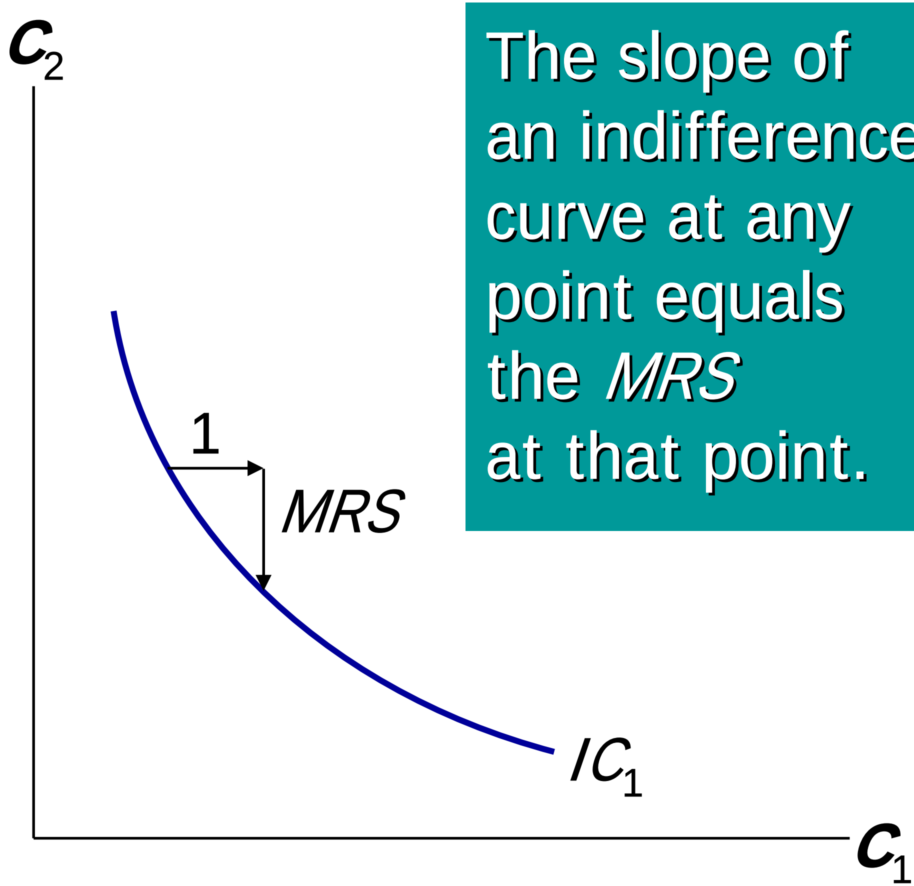
An **indifference curve** shows all combinations of C_1 and C_2 that make the consumer equally happy.



Higher indifference curves represent higher levels of happiness.

Consumer preferences

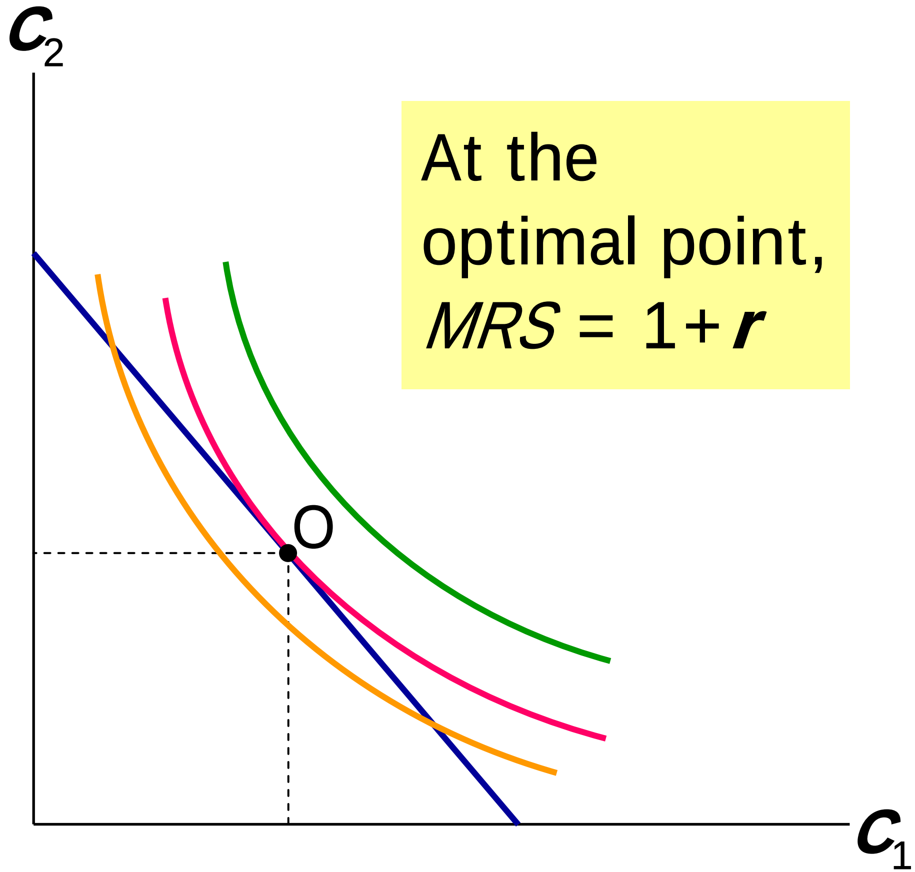
Marginal rate of substitution (*MRS*): the amount of C_2 consumer would be willing to substitute for one unit of C_1.



The slope of an indifference curve at any point equals the *MRS* at that point.

Optimization

The optimal (C_1, C_2) is where the budget line just touches the highest indifference curve.

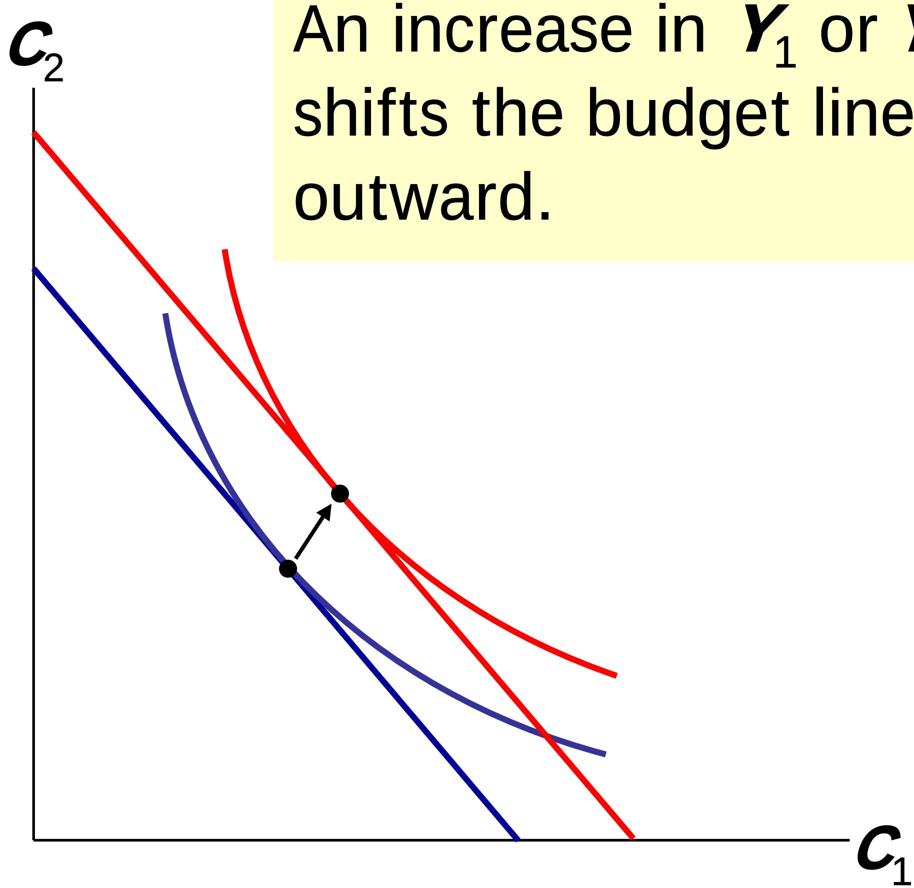


At the optimal point, $MRS = 1 + r$

How *C* responds to changes in *Y*

Results:
Provided they are both normal goods, C_1 and C_2 both increase,

...regardless of whether the income increase occurs in period 1 or period 2.



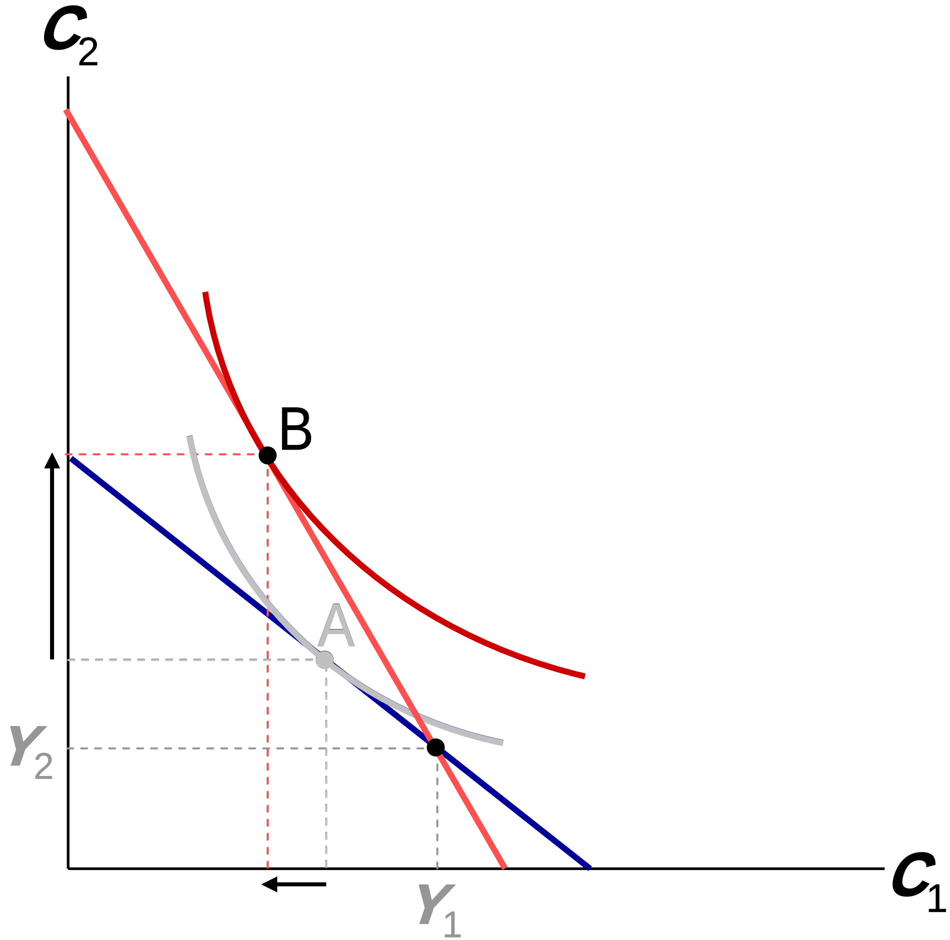
An increase in Y_1 or Y_2 shifts the budget line outward.

Keynes vs. Fisher

- Keynes:
  current consumption depends only on current income
- Fisher:
  current consumption depends only on the present value of lifetime income;
  the timing of income is irrelevant because the consumer can borrow or lend between periods.

How *C* responds to changes in *r*

An increase in r pivots the budget line around the point (Y_1, Y_2).



As depicted here, C_1 falls and C_2 rises. However, it could turn out differently...

How C responds to changes in r

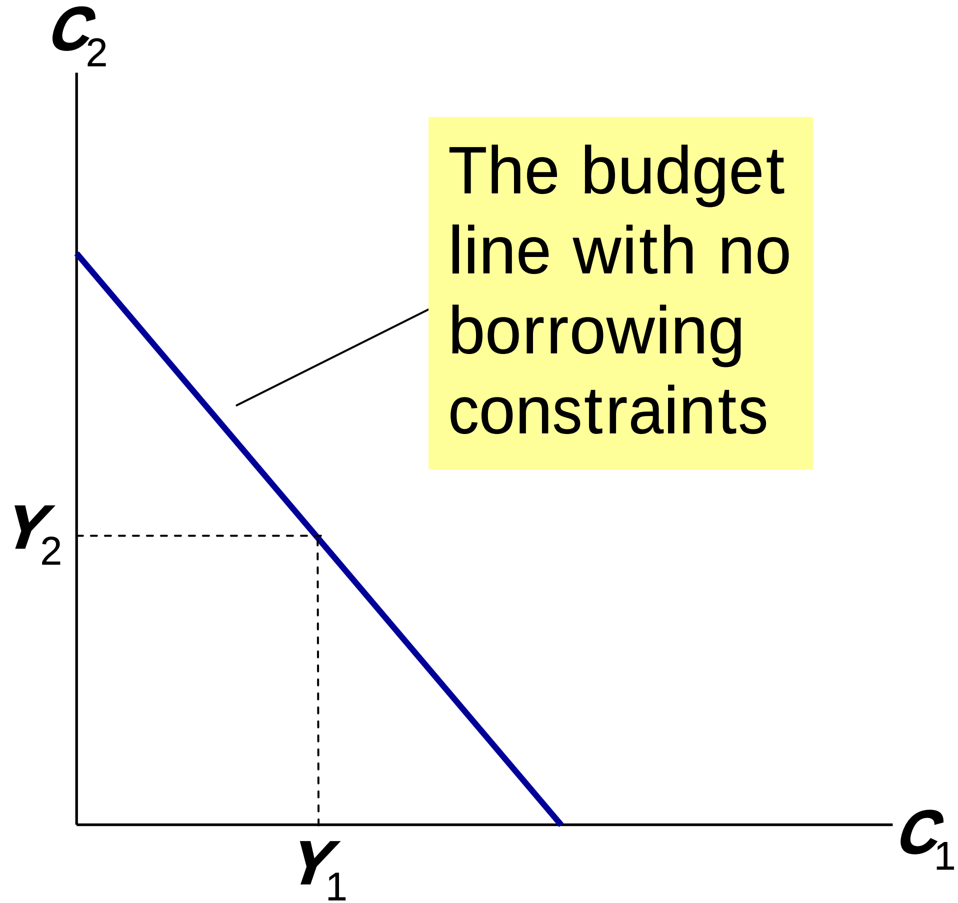
- <u>income effect</u>
  If consumer is a saver, the rise in r makes him better off, which tends to increase consumption in both periods.
- <u>substitution effect</u>
  The rise in r increases the opportunity cost of current consumption, which tends to reduce C_1 and increase C_2.
- Both effects $\Rightarrow \uparrow C_2$.
  Whether C_1 rises or falls depends on the relative size of the income & substitution effects.

Constraints on borrowing

- In Fisher's theory, the timing of income is irrelevant because the consumer can borrow and lend across periods.
- Example: If consumer learns that her future income will increase, she can spread the extra consumption over both periods by borrowing in the current period.
- However, if consumer faces **borrowing constraints** (aka "liquidity constraints"), then she may not be able to increase current consumption

  and her consumption may behave as in the Keynesian theory even though she is rational & forward-looking

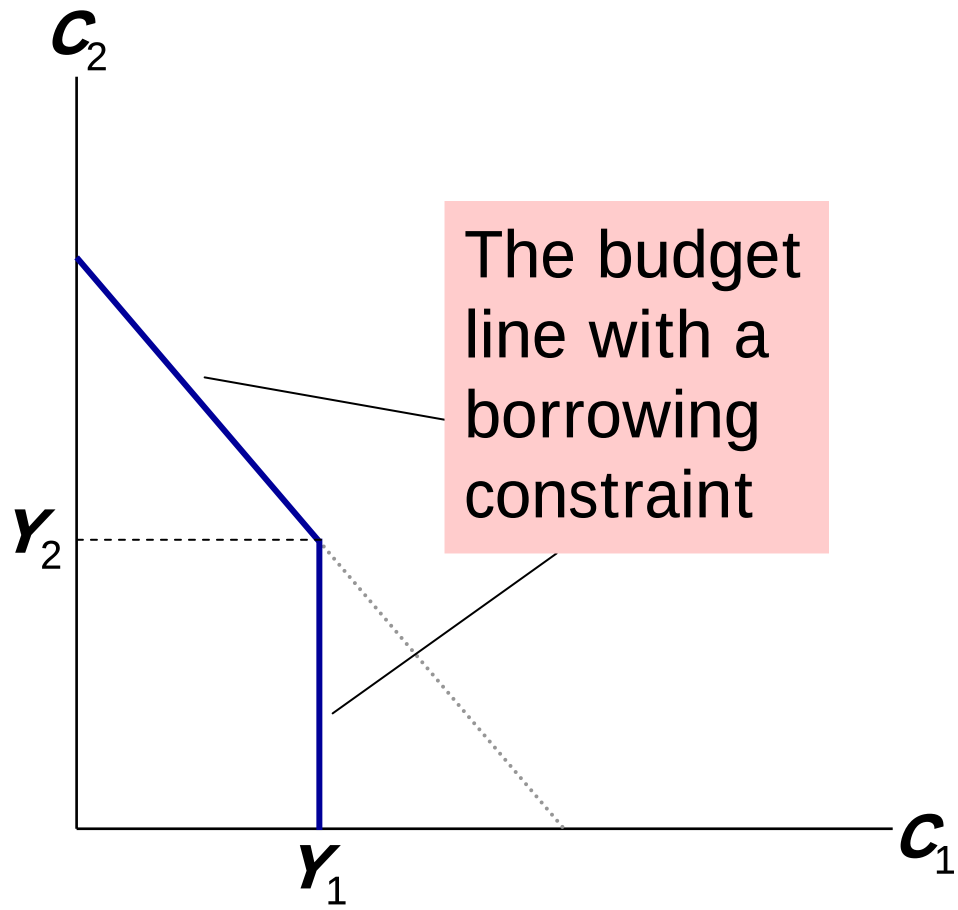
Constraints on borrowing



Constraints on borrowing

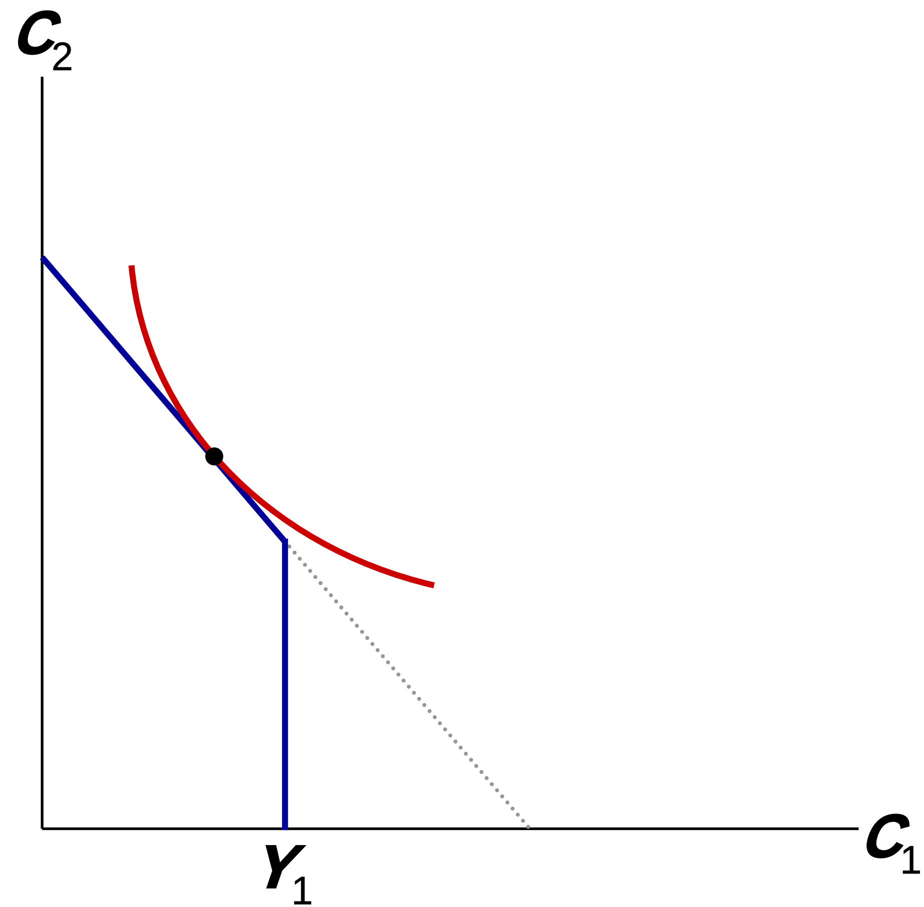
The borrowing constraint takes the form:

$$C_1 \leq Y_1$$



Consumer optimization when the borrowing constraint is **not binding**

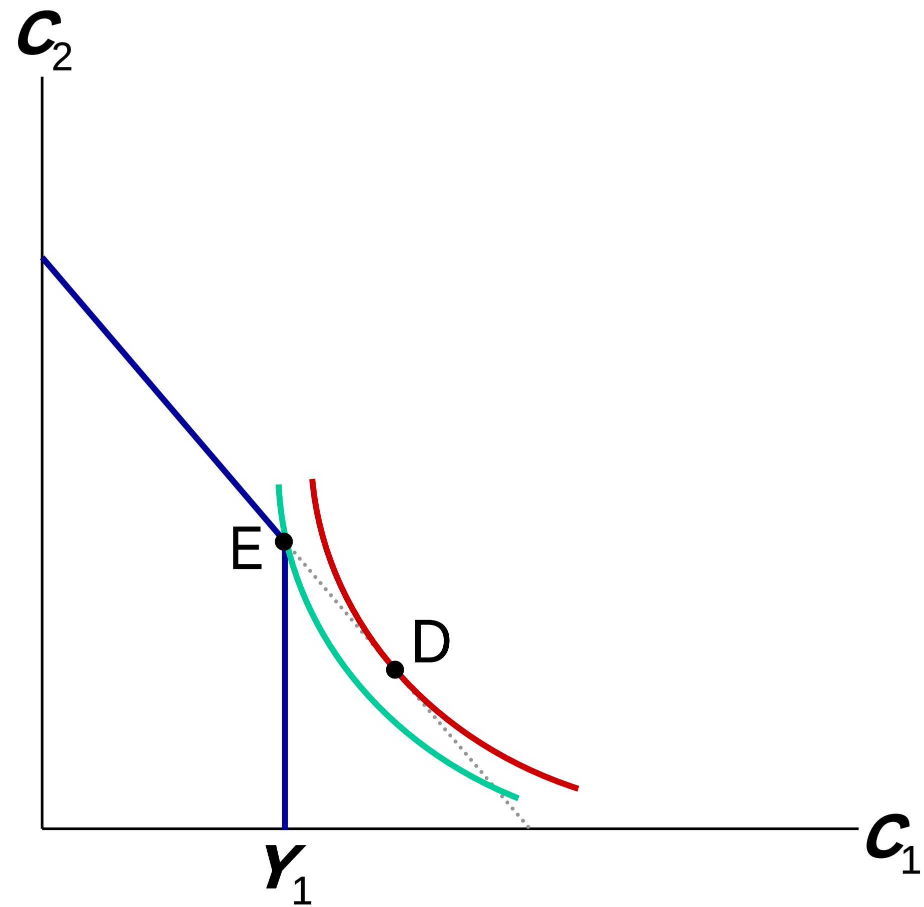
The borrowing constraint is not binding if the consumer's optimal C_1 is less than Y_1.



Consumer optimization when the borrowing constraint is binding

The optimal choice is at point D.

But since the consumer cannot borrow, the best he can do is point E.



The Life-Cycle Hypothesis

- due to Franco Modigliani (1950s)
- Fisher's model says that consumption depends on lifetime income, and people try to achieve smooth consumption.
- The LCH says that income varies systematically over the phases of the consumer's "life cycle," and saving allows the consumer to achieve smooth consumption.

The Life-Cycle Hypothesis

- The basic model:

  W = initial wealth

  Y = annual income until retirement (assumed constant)

  R = number of years until retirement

  T = lifetime in years

- Assumptions:
  - zero real interest rate (for simplicity)
  - consumption-smoothing is optimal

The Life-Cycle Hypothesis

- Lifetime resources = $\boldsymbol{W} + \boldsymbol{RY}$
- To achieve smooth consumption, consumer divides her resources equally over time:

$$\boldsymbol{C} = (\boldsymbol{W} + \boldsymbol{RY})/\boldsymbol{T}, \text{ or}$$

$$\boldsymbol{C} = \alpha \boldsymbol{W} + \beta \boldsymbol{Y}$$

where

$\alpha = (1/\boldsymbol{T})$ is the marginal propensity to consume out of wealth

$\beta = (\boldsymbol{R}/\boldsymbol{T})$ is the marginal propensity to consume out of income

Implications of the Life-Cycle Hypothesis

The Life-Cycle Hypothesis can solve the consumption puzzle:

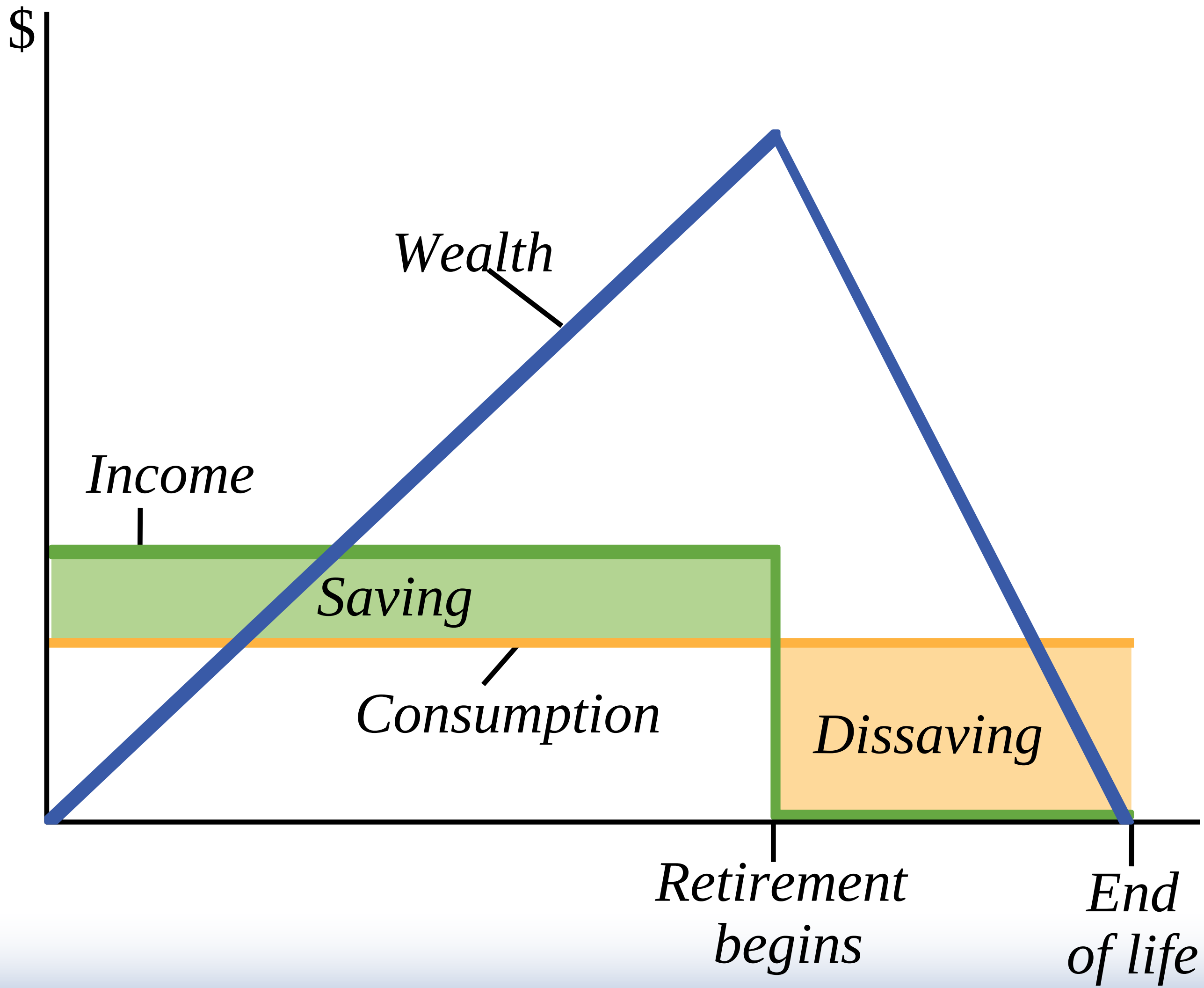
- The *APC* implied by the life-cycle consumption function is

$$C/Y = \alpha(W/Y) + \beta$$

- Across households, wealth does not vary as much as income, so high income households should have a lower APC than low income households.
- Over time, aggregate wealth and income grow together, causing APC to remain stable.

Implications of the Life-Cycle Hypothesis

The LCH implies that saving varies systematically over a person's lifetime.



The Permanent Income Hypothesis

- due to Milton Friedman (1957)
- The PIH views current income Y as the sum of two components:

  permanent income Y^P
  (average income, which people expect to persist into the future)

  transitory income Y^T
  (temporary deviations from average income)

The Permanent Income Hypothesis

- Consumers use saving & borrowing to smooth consumption in response to transitory changes in income.
- The PIH consumption function:

$$C = \alpha Y^P$$

where α is the fraction of permanent income that people consume per year.

The Permanent Income Hypothesis

The PIH can solve the consumption puzzle:

- The PIH implies

  $$APC = \boldsymbol{C/Y} = \alpha \boldsymbol{Y^P/Y}$$

- To the extent that high income households have higher transitory income than low income households, the APC will be lower in high income households.
- Over the long run, income variation is due mainly if not solely to variation in permanent income, which implies a stable *APC*.

PIH vs. LCH

- In both, people try to achieve smooth consumption in the face of changing current income.
- In the LCH, current income changes systematically as people move through their life cycle.
- In the PIH, current income is subject to random, transitory fluctuations.
- Both hypotheses can explain the consumption puzzle.

The Random-Walk Hypothesis

- due to Robert Hall (1978)
- based on Fisher's model & PIH, in which forward-looking consumers base consumption on expected future income
- Hall adds the assumption of **rational expectations**, that people use all available information to forecast future variables like income.

The Random-Walk Hypothesis

- If PIH is correct and consumers have rational expectations, then consumption should follow a **random walk**: changes in consumption should be unpredictable.
  - A change in income or wealth that was anticipated has already been factored into expected permanent income, so it will not change consumption.
  - Only unanticipated changes in income or wealth that alter expected permanent income will change consumption.

Implication of the R-W Hypothesis

If consumers obey the PIH
and have rational expectations,
then policy changes
will affect consumption
only if they are unanticipated.

The Psychology of Instant Gratification

- Theories from Fisher to Hall assumes that consumers are rational and act to maximize lifetime utility.
- recent studies by David Laibson and others consider the psychology of consumers.

The Psychology of Instant Gratification

- Consumers consider themselves to be imperfect decision-makers.
  - E.g., in one survey, 76% said they were not saving enough for retirement.
- Laibson: The "pull of instant gratification" explains why people don't save as much as a perfectly rational lifetime utility maximizer would save.

Two Questions and Time Inconsistency

1. Would you prefer
   (A) a candy today, or
   (B) two candies tomorrow?
2. Would you prefer
   (A) a candy in 100 days, or
   (B) two candies in 101 days?

In studies, most people answered A to question 1, and B to question 2.

A person confronted with question 2 may choose B. 100 days later, when he is confronted with question 1, the pull of instant gratification may induce him to change his mind.

Summing up

- Keynes suggested that consumption depends primarily on current income.
- Recent work suggests instead that consumption depends on
  – current income
  – expected future income
  – wealth
  – interest rates
- Economists disagree over the relative importance of these factors and of borrowing constraints and psychological factors.

Chapter summary

1. Keynesian consumption theory
   - Keynes' conjectures
     - *MPC* is between 0 and 1
     - *APC* falls as income rises
     - current income is the main determinant of current consumption
   - Empirical studies
     - in household data & short time series: confirmation of Keynes' conjectures
     - in long time series data:
       APC does not fall as income rises

Chapter summary

2. Fisher's theory of intertemporal choice
   - Consumer chooses current & future consumption to maximize lifetime satisfaction subject to an intertemporal budget constraint.
   - Current consumption depends on lifetime income, not current income, provided consumer can borrow & save.
3. Modigliani's Life-Cycle Hypothesis
   - Income varies systematically over a lifetime.
   - Consumers use saving & borrowing to smooth consumption.
   - Consumption depends on income & wealth.

Chapter summary

4. Friedman's Permanent-Income Hypothesis
   - Consumption depends mainly on permanent income.
   - Consumers use saving & borrowing to smooth consumption in the face of transitory fluctuations in income.
5. Hall's Random-Walk Hypothesis
   - Combines PIH with rational expectations.
   - Main result: changes in consumption are unpredictable, occur only in response to unanticipated changes in expected permanent income.

Chapter summary

6. Laibson and the pull of instant gratification
   - Uses psychology to understand consumer behavior.
   - The desire for instant gratification causes people to save less than they rationally know they should.

Learning objectives

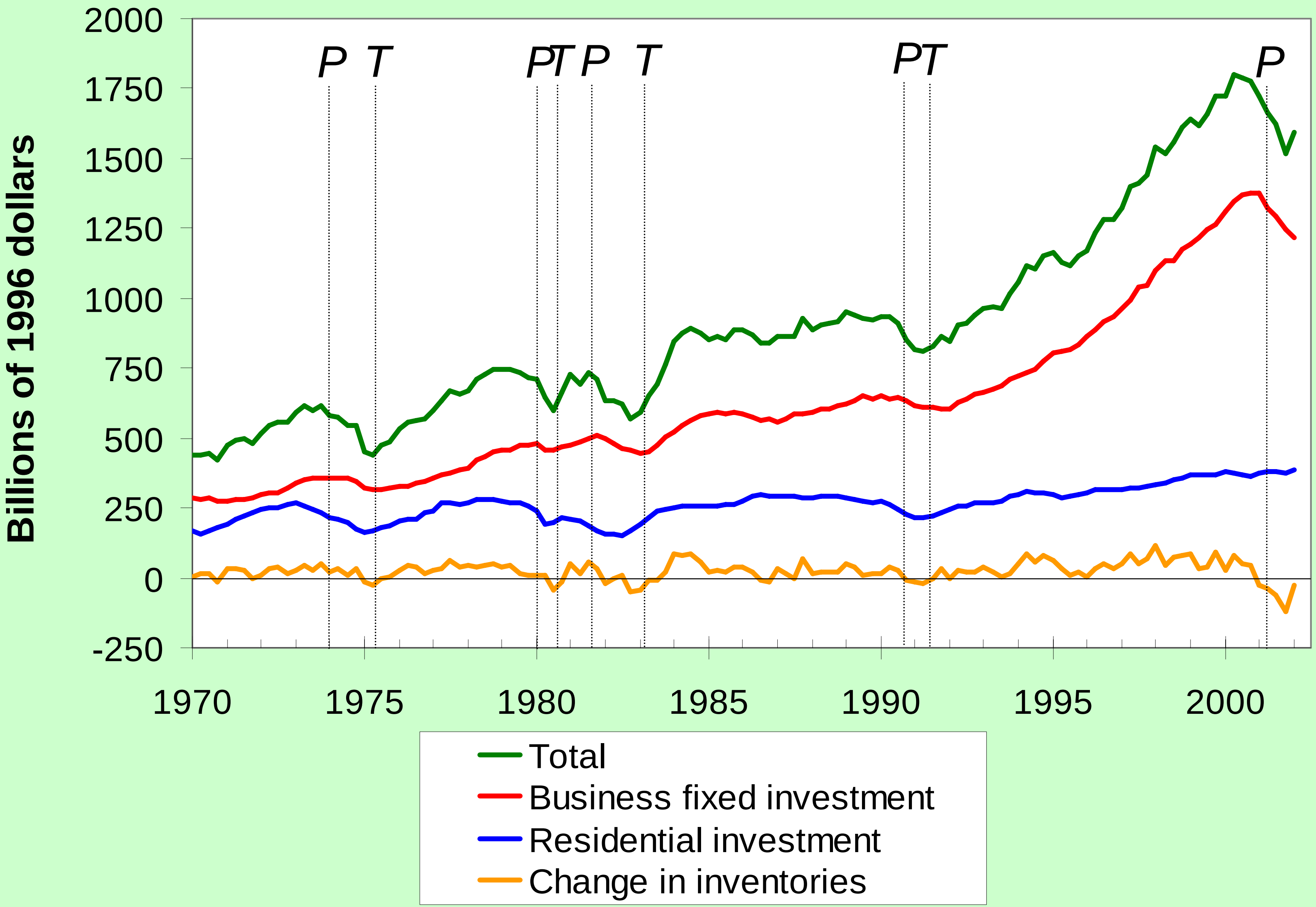
In this chapter, you will learn:

- leading theories to explain each type of investment
- why investment is negatively related to the interest rate
- things that shift the investment function
- why investment rises during booms and falls during recessions

Types of Investment

- **Business fixed investment**:
  businesses' spending on equipment and structures for use in production
- **Residential investment**:
  purchases of new housing units
  (either by occupants or landlords)
- **Inventory investment**:
  the value of the change in inventories
  of finished goods, materials and supplies, and work in progress.

U.S. Investment and its components, 1970-2002



Understanding business fixed investment

- The standard model of business fixed investment:
  the neoclassical model of investment
- Shows how investment depends on
  - MPK
  - interest rate
  - tax rules affecting firms

Two types of firms

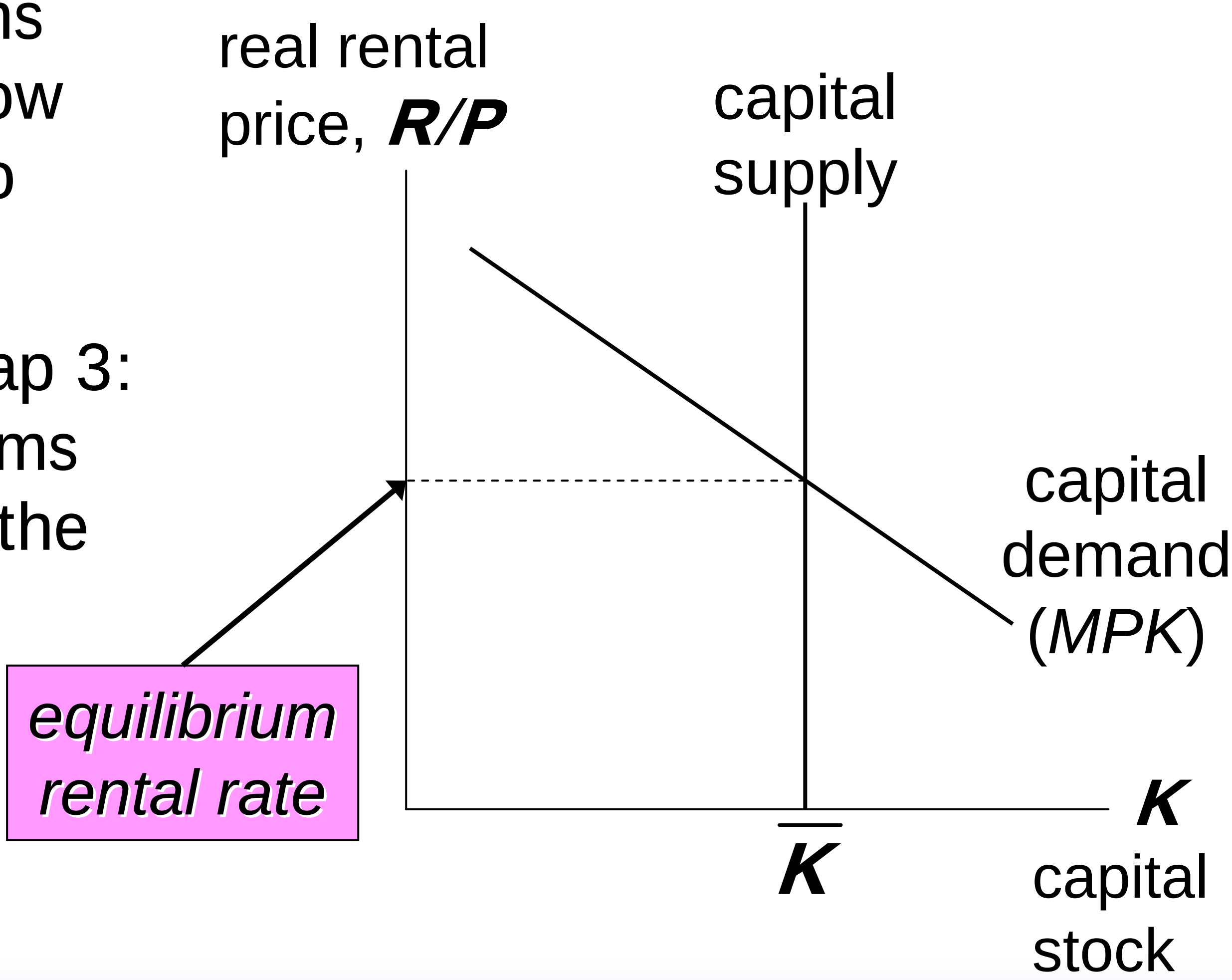
For simplicity, assume two types of firms:

1. *Production firms* rent the capital they use to produce goods and services.
2. *Rental firms* own capital, rent it out to production firms.

In this context,
"investment" is the rental firms' spending on new capital goods.

The capital rental market

- Production firms must decide how much capital to rent.
- Recall from chap 3: Competitive firms rent capital to the point where MPK = ***R/P***.



Factors that affect the rental price

For the Cobb-Douglas production function,

$$Y = AK^{\alpha}L^{1-\alpha}$$

the MPK (and hence equilibrium ***R/P***) is

$$\frac{R}{P} = MPK = \alpha A\left(L/K\right)^{1-\alpha}$$

The equilibrium ***R/P*** would increase if:

- $\downarrow$***K*** *(due, e.g., to earthquake or war)*
- $\uparrow$***L*** *(due, e.g., to pop. growth or immigration)*
- $\uparrow$***A*** *(technological improvement, or deregulation)*

Rental firms' investment decisions

Rental firms invest in new capital when the benefit of doing so exceeds the cost.

The benefit (per unit capital):

R/P, the income that rental firms earn from renting the unit of capital out to production firms.

The cost of capital

Components of the cost of capital:

- *interest cost:* $\boldsymbol{i} \times \boldsymbol{P}_{\mathbf{K}}$,
  where $\boldsymbol{P}_{\mathbf{K}}$ = nominal price of capital
- *depreciation cost:* $\delta \times \boldsymbol{P}_{\mathbf{K}}$,
  where δ = rate of depreciation
- *capital loss:* $-\Delta \boldsymbol{P}_{\mathbf{K}}$
  (A capital gain, $\Delta \boldsymbol{P}_{\mathbf{K}} > 0$, reduces cost of $\boldsymbol{K}$)

The total cost of capital is the sum of these three parts:

The cost of capital

Nominal cost of capital $= i\,P_K + \delta P_K - \Delta P_K = P_K\left(i + \delta - \dfrac{\Delta P_K}{P_K}\right)$

Example car rental company (capital: cars)

Suppose P_K = \$10,000, i = 0.10, δ = 0.20,

and $\Delta P_K / P_K$ = 0.06

Then,

interest cost	=	\$1000
depreciation cost	=	\$2000
capital loss	=	– \$600
total cost	=	**\$2400**

The cost of capital

For simplicity, assume $\Delta \boldsymbol{P_K} / \boldsymbol{P_K} = \pi$.

Then, the nominal cost of capital equals

$$\boldsymbol{P_K}(\boldsymbol{i} + \delta - \pi) = \boldsymbol{P_K}(\boldsymbol{r} + \delta)$$

and the real cost of capital equals $\dfrac{\boldsymbol{P_K}}{\boldsymbol{P}}(\boldsymbol{r} + \delta)$

The real cost of capital depends positively on:

- the relative price of capital
- the real interest rate
- the depreciation rate

The rental firm's profit rate

Firm's net investment depends on the profit rate:

$$\text{Profit rate} = \frac{\boldsymbol{R}}{\boldsymbol{P}} - \frac{\boldsymbol{P_K}}{\boldsymbol{P}}(\boldsymbol{r} + \delta) = \boldsymbol{MPK} - \frac{\boldsymbol{P_K}}{\boldsymbol{P}}(\boldsymbol{r} + \delta)$$

- If profit rate > 0,
  then it's profitable for firm to increase ***K***
- If profit rate < 0, then firm increases profits by reducing its capital stock.
  (Firm reduces ***K*** by not replacing it as it depreciates)

Net investment & gross investment

Hence,

$$\text{net investment} = \Delta \boldsymbol{K} = \boldsymbol{I}_n\left[\boldsymbol{MPK} - \left(\boldsymbol{P}_K/\boldsymbol{P}\right)\left(\boldsymbol{r} + \delta\right)\right]$$

where $\boldsymbol{I}_n(\ )$ is a function showing how net investment responds to the incentive to invest.

Total spending on business fixed investment equals net investment plus the replacement of depreciated capital:

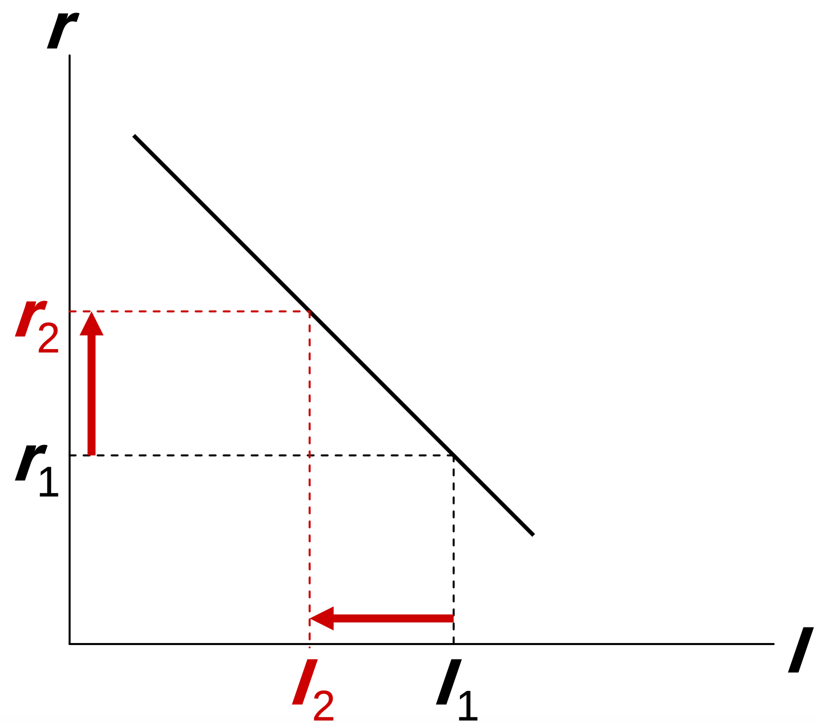
$$\begin{aligned}\text{gross investment} &= \Delta \boldsymbol{K} + \delta \boldsymbol{K} \\ &= \boldsymbol{I}_n\left[\boldsymbol{MPK} - \left(\boldsymbol{P}_K/\boldsymbol{P}\right)\left(\boldsymbol{r} + \delta\right)\right] + \delta \boldsymbol{K}\end{aligned}$$

The investment function

$$I = I_n\left[MPK - \left(P_K/P\right)\left(r+\delta\right)\right] + \delta K$$

An increase in r

- raises the cost of capital
- reduces the profit rate
- and reduces investment:

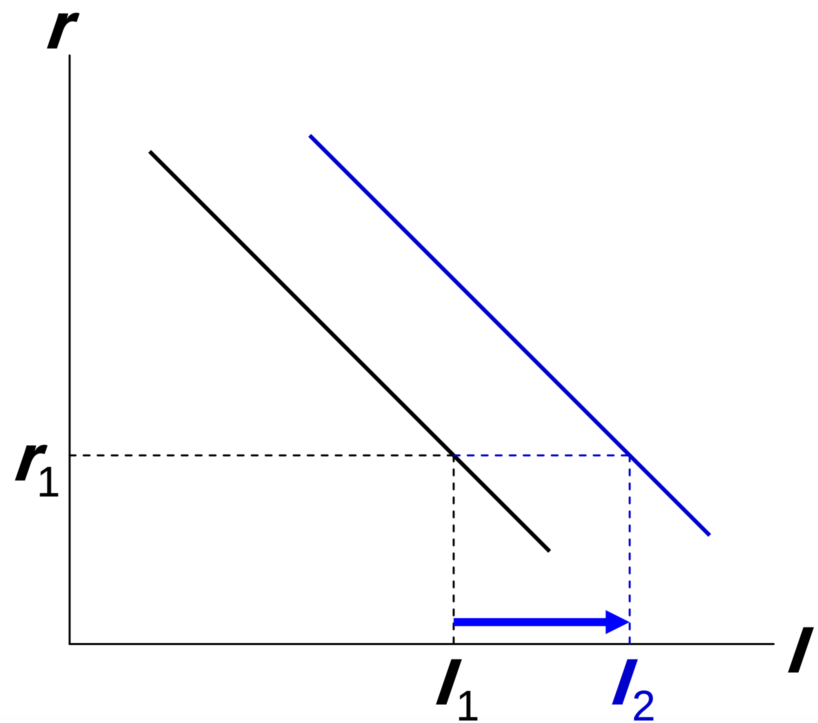


The investment function

$$I = I_n\left[MPK - \left(P_K/P\right)\left(r + \delta\right)\right] + \delta K$$

An increase in MPK or decrease in P_K/P

- increases the profit rate
- increases investment at any given interest rate
- shifts I curve to the right.



Taxes and Investment

Two of the most important taxes affecting investment:

1. Corporate income tax
2. Investment tax credit

Corporate Income Tax: A tax on profits

Impact on investment depends on definition of “profits”

- If the law used our definition (rental price minus cost of capital), then the tax doesn’t affect investment.
- In our definition, depreciation cost is measured using the current price of capital.
- But, legal definition uses the historical price of capital.
- If P_K rises over time, then the legal definition understates the true cost and overstates profit, so firms could be taxed even if their true economic profit is zero.
- Thus, corporate income tax discourages investment.

The investment tax credit (ITC)

- The ITC reduces a firm's taxes by a certain amount for each dollar it spends on capital
- Hence, the ITC effectively reduces P_K
- which increases the profit rate and the incentive to invest.

Tobin's *q*

$$q = \frac{\text{Market value of installed capital}}{\text{Replacement cost of installed capital}}$$

- *numerator:* the stock market value of the economy's capital stock
- *denominator:* the actual cost to replace the capital goods that were purchased when the stock was issued
- If $q > 1$, firms buy more capital to raise the market value of their firms
- If $q < 1$, firms do not replace capital as it wears out.

Relation between *q* theory and neoclassical theory described above

$$q = \frac{\text{Market value of installed capital}}{\text{Replacement cost of installed capital}}$$

- The stock market value of capital depends on the current & expected future profits of capital.
- If MPK > cost of capital,
  then profit rate is high, which drives up the stock market value of the firms, which implies a high value of q.
- If MPK < cost of capital, then firms are incurring loses, so their stock market value falls, and q is low.

The stock market and GDP

Why one might expect a relationship between the stock market and GDP:

1. A wave of pessimism about future profitability of capital would
   - cause stock prices to fall
   - cause Tobin's q to fall
   - shift the investment function down
   - cause a negative aggregate demand shock

The stock market and GDP

Why one might expect a relationship between the stock market and GDP:

2. A fall in stock prices would
   - reduce household wealth
   - shift the consumption function down
   - cause a negative aggregate demand shock

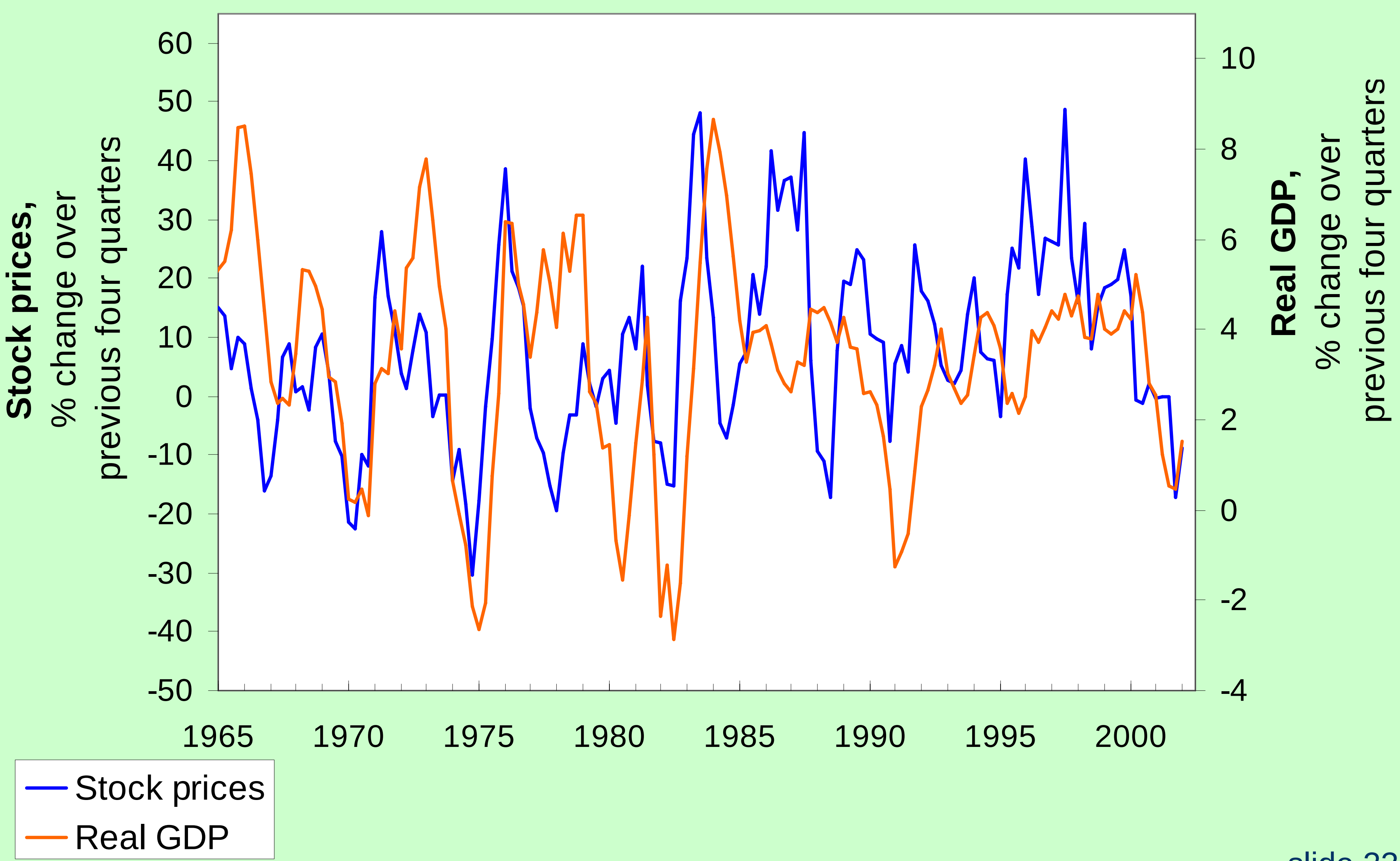
The stock market and GDP

Why one might expect a relationship between the stock market and GDP:

3. A fall in stock prices might reflect bad news about technological progress and long-run economic growth.

   This implies that aggregate supply and full-employment output will be expanding more slowly than people had expected.

The stock market and GDP



Financing constraints

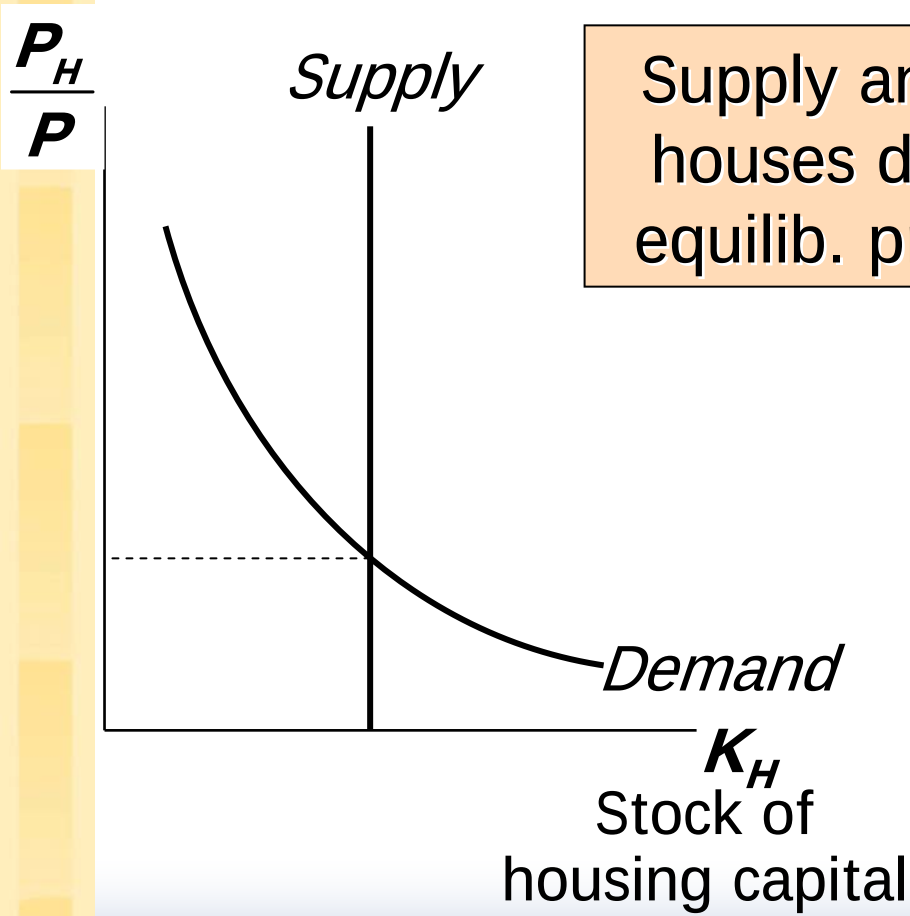
- Neoclassical theory assumes firms can borrow to buy capital whenever doing so is profitable
- But some firms face **financing constraints**: limits on the amounts they can borrow (or otherwise raise in financial markets)
- A recession reduces current profits.
  If future profits expected to be high,
  it might be worthwhile to continue to invest.
  But if firm faces financing constraints,
  then firm might be unable to obtain funds
  due to current profits being low.

Residential investment

- The flow of new residential investment, $\boldsymbol{I_H}$, depends on the relative price of housing, $\boldsymbol{P_H / P}$.
- $\boldsymbol{P_H / P}$ is determined by supply and demand in the market for existing houses.

How residential investment is determined

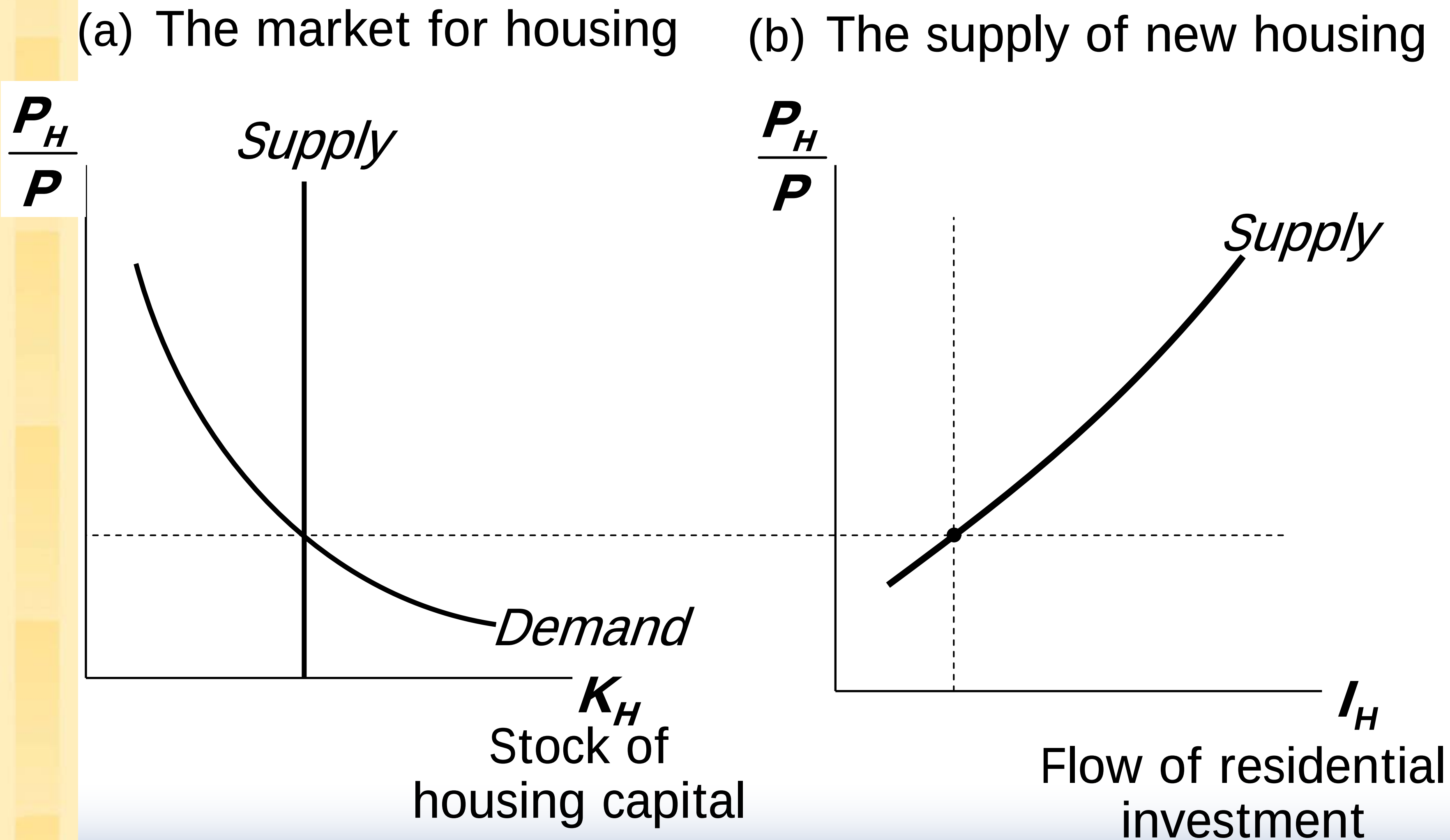
(a) The market for housing



Supply and demand for houses determines the equilib. price of houses.

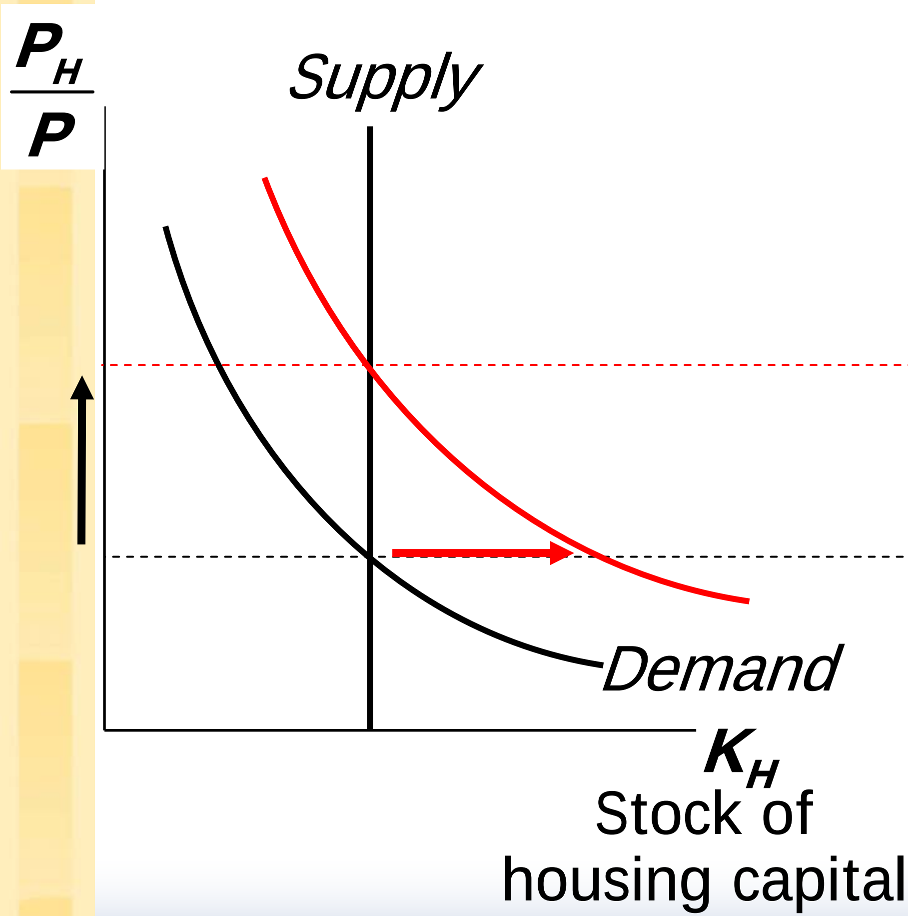
The equilibrium price of houses then determines residential investment:

How residential investment is determined

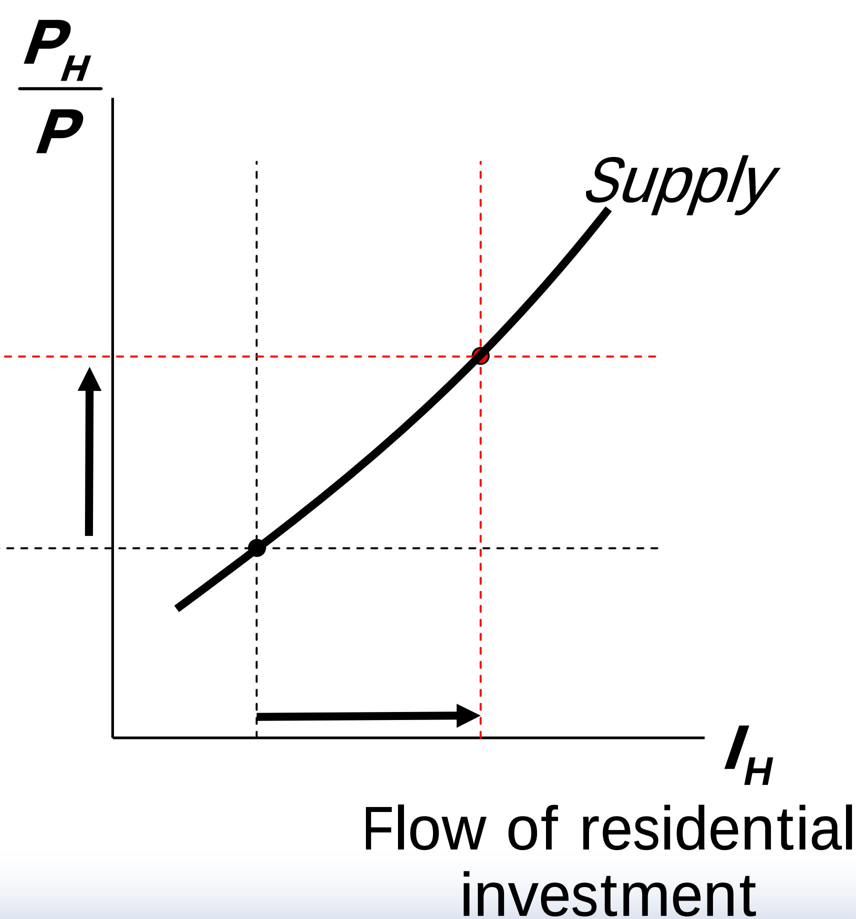


How residential investment responds to a fall in interest rates

(a) The market for housing



(b) The supply of new housing



The tax treatment of housing

- The tax code, in effect, subsidizes home ownership by allowing people to deduct mortgage interest.
- The deduction applies to the <u>nominal</u> mortgage rate, so this subsidy is higher when inflation and nominal mortgage rates are high than when they are low.
- Some economists think this subsidy causes over-investment in housing relative to other forms of capital
- But eliminating the mortgage interest deduction would be politically difficult.

Inventory Investment

Inventory investment is only about 1% of GDP

Yet, in the typical recession, more than half of the fall in spending is due to a fall in inventory investment.

Motives for holding inventories

1. **production smoothing**

   Sales fluctuate, but many firms find it cheaper to produce at a steady rate.

   When sales < production, inventories rise.

   When sales > production, inventories fall.

Motives for holding inventories

1. **production smoothing**
2. **inventories as a factor of production**

   Inventories allow some firms to operate more efficiently.

   - samples for retail sales purposes
   - spare parts for when machines break down

Motives for holding inventories

1. **production smoothing**
2. **inventories as a factor of production**
3. **stock-out avoidance**

   To prevent lost sales in the event of higher than expected demand.

Motives for holding inventories

1. **production smoothing**
2. **inventories as a factor of production**
3. **stock-out avoidance**
4. **work in process**

   Goods not yet completed are counted as part of inventory.

The Accelerator Model

A simple theory that explains the behavior of inventory investment, without endorsing any particular motive

The Accelerator Model

- Notation:
  $\boldsymbol{N}$ = stock of inventories
  $\Delta \boldsymbol{N}$ = inventory investment

- Assume:
  Firms hold a stock of inventories proportional to their output

  $$\boldsymbol{N} = \beta \boldsymbol{Y},$$

  where β is an exogenous parameter reflecting firms' desired stock of inventory as a proportion of output.

The Accelerator Model

Result:

$$\Delta \boldsymbol{N} = \beta \Delta \boldsymbol{Y}$$

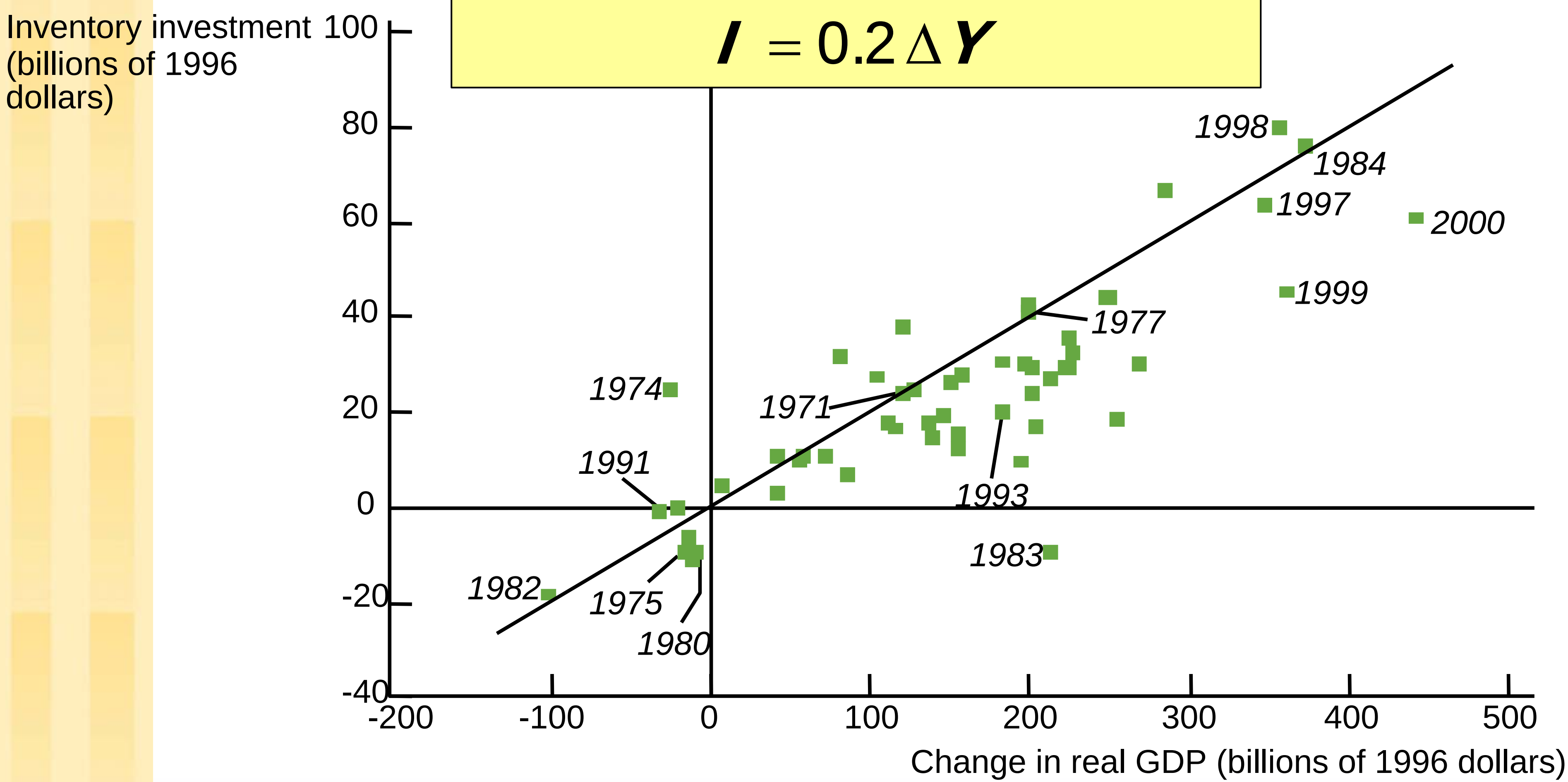
Inventory investment is proportion to the change in output.

- When output is rising, firms increase their inventories.
- When output is falling, firms allow their inventories to run down.

Evidence for the Accelerator Model

The estimated relationship is:

$$I = 0.2\,\Delta Y$$



Inventories and the real interest rate

- The opportunity cost of holding goods in inventory: the interest that could have been earned on the revenue from selling those goods.
- Hence, inventory investment depends on the real interest rate.
- *Example:*
  High interest rates in the 1980s motivated many firms to adopt *just-in-time* production, which is designed to reduce inventories.

Chapter summary

1. All types of investment depend negatively on the real interest rate.
2. Things that shift the investment function:
   - Technological improvements raise MPK and raise business fixed investment.
   - Increase in population raises demand for, price of housing and raises residential investment.
   - Economic policies (corporate income tax, investment tax credit) alter incentives to invest.

Chapter summary

3. Investment is the most volatile component of GDP over the business cycle.
   - Fluctuations in employment affect the MPK and the incentive for business fixed investment.
   - Fluctuations in income affect demand for, price of housing and the incentive for residential investment.
   - Fluctuations in output affect planned & unplanned inventory investment.

Chapter objectives

- Money supply
  - how the banking system “creates” money
  - three ways the Fed can control the money supply
  - why the Fed can’t control it precisely
- Theories of money demand
  - a portfolio theory
  - a transactions theory: the Baumol-Tobin model

Banks' role in the money supply

- The money supply equals currency plus demand (checking account) deposits:

$$M = C + D$$

- Since the money supply includes demand deposits, the banking system plays an important role.

A few preliminaries

- **Reserves (*R*)**: the portion of deposits that banks have not lent.
- To a bank, liabilities include deposits,
  assets include reserves and outstanding loans
- **100-percent-reserve banking**: a system in which banks hold all deposits as reserves.
- **Fractional-reserve banking**:
  a system in which banks hold a fraction of their deposits as reserves.

SCENARIO 1: No Banks

With no banks,

$$D = 0 \text{ and } M = C = \$1000.$$

SCENARIO 2: 100 Percent Reserve Banking

- Initially **C** = $1000, **D** = $0, **M** = $1000.
- Now suppose households deposit the $1000 at “Firstbank.”

FIRSTBANK’S balance sheet

Assets		Liabilities	
reserves	$1000	deposits	$1000

- After the deposit,
  C = $0,
  D = $1000,
  M = $1000.
- 100% Reserve Banking has no impact on size of money supply.

SCENARIO 3: Fractional-Reserve Banking

- Suppose banks hold 20% of deposits in reserve, making loans with the rest.
- Firstbank will make $800 in loans.

FIRSTBANK'S balance sheet

Assets	Liabilities
reserves $200	deposits $1000
loans $800	

The money supply now equals $1800:

The depositor still has $1000 in demand deposits,

but now the borrower holds $800 in currency.

SCENARIO 3: Fractional-Reserve Banking

Thus, in a fractional-reserve banking system, banks create money.

FIRSTBANK'S balance sheet

Assets	Liabilities
reserves $200	deposits $1000
loans $800	

The money supply now equals $1800:

The depositor still has $1000 in demand deposits,

but now the borrower holds $800 in currency.

SCENARIO 3: Fractional-Reserve Banking

- Suppose the borrower deposits the $800 in Secondbank.
- Initially, Secondbank's balance sheet is:

SECONDBANK'S balance sheet

Assets		Liabilities	
reserves	$160	deposits	$800
loans	$640		

- But then Secondbank will loan 80% of this deposit
- and its balance sheet will look like this:

SCENARIO 3: Fractional-Reserve Banking

- If this $640 is eventually deposited in Thirdbank,
- then Thirdbank will keep 20% of it in reserve, and loan the rest out:

THIRDBANK'S balance sheet

Assets		Liabilities	
reserves	$128	deposits	$640
loans	$512		

Finding the total amount of money:

	Original deposit	= \$1000
+	Firstbank lending	= \$ 800
+	Secondbank lending	= \$ 640
+	Thirdbank lending	= \$ 512
+	other lending...	

Total money supply = $(1/\boldsymbol{rr}) \times \$1000$

where $\boldsymbol{rr}$ = ratio of reserves to deposits

In our example, $\boldsymbol{rr} = 0.2$, so $\boldsymbol{M} = \$5000$

Money creation in the banking system

A fractional reserve banking system creates money,
but it doesn't create wealth:

bank loans give borrowers some new money
and an equal amount of new debt.

A model of the money supply

exogenous variables

- the **monetary base**, $B = C + R$
  controlled by the central bank
- the **reserve-deposit ratio**, $rr = R/D$
  depends on regulations & bank policies
- the **currency-deposit ratio**, $cr = C/D$
  depends on households' preferences

Solving for the money supply:

$$M = C + D = \frac{C + D}{B} \times B = m \times B$$

where

$$m = \frac{C + D}{B}$$

$$= \frac{C + D}{C + R} = \frac{(C/D) + (D/D)}{(C/D) + (R/D)} = \frac{cr + 1}{cr + rr}$$

The money multiplier

$$\boldsymbol{M} = \boldsymbol{m} \times \boldsymbol{B}, \quad \text{where} \quad \boldsymbol{m} = \frac{\boldsymbol{cr} + 1}{\boldsymbol{cr} + \boldsymbol{rr}}$$

- If $\boldsymbol{rr} < 1$, then $\boldsymbol{m} > 1$
- If monetary base changes by $\Delta \boldsymbol{B}$, then $\Delta \boldsymbol{M} = \boldsymbol{m} \times \Delta \boldsymbol{B}$
- $\boldsymbol{m}$ is called the **money multiplier**.

Exercise

$$\boldsymbol{M} = \boldsymbol{m} \times \boldsymbol{B}, \quad \text{where} \quad \boldsymbol{m} = \frac{\boldsymbol{cr} + 1}{\boldsymbol{cr} + \boldsymbol{rr}}$$

Suppose households decide to hold more of their money as currency and less in the form of demand deposits.

1. Determine impact on money supply.
2. Explain the intuition for your result.

Solution to exercise

Impact of an increase in the currency-deposit ratio $\Delta \boldsymbol{cr} > 0$.

1. An increase in $\boldsymbol{cr}$ increases the denominator of $\boldsymbol{m}$ proportionally more than the numerator. So $\boldsymbol{m}$ falls, causing $\boldsymbol{M}$ to fall too.

2. If households deposit less of their money, then banks can’t make as many loans, so the banking system won’t be able to “create” as much money.

Three instruments of monetary policy

1. Open market operations
2. Reserve requirements
3. The discount rate

Open market operations

- *definition:*
  The purchase or sale of government bonds by the Federal Reserve.
- *how it works:*
  If Fed buys bonds from the public,
  it pays with new dollars, increasing ***B*** and therefore ***M***.

Reserve requirements

- *definition:*
  Fed regulations that require banks to hold a minimum reserve-deposit ratio.
- *how it works:*
  Reserve requirements affect ***rr*** and ***m***:
  If Fed reduces reserve requirements, then banks can make more loans and "create" more money from each deposit.

The discount rate

- *definition:*
  The interest rate that the Fed charges on loans it makes to banks.
- *how it works:*
  When banks borrow from the Fed, their reserves increase, allowing them to make more loans and "create" more money.

  The Fed can increase ***B*** by lowering the discount rate to induce banks to borrow more reserves from the Fed.

Which instrument is used most often?

- Open market operations:
  Most frequently used.
- Changes in reserve requirements:
  Least frequently used.
- Changes in the discount rate:
  Largely symbolic;
  the Fed is a “lender of last resort,”
  does not usually make loans to banks
  on demand.

Why the Fed can't precisely control M

$$M = m \times B, \quad \text{where} \quad m = \frac{cr + 1}{cr + rr}$$

- Households can change cr, causing m and M to change.
- Banks often hold **excess reserves** (reserves above the reserve requirement). If banks change their excess reserves, then rr, m and M change.

CASE STUDY: Bank failures in the 1930s

From 1929 to 1933,

- Over 9000 banks closed.
- Money supply fell 28%.

This drop in the money supply may have caused the Great Depression.

It certainly contributed to the Depression's severity.

Table 18-1: The Money Supply and its Determinants: 1929 and 1933

	August 1929	March 1933
Money Supply	**26.5**	**19.0**
Currency	3.9	5.5
Demand deposits	22.6	13.5
Monetary Base	**7.1**	**8.4**
Currency	3.9	5.5
Reserves	3.2	2.9
Money Multiplier	**3.7**	**2.3**
Reserve–deposit ratio	0.14	0.21
Currency–deposit ratio	0.17	0.41

cr rose due to loss of confidence in banks

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rr rose because banks became more cautious, increased excess reserves

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The rise in ***cr*** and ***rr*** reduced the money multiplier.

Could this happen again?

- Many policies have been implemented since the 1930s to prevent such widespread bank failures.
- Example: Federal Deposit Insurance, to prevent bank runs and large swings in the currency-deposit ratio.

Money Demand

Two types of theories:

- Portfolio theories
  - emphasize “store of value” function
  - relevant for M2, M3
  - not relevant for M1. (As a store of value, M1 is **dominated** by other assets.)
- Transactions theories
  - emphasize “medium of exchange” function
  - also relevant for M1

A simple portfolio theory

$$(M/P)^d = L(\underset{-}{r_s}, \underset{-}{r_b}, \underset{-}{\pi^e}, \underset{+}{W}),$$

where

r_s = expected real return on stock

r_b = expected real return on bonds

π^e = expected inflation rate

W = real wealth

The Baumol-Tobin Model

- A transactions theory of money demand.
- Notation:

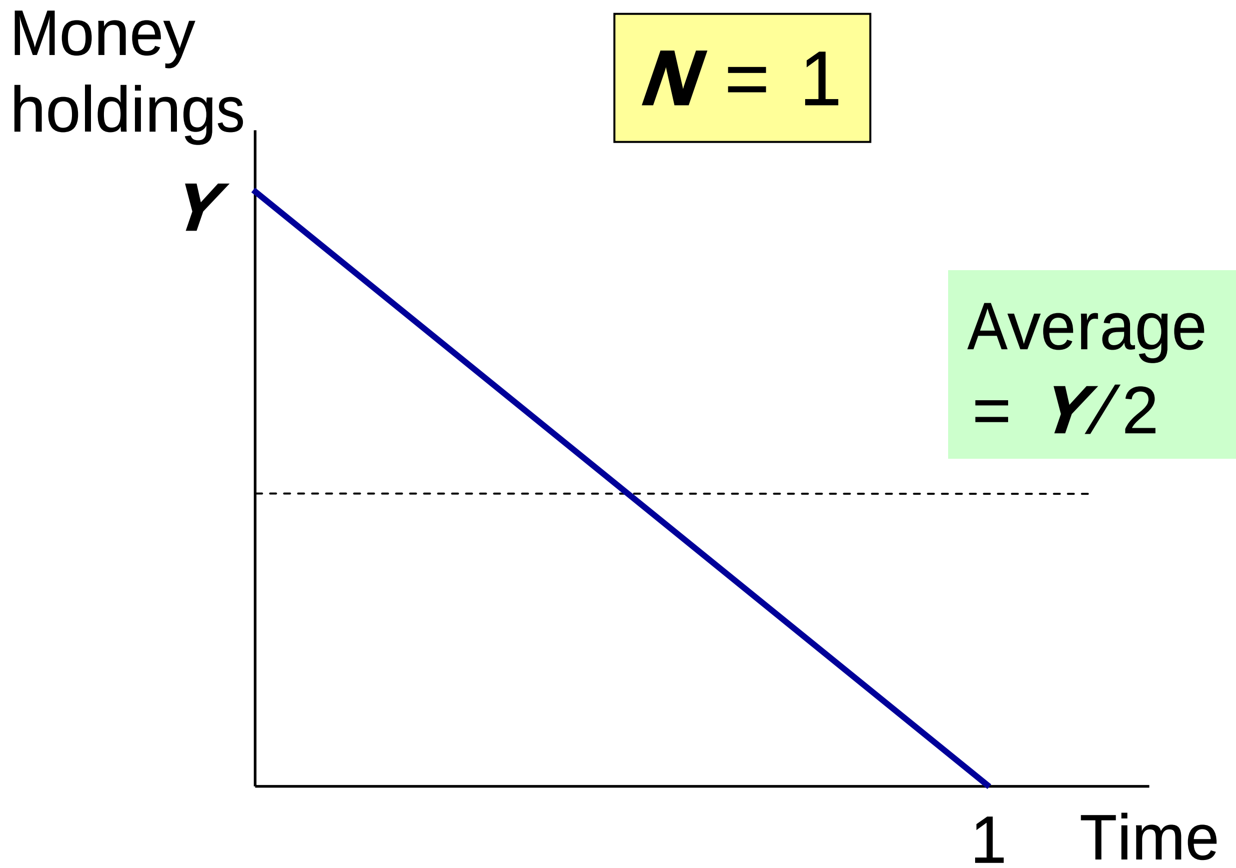
Y = total spending, done gradually over the year

i = interest rate on savings account

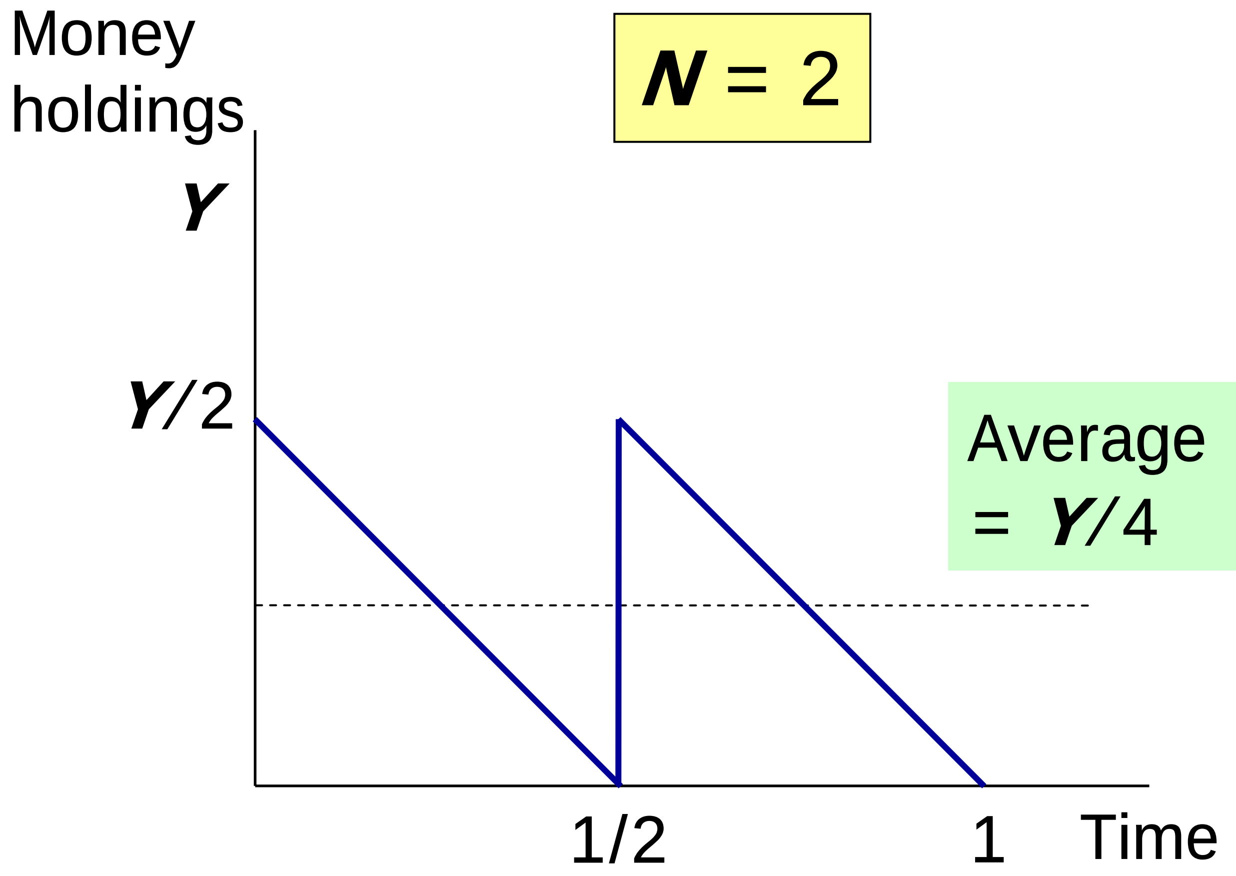
N = number of trips consumer makes to the bank to withdraw money from savings account

F = cost of a trip to the bank (e.g., if a trip takes 15 minutes and consumer's wage = \$12/hour, then ***F*** = \$3)

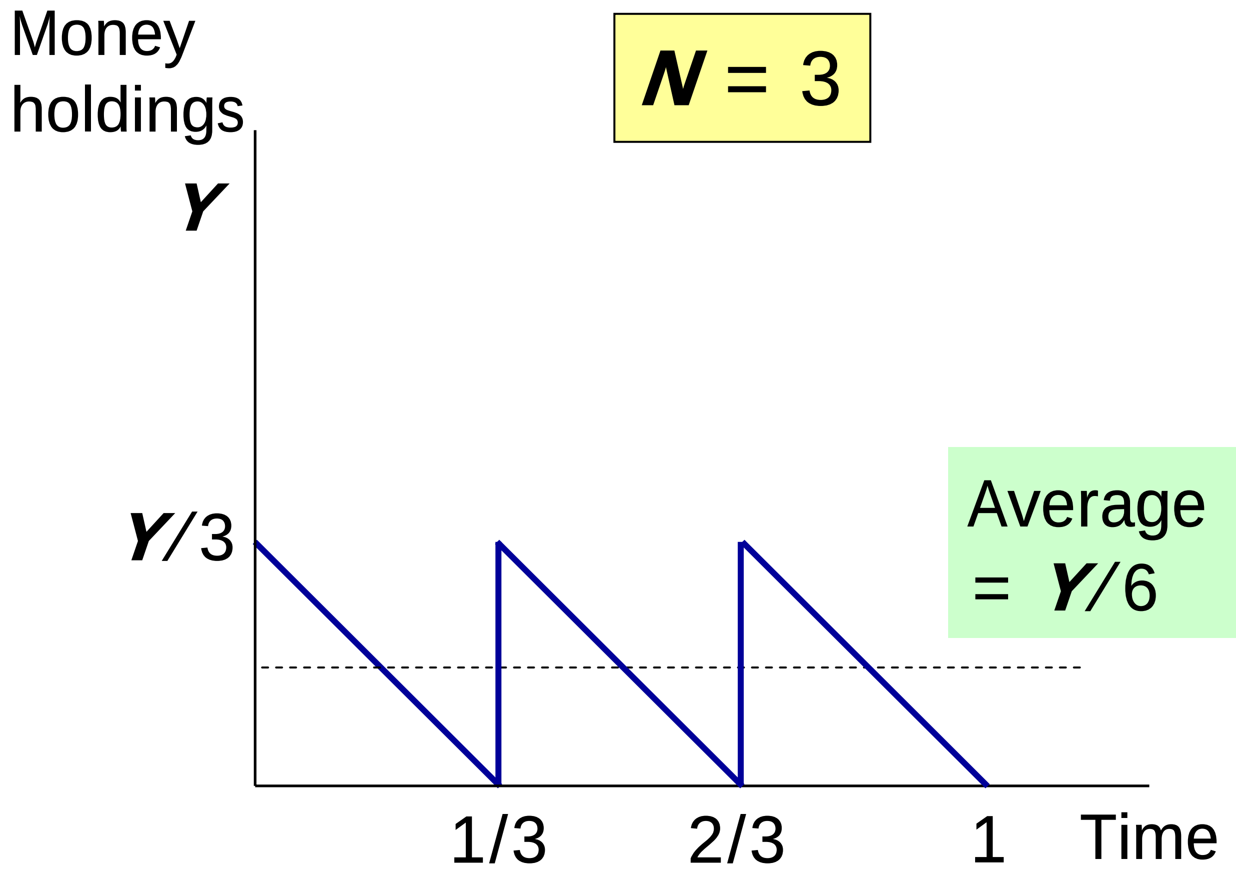
Money holdings over the year



Money holdings over the year



Money holdings over the year



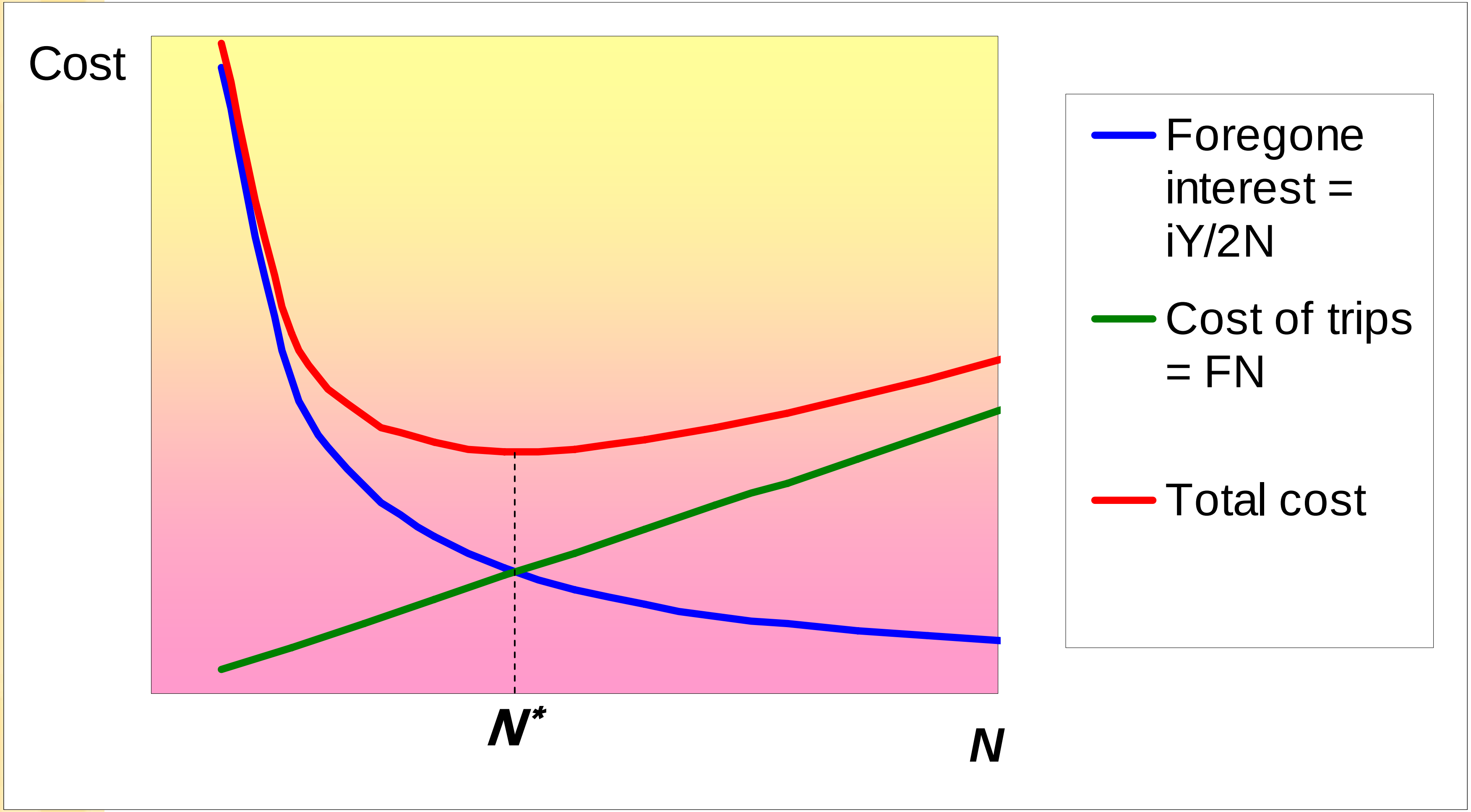
The cost of holding money

- In general, average money holdings = $\boldsymbol{Y/2N}$
- Foregone interest = $\boldsymbol{i} \times (\boldsymbol{Y/2N})$
- Cost of $\boldsymbol{N}$ trips to bank = $\boldsymbol{F} \times \boldsymbol{N}$
- Thus,

$$\text{total cost} = \boldsymbol{i} \times \frac{\boldsymbol{Y}}{2\boldsymbol{N}} + \boldsymbol{F} \times \boldsymbol{N}$$

- Given $\boldsymbol{Y}$, $\boldsymbol{i}$, and $\boldsymbol{F}$,
  consumer chooses $\boldsymbol{N}$ to minimize total cost

Finding the cost-minimizing N



The money demand function

- The cost-minimizing value of ***N*** : $\boldsymbol{N}^{*} = \sqrt{\dfrac{\boldsymbol{i}\boldsymbol{Y}}{2\boldsymbol{F}}}$
- To obtain the money demand function, plug ***N**** into the expression for average money holdings:

$$\text{average money holding} = \sqrt{\frac{\boldsymbol{Y}\boldsymbol{F}}{2\boldsymbol{i}}}$$

- Money demand depends positively on ***Y*** and ***F***, and negatively on ***i*** .

The money demand function

- The Baumol-Tobin money demand function:

$$(M/P)^d = \sqrt{\frac{YF}{2i}} = L(i, Y, F)$$

How the B-T money demand func. differs from the money demand func. from previous chapters:

- B-T shows how F affects money demand
- B-T implies that the
  income elasticity of money demand = 0.5,
  interest rate elasticity of money demand = –0.5

EXERCISE:
The impact of ATMs on money demand

During the 1980s, automatic teller machines became widely available.

How do you think this affected ***N**** and money demand? Explain.

Financial Innovation, Near Money, and the Demise of the Monetary Aggregates

Examples of financial innovation:

- many checking accounts now pay interest
- very easy to buy and sell assets
- mutual funds are baskets of stocks that are easy to redeem - just write a check

Non-monetary assets having some of the liquidity of money are called **near money**.

Money & near money are close substitutes, and switching from one to the other is easy.

Financial Innovation, Near Money, and the Demise of the Monetary Aggregates

- The rise of near money makes money demand less stable and complicates monetary policy.
- 1993: the Fed switched from targeting monetary aggregates to targeting the Federal Funds rate.
- This change may help explain why the U.S. economy was so stable during the rest of the 1990s.

Chapter summary

1. Fractional reserve banking creates money because each dollar of reserves generates many dollars of demand deposits.
2. The money supply depends on the
   - monetary base
   - currency-deposit ratio
   - reserve ratio
3. The Fed can control the money supply with
   - open market operations
   - the reserve requirement
   - the discount rate

Chapter summary

4. Portfolio theories of money demand
   - stress the store of value function
   - posit that money demand depends on risk/return of money & alternative assets
5. The Baumol-Tobin model
   - is an example of the transactions theories of money demand, stresses “medium of exchange” function
   - money demand depends positively on spending, negatively on the interest rate, and positively on the cost of converting non-monetary assets to money

Learning objectives

This chapter presents an overview of recent work in two areas:

- Real Business Cycle theory
- New Keynesian economics

The Theory of Real Business Cycles

- all prices flexible, even in short run
  - implies money is neutral, even in short run
  - classical dichotomy holds at all times
- fluctuations in output, employment, and other variables are the optimal responses to exogenous changes in the economic environment
- productivity shocks the primary cause of economic fluctuations

The economics of Robinson Crusoe

- Economy consists of a single producer-consumer, like Robinson Crusoe on a desert island.
- Assume Crusoe divides his time between
  - leisure
  - working
    - catching fish (production)
    - making fishing nets (investment)
- Assume Crusoe optimizes given the constraints he faces.

Shocks in the Crusoe island economy

- Big school of fish swims by island.
  Then, GDP rises because
  - Crusoe's fishing productivity is higher
  - Crusoe's employment rises: he decides to shift some time from leisure to fishing to take advantage of the high productivity
- Big storm hits the island. Then, GDP falls:
  - The storm reduces productivity, so Crusoe spends less time fishing for consumption.
  - More importantly, investment falls, because it's easy to postpone making nets until storm passes
  - Employment falls: Since he's not spending as much time fishing or making nets, Crusoe decides to enjoy more leisure time.

Economic fluctuations as optimal responses to shocks

- In Real Business Cycle theory, fluctuations in our economy are similar to those in Crusoe's economy.

The shocks aren't always desirable. But once they occur, fluctuations in output, employment, and other variables are the optimal responses to them.

The debate over RBC theory

...boils down to four issues:

- Do changes in employment reflect voluntary changes in labor supply?
- Does the economy experience large, exogenous productivity shocks in the short run?
- Is money really neutral in the short run?
- Are wages and prices flexible in the short run? Do they adjust quickly to keep supply and demand in balance in all markets?

The labor market

- **Intertemporal substitution of labor**: In RBC theory, workers are willing to reallocate labor over time in response to changes in the reward to working now versus later.
- The intertemporal relative wage equals

$$\frac{(1+\boldsymbol{r})\,\boldsymbol{W}_1}{\boldsymbol{W}_2}$$

where $\boldsymbol{W}_1$ is the wage in period 1 (the present) and $\boldsymbol{W}_2$ is the wage in period 2 (the future).

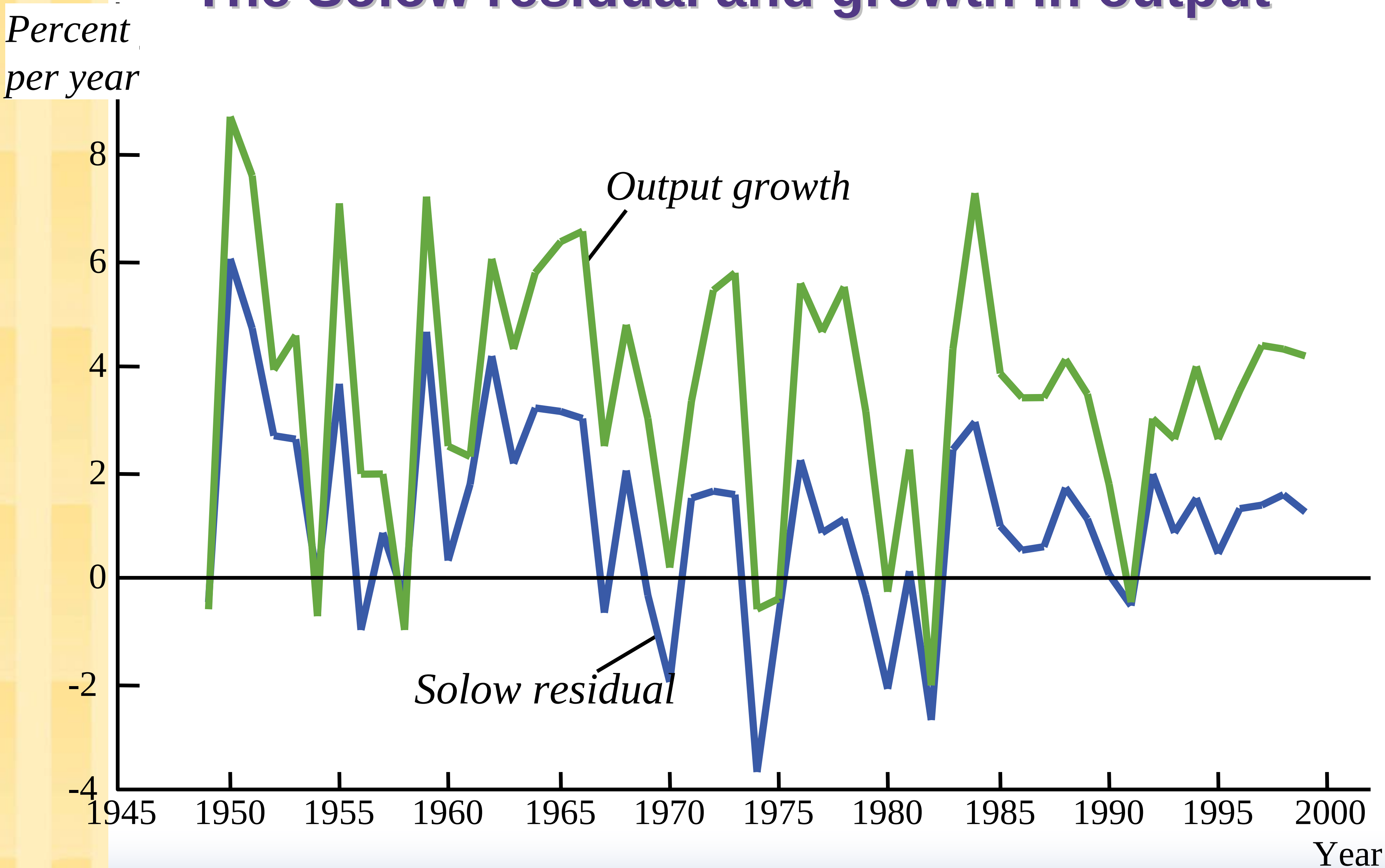
The labor market

- In RBC theory,
  - shocks cause fluctuations in the intertemporal wage
  - workers respond by adjusting labor supply
  - this causes employment and output to fluctuate
- Critics argue that
  - labor supply is not very sensitive to the intertemporal real wage
  - high unemployment observed in recessions is mainly involuntary

Technology shocks

- In RBC theory, economic fluctuations are caused by productivity shocks.
- The **Solow residual** is a measure of productivity shocks: it shows the change in output that cannot be explained by changes in capital and labor.
- RBC theory implies that the Solow residual should be highly correlated with output.
  Is it?

The Solow residual and growth in output



Technology shocks

- Proponents of RBC theory argue that the strong correlation between output growth and Solow residuals is evidence that productivity shocks are an important source of economic fluctuations.
- Critics note that the measured Solow residual is biased to appear more cyclical than the true, underlying technology.

The neutrality of money

- RBC critics note that reductions in money growth and inflation are almost always associated with periods of high unemployment and low output.
- RBC proponents respond by claiming that the money supply is endogenous:
  - Suppose output is expected to fall. Central bank reduces money supply in response to an expected fall in money demand.

The flexibility of wages and prices

- RBC theory assumes that wages and prices are completely flexible, so markets always clear.
- RBC proponents argue that the extent to which wages or prices may be sticky in the real world is not important for understanding economic fluctuations.
- They also prefer to assume flexible prices to be consistent with microeconomic theory.
- Critics believe that wage and price stickiness explains involuntary unemployment and the non-neutrality of money.

New Keynesian Economics

- Most economists believe that short-run fluctuations in output and employment represent deviations from the natural rate, and that these deviations occur because wages and prices are sticky.
- New Keynesian research attempts to explain the stickiness of wages and prices by examining the microeconomics of price adjustment.

Small menu costs and aggregate-demand externalities

- There are externalities to price adjustment:
  A price reduction by one firm causes the overall price level to fall (albeit slightly).
  This raises real money balances and increases aggregate demand, which benefits other firms.
- **Menu costs** are the costs of changing prices (e.g., costs of printing new menus or mailing new catalogs)
- In the presence of menu costs, sticky prices may be optimal for the firms setting them even though they are undesirable for the economy as a whole.

Recessions as coordination failure

- In recessions, output is low, workers are unemployed, and factories sit idle.
- If all firms and workers would reduce their prices, then economy would return to full employment.
- But, no individual firm or worker would be willing to cut his price without knowing that others will cut their prices. Hence, prices remain high and the recession continues.

The staggering of wages and prices

- All wages and prices do not adjust at the same time.
- This staggering of wage & price adjustment causes the overall price level to move slowly in response to demand changes.
- Each firm and worker knows that when it reduces its nominal price, its relative price will be low for a time. This makes them reluctant to reduce their price.

Top reasons for sticky prices: *results from surveys of managers*

1. Coordination failure: firms hold back on price changes, waiting for others to go first
2. Firms delay raising prices until costs rise
3. Firms prefer to vary other product attributes, such as quality, service, or delivery lags
4. Implicit contracts: firms tacitly agree to stabilize prices, perhaps out of ‘fairness’ to customers
5. Explicit contracts that fix nominal prices
6. Menu costs

Conclusion: the frontiers of research

- This chapter has explored two distinct approaches to the study of business cycles: Real Business Cycle theory and New Keynesian Theory.
- Not all economists fall entirely into one camp or the other.
- An increasing amount of research incorporates insights from both schools of thought to advance our study of economic fluctuations.

Chapter summary

1. Real Business Cycle theory
   - assumes perfect flexibility of wages and prices
   - shows how fluctuations arise in response to productivity shocks
   - the fluctuations are optimal given the shocks
2. Points of controversy in RBC theory
   - intertemporal substitution of labor
   - the importance of technology shocks
   - the neutrality of money
   - the flexibility of prices and wages

Chapter summary

3. New Keynesian economics
   - accepts the traditional model of aggregate demand and supply
   - attempts to explain the stickiness of wages and prices with microeconomic analysis, including
     - menu costs
     - coordination failure
     - staggering of wages and prices