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Chapter Title: Does Anticipated Aggregate Demand Policy Matter?

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6 Does Anticipated Aggregate Demand Policy Matter?

6.1 Introduction

Recent theorizing has focused on business cycle models that incorporate features of the natural rate model of Friedman (1968) and Phelps (1967) with the assumption that expectations are rational in the sense of Muth (1961). An important neutrality result from this research (Lucas 1973; Sargent and Wallace 1975) is that anticipated changes in aggregate demand policy will have been taken into account already in the behavior of economic agents and will evoke no further output or employment response. Therefore, deterministic, feedback policy rules will have no effect on output fluctuations in the economy. This policy ineffectiveness proposition of what Modigliani (1977) has dubbed the Macro Rational Expectations (MRE) hypothesis runs counter to much previous macroeconomic theorizing (and to views prevailing in policymaking circles). This proposition is of such importance that it demands a wide range of empirical research for verification or refutation.

This chapter applies the econometric methodology developed in Chapter 2 to the important question whether anticipated aggregate demand policy matters to the business cycle. It begins with a brief review of the methodology in Section 6.2, then follows with the empirical results in Section 6.3, and ends with a section of concluding remarks.

6.2 A Review of the Methodology

The tests here are based on the MRE model of the form

$$y_t = \bar{y}_t + \sum_{i=0}^{N} \beta_i (X_{t-i} - X^e_{t-i}) + \epsilon_t, \tag{1}$$

where

y_t = unemployment or real output at time t,
$\tilde{y}_t$ = natural level of unemployment or real output at time t,
X_t = aggregate demand policy variable, such as money growth, inflation, or nominal GNP growth,
X^e_t = anticipated X conditional on information at time $t-1$,
β_i = coefficients,
ϵ_t = error term.

A forecasting equation that can be used to generate these anticipations of X_t is

$$X_t = Z_{t-1}\gamma + u_t, \tag{2}$$

where

Z_{t-1} = a vector of variables used to forecast X_t available at time $t-1$,
γ = a vector of coefficients,
u_t = an error term which is assumed to be uncorrelated with any information available at $t-1$ (which includes Z_{t-i} or u_{t-i} for all $i \geq 1$, and hence u_t is serially uncorrelated).

A rational forecast for X_t then involves simply taking expectations of equation (2) conditional on information available at $t-1$:

$$X^e_t = Z_t\gamma. \tag{3}$$

Substituting into equation (1), we have

$$y_t = \tilde{y}_t + \sum_{i=0}^{N} \beta_i (X_{t-i} - Z_{t-i}\gamma) + \epsilon_t. \tag{4}$$

The MRE hypothesis embodies two sets of constraints. The neutrality proposition implies that deviations of output and unemployment from their natural levels are not correlated with the anticipated movements in aggregate demand policy. That is, $\delta_i = 0$ for all i in

$$y_t = \tilde{y}_t + \sum_{i=0}^{N} \beta_i (X_{t-i} - X^e_{t-i}) + \sum_{i=0}^{N} \delta_i X^e_{t-i} + \epsilon_t. \tag{5}$$

Rationality of expectations implies that (5) can be rewritten as

$$y_t = \tilde{y}_t + \sum_{i=0}^{N} \beta_i (X_{t-i} - Z_{t-i}\gamma^*) + \sum_{i=0}^{N} \delta_i Z_{t-i}\gamma^* + \epsilon_t, \tag{6}$$

where $\gamma = \gamma^*$.

The joint nonlinear estimation procedure outlined in Chapter 2 is used here to estimate both the constrained (2) and (4) system and the unconstrained (2) and (6) system where $\gamma = \gamma^*$ is not imposed. It corrects for serial correlation with a fourth-order autoregressive (AR) specification for the ϵ_t error term, and this is successful in reducing the residuals to white noise.[1] The conventional identifying assumption found in previous research on this topic is made that the output or unemployment equation is a true reduced form. The joint MRE hypothesis of rationality and neutrality is then tested with a likelihood ratio statistic constructed from a comparison of the two estimated systems. It is distributed asymptotically as $\chi^2(q)$ under the null hypothesis where q is the number of constraints.

If the joint hypothesis of rationality and neutrality is rejected, we can obtain information on how much the rationality versus the neutrality constraints contributes to this rejection. The neutrality constraints are tested under the maintained hypothesis of rational expectations by constructing a likelihood ratio statistic as above where the constrained system is (2) and (4), and the unconstrained system is (2) and (6) subject to the rationality constraints, $\gamma = \gamma^*$. A separate test for the rationality constraints proceeds similarly: the constrained system is (2) and (6) imposing $\gamma = \gamma^*$, and the unconstrained system is (2) and (6) where $\gamma = \gamma^*$ is not imposed.

In the results to follow, rejections of the MRE hypothesis occur when the number of lags (N) in the unemployment or output equation is large. However, although many degrees of freedom are used up in these estimations, there is no allowance for the loss of degrees of freedom in the likelihood ratio statistics. The danger thus arises that spurious rejections of the null hypothesis may occur because the small sample distributions of the test statistics differ substantially from the asymptotic distributions.

The nature of the problem here becomes more obvious if we look at the following analogous example. In an OLS regression, a test of restrictions can be carried out with a finite sample test, the F, or with an asymptotic test, the likelihood ratio. Asymptotically, the test statistics have the same distribution, but misleading inference with the likelihood ratio statistics can easily result in small samples. The F statistic is calculated as

$$(7) \qquad F(q, df) = \left[\left(\frac{\mathrm{SSR}^c - \mathrm{SSR}^u}{\mathrm{SSR}^u}\right)\frac{df}{q}\right]$$

while the likelihood ratio statistic is

$$(8) \qquad n[\log(\mathrm{SSR}^c/\mathrm{SSR}^u)],$$

1. In the output and unemployment equations estimates here, the Durbin-Watson statistics range from 1.82 to 2.26, and none indicates the presence of first-order serial correlation. Furthermore, the Ljung and Box (1978) adjusted Q statistics for the first twelve autocorrelations of the residuals cannot reject the null hypothesis that these autocorrelations are zero. The $Q(12)$ statistics range from 5.84 to 15.0 for all the models except those in Appendix 6.1, while the critical $Q(12)$ at 5 percent is 15.5. For the models in Appendix 6.1, the $Q(12)$ statistics range from 8.26 to 15.90, while the critical $Q(12)$ at 5 percent is 18.2.

where

df = the degrees of freedom of the unconstrained model,
n = the number of observations,
q = the number of constraints.

For over 100 degrees of freedom $qF(q,df)$ is nearly distributed as $\chi^2(q)$, and for small percentage differences, $(SSR^c - SSR^u)/SSR^u$ is approximately equal to $\log(SSR^c/SSR^u)$. Inference with the F statistic in the case of over 100 degrees of freedom involves approximately the comparison of $df[\log(SSR^c/SSR^u)]$ with the $\chi^2(q)$ distribution. Inference with the likelihood ratio statistic on the other hand involves the comparison of $n[\log(SSR^c/SSR^u)]$ with the $\chi^2(q)$ distribution. Even in the case where df is large, if n/df is substantially greater than one, the likelihood ratio statistic will reject the null hypothesis far more often than will the F. In the case of the freely estimated unemployment or output model in Appendix 6.3 and $N = 20$, the degrees of freedom of the unconstrained model for the joint or rationality tests is 111, while the number of observations is 184. The n/df of 1.7 in this case demonstrates that there is a potentially serious small sample bias in the likelihood ratio test when this many degrees of freedom are used up.

To make certain that rejections are valid, the output and unemployment models are estimated both with and without the smoothness restriction that the anticipated and unanticipated money growth coefficients (δ_i and β_i) lie along a fourth-order polynomial with an endpoint constraint. This particular polynomial distributed lag (PDL) specification was chosen because it is rarely rejected by the data and it has the advantage of using up few degrees of freedom.[2]

The anticipated aggregate demand X variable is constructed so that it will be serially uncorrelated, so that a smoothness restriction is not required to make coefficients on unanticipated aggregate demand intelligible. However, anticipated aggregate demand variables are highly

2. The PDL constraints are not rejected in models where money growth or inflation are the aggregate demand X variable. E.g., in model 2.1, $\chi^2(4) = 3.34$, while the critical value at 5 percent is 9.49; in model 4.1, $\chi^2(17) = 12.94$, while the critical value at 5 percent is 27.59; and in model A9.1, $\chi^2(14) = 20.54$, while the critical value at 5 percent is 23.7. The PDL constraints receive somewhat less support in the models using nominal GNP as the X variable. They are not rejected for the A5.1 output model at the 5 percent level, but are nearly so: $\chi^2(17) = 26.95$, while the critical $\chi^2(17)$ at 5 percent is 27.6. However, they are rejected at the 1 percent level in the unemployment model: $\chi^2(17) = 34.91$, while the critical $\chi^2(17)$ at 1 percent is 33.4. I experimented with an eighth-order PDL to see if this would fit the data substantially better, but it did not. Although this rejection of the PDL constraints is bothersome, the fact that the unrestricted models in Appendix 6.3 yield results so similar to those in tables 6.A.5 and 6.A.6 indicates that, imposing or not imposing, the PDL constraints yields the same conclusions.

serially correlated, and the use of PDLs has the advantage of providing more intelligible and more easily interpretable estimates of the anticipated aggregate demand coefficients, δ_i. The main results reported in this chapter thus are based on a PDL restriction. Comparing the main results with those in Appendix 6.3 obtained without a PDL restriction demonstrates that estimating with or without the restriction yields similar β coefficients and similar statistical inference on the validity of the MRE hypothesis. Therefore, we can be confident that any rejections of the MRE hypothesis are not due to small sample bias.

The specifications of the forecasting equations needed to estimate the MRE model are derived with the multivariate Granger (1969) procedure outlined in Chapter 2. The policy variable, X_t, is regressed on its own four lagged values (to insure white noise residuals) as well as on four lagged values of the following set of macrovariables: the quarterly $M1$ and $M2$ growth rate, the inflation rate, nominal GNP growth, the unemployment rate, the Treasury Bill rate, the growth rate of real government expenditure, the high employment surplus, the growth rate of the federal debt, and the balance of payments on current account. The four lagged values of each variable are retained in the equation only if they are jointly significant at the 5 percent level. This results in a specification of the money growth forecasting equation, for example, which is quite different from that used by Barro (1977, 1978) and Barro and Rush (1980): in addition to past money growth, past Treasury Bill rates and high employment budget surpluses appear as explanatory variables. Weintraub (1980) also finds significant explanatory power of short-term interest rates in the money growth equation, and the magnitude of his coefficients is similar to that found here. The specifications for the forecasting equations can be found in Appendix 6.4 as well as the F statistics for significant explanatory power of the four lagged values of each variable in these specifications.[3]

Earlier research on the MRE hypothesis (e.g., Barro 1977, 1978, 1979; Barro and Rush 1980; Grossman 1979; Leiderman 1980) uses a fairly short lag length—two years or less—on the anticipated and unanticipated X variables. This chapter looks at longer lag lengths for two reasons. Experimenting with plausible, less restrictive models that have longer lag lengths is appropriate for analyzing the robustness of results because this strategy has the disadvantage only of a potential decrease in the power of

3. Chow (1960) tests that split the sample into equal halves indicate that both the money growth and nominal GNP growth equations have the desirable property that the stability of the coefficients cannot be rejected. However, stability of the coefficients is rejected for the inflation equation. For the $M1$ growth equation, $F(13,66) = 1.37$, while the critical F at 5 percent is 1.88; for the nominal GNP equation, $F(9,74) = .60$, while the critical F at 5 percent is 2.0; and for the inflation equation, $F(13,55) = 3.40$, while the critical F at 5 percent is 1.9.

tests, but not of incorrect test statistics. In addition, estimates in this chapter and in Gordon (1979) find that unanticipated and anticipated aggregate demand variables lagged as far back as twenty quarters are significantly correlated with output and unemployment.

6.3 The Empirical Results

The tests of the MRE hypothesis in the text use seasonally adjusted, postwar quarterly data over the 1954–1976 period. The sample starts with 1954—the earliest possible starting date if models with long lags are to be estimated.[4] An advantage of excluding the early postwar years from the sample is that the potential change in policy regime occurring with the Fed-Treasury Accord in 1951 is avoided. In pursuit of information on robustness, both output and unemployment models are estimated, with $M1$ growth, nominal GNP growth, and inflation as the aggregate demand variable. The natural level of unemployment or output, $\tilde{y}_t$, is estimated as a time trend here, as in Barro (1978). A more complicated Barro (1977) specification has been avoided because, as Small (1979) and Barro (1979) indicate, its validity is doubtful.

6.3.1 The Data

The definitions and the sources of data used in this chapter are as follows:

$M1G$ = average growth rate (quarterly rate) of $M1$, calculated as the change in the log of quarterly $M1$, from the NBER data bank.

$M2G$ = average growth rate (quarterly rate) of $M2$, calculated as the change in the log of quarterly $M2$, from the NBER data bank.

RTB = average treasury bill rate at an annual rate (in fractions), from the MPS data bank.

π = inflation (quarterly rate), calculated as the changes in the log of the GNP deflator, from the MPS data bank.

GNP = real GNP ($billions 1972), from the MPS data bank.

UN = average quarterly unemployment rate, from the MPS data bank.

NGNP = growth rate (quarterly) of nominal GNP, calculated as the change in the log of nominal GNP, from the MPS data bank.

The other variables used in the search procedure for the forecasting equations were obtained from the NBER data bank.

4. Quarterly data on such variables as SURP do not become available until 1947. With twenty lags on anticipated or unanticipated X_t, the additional four lags in the forecasting equation and another four lags due to the fourth-order AR correction, the first twenty-eight observations are used up. This leaves us with a 1954:1 start date.

6.3.2 Results with Money Growth as the Aggregate Demand Variable

The text will focus its attention on results obtained when money growth is the aggregate demand variable in the MRE model. However, results with inflation and nominal GNP growth as the aggregate demand variable are presented in Appendix 6.2 and they are consistent with the money growth results. The money growth results deserve more attention for two reasons. Research with money growth as the aggregate demand variable (e.g., Barro 1977, 1978, 1979; Barro and Rush 1980; Leiderman 1980; Germany and Srivastava 1979; Small 1979) is more common in the literature and produces results most favorable to the MRE hypothesis. The methodology employed in this research has been criticized, however, and another look at the question of whether anticipated monetary policy matters to the business cycle is called for. Furthermore, the identifying assumption used to estimate the MRE model, that it is a true reduced form, is on firmer ground when money growth is the aggregate demand variable. Although the exogeneity of money growth in output or unemployment equations is still controversial, economists are more willing to accept the exogeneity of money growth than the exogeneity of nominal GNP growth or inflation.

Table 6.1 summarizes the major findings by presenting the likelihood ratio tests of the MRE hypothesis with *M*1 growth as the aggregate demand variable. It tells the following story: When the lag length on unanticipated and anticipated money growth is only seven, the lag length used by Barro and Rush (1980), the likelihood ratio tests are not unfavorable to the MRE hypothesis. The joint hypothesis of neutrality and rationality is not rejected at the 5 percent level in either the output or unemployment models, 2.1 and 2.2. Separate tests of the rationality and the neutrality hypotheses reject only in one case—neutrality in the employment model 2.2—and even here the rejection is barely at the 5 percent level. However, when the lag length is allowed to be longer—up to twenty lags in the other models of the table—strong rejections of the MRE hypothesis occur. The output model displays especially strong rejections of the joint hypothesis—the probability of finding that value of the likelihood ratio statistic or higher under the null hypothesis is as low as 1 in 10,000. Here, both sets of constraints contribute to this rejection, with the neutrality and rationality hypothesis rejected at the 1 percent level. The long lag, unemployment models are also unfavorable to the joint MRE hypothesis, with the rejection at the 1 percent level. However, here the neutrality constraints are rejected far more strongly than the rationality constraints.

Excluding relevant variables from a model results in incorrect test statistics, and including irrelevant variables will at worst only reduce the power of tests and make rejections even more telling. The table 6.1

Table 6.1 **Likelihood Ratio Tests of the MRE Hypothesis with *M*1 Growth as the Aggregate Demand Variable**

Model:	2.1	2.2	4.1	4.2
Dependent Variable:	Log(GNP_t)	UN_t	log(GNP_t)	UN_t
Description:	7 Lags of $M1G_t - M1G_t^e$	7 Lags of $M1G_t - M1G_t^e$	20 lags of $M1G_t - M1G_t^e$	20 lags of $M1G_t - M1G_t^e$
Joint hypothesis:				
Likelihood ratio statistic	$\chi^2(15) = 22.69$	$\chi^2(15) = 22.80$	$\chi^2(15) = 43.83$**	$\chi^2(15) = 31.54$**
Marginal significance level	.0909	.0885	.0001	.0074
Neutrality:				
Likelihood ratio statistic	$\chi^2(4) = 3.36$	$\chi^2(4) = 9.67$*	$\chi^2(4) = 15.45$**	$\chi^2(4) = 12.08$*
Marginal significance level	.4993	.0464	.0039	.0168
Rationality:				
Likelihood ratio statistic	$\chi^2(11) = 19.44$	$\chi^2(11) = 13.31$	$\chi^2(11) = 29.17$**	$\chi^2(11) = 19.89$*
Marginal significance level	.0536	.2735	.0021	.0469

Note: Marginal significance level = the probability of getting that value of the likelihood ratio statistic or higher under the null hypothesis.

*Significant at the 5 percent level.

**Significant at the 1 percent level.

results therefore raise questions about previous empirical evidence from shorter lag models that supports the MRE hypothesis, neutrality in particular. Indeed, it appears that the shorter lag models are more favorable to the MRE hypothesis only because misspecification yields incorrect test statistics.

A look at the estimates of unemployment and output equations from these models leads to a deeper understanding of the test results. Table 6.2 contains the output, and unemployment equations with short lags, jointly estimated from the (2) and (4) system which impose the cross-equation rationality constraints. The resulting γ estimates for the models of table 6.2 and the following tables are in Appendix 6.4.

The table 6.2 models fit the data well, and the unanticipated money growth variables have significant explanatory power: many of their coefficients' asymptotic *t* statistics are greater than four in absolute value. The test results in table 1 become clearer when we study the estimated output and unemployment equations where current and lagged anticipated money growth are added as explanatory variables. The table 6.3 results illustrate why the neutrality proposition is not rejected for the output equation. The coefficients on anticipated money growth have no obvious pattern, are never significantly different from zero, and, in seven out of eight cases, are smaller in absolute value than their asymptotic standard errors. However, in the unemployment equation some coefficients on anticipated money growth are significantly different from zero at the 5 percent level, and this is enough to reject neutrality. Here, the last two lag coefficients on anticipated money growth are the most significant, with asymptotic *t* statistics exceeding 2.5. This creates the suspicion that even longer lag lengths for unanticipated and anticipated money growth may lead to strong rejections of the MRE hypothesis.

Table 6.4 contains estimates of the output and unemployment equations in which longer lags (twenty) of unanticipated money growth are used as explanatory variables. Tables 6.5 and 6.6 demonstrate why strong rejections of the MRE hypothesis now occur. Many of the coefficients on anticipated money growth are now significantly different from zero at the 1 percent level, with some asymptotic *t* statistics even exceeding four in absolute value. Of course these coefficients may be statistically significant and still unimportant from an economic viewpoint; but this is clearly not the case. The unanticipated coefficients not only tend to be greater in absolute value than their unanticipated counterparts, but generally they have higher asymptotic *t* statistics as well. In fact, only one out of twenty-one β coefficients is statistically significant, as opposed to nearly half of the δ coefficients. Contrary to what is implied by the MRE hypothesis, anticipated monetary policy does not appear to be less important than unanticipated monetary policy. In fact, the opposite seems to be the case.

Table 6.2 **Nonlinear Estimates of Output and Unemployment Equations**
Explanatory Variables: Unanticipated Money Growth, Seven Lags (PDL)

$$y_t = c + \tau \mathrm{TIME} + \sum_{i=0}^{7} \beta_i (M1G_{t-i} - M1G^e_{t-i}) + \rho_1\epsilon_{t-1} + \rho_2\epsilon_{t-2} + \rho_3\epsilon_{t-3} + \rho_4\epsilon_{t-4} + \eta_t$$

Model:	2.1		2.2	
Dependent Variable:	log(GNP_t)		UN_t	
	c = 6.178(.047)**	τ = .008(.0005)	c = 3.55(1.54)*	τ = .024(.018)
	β_0 = .715(.230)**		β_0 = −20.01(8.69)**	
	β_1 = 1.617(.340)**		β_1 = −43.21(15.38)**	
	β_2 = 2.196(.414)**		β_2 = −70.04(17.94)**	
	β_3 = 2.412(.467)**		β_3 = −87.80(19.63)**	
	β_4 = 2.273(.485)**		β_4 = −89.58(20.20)**	
	β_5 = 1.835(.449)**		β_5 = −74.20(18.30)**	
	β_6 = 1.262(.371)**		β_6 = −46.27(14.23)**	
	β_7 = .524(.255)*		β_7 = −16.16(9.04)	
	ρ_1 = 1.109(.117)**	ρ_3 = .162(.169)	ρ_1 = 1.464(.112)**	ρ_3 = .077(.202)
	ρ_2 = −.345(.172)*	ρ_4 = .002(.115)	ρ_2 = −.763(.201)**	ρ_4 = .144(.115)
	R^2 = .9988 SE = .00851	D-W = 2.02	R^2 = .9507 SE = .3049	D-W = 2.18

Note: Estimated from the (2) and (4) system, imposing the cross-equation constraints that γ is equal in (2) and (4). The β_i are constrained to lie along a fourth-order polynomial with the endpoint constrained. Asymptotic standard errors are in parentheses. SE = standard error of the equation (the unbiased estimate) = the square root of the sum of squared residuals (SSR) divided by $\frac{1}{2}$ the degrees of freedom, e.g., it equals $\sqrt{2(\mathrm{SSR})/161}$ in tables 6.2 and 6.4; TIME = time trend = 29 in 1954:1 . . . 120 in 1976:4; $M1G - M1G^e$ = unanticipated $M1$ growth; log(GNP_t) = log of real GNP; UN_t = average quarterly unemployment rate.

*Significant at the 5 percent level.

**Significant at the 1 percent level.

Table 6.3 **Nonlinear Estimates of Output and Unemployment Equations**
Explanatory Variables: Unanticipated and Anticipated Money Growth, Seven Lags (PDL)

$$y_t = c + \tau \text{TIME} + \sum_{i=0}^{7} \beta_i (M1G_{t-i} - M1G^e_{t-i}) + \sum_{i=0}^{7} \delta_i M1G^e_{t-i} + \rho_1\epsilon_{t-1} + \rho_2\epsilon_{t-2} + \rho_3\epsilon_{t-3} + \rho_4\epsilon_{t-4} + \eta_t$$

Model:	3.1		3.2	
Dependent Variable:	log(GNP$_t$)		UN_t	
	$c = 6.194(.060)^{**}$	$\tau = .008(.0008)$	$c = 3.00(1.74)$	$\tau = .04(.025)$
	$\beta_0 = .660(.243)^{**}$	$\delta_0 = .402(.564)$	$\beta_0 = -14.90(8.70)$	$\delta_0 = -10.82(15.43)$
	$\beta_1 = 1.263(.599)^{*}$	$\delta_1 = -.211(.669)$	$\beta_1 = 25.16(19.53)$	$\delta_1 = 6.32(19.82)$
	$\beta_2 = 2.191(.814)^{**}$	$\delta_2 = -.568(.753)$	$\beta_2 = -61.33(24.90)^{*}$	$\delta_2 = 12.72(23.43)$
	$\beta_3 = 2.953(.993)^{**}$	$\delta_3 = -.621(.776)$	$\beta_3 = -96.52(30.34)^{**}$	$\delta_3 = -7.47(25.55)$
	$\beta_4 = 3.240(1.097)^{**}$	$\delta_4 = -.397(.720)$	$\beta_4 = -113.59(34.07)^{**}$	$\delta_4 = -7.12(24.10)$
	$\beta_5 = 2.932(1.046)^{**}$	$\delta_5 = -.002(.606)$	$\beta_5 = -105.18(32.60)^{**}$	$\delta_5 = -25.52(19.10)$
	$\beta_6 = 2.092(.841)^{*}$	$\delta_6 = .382(.542)$	$\beta_6 = -73.70(25.42)^{**}$	$\delta_6 = -38.98(15.20)^{*}$
	$\beta_7 = .967(.533)$	$\delta_7 = .495(.483)$	$\beta_7 = -31.33(14.51)^{*}$	$\delta_7 = -35.54(13.33)^{**}$
	$\rho_1 = 1.121(.119)^{**}$	$\rho_3 = .075(.193)$	$\rho_1 = 1.450(.111)^{**}$	$\rho_3 = -.031(.205)$
	$\rho_2 = -.350(.176)^{*}$	$\rho_4 = .091(.128)$	$\rho_2 = -.740(.199)^{**}$	$\rho_4 = -.250(.120)$
	$R^2 = .9989$ SE $= .00845$	D-W = 2.01	$R^2 = .9543$ SE $= .2970$	D-W = 2.20

Note: Estimated from the (2) and (6) system, imposing $\gamma = \gamma^*$. The β_i and δ_i are constrained to lie along a fourth-order polynomial with the endpoint constrained.

*Significant at the 5 percent level.

**Significant at the 1 percent level.

Table 6.4 **Nonlinear Estimates of Output and Unemployment Equations**
Explanatory Variables: Unanticipated Money Growth, Twenty Lags (PDL)

$$y_t = c + \tau \text{TIME} + \sum_{i=0}^{20} \beta_i (M1G_{t-i} - M1G^e_{t-i}) + \rho_1\epsilon_{t-1} + \rho_2\epsilon_{t-2} + \rho_3\epsilon_{t-3} + \rho_4\epsilon_{t-4} + \eta_t$$

Model:	4.1		4.2	
Dependent Variable:	log(GNP$_t$)		UN_t	
	$c = 6.181(.053)$**	$\tau = .008(.0005)$	$c = 3.94(1.85)$*	$\tau = .019(.21)$
	$\beta_0 = .751(.230)$**	$\beta_{11} = .076(.682)$	$\beta_0 = -25.30(7.94)$**	$\beta_{11} = 8.07(26.27)$
	$\beta_1 = 1.578(.328)$**	$\beta_{12} = -.154(.682)$	$\beta_1 = -53.64(12.97)$**	$\beta_{12} = 15.83(25.57)$
	$\beta_2 = 2.060(.440)$**	$\beta_{13} = -.313(.645)$	$\beta_2 = -69.55(17.46)$**	$\beta_{13} = 20.79(24.39)$
	$\beta_3 = 2.266(.519)$**	$\beta_{14} = -.398(.599)$	$\beta_3 = -75.53(20.28)$**	$\beta_{14} = 22.88(22.85)$
	$\beta_4 = 2.255(.573)$**	$\beta_{15} = -.414(.549)$	$\beta_4 = -73.85(21.92)$**	$\beta_{15} = 22.30(21.11)$
	$\beta_5 = 2.086(.612)$**	$\beta_{16} = -.370(.498)$	$\beta_5 = -66.55(22.97)$**	$\beta_{16} = 19.42(19.29)$
	$\beta_6 = 1.806(.645)$**	$\beta_{17} = -.281(.447)$	$\beta_6 = -55.47(23.83)$*	$\beta_{17} = 14.87(17.38)$
	$\beta_7 = 1.459(.674)$*	$\beta_{18} = -.169(.387)$	$\beta_7 = -42.23(24.69)$	$\beta_{18} = 9.48(15.12)$
	$\beta_8 = 1.084(.697)$	$\beta_{19} = -.061(.307)$	$\beta_8 = -28.21(25.51)$	$\beta_{19} = 4.31(12.00)$
	$\beta_9 = .712(.713)$	$\beta_{20} = .008(.185)$	$\beta_9 = -14.56(26.15)$	$\beta_{20} = .65(7.27)$
	$\beta_{10} = .370(.716)$		$\beta_{10} = -2.23(26.45)$	
	$\rho_1 = 1.140(.117)$**	$\rho_3 = .130(.171)$	$\rho_1 = 1.460(.113)$**	$\rho_3 = .063(.204)$
	$\rho_2 = -.333(.174)$	$\rho_4 = -.011(.116)$	$\rho_2 = -.720(.202)$**	$\rho_4 = .124(.133)$
	$R^2 = .9987$ SE = .00872	D-W = 2.00	$R^2 = .9493$ SE = .3089	D-W = 2.13

Note: Estimated from the (2) and (4) system, imposing the cross-equation constraints that γ is equal in (2) and (4). The β_i are constrained to lie along a fourth-order polynomial with the endpoint constrained.

*Significant at the 5 percent level.

**Significant at the 1 percent level.

Table 6.5 **Nonlinear Estimates of Output Equation**
Explanatory Variables: Unanticipated and Anticipated Money Growth, Twenty Lags (PDL)

$$\mathrm{Log(GNP}_t) = c + \tau\mathrm{TIME} + \sum_{i=0}^{20} \beta_i(M1G_{t-i} - M1G^e_{t-i}) + \sum_{i=0}^{20} \delta_i M1G^e_{t-i} + \rho_1\epsilon_{t-1} + \rho_2\epsilon_{t-2} + \rho_3\epsilon_{t-3} + \rho_4\epsilon_{t-4} + \eta_t$$

Model:		5.1		
Dependent Variable:		log(GNP$_t$)		
	c = 6.212(.032)**		τ = .007(.0006)	
β_0 = .645(.237)**	β_{11} = .978(.865)		δ_0 = 1.293(.365)**	δ_{11} = −.219(.333)
β_1 = .402(.405)	β_{12} = .899(.849)		δ_1 = 1.733(.388)**	δ_{12} = −.429(.326)
β_2 = .305(.570)	β_{13} = .773(.813)		δ_2 = 1.944(.429)**	δ_{13} = −.578(.322)
β_3 = .316(.666)	β_{14} = .608(.761)		δ_3 = 1.972(.446)**	δ_{14} = −.664(.322)*
β_4 = .400(.713)	β_{15} = .417(.700)		δ_4 = 1.858(.440)**	δ_{15} = −.686(.329)*
β_5 = .525(.736)	β_{16} = .217(.630)		δ_5 = 1.639(.419)**	δ_{16} = −.649(.338)
β_6 = .666(.756)	β_{17} = .030(.561)		δ_6 = 1.351(.393)**	δ_{17} = −.561(.342)
β_7 = .800(.780)	β_{18} = −.117(.483)		δ_7 = 1.023(.370)**	δ_{18} = −.435(.328)
β_8 = .909(.811)	β_{19} = −.196(.382)		δ_8 = .682(.354)	δ_{19} = −.285(.278)
β_9 = .980(.840)	β_{20} = −.170(.232)		δ_9 = .349(.345)	δ_{20} = −.133(.176)
β_{10} = 1.004(.861)			δ_{10} = .044(.339)	
	ρ_1 = 1.051(.115)**		ρ_3 = .081(.169)	
	ρ_2 = −.238(.171)		ρ_4 = −.106(.111)	
	R^2 = .9989	SE = .00838	D-W = 2.16	

Note: Estimated from the (2) and (6) system, imposing $\gamma = \gamma^*$. The β_i and δ_i are constrained to lie along a fourth-order polynomial with the endpoint constrained.

*Significant at the 5 percent level.

**Significant at the 1 percent level.

Table 6.6 Nonlinear Estimates of Unemployment Equation
Explanatory Variables: Unanticipated and Anticipated Money Growth, Twenty Lags (PDL):

$$UN_t = c + \tau TIME + \sum_{i=0}^{20} \beta_i (M1G_{t-i} - M1G^e_{t-i}) + \sum_{i=0}^{20} \delta_i M1G^e_{t-i} + \rho_1\epsilon_{t-1} + \rho_2\epsilon_{t-2} + \rho_3\epsilon_{t-3} + \rho_4\epsilon_{t-4} + \eta_t$$

Model:		6.1		
Dependent Variable:		UN_t		
		c = 3.28(1.79)	τ = .067(.031)*	
β_0 = −18.38(8.36)*	β_{11} = 21.29(33.69)		δ_0 = −17.09(12.27)	δ_{11} = −3.59(12.22)
β_1 = −25.41(14.34)	β_{12} = 25.28(32.55)		δ_1 = −38.80(12.87)**	δ_{12} = 3.98(11.47)
β_2 = −28.09(19.95)	β_{13} = 27.83(30.59)		δ_2 = −52.16(14.38)**	δ_{13} = 9.95(10.84)
β_3 = −27.30(23.51)	β_{14} = 28.84(27.98)		δ_3 = −58.66(15.37)**	δ_{14} = 14.11(10.52)
β_4 = −28.85(25.74)	β_{15} = 28.30(25.00)		δ_4 = −59.67(15.70)**	δ_{15} = 16.39(10.58)
β_5 = −18.50(27.40)	β_{16} = 26.24(21.96)		δ_5 = −56.43(15.56)**	δ_{16} = 16.80(10.91)
β_6 = −11.89(28.98)	β_{17} = 22.79(19.05)		δ_6 = −50.10(15.18)**	δ_{17} = 15.48(11.13)
β_7 = 4.65(30.62)	β_{18} = 18.14(16.18)		δ_7 = −41.69(14.69)**	δ_{18} = 12.71(10.75)
β_8 = 2.71(32.71)	β_{19} = 12.56(12.76)		δ_8 = −32.10(14.17)*	δ_{19} = 8.86(9.19)
β_9 = 9.73(33.36)	β_{20} = 6.37(7.78)		δ_9 = −22.13(13.61)	δ_{20} = 4.42(5.82)
β_{10} = 16.02(33.93)			δ_{10} = −12.44(12.96)	
		ρ_1 = 1.442(.112)**	ρ_3 = −.008(.202)	
		ρ_2 = −.690(.199)**	ρ_4 = .171(.113)	
		R^2 = .9539 SE = .2983	D-W = 2.26	

Note: See table 6.5.
*Significant at the 5 percent level.
**Significant at the 1 percent level.

Interpreting the δ coefficients of anticipated money growth poses some difficulties. One natural tendency is to make inferences about long-run neutrality by testing whether the sum of the δ coefficients differs from zero. The following implicit question is being asked: What will be the output or unemployment response to a permanent increase of 1 percent in the expected rate of money growth? Lucas (1976), Sargent (1971, 1977), and Mishkin (1979) show that this question cannot be answered with reduced-form models, of which the MRE model is one example. The parameters of the MRE model are not invariant to changes in the time-series process of money growth and thus cannot yield reliable inferences about what will happen when the time-series process of money growth differs from that in the sample period. As the money growth equations in the appendices in this and in Chapter 5 indicate, the time-series process of money growth is stationary and is quite different from a random walk. Yet a permanent increase in expected money growth is consistent only with a random walk time-series process. Trying to use the estimated MRE model here to make inferences about the response to a permanent increase in expected money growth is thus inappropriate.

Furthermore, most structural macroeconometric models in use do not distinguish between anticipated and unanticipated monetary policy and are incapable of interpreting the lag patterns of the δ's versus the β's in tables 6.5 and 6.6. It is not obvious what form these lag patterns should take in a model where expectations are rational, yet anticipated monetary policy matters. Econometric models of this type are only now being developed—Taylor (1979), for example—but to my knowledge simulation results displaying the reduced-form β and δ coefficients are not yet available.

Output and unemployment models were also estimated using *M*2 growth rather than *M*1 growth as the policy variable. Here the Granger (1969) criterion generates a specification of the *M*2 equation that includes only past *M*2 growth and Treasury Bill rates as explanatory variables. The results are not reported here in the interests of brevity, but they indicate that using *M*1 rather than *M*2 in the estimated models does not change the conclusions.[5] However, using unanticipated *M*2 growth rather than *M*1 growth does lead to some deterioration in the fit of the equations as well as lower asymptotic t statistics.

It does not seem to matter, either, whether seasonally adjusted or seasonally unadjusted data are used in the empirical work here. Season-

5. E.g., the freely estimated A14.1 *M*2 model does not lead to rejection of the joint hypothesis. The likelihood statistic is $\chi^2(15) = 18.1$ with a marginal significance level of .26. However, the *M*2 results for the longer lag models explored in this chapter are just as negative to the MRE hypothesis. E.g., the freely estimated A15.1 model with *M*2 data leads to a likelihood ratio statistic for the joint hypothesis of $\chi^2(28) = 58.90$ with a marginal significance level of .0006.

ally unadjusted $M1$ data in output and unemployment models give results not appreciably different from seasonally adjusted data.[6] The empirical work in Chapters 4 and 5 that use models resembling the one here also find results not appreciably affected by the choice of seasonally adjusted over unadjusted data.

The money growth results here are much less favorable to the MRE hypothesis than previous work. Which of the several differences in the analysis here from that of earlier work might explain the less favorable results? As pointed out in Chapter 2, the joint nonlinear estimation procedure used here is even more favorable to the null hypothesis than the two-step procedure used in previous work, so this procedure cannot be the cause of the rejections. Polynomial distributed lags have been used in order to insure that rejections of the MRE hypothesis are not spurious. They have made very little difference to the results and do not appear to be a factor in the rejections.

The money growth specifications yielded by the procedure used here is substantially different from specifications in previous studies. In contrast to those, neither real government expenditures nor unemployment are explanatory variables in the money growth equation. Because so much of the debate on the MRE hypothesis has focused on the specification of the money growth equation (see Barro 1977; Small 1979; Germany and Srivastava 1979; Blinder 1980; Weintraub 1980), we may wonder whether this different specification is central to the findings. A comparison of the findings here with those from the other study that analyzes postwar quarterly data, Barro and Rush (1980), should help answer this question.

The models of table 6.2 that have the same seven-quarter lag length used in Barro and Rush yield results very similar to theirs, even though they use a different specification for the money growth equation. As in Barro and Rush, the models in this study fit the data well, the unanticipated money growth variables have significant explanatory power, and the tests of the rationality and neutrality constraints are not unfavorable to the MRE hypothesis. Most striking is the similarity of the parameter estimates. Not only do the table 6.2 models display the same pattern of serial correlation in the residuals as the Barro and Rush results, but the lag structure has the same humped pattern and peaks at identical lags.

6. Because a fourth-order autoregression is not sufficient to reduce the seasonally unadjusted $M1$ growth to white noise, values of the unadjusted $M1$ growth for lags five through eight replaced the SURP variables in the forecasting equation specification. The coefficients and asymptotic standard errors of the freely estimated A14.1 model estimated with unadjusted data are close to those using the adjusted data. In this case the likelihood ratio statistic of the joint hypothesis is $\chi^2(19) = 29.75$ with a marginal significance level of .0551. The unadjusted results for the long lag A15.1 model are unfavorable to the MRE hypothesis. So are the results using adjusted data: the likelihood ratio statistic for the joint hypothesis is $\chi^2(32) = 62.65$ with a marginal significance level of .0010.

The close resemblance between the table 6.2 results and those of Barro and Rush is an important finding. Although misspecification of the money growth forecasting equation would lead to an error-in-variables bias in the coefficients of the unemployment or output equation, the preceding chapter has argued and found evidence that the bias should not be severe. The similarity of the results in table 6.2 to those of Barro and Rush lends support to this view, and further support comes from the similarity of the *M2* and *M1* results where the specification of the money growth forecasting equation also differs.

The similarity of the table 6.2 and Barro-Rush results certainly shows that using a different sample period from Barro and Rush's is not what caused the MRE hypothesis to be rejected. By a process of elimination, we are left with the longer lag lengths as the key reason why this chapter contains results so much more unfavorable to the MRE hypothesis. However, there are three other minor differences between the models here and those in Barro and Rush: (1) a fourth-order AR serial correlation correction rather than a second-order AR correction, (2) exclusion of government expenditure variables from the output and employment equations, and (3) a different definition of the unemployment variable. Could these differences lead to the rejections found here? To ascertain the effect of these differences, the long lag models were reestimated so that the output and unemployment equations conformed to the Barro and Rush specification. The resulting models are found in Appendix 6.1.

As Barro and Rush found, the coefficient on their government expenditure variables do have the expected sign, indicating that a rise in government expenditure is associated with higher output and lower unemployment. Although the government expenditure variable does not exhibit significant additional explanatory power in the unemployment equation, it does so in the output equation. There the coefficient on the log of government expenditure is significantly different from zero at the 1 percent level: it is over three times its standard error. However, it is not clear that actual government expenditure belongs in an output or unemployment equation consistent with the MRE hypothesis. Some distinction between anticipated and unanticipated seems called for in this case. An attempt was made to estimate models that make this distinction, but the attempt was not very successful: the Granger criterion led to a specification of the government expenditure forecasting equation where the identification condition discussed in Chapter 2 was not satisfied: that is, no other variables besides past government expenditure were found to be significant explanatory variables in this equation. This is the reason why, despite its use by Barro and Rush, no form of government expenditure was included as an explanatory variable in the models of tables 6.1–6.6.

The basic finding in Appendix 6.1 is that the three changes in specification suggested by Barro and Rush (1980) do not appreciably affect the results. The test statistics are quite close to those found for the models in tables 6.1–6.6. The strong rejections of the MRE hypothesis hold up. Furthermore, contrary to the MRE hypothesis, anticipated monetary policy continues to be more important than unanticipated monetary policy in these results. As in tables 6.5 and 6.6, the coefficients on anticipated money growth are larger and more statistically significant than those of unanticipated money growth.

6.4 Conclusions

This chapter asks the question, "Does Anticipated Aggregate Demand Policy Matter?" The reported findings answer this question with a strong "yes": anticipated policy does seem to matter.

The most important results are those with money growth as the aggregate demand variable. These results strongly reject the neutrality proposition of the MRE hypothesis. Furthermore, contrary to the implications of the MRE hypothesis, unanticipated movements in monetary policy do not have a larger impact on output and unemployment than anticipated movements. The other proposition embodied in the MRE hypothesis, that expectations are rational, fares better in the empirical tests here. When the MRE component hypotheses of rationality and neutrality are tested jointly, strong rejections occur in both the output and unemployment models. In one case, the probability of finding the same or higher value of the likelihood ratio statistic under the null hypothesis is only 1 in 10,000. The crucial factor in the unfavorable findings on the MRE hypothesis appears to be the inclusion of long lags in the output and unemployment equations. The results here thus give further impetus to theoretical research (see Blinder's 1980 discussion) that is currently exploring why long lags may exist in rational expectations models of the business cycle.

Models with longer lags are less restrictive. The rejections in these models are therefore very damaging to earlier evidence in support of the MRE hypothesis obtained from models with shorter lags. As discussed in Chapter 2, the only cost to estimating the models with longer lags is a potential decrease in the power of the test statistics. Rejections in this case are thus even more telling. The failure to reject the MRE hypothesis in shorter lag models appears to be the result of an overly restrictive specification that leads to inconsistent parameter estimates and incorrect test statistics.

There is one qualification of the results that warrants further discussion. The methodology used here follows previous research in this area by using the identifying assumption that the output and unemployment equations are true reduced forms. It is not clear whether, if this assumption proved invalid, it might lead to rejections of the MRE hypothesis even if the hypothesis was true. The money growth results here are then by no means a definitive rejection of this hypothesis. However, this work does cast doubt on the previous evidence, also of a reduced-form nature, marshaled to support the view that only unanticipated monetary policy is relevant to the business cycle.

The above qualification is even more important for the results in Appendix 6.3 where the aggregate demand variables are nominal GNP growth or inflation, both of which are less likely to be exogenous. However, these results confirm the money growth results. Rejections of neutrality are extremely strong. In one case, for example, the probability of finding that value of the likelihood ratio statistic under the null hypothesis of neutrality is only 1 in 200,000. The hypothesis of rational expectations fares much better in these tests. Although the rationality hypothesis does not come out unscathed—there is one rejection at the 5 percent level, but just barely—it is not rejected in any other tests in this appendix at the 5 percent level.[7] This result might encourage those who are willing to assume rationality of expectations in constructing their macro models, yet are unwilling to assert the short-run neutrality of policy.

7. I do not cite the rationality test results in Appendix 6.3. In Chapter 2 I explain why they may not be reliable because of small sample bias.

Appendix 6.1: Output and Unemployment Models with Barro and Rush Specification

Table 6.A.1 **Nonlinear Estimates of Output and Unemployment Equations**
Explanatory Variables: Unanticipated Money Growth, Twenty Lags (PDL) and Government Expenditure Variables

$$y_t = c + \tau\ \text{TIME} + \theta G_t + \sum_{i=0}^{20} \beta_i\,(M1G_{t-i} - M1G^e_{t-i}) + \rho_1\epsilon_{t-1} + \rho_2\epsilon_{t-2} + \eta_t$$

Model:	A1.1			A1.2		
Dependent Variable:	log (GNP_t)			log $[UN_t/(1-UN_t)]$		
	c = 5.579(.140)**	τ = .008(.0003)**	θ = .139(.030)**	c = −2.86(.53)**	τ = .006(.004)	θ = −4.30(2.46)
	β_0 = .736(.218)**	β_{11} = .530(.340)		β_0 = −4.98(1.58)**	β_{11} = −12.67(6.43)*	
	β_1 = 1.523(.269)**	β_{12} = .426(.324)		β_1 = −9.38(2.82)**	β_{12} = −11.27(6.26)	
	β_2 = 1.974(.345)**	β_{13} = .386(.309)		β_2 = −12.65(3.78)**	β_{13} = −9.84(5.93)	
	β_3 = 2.162(.389)**	β_{14} = .403(.300)		β_3 = −14.93(4.34)**	β_{14} = −8.43(5.48)	
	β_4 = 2.152(.405)**	β_{15} = .464(.297)		β_4 = −16.37(4.69)**	β_{15} = −7.06(4.96)	
	β_5 = 2.004(.403)**	β_{16} = .546(.303)		β_5 = −17.10(4.97)**	β_{16} = −5.76(4.42)	
	β_6 = 1.767(.392)**	β_{17} = .619(.307)*		β_6 = −17.24(5.27)**	β_{17} = −4.51(3.89)	
	β_7 = 1.485(.381)**	β_{18} = .649(.296)*		β_7 = −16.90(5.62)**	β_{18} = −3.34(3.34)	
	β_8 = 1.195(.371)**	β_{19} = .591(.254)*		β_8 = −16.19(5.97)**	β_{19} = 2.21(2.64)	
	β_9 = .926(.363)*	β_{20} = .394(.162)*		β_9 = −15.20(6.26)*	β_{20} = −1.11(1.60)	
	β_{10} = .699(.353)*			β_{10} = −14.00(6.42)*		
	ρ_1 = .993(.110)**			ρ_1 = 1.460(.089)**		
	ρ_2 = −.273(.110)*			ρ_2 = −.628(.087)**		
	R^2 = .9989	SE = .00808	D-W = 2.02	R^2 = .9512	SE = .0588	D-W = 2.14

Note: Estimates from (2) and (4) system (where [4] includes the θG_t term) imposing the cross-equation constraints that γ is equal in (2) and (4). The β_i are constrained to lie along a fourth-order polynomial with the endpoint constrained. $G_t = \log(\text{GEXP}_t)$ in A1.1, where GEXP_t is real federal government expenditure for quarter t, and $G_t = \text{GEXP}_t/\text{GNP}_t$ in A1.2.

*Significant at the 5 percent level.

**Significant at the 1 percent level.

Table 6.A.2 Likelihood Ratio Tests for the Models of Table 6.A.1

	Model	
	A1.1	A1.2
Joint hypothesis:		
Likelihood ratio statistic	$\chi^2(15) = 43.02$**	$\chi^2(15) = 31.26$**
Marginal significance level	.0002	.0081
Neutrality:		
Likelihood ratio statistic	$\chi^2(4) = 13.13$*	$\chi^2(4) = 13.78$**
Marginal significance level	.0106	.0081
Rationality		
Likelihood ratio statistic	$\chi^2(11) = 30.45$**	$\chi^2(11) = 18.80$
Marginal significance level	.0013	.0648

*Significant at the 5 percent level.

**Significant at the 1 percent level.

Table 6.A.3 **Nonlinear Estimate of Output Equation**
Explanatory Variables: Unanticipated and Anticipated Money Growth, Twenty Lags (PDL), and Government Expenditure Variable

$$\text{Log}(\text{GNP}_t) = c + \tau\ \text{TIME} + \theta G_t + \sum_{i=0}^{20} \beta_i\,(M1G_{t-i} - M1G^e_{t-i}) + \sum_{i=0}^{20} \delta_i M1G^e_{t-i} + \rho_1\epsilon_{t-1} + \rho_2\epsilon_{t-2} + \eta_t$$

Model: A3.1
Dependent Variable: log (GNP_t)

	c = 5.570(.184)**	τ = .007(.0006)**	θ = .129(.038)**
β_0 = .566(.225)*	β_{11} = −.742(.945)	δ_0 = 1.321(.337)**	δ_{11} = .204(.313)
β_1 = .184(.366)	β_{12} = −.771(.909)	δ_1 = 1.690(.337)**	δ_{12} = .010(.282)
β_2 = −.098(.536)	β_{13} = −.799(.854)	δ_2 = 1.881(.372)**	δ_{13} = −.143(.252)
β_3 = −.300(.660)	β_{14} = −.822(.785)	δ_3 = 1.926(.402)**	δ_{14} = −.250(.226)
β_4 = −.440(.748)	β_{15} = −.834(.706)	δ_4 = 1.856(.416)**	δ_{15} = −.311(.211)
β_5 = −.535(.813)	β_{16} = −.825(.623)	δ_5 = 1.701(.418)**	δ_{16} = −.328(.207)
β_6 = −.597(.865)	β_{17} = −.785(.538)	δ_6 = 1.485(.411)**	δ_{17} = −.304(.209)
β_7 = −.638(.908)	β_{18} = −.699(.449)	δ_7 = 1.232(.399)**	δ_{18} = −.248(.203)
β_8 = −.667(.940)	β_{19} = −.552(.344)	δ_8 = .961(.384)*	δ_{19} = −.170(.177)
β_9 = −.692(.959)	β_{20} = −.326(.203)	δ_9 = .691(.364)	δ_{20} = −.082(.114)
β_{10} = −.716(.961)		δ_{10} = .434(.341)	
		ρ_1 = .967(.113)**	
		ρ_2 = −.164(.109)	

R^2 = .9990 SE = .00779 D-W = 2.08

Note: Estimated from the (2) and (6) system (where [6] includes the θG_t term), imposing $\gamma = \gamma^*$. The β_i and δ_i are constrained to lie along a fourth-order polynomial with the endpoint constrained. $G_t = \log(\text{GEXP}_t)$, where GEXP_t = real federal government expenditure for quarter t.
*Significant at the 5 percent level.
**Significant at the 1 percent level.

Table 6.A.4 **Nonlinear Estimate of Unemployment Equation**
Explanatory Variables: Unanticipated and Anticipated Money Growth, Twenty Lags (PDL), and Government Expenditure Variable

$$\mathrm{Log}[UN_t/(1-UN_t)] = c + \tau\,\mathrm{TIME} + \theta G_t + \sum_{i=0}^{20} \beta_i (M1G_{t-i} - M1G^e_{t-i}) + \sum_{i=0}^{20} \delta_i M1G^e_{t-i} + \rho_1 \epsilon_{t-1} + \rho_2 \epsilon_{t-2} + \eta_t$$

Model:	A4.1		
Dependent Variable:	$\log[UN_t/(1-UN_t)]$		
	$c = -2.64(.47)$**	$\tau = .011(.004)$**	$\theta = -4.51(2.49)$
$\beta_0 = -4.32(1.53)$**	$\beta_{11} = -3.19(5.87)$	$\delta_0 = -3.34(2.38)$	$\delta_{11} = .04(2.21)$
$\beta_1 = -5.71(2.75)$*	$\beta_{12} = -2.51(5.78)$	$\delta_1 = -8.05(2.63)$**	$\delta_{12} = 1.74(2.13)$
$\beta_2 = -6.60(3.79)$	$\beta_{13} = -1.88(5.54)$	$\delta_2 = -10.95(2.97)$**	$\delta_{13} = 3.08(2.10)$
$\beta_3 = -7.05(4.36)$	$\beta_{14} = -1.34(5.17)$	$\delta_3 = -12.34(3.13)$**	$\delta_{14} = 4.02(2.16)$
$\beta_4 = -7.16(4.61)$	$\beta_{15} = -.89(4.73)$	$\delta_4 = -12.53(3.12)$**	$\delta_{15} = 4.51(2.30)$
$\beta_5 = -6.99(4.74)$	$\beta_{16} = -.54(4.26)$	$\delta_5 = -11.80(2.99)$**	$\delta_{16} = 4.57(2.47)$
$\beta_6 = -6.59(4.88)$	$\beta_{17} = -.29(3.79)$	$\delta_6 = -10.37(2.82)$**	$\delta_{17} = 4.22(2.58)$
$\beta_7 = -6.04(5.10)$	$\beta_{18} = -.12(3.27)$	$\delta_7 = -8.49(2.66)$**	$\delta_{18} = 3.50(2.52)$
$\beta_8 = -5.38(5.37)$	$\beta_{19} = -.03(2.60)$	$\delta_8 = -6.35(2.52)$*	$\delta_{19} = 2.49(2.17)$
$\beta_9 = -4.66(5.63)$	$\beta_{20} = .00(1.58)$	$\delta_9 = -4.12(2.41)$	$\delta_{20} = 1.28(1.37)$
$\beta_{10} = -3.92(5.82)$		$\delta_{10} = -1.95(2.31)$	
	$\rho_1 = 1.372(.094)$**		
	$\rho_2 = -.526(.090)$**		
	$R^2 = .9572$	SE = .0558	D-W = 2.14

Note: Estimated from the (2) and (6) system (where [6] includes the θG_t term), imposing $\gamma = \gamma^*$. The β_i and δ_i are constrained to lie along a fourth-order polynomial with the endpoint constrained. $G_t = \mathrm{GEXP}_t/\mathrm{GNP}_t$, where GEXP_t = real federal government expenditure for quarter t.

*Significant at the 5 percent level.

**Significant at the 1 percent level.

Appendix 6.2: Results with Nominal GNP Growth and Inflation as the Aggregate Demand Variable

Nominal GNP Growth as the Aggregate Demand Variable

The models here follow Gordon (1979) and Grossman (1979) in using nominal GNP growth as the aggregate demand variable in the output and unemployment equations. We should be cautious in interpreting the results because the assumptions that nominal GNP growth is exogenous and that the models are reduced forms are questionable. Nevertheless, these results will shed light on previous evidence on the MRE hypothesis using nominal GNP growth as the X variable. Table 6.A.5 reports the output and unemployment equations that have been estimated from the (2) and (4) system, imposing the cross-equation constraints that the γ are equal in both equations. Twenty lagged quarters of unanticipated nominal GNP growth have been included in the models because coefficients on lags as far back as this are significantly different from zero at the 5 percent level—a result confirmed by Gordon (1979).[8]

The signs and shape of the A5.1 and A5.2 models are sensible, showing an increase in unanticipated nominal GNP growth usually associated with an increase in output or a decrease in unemployment. The fit of these equations is good too—compare them, for example, with the results in table 6.2 and table 6.A.9—and several of the coefficients on unanticipated nominal GNP growth even exceed their asymptotic standard errors by a factor of 10. The good fit is not surprising because we would expect nominal GNP fluctuations to track short-run movements accurately in real GNP or unemployment if price level movements are smooth.

Despite these attractive results, table 6.A.6 indicates that the MRE hypothesis is not supported. Both the unemployment and output models lead to strong rejections of the joint hypothesis. Rejection in the output model is at the .00001 level; in the unemployment model it is at the .0009 level.[9] One reason for the stronger rejections here with nominal GNP growth as the aggregate demand variable may be that the higher correlation of this aggregate demand variable with output or unemployment leads to tests with greater power. The most interesting aspect of these results is that the rationality constraints contribute very little to these rejections. In both models, the data do not reject the rationality of expectations. The culprit behind the rejections of the joint hypothesis is

8. See McCallum (1979*b*) for a critique of the Gordon (1979) study.

9. As in the money growth results, the long lags for the unanticipated and anticipated nominal GNP variables are critical to the negative findings on the MRE hypothesis. E.g., an output model with only seven lags of nominal GNP growth and the lag coefficients freely estimated does not reject the joint hypothesis: $\chi^2(15) = 23.07$ with a marginal significance level of .0827.

Table 6.A.5 **Nonlinear Estimates of Output and Unemployment Equations**
Explanatory Variables: Unanticipated Nominal Income Growth, Twenty Lags, Polynomial Distributed Lags

$$y_t = c + \tau \text{time} + \sum_{i=0}^{20} \beta_i(\text{NGNP}_{t-i} - \text{NGNP}^e_{t-i}) + \rho_1\epsilon_{t-1} + \rho_2\epsilon_{t-2} + \rho_3\epsilon_{t-3} + \rho_4\epsilon_{t-4} + \eta_t$$

Model:	A5.1		A5.2	
Dependent Variable:	$\log(\text{GNP}_t)$		UN_t	
	c = 6.191(.043)**	τ = .008(.0005)	c = −138.011(1840)	τ = .519(3.408)
	β_0 = .927(.043)**	β_{11} = .351(.279)	β_0 = −25.529(2.626)**	β_{11} = −32.213(13.077)*
	β_1 = 1.134(.106)**	β_{12} = .229(.258)	β_1 = −53.559(5.102)**	β_{12} = −24.676(12.297)*
	β_2 = 1.246(.171)**	β_{13} = .126(.233)	β_2 = −71.535(7.559)**	β_{13} = −18.593(11.236)
	β_3 = 1.281(.220)**	β_{14} = .044(.203)	β_3 = −81.300(9.409)**	β_{14} = −14.057(9.948)
	β_4 = 1.253(.256)**	β_{15} = −.016(.172)	β_4 = −84.534(10.785)**	β_{15} = −11.000(8.519)
	β_5 = 1.178(.280)**	β_{16} = −.053(.139)	β_5 = −82.760(11.831)	β_{16} = − 9.199(7.057)
	β_6 = 1.067(.296)**	β_{17} = −.069(.107)	β_6 = −77.342(12.633)**	β_{17} = − 8.268(5.670)
	β_7 = .933(.305)**	β_{18} = −.067(.077)	β_7 = −69.486(13.225)**	β_{18} = − 7.664(4.424)
	β_8 = .786(.307)*	β_{19} = −.051(.052)	β_8 = −60.237(13.595)**	β_{19} = − 6.685(3.253)*
	β_9 = .636(.304)*	β_{20} = −.027(.028)	β_9 = −50.483(13.715)**	β_{20} = − 4.470(1.911)*
	β_{10} = .488(.294)		β_{10} = −40.952(13.549)**	
	ρ_1 = 1.285(.110)**	ρ_3 = −.086(.179)	ρ_1 = 1.227(.112)**	ρ_3 = .058(.179)
	ρ_2 = −.073(.179)	ρ_4 = −.165(.110)	ρ_2 = −.300(.178)	ρ_4 = .012(.115)
	R^2 = .9998 SE = .00350	D-W = 1.89	R^2 = .9754 SE = .21267	D-W = 2.01

Note: Estimated from the (2) and (4) system, imposing the cross-equation constraints that γ is equal in (2) and (4). The β_i are constrained to lie along a fourth-order polynomial with the endpoint constrained.

*Significant at the 5 percent level.

**Significant at the 1 percent level.

Table 6.A.6 Likelihood Ratio Tests for the Models of Table 6.A.5

	Model	
Model	A5.1	A5.2
Joint hypothesis:		
Likelihood ratio statistic	$\chi^2(11) = 43.19$**	$\chi^2(11) = 31.69$**
Marginal significance level	1.01×10^{-5}	.0009
Neutrality:		
Likelihood ratio statistic	$\chi^2(4) = 30.22$**	$\chi^2(4) = 19.90$**
Marginal significance level	4.41×10^{-6}	.0005
Rationality:		
Likelihood ratio statistic	$\chi^2(7) = 12.86$	$\chi^2(7) = 11.28$
Marginal significance level	.0756	.1269

*Significant at the 5 percent level.
**Significant at the 1 percent level.

the neutrality proposition. These neutrality rejections are exceedingly strong: the probability of finding the same or higher value of the likelihood ratio statistic under the null hypothesis of neutrality is 1 in 2,000 for the unemployment model and 1 in 200,000 for the output model! Clearly, in these models, anticipated nominal GNP growth does matter, and rejection of the neutrality constraints cannot be blamed on the failure of the maintained hypothesis of rationality. These results then lend some support to modeling strategies in which expectations are assumed to be rational.

Tables 6.A.7 and 6.A.8 contain the results from the (2) and (6) system with rational expectations imposed. As we would expect from table 6.A.6, many of the coefficients on anticipated nominal GNP growth are significantly different from zero at the 1 percent level, with some asymptotic t statistics even exceeding 7 in absolute value. The coefficients on anticipated nominal GNP growth are of a similar magnitude to the coefficients on unanticipated nominal GNP growth. Contrary to what is implied by the MRE hypothesis, anticipated aggregate demand policy as represented by nominal GNP growth is not obviously less important than unanticipated aggregate demand policy.

Inflation as the Aggregate Demand Variable

The next set of results explores á Lucas (1973) supply function where inflation is the aggregate demand variable. We should be cautious in interpreting these results, not only because the assumption that inflation is exogenous is tenuous, but also because the γ coefficients in the inflation-forecasting equation were not found to be stable. Table 6.A.9 presents the output and unemployment equations estimated from the constrained (2) and (4) system. The seventeen-quarter lag length on

Table 6.A.7 **Nonlinear Estimates of Output Equations**
Explanatory Variables: Unanticipated and Anticipated Nominal GNP Growth, Twenty Lags (PDL)

$$\mathrm{Log}(\mathrm{GNP}_t) = c + \tau \mathrm{TIME} + \sum_{i=0}^{20} \beta_i(\mathrm{NGNP}_{t-i} - \mathrm{NGNP}^e_{t-i}) + \sum_{i=0}^{20} \delta_i \mathrm{NGNP}^e_{t-i} + \rho_1\epsilon_{t-1} + \rho_2\epsilon_{t-2} + \rho_3\epsilon_{t-3} + \rho_4\epsilon_{t-4} + \eta_t$$

Model:		A7.1		
Dependent Variable:		$\log(\mathrm{GNP}_t)$		
	$c = 6.127(.049)$**		$\tau = .009(.0007)$	
	$\beta_0 = .913(.040)$**	$\beta_{11} = .121(.128)$	$\delta_0 = .744(.098)$**	$\delta_{11} = -.415(.257)$
	$\beta_1 = .815(.058)$**	$\beta_{12} = .075(.124)$	$\delta_1 = .745(.104)$**	$\delta_{12} = -.460(.248)$
	$\beta_2 = .725(.075)$**	$\beta_{13} = .034(.117)$	$\delta_2 = .688(.126)$**	$\delta_{13} = -.477(.214)$*
	$\beta_3 = .640(.090)$**	$\beta_{14} = -.002(.109)$	$\delta_3 = .588(.150)$**	$\delta_{14} = -.467(.214)$*
	$\beta_4 = .560(.101)$**	$\beta_{15} = -.031(.098)$	$\delta_4 = .460(.173)$**	$\delta_{15} = -.431(.191)$*
	$\beta_5 = .486(.110)$**	$\beta_{16} = -.052(.087)$	$\delta_5 = .315(.195)$	$\delta_{16} = -.374(.166)$*
	$\beta_6 = .415(.117)$**	$\beta_{17} = -.064(.074)$	$\delta_6 = .163(.215)$	$\delta_{17} = -.301(.139)$*
	$\beta_7 = .349(.123)$**	$\beta_{18} = -.067(.061)$	$\delta_7 = .014(.233)$	$\delta_{18} = -.218(.111)$*
	$\beta_8 = .286(.127)$*	$\beta_{19} = -.058(.045)$	$\delta_8 = -.123(.247)$	$\delta_{19} = -.134(.081)$
	$\beta_9 = .227(.130)$	$\beta_{20} = -.036(.026)$	$\delta_9 = -.244(.256)$	$\delta_{20} = -.058(.046)$
	$\beta_{10} = .172(.130)$		$\delta_{10} = -.342(.266)$	
		$\rho_1 = 1.207(.105)$**	$\rho_3 = .030(.170)$	
		$\rho_2 = .009(.171)$	$\rho_4 = -.273(.106)$*	
		$R^2 = .9998$ SE $= .00332$	D-W $= 1.95$	

Note: Estimates from the (2) and (6) system imposing $\gamma = \gamma^*$. The β_i and δ_i are constrained to lie along a fourth-order polynomial with the endpoint constrained.

*Significant at the 5 percent level.

**Significant at the 1 percent level.

Table 6.A.8 **Nonlinear Estimates of Unemployment Equation**
Explanatory Variables: Unanticipated and Nominal GNP Growth, Twenty Lags (PDL)

$$UN_t = c + \tau TIME + \sum_{i=0}^{20} \beta_i (NGNP_{t-i} - NGNP^e_{t-i}) + \sum_{i=0}^{20} \delta_i NGNP^e_{t-i} + \rho_1\epsilon_{t-1} + \rho_2\epsilon_{t-2} + \rho_3\epsilon_{t-3} + \rho_4\epsilon_{t-4} + \eta_t$$

Model:		A8.1	
Dependent Variable:		UN_t	
	$c = -168.2(2420)$	$\tau = .575(3.85)$	
$\beta_0 = -23.90(2.64)$**	$\beta_{11} = -11.35(5.38)$*	$\delta_0 = -36.46(5.78)$**	$\delta_{11} = -16.73(8.73)$
$\beta_1 = -35.22(4.00)$**	$\beta_{12} = -8.70(5.14)$	$\delta_1 = -40.33(5.36)$**	$\delta_{12} = -12.91(8.47)$
$\beta_2 = -41.42(5.33)$**	$\beta_{13} = -7.08(4.88)$	$\delta_2 = -42.27(5.97)$**	$\delta_{13} = -9.44(8.11)$
$\beta_3 = -43.60(6.14)$**	$\beta_{14} = -6.41(4.64)$	$\delta_3 = -42.58(6.71)$**	$\delta_{14} = -6.39(7.69)$
$\beta_4 = -42.72(6.51)$**	$\beta_{15} = -6.50(4.41)$	$\delta_4 = -41.55(7.32)$**	$\delta_{15} = -3.84(7.24)$
$\beta_5 = -39.67(6.58)$**	$\beta_{16} = -7.09(4.20)$	$\delta_5 = -39.44(7.80)$**	$\delta_{16} = -1.82(6.77)$
$\beta_6 = -35.21(6.46)$**	$\beta_{17} = -7.78(3.95)$*	$\delta_6 = -36.51(8.19)$**	$\delta_{17} = -.37(6.24)$
$\beta_7 = -30.01(6.26)$**	$\beta_{18} = -8.06(3.57)$*	$\delta_7 = -32.99(8.50)$**	$\delta_{18} = .51(5.50)$
$\beta_8 = -24.62(6.04)$**	$\beta_{19} = -7.35(2.92)$*	$\delta_8 = -29.07(8.73)$**	$\delta_{19} = .84(4.39)$
$\beta_9 = -19.50(5.82)$**	$\beta_{20} = -4.93(1.79)$**	$\delta_9 = -24.94(8.86)$**	$\delta_{20} = .65(2.65)$
$\beta_{10} = -15.00(5.61)$**		$\delta_{10} = -20.78(8.86)$*	
	$\rho_1 = 1.222(.112)$**	$\rho_3 = -.007(.179)$	
	$\rho_2 = -.324(.180)$	$\rho_4 = .106(.112)$	
	$R^2 = .9766$	SE = .20999	D-W = 2.06

Note: See table 6.A.7.
*Significant at the 5 percent level.
**Significant at the 1 percent level.

Table 6.A.9 **Nonlinear Estimates of Output and Unemployment Equations**
Explanatory Variables: Unanticipated Inflation, Seventeen Lags, Polynomial Distributed Lags

$$y_t = c + \tau\text{TIME} + \sum_{i=0}^{17} \beta_i(\pi_{t-i} - \pi^e_{t-i}) + \rho_1\epsilon_{t-1} + \rho_2\epsilon_{t-2} + \rho_3\epsilon_{t-3} + \rho_4\epsilon_{t-4} + \eta_t$$

Model:	A9.1		A9.2	
Dependent Variable:	log(GNP_t)		UN_t	
	c = 6.159(.035)**	τ = .009(.0004)	c = 4.176(1.124)**	τ = .016(.013)
	β_0 = − .523(.322)	β_9 = −1.316(.701)	β_0 = 2.509(10.799)	β_9 = 67.993(25.671)**
	β_1 = − .843(.520)	β_{10} = −1.308(.676)	β_1 = 2.501(19.858)	β_{10} = 69.993(26.068)**
	β_2 = −1.057(.667)	β_{11} = −1.295(.636)*	β_2 = 7.360(24.992)	β_{11} = 69.012(25.512)**
	β_3 = −1.192(.736)	β_{12} = −1.220(.583)*	β_3 = 15.519(26.368)	β_{12} = 65.044(23.988)**
	β_4 = −1.270(.753)	β_{13} = −1.221(.524)*	β_4 = 25.589(25.553)	β_{13} = 58.255(21.715)**
	β_5 = −1.309(.746)	β_{14} = −1.135(.464)*	β_5 = 36.349(24.121)	β_{14} = 48.987(19.013)**
	β_6 = −1.324(.733)	β_{15} = − .994(.403)*	β_6 = 46.755(23.308)*	β_{15} = 37.753(16.076)*
	β_7 = −1.326(.723)	β_{16} = − .775(.326)*	β_7 = 55.934(23.603)*	β_{16} = 25.242(12.646)*
	β_8 = −1.322(.715)	β_{17} = − .453(.205)*	β_8 = 63.189(24.639)*	β_{17} = 12.313(7.796)
	ρ_1 = 1.320(.112)**	ρ_3 = .021(.185)	ρ_1 = 1.601(.112)**	ρ_3 = .055(.208)
	ρ_2 = −.419(.186)*	ρ_4 = −.044(.112)	ρ_2 = −.855(.210)**	ρ_4 = .056(.106)
	R^2 = .9986 SE = .00942 D-W = 2.02		R^2 = .9435 SE = .32652 D-W = 2.15	

Note: See table 6.A.5.
*Significant at the 5 percent level.
**Significant at the 1 percent level.

unanticipated inflation has been included in the models again because coefficients on lags as far back as this are significantly different from zero at the 5 percent level.

The suprising result of table 6.A.9 is that the coefficients on unanticipated inflation are often significantly different from zero and yet they have the opposite sign to what we would expect from a Lucas supply function. These results contradict Sargent's (1976*a*) finding of a negative correlation between unanticipated inflation and employment, but are in agreement with Fair (1979). Our results may contradict Sargent because 1973–1975 data are included in the sample period. Sargent takes unanticipated inflation to be a response to aggregate demand shifts, possibly a more reasonable assumption for the sample period he used in estimation. However, it is plausible that the supply shock effect of a decreased supply of food and energy—which would be linked to an unanticipated upward movement in the U.S. inflation rate coupled with an output decline—is dominating the aggregate demand effects on unanticipated inflation in the data used here. Thus the estimated coefficients on unanticipated inflation may not contradict the MRE hypothesis, but they certainly do not support it.

The likelihood ratio tests in table 6.A.10 indicate that the MRE hypothesis is not supported for the models with inflation as the aggregate demand variable. The joint hypothesis is rejected for both models at the 5 percent significance level, with the neutrality hypothesis the major contributor to these rejections. The neutrality constraints are rejected at the .001 marginal significance level for the output model and .01 for the unemployment model. The rationality constraints again fare better with the marginal significance levels equaling .51 for the output model and .04 for the unemployment model. The evidence, as before, seems to be

Table 6.A.10 Likelihood Ratio Tests for Models of Table 6.A.9

	Model	
	A9.1	A9.2
Joint hypothesis:		
Likelihood ratio statistic	$\chi^2(15) = 28.45$*	$\chi^2(15) = 32.34$**
Marginal significance level	.0189	.0058
Neutrality:		
Likelihood ratio statistic	$\chi^2(4) = 18.52$**	$\chi^2(4) = 13.20$*
Marginal significance level	.0010	.0104
Rationality:		
Likelihood ratio statistic	$\chi^2(11) = 10.23$	$\chi^2(11) = 20.16$*
Marginal significance level	.5098	.0432

*Significant at the 5 percent level.
**Significant at the 1 percent level.

negative on the neutrality implications of the MRE hypothesis, but far less so on the rationality implication.

Tables 6.A.11 and 6.A.12 show that, contrary to the MRE hypothesis, the effects from unanticipated inflation are not stronger than from anticipated inflation. Not only are the coefficients on anticipated inflation substantially larger than the unanticipated coefficients, but their asymptotic *t* statistics are substantially larger as well. Overall, the Lucas supply model estimated here is not successful. Its coefficients have the "wrong" signs, it fits the data worse than a corresponding model with money growth as the aggregate demand variable, and it strongly rejects neutrality, with anticipated inflation proving to be more significantly correlated with output and unemployment than unanticipated inflation.

Table 6.A.11 **Nonlinear Estimates of Output Equation**

Explanatory Variables: Unanticipated and Anticipated Inflation, Seventeen Lags (PDL)

$$\text{Log}(\text{GNP}_t) = c + \tau\,\text{TIME} + \sum_{i=0}^{17} \beta_i(\pi_{t-i} - \pi^e_{t-i}) + \sum_{i=0}^{17} \delta_i \pi^e_{t-i} + \rho_1\epsilon_{t-1} + \rho_2\epsilon_{t-2} + \rho_3\epsilon_{t-3} + \rho_4\epsilon_{t-4} + \eta_t$$

Model:	A11.1		
Dependent Variable:	$\log(\text{GNP}_t)$		
	$c = 6.089(.068)^{**}$	$\tau = .011(.001)$	
$\beta_0 = -.082(.311)$	$\beta_{11} = -.293(.803)$	$\delta_0 = .128(.538)$	$\delta_{11} = -.334(.343)$
$\beta_1 = .032(.466)$	$\beta_{12} = -.589(.748)$	$\delta_1 = -.994(.397)^{*}$	$\delta_{12} = -.559(.354)$
$\beta_2 = .192(.624)$	$\beta_{13} = -.856(.680)$	$\delta_2 = -1.544(.390)^{**}$	$\delta_{13} = -.838(.405)^{*}$
$\beta_3 = .358(.730)$	$\beta_{14} = -1.052(.600)$	$\delta_3 = -1.682(.391)^{**}$	$\delta_{14} = -1.104(.469)^{*}$
$\beta_4 = .498(.800)$	$\beta_{15} = -1.126(.507)^{*}$	$\delta_4 = -1.547(.378)^{**}$	$\delta_{15} = -1.272(.508)^{*}$
$\beta_5 = .589(.836)$	$\beta_{16} = -1.021(.389)^{**}$	$\delta_5 = -1.258(.369)^{**}$	$\delta_{16} = -1.233(.475)^{**}$
$\beta_6 = .615(.861)$	$\beta_{17} = -.669(.228)^{**}$	$\delta_6 = -.912(.373)^{*}$	$\delta_{17} = -.858(.323)^{**}$
$\beta_7 = .566(.875)$		$\delta_7 = -.588(.386)$	
$\beta_8 = .441(.879)$		$\delta_8 = -.342(.393)$	
$\beta_9 = -.246(.869)$		$\delta_9 = -.211(.384)$	
$\beta_{10} = -.006(.844)$		$\delta_{10} = -.210(.361)$	
	$\rho_1 = 1.092(.121)^{**}$	$\rho_3 = .202(.172)$	
	$\rho_2 = -.312(.171)$	$\rho_4 = -.067(.119)$	
	$R^2 = .9988$ SE = .00855	D-W = 1.99	

Note: Estimates from the (2) and (6) system imposing $\gamma = \gamma$.* The β_1 and δ_i are constrained to lie along a fourth-order polynomial with the endpoint constrained.

*Significant at the 5 percent level.

**Significant at the 1 percent level.

Table 6.A.12 **Nonlinear Estimates of Unemployment Equation**
Explanatory Variables: Unanticipated and Anticipated Inflation, Seventeen Lags (PDL)

$$UN_t = c + \tau\, TIME + \sum_{i=0}^{20} \beta_i(\pi_{t-i} - \pi^e_{t-i}) + \sum_{i=0}^{20} \delta_i \pi^e_{t-i} + \rho_1\epsilon_{t-1} + \rho_2\epsilon_{t-2} + \rho_3\epsilon_{t-3} + \rho_4\epsilon_{t-4} + \eta_t$$

Model:		A12.1		
Dependent Variable:		UN_t		
		c = 6.981(2.687)**	τ = −.068(.045)	
β_0 = 4.54(10.27)	β_{11} = −12.57(28.53)		δ_0 = −42.90(26.23)	δ_{11} = 13.52(13.83)
β_1 = 12.65(18.50)	β_{12} = −4.50(26.86)		δ_1 = 11.15(16.72)	δ_{12} = 15.84(14.71)
β_2 = 13.15(25.01)	β_{13} = 4.52(24.77)		δ_2 = 43.03(15.77)**	δ_{13} = 20.45(17.19)
β_3 = 8.66(28.65)	β_{14} = 13.04(22.27)		δ_3 = 58.14(15.99)**	δ_{14} = 25.75(20.23)
β_4 = 1.47(30.32)	β_{15} = 19.23(19.19)		δ_4 = 61.24(15.28)**	δ_{15} = 29.53(22.05)
β_5 = −6.55(30.89)	β_{16} = 20.89(15.05)		δ_5 = 56.47(14.34)**	δ_{16} = 28.93(20.73)
β_6 = −13.86(31.00)	β_{17} = 15.46(9.04)		δ_6 = 47.31(14.04)**	δ_{17} = 20.46(14.15)
β_7 = −19.32(30.96)			δ_7 = 36.62(14.44)*	
β_8 = −22.14(30.83)			δ_8 = 26.63(14.89)	
β_9 = −21.91(30.47)			δ_9 = 18.92(14.83)	
β_{10} = −18.61(29.73)			δ_{10} = 14.44(14.24)	
		ρ_1 = 1.410(.122)**	ρ_3 = .016(.201)	
		ρ_2 = −.665(.203)**	ρ_4 = .161(.115)	
		R^2 = .9530 SE = .30255	D-W = 2.10	

Note: See table 6.A.11.
*Significant at the 5 percent level.
**Significant at the 1 percent level.

Appendix 6.3: Results Not Using Polynominal Distributed Lags

Table 6.A.13 Likelihood Ratio Tests of the MRE Hypothesis with *M1* Growth as the Aggregate Demand Variable

	Model			
	A14.1	A14.2	A15.1	A15.2
Joint hypothesis:				
Likelihood ratio statistic	$\chi^2(19) = 22.37$	$\chi^2(19) = 31.55^*$	$\chi^2(32) = 66.90^{**}$	$\chi^2(32) = 54.06^{**}$
Marginal significance level	.2662	.0351	.0003	.0087
Neutrality:				
Likelihood ratio statistic	$\chi^2(8) = 9.53$	$\chi^2(8) = 11.97$	$\chi^2(21) = 45.22^{**}$	$\chi^2(21) = 36.47$
Marginal significance level	.2996	.1524	.0016	.0830
Rationality:				
Likelihood ratio statistic	$\chi^2(11) = 12.34$	$\chi^2(11) = 20.14^*$	$\chi^2(11) = 27.10^{**}$	$\chi^2(11) = 27.01^{**}$
Marginal significance level	.3386	.0435	.0044	.0046

Note: The tables here correspond to previous tables as follows: 6.A.13 to 6.1, 6.A.14 to 6.2, 6.A.15 to 6.4, 6.A.16 to 6.A.5, 6.A.17 to 6.A.6, 6.A.18 to 6.A.9, 6.A.19 to 6.A.10.

Table 6.A.14 **Nonlinear Estimates of Output and Unemployment Equations**
Explanatory Variables: Unanticipated Money Growth, Seven Lags, Freely Estimated

$$y_t = c + \tau \text{TIME} + \sum_{i=0}^{7} \beta_i (M1G_{t-i} - M1G^e_{t-i}) + \rho_1 \epsilon_{t-1} + \rho_2 \epsilon_{t-2} + \rho_3 \epsilon_{t-3} + \rho_4 \epsilon_{t-4} + \eta_t$$

Model:	A14.1		A14.2	
Dependent Variable:	log(GNP_t)		UN_t	
	$c = 6.175(.046)$**	$\tau = .008(.0005)$	$c = 3.563(1.590)$*	$\tau = .024(.018)$
	$\beta_0 = .743(.247)$**		$\beta_0 = -18.73(\ 9.03)$*	
	$\beta_1 = 1.616(.375)$**		$\beta_1 = -40.73(16.05)$*	
	$\beta_2 = 2.065(.444)$**		$\beta_2 = -69.01(19.33)$**	
	$\beta_3 = 2.450(.484)$**		$\beta_3 = -86.41(20.40)$**	
	$\beta_4 = 2.244(.501)$**		$\beta_4 = -92.79(20.85)$**	
	$\beta_5 = 1.812(.484)$**		$\beta_5 = -72.45(20.32)$**	
	$\beta_6 = .996(.421)$*		$\beta_6 = -42.26(16.53)$*	
	$\beta_7 = .509(.269)$		$\beta_7 = -15.14(\ 9.26)$	
	$\rho_1 = 1.138(.119)$**	$\rho_3 = .195(.177)$	$\rho_1 = 1.474(.114)$	$\rho_3 = .072(.208)$
	$\rho_2 = -.379(.177)$*	$\rho_4 = -.027(.119)$	$\rho_2 = -.777(.206)$	$\rho_4 = .156(.118)$
	$R^2 = .9989$ SE = .0085	D-W = 1.97	$R^2 = .9514$ SE = .3062	D-W = 2.05

Note: Estimated from the (2) and (4) system, imposing the cross-equation constraints that γ is equal in (2) and (4). Note that the β_i are estimated without constraints.

*Significant at the 5 percent level.

**Significant at the 1 percent level.

Table 6.A.15 **Nonlinear Estimates of Output and Unemployment Growth**
Explanatory Variables: Unanticipated Money Growth, Twenty Lags, Freely Estimated

$$y_t = c + \tau\text{TIME} + \sum_{i=0}^{20} \beta_i(M1G_{t-i} - M1G^e_{t-i}) + \rho_1\epsilon_{t-1} + \rho_2\epsilon_{t-2} + \rho_3\epsilon_{t-3} + \rho_4\epsilon_{t-4} + \eta_t$$

Model:	A15.1		A15.2	
Dependent Variable:	log(GNP$_t$)		UN$_t$	
	c = 6.195(.048)**	τ = .008(.0005)	c = 3.375(2.064)	τ = .026(.023)
	β_0 = .850(.275)**	β_{11} = .200(.640)	β_0 = −11.73(9.92)	β_{11} = 6.66(27.18)
	β_1 = 1.784(.430)**	β_{12} = .482(.620)	β_1 = −21.61(18.24)	β_{12} = 10.64(26.63)
	β_2 = 2.320(.523)**	β_{13} = .625(.616)	β_2 = −52.81(22.04)*	β_{13} = 10.52(26.20)
	β_3 = 2.935(.614)**	β_{14} = .624(.631)	β_3 = −83.72(23.14)**	β_{14} = 4.85(25.94)
	β_4 = 2.989(.722)**	β_{15} = .751(.640)	β_4 = −103.18(25.16)**	β_{15} = 6.02(25.22)
	β_5 = 2.605(.796)**	β_{16} = .889(.616)	β_5 = −91.00(27.33)**	β_{16} = 1.33(24.09)
	β_6 = 1.637(.822)*	β_{17} = .882(.574)	β_6 = −72.77(28.43)*	β_{17} = −14.13(22.76)
	β_7 = 1.103(.802)	β_{18} = .512(.534)	β_7 = −50.06(28.90)	β_{18} = −24.56(21.36)
	β_8 = .677(.764)	β_{19} = .300(.444)	β_8 = −25.47(29.57)	β_{19} = −17.22(17.07)
	β_9 = .496(.719)	β_{20} = .099(.277)	β_9 = −5.44(29.28)	β_{20} = −2.57(9.49)
	β_{10} = .166(.675)		β_{10} = 3.16(24.15)	
	ρ_1 = 1.098(.127)**	ρ_3 = .184(.184)	ρ_1 = 1.463(.117)**	ρ_3 = −.070(.217)
	ρ_2 = −.338(.184)	ρ_4 = −.042(.129)	ρ_2 = −.708(.212)**	ρ_4 = .249(.126)*
	R^2 = .9989 SE = .0086	D-W = 1.97	R^2 = .9564 SE = .3027	D-W = 2.09

Note: See table 6.A.14.
*Significant at the 5 percent level.
**Significant at the 1 percent level.

Table 6.A.16 **Nonlinear Estimates of Output and Unemployment Equations**
Explanatory Variables: Unanticipated Nominal GNP Growth, Twenty Lags, Freely Estimated

$$y_t = c + \tau \mathrm{TIME} + \sum_{i=0}^{20} \beta_i (\mathrm{NGNP}_{t-i} - \mathrm{NGNP}^e_{t-i}) + \rho_1\epsilon_{t-1} + \rho_2\epsilon_{t-2} + \rho_3\epsilon_{t-3} + \rho_4\epsilon_{t-4} + \eta_t$$

Model:	A16.1		A16.2	
Dependent Variable:	log(GNP$_t$)		UN_t	
	c = 6.176(.034)**	τ = .008(.0004)	c = −208.831(3501.00)	τ = .682(5.828)
	β_0 = .893(.045)**	β_{11} = −.035(.237)	β_0 = −24.549(2.614)**	β_{11} = −15.367(7.713)*
	β_1 = 1.142(.125)**	β_{12} = −.028(.225)	β_1 = −52.080(5.058)**	β_{12} = −12.427(7.046)
	β_2 = 1.060(.191)**	β_{13} = −.001(.210)	β_2 = −63.001(7.881)**	β_{13} = −14.263(6.821)*
	β_3 = .971(.234)**	β_{14} = −.026(.191)	β_3 = −66.126(10.215)**	β_{14} = −14.319(6.523)
	β_4 = .704(.267)**	β_{15} = −.094(.168)	β_4 = −59.198(11.931)**	β_{15} = −12.399(6.009)*
	β_5 = .448(.283)	β_{16} = −.101(.144)	β_5 = −48.080(12.763)**	β_{16} = − 7.101(5.555)
	β_6 = .260(.282)	β_{17} = −.034(.118)	β_6 = −43.597(12.635)**	β_{17} = −10.166(4.975)*
	β_7 = .157(.275)	β_{18} = −.071(.090)	β_7 = −39.639(11.906)**	β_{18} = − 9.791(4.262)*
	β_8 = .043(.262)	β_{19} = −.074(.067)	β_8 = −31.964(10.624)**	β_{19} = − 7.402(3.647)*
	β_9 = .014(.252)	β_{20} = −.015(.039)	β_9 = −26.995(9.200)**	β_{20} = − 5.610(2.216)*
	β_{10} = .002(.245)		β_{10} = −21.845(8.313)**	
	ρ_1 = 1.410(.119)**	ρ_3 = −.191(.204)	ρ_1 = 1.357(.119)**	ρ_3 = .055(.194)
	ρ_2 = −.150(.203)	ρ_4 = −.110(.123)	ρ_2 = −.404(.197)*	ρ_4 = −.010(.118)
	R^2 = .9998 SE = .00340	D-W = 1.82	R^2 = .9816 SE = .19424	D-W = 1.94

Note: See table 6.A.14.
*Significant at the 5 percent level.
**Significant at the 1 percent level.

Table 6.A.17 Likelihood Ratio Tests for Models of Table 6.A.16

	Model	
	A16.1	A16.2
Joint hypothesis:		
Likelihood ratio statistic	$\chi^2(28) = 57.89$**	$\chi^2(28) = 71.21$**
Marginal significance level	.0008	1.25×10^{-5}
Neutrality:		
Likelihood ratio statistic	$\chi^2(21) = 56.11$**	$\chi^2(21) = 64.04$**
Marginal significance level	4.86×10^{-5}	3.07×10^{-6}
Rationality:		
Likelihood ratio statistic	$\chi^2(7) = 1.85$	$\chi^2(7) = 4.20$
Marginal significance level	.9674	.7561

*Significant at the 5 percent level.

**Significant at the 1 percent level.

Table 6.A.18 **Nonlinear Estimates of Output and Unemployment Equations**
Explanatory Variables: Unanticipated Inflation, Seventeen Lags, Freely Estimated

$$y_t = c + \tau \mathrm{TIME} + \sum_{i=0}^{17} \beta_i(\pi_{t-i} - \pi^e_{t-i}) + \rho_1\epsilon_{t-1} + \rho_2\epsilon_{t-2} + \rho_3\epsilon_{t-3} + \rho_4\epsilon_{t-4} + \eta_t$$

Model:	A18.1		A18.2	
Dependent Variable:	log(GNP_t)		UN_t	
	$c = 6.155(.040)$**	$\tau = .009(.0005)$	$c = 4.143(1.207)$**	$\tau = .017(.014)$
	$\beta_0 = -.634(.344)$	$\beta_9 = -1.400(.921)$	$\beta_0 = 4.399(12.251)$	$\beta_9 = 79.022(36.798)$*
	$\beta_1 = -1.067(.565)$	$\beta_{10} = -1.131(.855)$	$\beta_1 = 12.877(22.979)$	$\beta_{10} = 76.155(37.139)$*
	$\beta_2 = -1.012(.695)$	$\beta_{11} = -1.034(.745)$	$\beta_2 = 11.192(31.350)$	$\beta_{11} = 70.156(37.001)$
	$\beta_3 = -.778(.759)$	$\beta_{12} = -1.376(.660)$*	$\beta_3 = 11.586(35.338)$	$\beta_{12} = 73.634(37.472)$*
	$\beta_4 = -1.434(.815)$	$\beta_{13} = -1.255(.574)$*	$\beta_4 = 10.521(35.997)$	$\beta_{13} = 60.702(37.027)$
	$\beta_5 = -2.021(.870)$*	$\beta_{14} = -.758(.511)$	$\beta_5 = 31.214(35.693)$	$\beta_{14} = 43.523(33.948)$
	$\beta_6 = -1.828(.904)$*	$\beta_{15} = -1.147(.466)$*	$\beta_6 = 43.389(35.602)$	$\beta_{15} = 25.826(28.163)$
	$\beta_7 = -1.173(.936)$	$\beta_{16} = -1.400(.388)$**	$\beta_7 = 55.321(36.368)$	$\beta_{16} = 25.187(19.344)$
	$\beta_8 = -1.608(.939)$	$\beta_{17} = -.852(.242)$**	$\beta_8 = -67.247(36.701)$	$\beta_{17} = 10.284\ (9.580)$
	$\rho_1 = 1.370(.117)$**	$\rho_3 = -.0385(.198)$	$\rho_1 = 1.650(.117)$**	$\rho_3 = .028(.229)$
	$\rho_2 = -.440(.198)$*	$\rho_4 = .001\ (.121)$	$\rho_2 = -.891(.228)$**	$\rho_4 = .086(.114)$
	$R^2 = .9989$ SE = .00876	D-W = 1.95	$R^2 = .9493$ SE = .32333	D-W = 2.05

Note: See table 6.A.14.
*Significant at the 5 percent level.
**Significant at the 1 percent level.

Table 6.A.19 **Likelihood Ratio Tests for Models of Table 6.A.18**

	Model	
	A18.1	A18.2
Joint hypothesis:		
Likelihood ratio statistic	$\chi^2(29) = 64.38^{**}$	$\chi^2(29) = 57.03^{**}$
Marginal significancc level	.0002	.0014
Neutrality:		
Likelihood ratio statistic	$\chi^2(18) = 43.51^{**}$	$\chi^2(18) = 33.93^{*}$
Marginal significance level	.0007	.0129
Rationality:		
Likelihood ratio statistic	$\chi^2(11) = 22.33^{*}$	$\chi^2(11) = 32.01^{*}$
Marginal significance level	.0219	.0008

*Significant at the 5 percent level.

**Significant at the 1 percent level.

Appendix 6.4: Jointly Estimated Forecasting Equations

Table 6.A.20 **Money Growth Equations Estimated Jointly with Output and Unemployment Equations in Text**

	Model							
	2.1	2.2	3.1	3.2	4.1	4.2	5.1	6.1
Constant term	.002	.003	.002	.002	.002	.002	.003	.003
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
$M1G_{t-1}$	.768	.712	.770	.730	.740	.676	.672	.690
	(.110)	(.111)	(.113)	(.112)	(.112)	(.112)	(.113)	(.112)
$M1G_{t-2}$	−.018	−.052	−.006	.024	−.010	−.024	.039	.028
	(.143)	(.142)	(.147)	(.138)	(.143)	(.142)	(.143)	(.142)
$M1G_{t-3}$	−.116	−.058	−.073	−.032	−.092	−.042	−.012	−.004
	(.130)	(.130)	(.131)	(.119)	(.130)	(.129)	(.129)	(.132)
$M1G_{t-4}$	−.161	−.133	−.149	−.116	−.055	−.065	−.016	−.026
	(.101)	(.105)	(.102)	(.098)	(.106)	(.108)	(.107)	(.115)
RTB_{t-1}	−.319	−.379	−.265	−.350	−.273	−.349	−.408	−.425
	(.089)	(.092)	(.088)	(.093)	(.093)	(.094)	(.099)	(.101)
RTB_{t-2}	.628	.634	.558	.583	.560	.590	.541	.597
	(.161)	(.162)	(.166)	(.159)	(.163)	(.160)	(.163)	(.163)
RTB_{t-3}	−.237	−.258	−.237	−.219	−.188	−.188	−.210	−.205
	(.169)	(.170)	(.167)	(.161)	(.171)	(.169)	(.170)	(.171)
RTB_{t-4}	.002	.070	−.000	.031	−.057	−.030	.082	.036
	(.098)	(.102)	(.091)	(.094)	(.104)	(.105)	(.104)	(.109)
SURP_{t-1}	−.140	−.143	−.152	−.156	−.156	−.165	−.197	−.176
	(.067)	(.070)	(.061)	(.065)	(.069)	(.070)	(.070)	(.075)
SURP_{t-2}	.132	.099	.185	.153	.118	.093	.128	.072
	(.082)	(.082)	(.080)	(.079)	(.082)	(.081)	(.082)	(.083)
SURP_{t-3}	.042	.047	−.006	.021	.048	.062	.018	.046
	(.086)	(.086)	(.085)	(.083)	(.086)	(.085)	(.086)	(.087)
SURP_{t-4}	−.147	−.120	−.126	−.115	−.113	−.097	−.066	−.068
	(.069)	(.071)	(.067)	(.066)	(.069)	(.070)	(.070)	(.075)
R^2	.6290	.6369	.6284	.6469	.6322	.6475	.6548	.6584
SE	.00437	.00432	.00443	.00432	.00435	.00427	.00427	.00425
D-W	1.95	1.92	1.97	1.99	1.94	1.90	2.02	2.03

Note: Forecasting equations were estimated with the output or unemployment equation imposing the cross-equation constraints that γ is equal in both equations. For purposes of comparison, OLS column shows the estimate of the unconstrained forecasting equation. Note that SE is the unbiased standard error and is calculated as described in the note to table 6.2.

Model								
A1.1	A1.2	A3.1	A4.1	A14.1	A14.2	A15.1	A15.2	OLS
.002	.002	.003	.003	.002	.003	.002	.002	.003
(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.601)	(.001)
.741	.696	.699	.685	.755	.718	.810	.735	.673
(.111)	(.111)	(.114)	(.110)	(.111)	(.113)	(.118)	(.119)	(.113)
−.060	−.034	.056	.006	−.002	−.045	.022	−.007	.047
(.141)	(.139)	(.143)	(.138)	(.145)	(.145)	(.154)	(.151)	(.143)
−.095	−.005	.005	.017	−.131	−.078	−.108	−.091	−.035
(.130)	(.127)	(.130)	(.129)	(.130)	(.132)	(.138)	(.136)	(.136)
−.150	−.053	.064	−.080	−.154	−.124	−.232	−.115	−.039
(.105)	(.106)	(.107)	(.112)	(.102)	(.107)	(.110)	(.113)	(.118)
−.260	−.376	−.433	−.417	−.313	−.370	−.331	−.336	−.404
(.092)	(.092)	(.100)	(.099)	(.091)	(.093)	(.092)	(.094)	(.103)
.574	.597	.533	.605	.613	.613	.657	.572	.592
(.162)	(.157)	(.165)	(.159)	(.162)	(.164)	(.163)	(.163)	(.164)
−.216	−.236	−.206	−.220	−.229	−.231	−.247	−.165	−.190
(.170)	(.166)	(.170)	(.167)	(.170)	(.173)	(.172)	(.173)	(.173)
−.024	.052	.087	.054	.003	.055	−.013	−.013	.009
(.102)	(.103)	(.102)	(.108)	(.100)	(.103)	(.104)	(.106)	(.113)
−.147	−.134	−.190	−.168	−.157	−.152	−.164	−.137	−.206
(.069)	(.069)	(.068)	(.073)	(.067)	(.070)	(.069)	(.070)	(.076)
.123	.099	.155	.075	.147	.108	.150	.009	.100
(.082)	(.080)	(.082)	(.081)	(.080)	(.082)	(.085)	(.083)	(.084)
.054	.047	.019	.055	.042	.046	.064	.040	.039
(.087)	(.084)	(.086)	(.085)	(.085)	(.082)	(.090)	(.088)	(.088)
−.137	−.105	−.013	−.095	−.149	−.119	−.175	−.101	−.078
(.069)	(.070)	(.070)	(.073)	(.069)	(.071)	(.073)	(.071)	(.076)
.6231	.6504	.6397	.6568	.6306	−.6370	.6263	.6426	.6601
.00440	.00424	.00435	.00424	.00441	.00438	.00466	.00453	.00422
1.87	1.95	2.03	1.98	1.93	1.90	2.00	2.09	1.98

Table 6.A.21 **Nominal GNP Growth Forecasting Equations, Estimated Jointly with Output and Unemployment Equations in Text**

	Model						
	A5.1	A5.2	A7.1	A8.1	A16.1	A16.2	OLS
Constant Term	.0084**	.0079**	.0068**	.0076**	.0113**	.0116**	.0068**
	(.0022)	(.0017)	(.0024)	(.0025)	(.0025)	(.0024)	(.0025)
$NGNP_{t-1}$	.3139**	.4437**	.1481	.2645**	.3293**	.3000**	.2209*
	(.0952)	(.1007)	(.0956)	(.0934)	(.1112)	(.1120)	(.1047)
$NGNP_{t-2}$	.0587	−.0062	−.1712	−.1470	−.1141	−.1390	−.1368
	(.0485)	(.0959)	(.0943)	(.0908)	(.1104)	(.1135)	(.1086)
$NGNP_{t-3}$	.0643	.1448	−.0131	.1082	.0995	.1540	.0407
	(.0456)	(.0894)	(.0911)	(.0902)	(.1081)	(.1112)	(.1071)
$NGNP_{t-4}$	.0177	−.0900	−.1054	−.2256**	−.1898**	−.2061*	−.1774
	(.0444)	(.0752)	(.0843)	(.0864)	(.0958)	(.0993)	(.0997)
$M2G_{t-1}$	−.0040	.2049	.2222	.1618	.0833	.1891	.3549
	(.0808)	(.1294)	(.1667)	(.1603)	(.0790)	(.1211)	(.1898)
$M2G_{t-2}$	−.0051	−.3015	.0074	.2755	.0307	−.1168	.0085
	(.1040)	(.2196)	(.2245)	(.2115)	(.1038)	(.1886)	(.2841)
$M2G_{t-3}$	.2141*	.4024	.5786*	.1877	.1828	.2397	.4365
	(.1037)	(.2210)	(.2312)	(.2092)	(.1035)	(.1874)	(.2598)
$M2G_{t-4}$	−.1332	−.2474	.0180	−.0120	−.0631	−.0778	−.0799
	(.0895)	(.1422)	(.1806)	(.1775)	(.0885)	(.1362)	(.2103)
R^2	.2017	.2341	.3453	.3552	.2943	.2874	.3712
SE	.00994	.00974	.00912	.00905	.00987	.00992	.00880
D-W	1.86	2.14	1.93	2.22	2.10	2.04	2.11

Note: See table 6.A.20.
*Significant at the 5 percent level.
**Significant at the 1 percent level.

Table 6.A.22 **Inflation Forecasting Equations, Estimated Jointly with Output and Unemployment Equations**

	Model						
	A9.1	A9.2	A11.1	A12.1	A18.1	A18.2	OLS
Constant Term	−.0011	−.0012	−.0005	−.0005	−.0011	−.0012	−.0008
	(.0010)	(.0010)	(.0011)	(.0011)	(.0011)	(.0011)	(.0011)
π_{t-1}	.2040*	.2405*	.2408*	.2225**	.2126*	.2343*	.2477*
	(.1030)	(.1039)	(.0953)	(.0861)	(.1028)	(.1088)	(.1054)
π_{t-2}	.1259	.1314	.1491	.1710	.0976	.1580	.1598
	(.1053)	(.1067)	(.0993)	(.0804)	(.1056)	(.1100)	(.1087)
π_{t-3}	.2280*	.2087*	.2249*	.2196*	.1810	.2271*	.2744*
	(.1048)	(.1057)	(.0999)	(.0815)	(.1034)	(.1088)	(.1089)
π_{t-4}	.0888	.0240	.0549	.0913	.1541	−.0019	.0466
	(.1003)	(.1020)	(.0953)	(.0803)	(.0957)	(.1039)	(.1036)
RTB_{t-1}	.2284**	.2280**	.2890**	.2269**	.2400**	.2432**	.2513**
	(.0802)	(.0804)	(.0747)	(.0656)	(.0701)	(.0804)	(.0816)
RTB_{t-2}	−.1093	−.1208	−.1563	−.1018	−.0490	−.1378	−.1311
	(.1308)	(.1323)	(.1273)	(.0987)	(.1092)	(.1303)	(.1324)
RTB_{t-3}	.1819	.1832	.1824	.1849	.0250	.1806	.1684
	(.1471)	(.1488)	(.1385)	(.1154)	(.1242)	(.1464)	(.1490)

Table 6.A.22 (continued)

	Model						
	A9.1	A9.2	A11.1	A12.1	A18.1	A18.2	OLS
RTB_{t-4}	−.2408*	−.2134*	−.2366*	−.2530**	−.1549	−.2107*	−.2423*
	(.0991)	(.0991)	(.0936)	(.0845)	(.0894)	(.0996)	(.1018)
$M2G_{t-1}$	.1271	.1147	.0889	.0238	.1432	.1249	.1234
	(.0907)	(.0915)	(.0819)	(.0734)	(.0842)	(.0906)	(.0935)
$M2G_{t-2}$	.0083	−.0042	−.0238	.0886	−.0364	.0052	.0051
	(.1188)	(.1201)	(.1104)	(.0846)	(.1073)	(.1167)	(.1104)
$M2G_{t-3}$	.2093*	.1982	.2082*	.0948	.2029*	.1678	.1874
	(.1067)	(.1079)	(.1025)	(.0797)	(.0984)	(.1060)	(.1090)
$M2G_{t-4}$	−.2212**	−.1964*	−.2513**	−.1464*	−.1844*	−.1845*	−.2240**
	(.0845)	(.0853)	(.0778)	(.0704)	(.0793)	(.0858)	(.0868)
R^2	.7369	.7367	.7359	.7306	.7263	.7371	.7411
SE	.00347	.00347	.00352	.00355	.00370	.00363	.00347
D-W	1.92	1.99	2.01	1.92	1.65	1.70	1.74

Note: See table 6.A.20.

*Significant at the 5 percent level.

**Significant at the 1 percent level.

Table 6.A.23 ***F* Statistics for Significant Explanatory Power in Forecasting Equations of Four Lags of Each Variable**

Variable	$M1G$ Forecasting Equation	NGNP Forecasting Equation	π Forecasting Equation
NGNP	1.09	2.24	1.44
π	1.69	.96	8.38**
RTB	5.28**	.11	5.01**
M2G	1.25	5.65**	3.04*
M1G	15.80**	.48	.60
UN	1.66	1.62	.76
RGNP	.82	.94	1.44
G	.13	2.47	1.55
BOP	1.28	.61	2.26
GDEBT	1.52	.92	.61
SURP	2.56*	1.66	1.35

Note: The F statistics test the null hypothesis that the coefficients on the four lagged values of each of these variables equals zero. The F statistics are distributed asymptotically as $F(4,x)$ where x runs from 75 to 83. The critical F at the 5 percent level is 2.5 and at the 1 percent level is 3.6. NGNP = quarterly rate of growth of real GNP, π = quarterly rate of growth of the GNP deflator, RTB = average 90-day treasury bill rate, $M2G$ = quarterly rate of growth of average $M2$, $M1G$ = quarterly rate of growth of average $M1$, UN = average unemployment rate, RGNP = quarterly rate of growth of real GNP, G = quarterly rate of growth of real federal government expenditure, BOP = average balance of payments on current account, GDEBT = quarterly rate of growth of government debt, SURP = high employment surplus.

*Significant at the 5 percent level.

**Significant at the 1 percent level.