# EXTERNAL SHOCKS, POLICY REFORM, AND INCOME DISTRIBUTION IN NIGER

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and

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## CONTENTS

## LIST OF TABLES

**LIST OF FIGURES**

## ABBREVIATIONS

| | |
|---|---|
| BCEAO | Banque Centrale des Etats de l'Afrique de l'Ouest |
| CES | Constant Elasticity of Substitution |
| CFA | Communauté Financière Africaine (African Financial Community) |
| CGE | Computable General Equilibrium |
| CPI | Consumer Price Index |
| DSF | Declaration Statistique et Fiscale |
| FCFA | CFA Franc |
| GAMS | General Algebraic Modeling System |
| GDP | Gross Domestic Product |
| GNP | Gross National Product |
| SAM | Social Accounting Matrix |
| UMOA | Union Monétaire Ouest-Africaine |

# 1. INTRODUCTION

Since the start of the 1980s, Niger has experienced an economic crisis caused by four external shocks: a fall in uranium export revenues, reduced foreign capital inflows, drought, and adverse effects of economic fluctuations in neighboring Nigeria.

The expansion of world demand for uranium in the 1970s, linked to the steep rise in petroleum prices in these years, boosted uranium prices and exports for Niger. The value of Niger's uranium exports increased from 2.0 billion FCFA in 1971 to 100.8 billion FCFA in 1980, when they accounted for 74 percent of Niger's export revenues. With additional uranium revenues as collateral, the government of Niger (and parastatals) were able to borrow heavily on world markets, greatly increasing foreign capital inflows into Niger and spurring domestic investment. From 1978 to 1980, the modern sector's share of GDP rose rapidly from 15 to 25 percent.

Since 1985, world supply of uranium has grown faster than a stagnating demand. Niger's export receipts fell as quantities exported declined between 1981 and 1985. And beginning in 1987, Niger's contract price, negotiated with French importers, also dropped from 38,800 FCFA per kilogram in 1987 to 25,000 in 1989 and 20,400 in 1990 (Hugon 1990). The uranium crisis has had numerous negative effects on the economy, including a decrease in output of the mining sector, a reduction in demand for construction services as investments have declined, and a large drop in fiscal receipts of the government.

Related to the drop in uranium revenues and the drop in world uranium prices was a decline in foreign capital inflows. Until 1975, Niger's foreign debt was fairly small although from 1970 to 1975 public and publicly guaranteed increased from 5 to 12 percent of GNP. This figure was still considerably less than the average debt ratio of other low income African countries (25 percent of GNP). In the early 1970s, the debt had a tendency to increase when export receipts declined and to decrease when export receipts rose. The debt was structured such that the unit cost was small. In 1975, 90 percent of the debt was due to public sector institutions, and only 10 percent of Niger's borrowing was from commercial banks.

Beginning in 1976, Niger changed its borrowing strategy, and public debt increased as export earnings increased, as did the percentage of loans from commercial banks. A large part of this debt was contracted at variable interest rates that were higher than loans obtained by other countries at comparable income levels. After 1981, Niger's ability to obtain credit on world markets declined as world uranium prices dropped, and net transfers fell. Counting foreign grants, transfers (net of foreign grants) declined from 10.6 percent of GDP in 1981 to 0.3 percent in 1982. The grant component of these transfers fell as well, from 50.2 percent to 20.9 percent of budgetary receipts.

Climatic conditions were also disastrous. During the 1980s rainfall was satisfactory only in 1986 and 1990. Drought struck in 1984 and 1987. The drought in 1984 was especially severe, causing large declines in the livestock herd and crop production. Food production per capita fell 22 percent in 1984, but recovered in subsequent years of higher rainfall. The effects on livestock lasted longer: the cattle population fell 40 percent in 1984 and continued to decline until 1986 when it was 59 percent below 1983 levels.

Finally, economic policies and economic conditions in Nigeria in the 1980s had large negative impacts on Niger. Most exports of the rural sector (livestock, cowpeas, onions) are sold to Nigeria. These transactions take place most often in the informal sector and are determined by relative prices in the two countries, which are in turn greatly influenced by Nigeria's exchange rate policies. The real exchange rate, expressed as FCFA per Naira (calculated using parallel market exchange rates and consumer price indices in the two countries), appreciated by nearly 50 percent between the 1979 - 1981 period and 1987 implying a loss of competitiveness by Niger vis à vis its large neighbor. Declining real incomes in Nigeria during the 1980s also reduced demand for Niger's exports products.

To deal with the economic crisis, the government of Niger adopted stabilization and structural adjustment policies. These policies were intended to the reduce aggregate global demand in order to restore financial stability and to create conditions for economic growth. Stabilization policies focused on reducing government budget deficits and controlling credits to the economy. Structural adjustment measures emphasized removing constraints on supply and improving incentives for production of tradeable goods through a depreciation of the real exchange rate (an increase in the relative price of tradeable to nontradeable goods).

The shocks as well as the economic policy initiatives certainly had an impact on the allocation of resources and the distribution of incomes arising from various sectors. The interactions between world market conditions, macroeconomic policies, sectoral outputs, and household incomes are complex and require a formal analytical framework. In this context, a general equilibrium model of the economy of Niger is the most appropriate analytical tool.

The rest of this document is presented in four sections. The economy of Niger is described in Section 2 and the model in Section 3. Results of several model simulations are covered in Section 4. Section 5 contains the conclusions.

## 2. NIGER'S ECONOMY

Niger, a landlocked country in the Sahelian zone of West Africa, covers an area of 1.27 million square kilometers, more than two-thirds of which is in the Sahara desert. Ninety percent of its population of 7.25 million live in a narrow band along the Niger river in the southwest corner of the country or within 150 kilometers of the country's southern border with Nigeria. The country's population is predominantly rural, young, and uneducated. Only about 15 percent of the population lives in urban areas; half of the population is under 15 years of age, and only 28 percent of the schoolage children attend school, among the lowest school enrollment rates in Africa. Continued population growth (3.2 percent per year), shortage of arable land, and recurring droughts make food security uncertain.

Niger has important mineral resources, in particular uranium, mined from the central regions of the country. The economy is dominated by agricultural and livestock activities, however. Millet and sorghum are the major food staples. In 1989, these two grains accounted for 80 percent of area cultivated. Livestock, cowpeas, and onions are exported (mainly to Nigeria). Agriculture's share in GDP has remained stable during the 1980s at 20 percent. In all, the primary sector (including agriculture and livestock) accounted for 35 percent of GDP in 1987, while the share of the mining and industrial sector is only 15 percent (Table 1).[1]

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[1] For more detailed discussion of the Nigerian economy see Dorosh (1992), Jabara (1991), SEDES (1987, 1988), Horowitz et al. (1983)

**Table 1 — Niger: Production Activities in the SAM**

| SAM Subsector | National Accounts Subsector | Production | Value-Added | Value-Added |
|---|---|---|---|---|
| | | FCFA billions | FCFA billions | Percentage |
| Grains | 11 | 70,932 | 64,211 | 9.8 |
| Export crops | 11 | 23,821 | 18,314 | 2.8 |
| Other crops | 11 | 56,835 | 53,157 | 8.1 |
| Livestock | 12 | 84,772 | 83,441 | 12.7 |
| Forestry, fish | 13 | 23,384 | 22,319 | 3.4 |
| Mining[a] | 21 | 91,194 | 43,948 | 6.7 |
| Meat processing | 31 | 63,935 | 9,487 | 1.4 |
| Food processing | 31 | 17,189 | 7,048 | 1.1 |
| Formal | | 10,279 | 3,573 | 0.5 |
| Informal | | 6,910 | 3,475 | 0.5 |
| Manufacturing | 32-39, 41-42 | 84,553 | 41,413 | 6.3 |
| Formal | | 56,880 | 22,262 | 3.4 |
| Informal | | 27,673 | 19,151 | 2.9 |
| Construction | 51, 52 | 55,835 | 20,674 | 3.2 |
| Formal | | 37,303 | 14,583 | 2.2 |
| Informal | | 18,532 | 6,091 | 0.9 |
| Trade | 61 | 165,827 | 123,781 | 18.9 |
| Formal | | 31,179 | 18,926 | 2.9 |
| Informal | | 134,648 | 104,855 | 16.0 |
| Transportation/communication | 63, 71, 72 | 56,602 | 34,169 | 5.2 |
| Formal | | 25,099 | 16,392 | 2.5 |
| Informal | | 31,503 | 17,777 | 2.7 |
| Private services | 81, 83, 94, 95 | 76,920 | 58,928 | 9.0 |
| Formal | | 16,576 | 10,745 | 1.6 |
| Informal | | 60,344 | 48,183 | 7.4 |
| Public services | 91, 96 | 106,291 | 73,962 | 11.3 |
| **Total** | | **968,089** | **654,852** | **100.0** |
| Primary sectors | | 259,744 | 241,443 | 36.9 |
| Formal industry[b] | | 158,353 | 69,783 | 10.7 |
| Informal industry[c] | | 88,518 | 32,113 | 4.9 |
| Formal services | | 110,157 | 60,646 | 9.3 |
| Informal services | | 245,026 | 176,905 | 27.0 |
| Public services | | 106,291 | 73,962 | 11.3 |
| **Total** | | **968,089** | **654,852** | **100.0** |

**Source:** Dorosh and Nssah (1991).

[a] Mining and meat processing subsectors include both formal and informal activities.

[b] Formal industry figures include informal mining activities.

[c] Informal industry includes formal meat processing activities.

Production linkages in Niger's economy are small. Use of domestically produced inputs in manufacturing is limited, and fertilizer and other inputs are seldom used in agricultural production outside of limited irrigated areas. Forward linkages, reflecting the extent to which a sector's output is used as inputs by other production activities, are largest for energy, financial services, transport and communications, and livestock (Table 2).[2] Backward linkages, showing the extent to which a sector uses inputs produced by other sectors, are largest for mining, commerce, and administration. The agricultural sector has weak forward and backward production linkages.

Another key characteristic of Niger's economy is the sharp difference in structure and behavior of the formal and informal sectors. Formal sector enterprises (those registered for tax purposes by completing a *declaration statistique et fiscale [DSF]*), dominate the mining, energy, industry, modern construction, transport, and communications sectors. Informal sector activities include, in addition to agriculture and livestock, artisanry, meat processing, baking, and traditional construction, as well as much of the wholesale and retail trade. Informal sector activities account for more than two-thirds of GDP.

In general, informal sector activities are less capital-intensive than formal sector activities, wages are lower, and employment is less certain. Prior to the adjustment programs of the mid-1980s, prices and wages were fixed in the formal sector. The economy has been liberalized to some extent,

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[2] The linkage indices shown in Table 2 (called Rasmussen indices) represent the degree to which linkages in a given sector are greater or less than the average linkages for the economy as a whole. An index number greater (or less) than one indicates that the linkages in a given sector are greater (or less) than the average degree of linkage for the economy as a whole. See Dorosh and Nssah (1991) for details of the calculations

**Table 2** – Production Linkages in Niger's Economy, 1987

| | Index of Backward Linkages | Index of Forward Linkages |
|---|---|---|
| Agriculture | 0.798 | 0.818 |
| Livestock | 0.733 | 1.195 |
| Fishing and forestry | 0.740 | 1.059 |
| Mining | 1.339 | 0.732 |
| Formal industry | 0.826 | 1.149 |
| Informal industry | 1.159 | 1.008 |
| Energy | 1.146 | 1.472 |
| Formal construction | 0.925 | 0.765 |
| Informal construction | 1.129 | 0.760 |
| Commerce | 1.292 | 0.724 |
| Transport and communications | 0.916 | 1.203 |
| Financial institutions | 0.799 | 1.474 |
| Other private services | 0.981 | 0.916 |
| Public administration | 1.217 | 0.725 |

**Source:** Dorosh and Nssah (1991).

**Note:** Backward and forward linkage indices shown are Rasmussen indices.

but prices, employment, and wages still tend to be more rigid in the formal sector than in the informal sector. Another distinction is that almost all exports of informal sector products are sold to Nigeria as part of unrecorded trade at parallel market exchange rates; exports from the formal sector (mainly uranium) are generally sold at official exchange rates to developed countries. Finally, since only the formal sector enterprises are registered for tax purposes, their contribution to fiscal revenues is much greater than the informal sector, which is subject only to licensing fees.

Niger's economic policy is constrained by the country's membership in the West African Monetary Union (*Union Monétaire Ouest-Africaine [UMOA]*). As a member of the monetary union, Niger shares a common currency (the CFA franc) with the other members of the Union, and the exchange rate of the CFA franc is fixed at 50 FCFA to 1 French franc (Ffr). The central bank of UMOA, the *Banque Centrale des Etats de l'Afrique de l'Ouest* (BCEAO), maintains an operations account with the French treasury, which in turn guarantees the free convertibility of the CFA franc with the French franc. The arrangement guarantees that Niger and the other member countries do not experience shortages of foreign exchange. However, the countries give up their ability to independently set their own monetary policies.

The above institutional and structural characteristics of Niger's economy have greatly influenced overall economic growth and the response of the economy to external shocks and changes in economic policies in the 1980s. The next sections attempt to shed light on how the combination of economic and institutional structure, external shocks, and policy changes affected various household groups.

# 3. MODEL STRUCTURE AND EQUATIONS

This section describes the mathematical structure underlying the Computable General Equilibrium (CGE) model of the economy of Niger used in the analysis.[3] The Niger model follows the structure developed by Dervis, de Melo and Robinson (1982). In particular, it is a variant of the Cameroon model by Benjamin and Devarajan (1985).

## THE SOCIAL ACCOUNTING MATRIX

The basic structure of the CGE model is reflected in the underlying data base, the social accounting matrix (SAM). In the SAM, data on production, consumption, investment, trade and income distribution are organized in a consistent set of accounts that explicitly show the circular flow of incomes and expenditures in a given year.[4]

The model (and the base SAM) show production accounts for twenty activities (shown in Table 1). This level of disaggregation reflects important differences in technologies between the formal and informal sectors and the importance of certain traded goods in the economy (e.g., uranium and cowpeas). For a number of industrial goods and various services, two separate production technologies (for formal and informal sectors) are modeled, each

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[3] Robinson (1989) provides a thorough discussion of CGE modeling.

[4] Dorosh and Nssah (1991) provide details of the construction of the SAM.

producing the same commodity output. Thus, for these commodities, the output of the corresponding formal sector activity is treated as a perfect substitute for the production of that same commodity by the informal sector.

Eight primary factors of production are defined in the model: skilled and unskilled labor, formal and informal capital, land north of the 400 mm rainfall isohyte belonging to high and low income farmers, and land south of the 400 mm isohyte belonging to high and low income farmers. Agricultural capital, including livestock capital, is included with land.[5]

Ten domestic institutions are distinguished: seven types of households, formal enterprises, informal enterprises, and the government. Urban I households are those with a skilled head of household; per capita income of these households is 2.6 times that of Urban II households, whose household heads are unskilled (Table 3). Semiurban households, those residing in cities with a 1988 population of less than 50,000, comprise the group Urban III. Rural households are divided according to the same geographical criteria (the 400 mm rainfall isohyte) as is land. High income households in both the north and south are defined as those that own cattle. Note that these rural "high income" households have a lower per capita income than urban low income households.

**MODEL EQUATIONS**

The specification of a CGE model is based on the two fundamental principles of economics: optimization and equilibrium. Thus the system of

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[5] In the production functions of the model, each activity's capital stock is a simple aggregation of stocks of capital of all types.

**Table 3 —** Household Incomes

| | Population | Revenue Per Capita | Total Revenue |
|---|---|---|---|
| | (Percent) | (FCFA 1,000) | (Percent) |
| Urban I | 3.2 | 414.5 | 16.8 |
| Urban II | 6.4 | 159.9 | 12.9 |
| Semiurban | 4.9 | 59.8 | 3.7 |
| All urban | 14.6 | 182.9 | 33.4 |
| Rural North - high income | 10.4 | 115.5 | 15.0 |
| Rural North - low income | 31.2 | 49.0 | 19.1 |
| Rural South high income | 23.7 | 67.8 | 20.0 |
| Rural South low income | 20.2 | 49.2 | 12.4 |
| All rural | 85.4 | 62.3 | 66.6 |
| All Niger | 100.0 | 79.9 | 100.0 |

**Source:** Dorosh and Nssah (1991).

[a] Percentage of national total.

equations forming the model describes the behavior of various economic agents, the constraints they face, and the equilibrium conditions in various markets. The system is typically specified in four blocks:

(1) The price block essentially describes the structure of incentives facing the private sector. The government uses a combination of trade and domestic taxes along with an exchange rate regime to drive a wedge between domestic and world prices for the tradeables, and between the producer and consumer prices for the nontradeables.

(2) The supply block shows that sectoral production plans are guided by profit maximization. Sectoral production has a nested structure. At one level, output is a linear function of value-added and intermediate consumption. At another level, value-added is a constant elasticity of substitution (CES) function of labor and capital.

(3) The demand block distinguishes intermediate demand from final demand. The former is linked linearly to the production activities. Final demand is composed of private, government, and investment consumption.

(4) The last block represents various equilibrium conditions and constraints. These include employment conditions in factor markets and factor mobility, material balance in goods markets, the government budget and trade deficit constraints, and the savings-investment balance. As specified, the model is consistent with the Walrasian paradigm. The implicit excess demand functions are homogeneous of degree zero in all prices, including the exchange rate (which is the domestic price of foreign currency). Therefore, only relative prices matter. And in principle one could choose just about any price as *numéraire* and interpret all prices in terms of the chosen one. The choice of *numéraire* is also referred to as price-normalization rule. In the

context of policy analysis and formulation, a "no-inflation" normalization rule is often used for clarity (see Dervis, de Melo, and Robinson 1982, p. 150). Such a choice of *numéraire* allows all price changes to be interpreted as changes in relative prices. Thus, the general price level has to be determined exogenously. This means of course that the model cannot be used to discuss macroeconomic issues such as inflation.

## THE PRICE BLOCK

The equations in the price block define the domestic prices of the various categories of goods distinguished in the model. The Niger model follows the tradition of most trade-focused CGE models. There is a fundamental distinction between tradeable and nontradeable goods. In order to study the terms-of-trade shocks, the class of tradeable goods is further subdivided into exportables and importables. This characterization leads to the definition of composite producer and consumer goods. The price definition takes into consideration the above classification of goods and the tax policies in place. Thus, the domestic prices of importables ($PM_i$) and exportables ($PE_i$) are given by the following two equations:

$$PM_i = PWM_i * (1 + tm_i) * ER \quad (1)$$

$$PE_i = \frac{PWE_i * ER}{1 + te_i}, \quad (2)$$

where $ER$ is the CFA/US dollar exchange rate: $PWM_i$ and $PWE_i$ are the world market prices (in US dollars) of imports and exports, respectively: $tm_i$ is the *ad valorem* import tariff and $te_i$ is the export tax rate.

As far as producer prices are concerned, the price of the composite producer good, $PPT_i$, is defined from the equation giving the value of domestic output, $XPT_i$:

$$PPT_i * XPT_i = PPD_i * XPD_i + \frac{PE_i}{(1 + margx_i)} * E_i, \qquad \textbf{(3)}$$

where $PPD_i$ is the domestic sale price at factory gate, $XPD_i$ domestic sales (valued at factory gate), $margx_i$ the marketing margin rates on exports, and $E_i$ the level of exports. Because the output of each sector *i* is an aggregation of many commodities, the factory-gate price of goods sold domestically $(PPD_i)$ may be different from the factory-gate price of export goods $(PE_i/[1+margx_i])$. The equation giving the net price or unit value-added of an activity is:

$$PVA_j = PPT_j\ (1 - tprod_j) - \sum_i PC_i a_{ij}, \qquad \textbf{(4)}$$

where $tprod_j$ is the indirect tax rate in the sector, $PC_i$ is the price of th consumer composite good to be defined later, and $a_{ij}$ the relevant input-output coefficients.[6]

The user price ($PC_i$) of the consumer composite good is derived in a manner analogous to the derivation of the price of the producer composite good. Use is made here of the equation giving the value of domestic sales. We thus have:

$$\begin{aligned} PC_i * XT_i = {} & PPD_i\ (1 + margd_i + dsalr_i) * XPD_i \\ & + PM_i * (1 + margm_i + isalr_i) * M_i, \end{aligned} \tag{5}$$

where $margd_i$ and $margm_i$ stand for marketing margin rates on domestic sales and on imports, respectively, and $dsalr_i$ and $isalr_i$ stand for sales tax rates on domestic products and on imports, respectively. Figure 1 shows the relationships between some of the quantity and price variables in the model.

Three additional prices are defined in the model: the price of capital goods, activity prices, and the aggregate price index. These are described by equations 6 through 8.

$$PK_j = \sum_i PC_i * IMAT_{ij}, \tag{6}$$

where $PK_j$ is the price of a unit of capital in sector $j$, and $IMAT_{ij}$ is the $(i,j)$ element of the capital composition (or investment) matrix, i.e., the demand for investment good $i$ per unit of investment for sector $j$.

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[6] In the model computer code, the index *IACT* is used instead of $j$ for production activities.

**Figure 1** — Structure of Price and Quantity Aggregations

Activity Price and Output

$PPTACT_j * XPTACT_j$

Commodity Price and Output (factory gate)

$PPT_i * XPT_i$

Domestic Sales (factory gate)

$PPD_i*XPD_i$

Exports (factory gate)

$PE_i/(1+MARGX_i)*E_i$

$PE_i = PWE_i*ER/(1+TE_i)$

Domestic Utilization (user price)

$PC_j*XT_j$

Domestic Sales (user price)

$PPD_i*(1+MARGD_i+DSALRATE_i)*XPD_i$

Imports (user price)

$PM_i*(1+MARGM_i+ISALRATE_i)*M_i$,

$Pm_i = PWM_i*ER*(1+TM_i)$

The price of activity $j$ is defined as the weighted average of the prices of all goods produced by the activity:

$$PPTACT_j = \sum_i PPT_i * OUTMAT_{ji}, \tag{7}$$

where the $OUTMAT_{ji}$ are elements of the output matrix showing the share of each good $i$ in total output of activity $j$, $XPTACT_j$. Thus,

$$XPT_i = \sum_j XPTACT_j * OUTMAT_{ji} \tag{8}$$

In the Niger model, each of the twenty activities produces only one good, so for each activity $j$, $OUTMAT_{ji} = 1$ for one good $i$, and $0$ for all other $i$.

Finally, the aggregate price index is computed as a weighted average of user prices for composite goods. Thus:

$$PINDEX = \sum_i \theta_i * PC_i, \tag{9}$$

where $\theta_i$ is the share of consumption of good $i$ in total private consumption.

## THE SUPPLY BLOCK

The supply of domestically produced goods to be sold either on the domestic or the world market depends on the behavior of producers in each sector of the economy subject to technological, factor endowment, and market constraints. In the simplest version of the Niger model, technology is approximated by sectoral **Cobb-Douglas** production functions of the type:

$$XPTACT_j = AD_j \, L_{1j}^{\alpha_{1j}} \, L_{2j}^{\alpha_{2j}} \, K_j^{\alpha_{3j}}, \tag{10}$$

where $\alpha_{3j} = (1 - \alpha_{1j} - \alpha_{2j})$ and $AD_j$ is a constant. Only two types of labor are employed: skilled and unskilled.

Assuming that capital is fixed in each sector, perfect competition prevails and producers seek to maximize profits. Then each labor category will be demanded up to the point where its wage equals its marginal value product. This condition is translated as follows:

$$WDIST_{lc,j} * W_{lc} * L_{lc,j} = \alpha_{lc,j} * PVA_j * XPTACT_j. \tag{11}$$

Note that, in the above equation, the wage rate of type $lc$ labor in sector $j$ is equal to the economy wide average wage $w_{lc}$, multiplied by a constant ($WDIST_{lc,j}$). The constant is included because observed wage rates for labor of a particular skill are rarely uniform across sectors as they would be if resources were allocated optimally in a perfectly competitive environment. Thus $WDIST_{lc,j}$ is a measure of the extent to which the sectoral returns to type $lc$ labor differs from the economy wide average, $w_{lc}$. When the model is solved, it is this average wage that will change to equate labor demand and supply according to the following equation:

$$\sum_j L_{lc,j} = L_{lc}^{s}. \tag{12}$$

The domestic supply is allocated between domestic sales, $XPD_i$, and exports, $E_i$. This allocation hinges crucially on the price of exports relative to domestic sales. According to Equation 2, the domestic price of exports is a function of the world price, $PWE_i$. However, the level of world price received by a country depends on the type of demand curve it faces from the rest of the world. In the case of a small open economy, classical trade theory assumes that the country is a price taker in world markets and can therefore export as much as it likes at the going price. Such an assumption is quite unrealistic in view of the various obstacles facing exporting developing countries in world markets. We therefore assume, instead, that the country faces a downward sloping demand curve for its exports. This is given by the following equation:

$$E_i/EO_i = \left(\frac{PWEO_i}{PWE_i}\right)^{\eta_i}, \tag{13}$$

where $PWEO_i$ is the initial world price of exports and $\eta_i$ is the elasticity of demand for exports of sector $i$.

Furthermore, if we assume that the allocation is made such as to maximize the value of domestic output given by Equation 3 subject to constant elasticity of transformation between domestic sales and exports:

$$XPT_i = AT_i\,(\gamma_i E_i^{\psi_i} + (1 - \gamma_i)\,XPD_i^{\psi_i})^{1/\psi_i}. \tag{14}$$

Then the relative export supply is given by:

$$\frac{E_i}{XPD_i} = \left[\frac{PE_i^*}{PPD_i} * \frac{(1 - \gamma_i)}{\gamma_i}\right]^{\phi_i}, \tag{15}$$

where $PE_i^* = \frac{PE_i}{1 + margx_i}$ and $\phi_i = \frac{1}{\psi_i - 1}$.

The supply of imports from the rest of the world is treated in a similar fashion. This time the price-taking behavior assumed in classical trade theory is maintained on the import side. In other words, the country faces a perfectly elastic supply of imports at the given world price. The relative share of imports in total absorption depends on relative prices and the elasticity of substitution between imported and domestic goods. It is assumed that consumers purchase a composite good, which is a CES (constant elasticity of substitution) aggregation of imports and domestic goods according to the following equation:

$$XT_i = AC_i\left(\delta_i M_i^{-\rho_i} + (1 - \delta_i)\, XPD_i^{-\rho_i}\right)^{-\frac{1}{\rho_i}}, \tag{16}$$

where $AC_i$ is a constant and $\delta_i$ is the share parameter.

Minimizing the cost of acquiring a unit of the composite commodity yields the following relative demand for imports:

$$\frac{M_i}{XPD_i} = \left(\frac{PPD_i^*}{PM_i^*} * \frac{\delta_i}{1 - \delta_i}\right)^{\sigma_i}, \tag{17}$$

where $\sigma_i = \frac{1}{1 + \rho_i}$ is the elasticity of substitution,

$PPD_i^* = PPD_i\,(1 + margd_i + dsalr_i)$, and $PM_i^* = PM_i\,(1 + margm_i + isalr_i)$.

The equations for nontraded goods are simpler than those for traded goods. For nonexportable goods, Equation 14 reduces to:

$$XT_i = XPD_i. \tag{18}$$

For nonimportable goods, the aggregation of Equation 16 becomes:

$$XPT_i = XPD_i \tag{19}$$

## THE DEMAND BLOCK

There are five components of domestic demand for the composite commodity: intermediate demand, private consumption, government demand for final goods, the demand for capital goods, and inventory demand. The levels of these variables are determined in general by the income-expenditure patterns of the various sectors in the economy. The ultimate determinants are, of course, factor and commodity prices. The following equations describe in detail, what is involved.

### Intermediate Demand

Assuming that the amount of intermediate input $i$ required in the production process $j$ is in direct and fixed proportion to the level of output in sector $j$, the total demand of good $i$ for intermediate use is given by:

$$INT_i = \sum_j a_{ij} XPTACT_j. \tag{20}$$

For goods produced by the commerce sector (commodity 11), Equation 20 is modified to include marketing margins on exports (*MARGXTOT*), imports (*MARGMTOT*), and domestic production (*MARGDTOT*):

$$INT_{11} = \sum_j a_{ij} XPTACT_j + (MARGXTOT + MARGMTOT + MARGDTOT) / PC_{11}, \tag{21}$$

where

$$MARGXTOT = \sum_i PE_i * MARGX_i / (1 + MARGX_i) * E_i \tag{22}$$

$$MARGMTOT = \sum_i PM_i * MARGM_i * M_i \tag{23}$$

$$MARGDTOT = \sum_i PPD_i * MARGD_i * XPD_i. \tag{24}$$

**Private Consumption**

Seven households are distinguished in the Niger model: two urban (rich and poor), one semiurban; and four rural (low and high income northerners, and low and high income southerners). The consumption of commodity *i* by household *h* is assumed to be a fixed share of total expenditure:

$$PC_i * CD_{ih} = cles_{ih} * YD_h, \tag{25}$$

where $CD_{ih}$ stands for real consumption of commodity *i* by household *h*, and $YD_h$ is the disposable income of the household. This disposable income is defined as total household income ($Y_h$) minus the savings ($SAVHH_h$), income tax

($TDIR_h * Y_h$), and all transfer payments made by the household to the other institutions in the economy ($TRANHH_h$):[7]

$$YD_h = Y_h - SAVHH_h - TRANHH_h - TDIR_h * Y_h \tag{26}$$

and

$$TRANHH_h = \sum_{INST} TRANSFER_{INST,h}. \tag{27}$$

Total income of household *h* has three basic components: wages, returns to capital, and transfers received from both the domestic institutions and the rest of the world. The amount of labor income flowing to a particular household depends on the employment status of its members and the skill distribution within the household. The total salary paid to labor of a certain skill category *lc* ($LCSAL_{lc}$) is given by:

$$LCSAL_{lc} = \sum_j \delta_{lc,j} * W_j * L_{lc,j}. \tag{28}$$

Similarly, total returns to capital of type *kc* are given by:

$$RETK_{kc} = \sum_j (PVA_j * XPTACT_j - ACTSAL_j) * SHRKC_{kc,j}, \tag{29}$$

where $SHRKC_{kc,j}$ is the constant share of total returns to capital in activity *j* paid to capital of type *kc*, and $ACTSAL_j$ is total salaries paid in activity *j*:

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[7] Institutions include all households, formal enterprises, financial institutions, government, and the rest of the world.

$$ACTSAL_j = \sum_{lc} (WA_{lc} * WDIST_{j,lc} * L_{j,lc}. \tag{30}$$

Total income for household *h* equals:

$$Y_h = \sum_{lc} (shr_{lc,h} * LCSAL_{lc}) + \sum_{kc} (shr_{kc,h} * RETK_{kc}) + \sum_{INST} TRANSFER_{h,INST}, \tag{31}$$

where $shr_{lc,h}$ is the share of labor of type *lc* owned by household *h*, $shr_{kc,h}$ is the share of capital of type *kc* owned by household *h*, and $TRANSFER_{h,INST}$ are transfers received by household *h* from institutions *INST*. Savings by the household ($SAVHH_h$) are given by:

$$SAVHH_h = SO_h + mps_h \cdot Y_h. \tag{32}$$

**Government Current Accounts**

Let $\beta_i^G$ and *GDOT* stand respectively for government expenditure shares and real government consumption. Then government consumption of good *i* is given by the equation:

$$GD_i = \beta_i^G \cdot GDTOT \tag{33}$$

Government revenues are equal to import tariffs *(TARIFF)*, export duties *(DUTY)*, indirect taxes on production *(PRODTX)*, indirect taxes on domestic commodities *(DSALETX)*, sales taxes on imported goods *(ISALETX)*, direct taxes on households *(DIRTX)*, and transfers from other institutions (which include income taxes on formal sector enterprises). In addition, Niger's national accounts (and the Niger SAM) consider returns to capital in the production of public services (sector 11) as government revenue.

$$GR = TARIFF + DUTY + PRODTX + DSALETX + ISALETX + DIRTX + \sum_{inst} TRAN_{adpub,inst} + (PVA_{11} * XPTACT_{11} - ACTSAL_{11}) \tag{34}$$

$$TARIFF = \sum_{i} TM_i * PWM_i * M_i * ER \tag{35}$$

$$DUTY = \sum_{i} TE_i * PE_i * E_i \tag{36}$$

$$PRODTX = \sum_{j} TPROD_j * PPTACT_j * XPTACT_j \tag{37}$$

$$DSALETX = \sum_{i} DSALRATE_i * PPD_i * XPD_i \tag{38}$$

$$ISALETX = \sum_{i} ISALRATE_i * PM_i * M_i \tag{39}$$

$$DIRTX = \sum_{h} TDIR_h * Y_h. \tag{40}$$

Government savings are defined as:

$$GOVSAV = GR - \sum_{i} PC_i * GD_i - \sum_{INST} TRANSFER_{INST,ADPUB}, \tag{41}$$

where $TRANSFER_{INST,ADPUB}$ stands for transfer payments made by the government to all other institutions.

**Other Institutions**

Equations for other institutions in the model, formal enterprises and financial institutions, are essentially accounting identities.[8]

Income of formal sector enterprises *(YENTDEF)* comes from formal sector capital and from transfers:

$$YENTF = RETK_{KFORM} - (PVA_{11} * XPTACT_{11} - ACTSAL_{11}) + \sum_{INST} TRANSFER_{ENTF,\,INST}, \tag{42}$$

where the subscript indicates activity 11, public services.

All income of formal sector institutions goes toward transfers (dividends, insurance payments, etc.), which are exogenous, and to savings *(ENTFSAV)*:

$$ENTFSAV = YENTF - \sum_{INST} TRANSFER_{INST,\,ENTF}. \tag{43}$$

Financial institutions income *(YINFIN)* (mostly interest payments) are exogenous transfers:

$$YINFIN = \sum_{INST} TRANSFER_{INST,\,INFIN}. \tag{44}$$

As with formal sector enterprises, all income of financial institutions is either spent on transfers or is saved *(INFINSAV)*:

$$INFINSAV = YINFIN - \sum_{INST} TRANSFER_{INST,\,INFIN}. \tag{45}$$

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8 These institutions are explicitly specified in the model so that richer institutional behavior can later be added more easily.

**Investment Demand**

Since this is a static model, it is worth mentioning that, even though investment is a source of demand it does not affect current capital stock. Three categories of investment are considered: private demand for productive investment, government investment, and inventory investment. Investment by sector of origin is determined by the composition of investment in each sector:

$$ID_i = \sum_j IMAT_{ij} * DK_j, \tag{46}$$

where $DK_j$ is investment by sector of destination and $IMAT_{ij}$ are the fixed shares of investment good $i$ in total private investment in sector $j$.

Government investment by commodity is given by:

$$GID_i = gio_i * GOVIVT, \tag{47}$$

where $gio_i$ are the government investment shares by commodity, and $GOVIVT$ stands for total volume of government investment. Total value of government investment ($VGOVIVT$) is:

$$VGOVIVT = \sum_i PC_i * GID_i. \tag{48}$$

The value of investment by sector of destination ($PK_j * DK_j$, where $PK_j$ is the aggregate price of new capital [investment] for sector $j$) is in turn assumed to be a fixed share of total private investment:

$$PK_j * DK_j = KIO_j * (SAVINGS - TOTDSTK - VGOVIVT), \quad (49)$$

where *SAVINGS* is total savings and *TOTDSTK* is the value of total change in stocks. *TOTDSTK* is defined simply as:

$$TOTDSTK = \sum_i PC_i * DST_i, \quad (50)$$

where $DST_i$, the change in stock of good $i$, is assumed to be a fixed share ($DSTR_i$) of current output, $XPT_i$:[9]

$$DST_i = DSTR_i * XPT_i. \quad (51)$$

Total savings (*SAVINGS*) is equal to the sum of total household savings (*TOTHHSAV*), government savings (*GOVSAV*), savings of formal enterprises and financial institutions (*ENTFSAV* and *INFINSAV*), and foreign savings (*FSAV*) multiplied by the exchange rate (*ER*) and depreciation (*DEPRECIA*):

$$SAVINGS = TOTHHSAV + GOVSAV + ENTFSAV + INFINSAV + FSAV * ER, \quad (52)$$

where

$$TOTHHSAV = \sum_h SAVHH_h. \quad (53)$$

[9] Alternatively, changes in stocks could be modeled as an exogenous variable.

Depreciation[10] is assumed to be a fixed percentage ($DEPR_j$) of the value of the capital stock in each activity $j$:

$$DEPRECIA = \sum_j DEPR_j * PK_j * K_j. \tag{54}$$

Total private investment is simply the sum of private investment in each activity:

$$DKTOT = \sum_j DK_j. \tag{55}$$

**The Current Account and Foreign Savings**

The current account equation defines foreign savings (expressed in terms of foreign currency) as the total value of imports and transfers from Niger less the total value of exports and transfers from the rest of the world:

$$\begin{aligned} &\sum_i PWM_i * M_i + (1/ER) \sum_{INST} TRANSFER_{ROW,INST} \\ &= \sum_i PWE_i * E_i + (1/ER) \sum_{INST} TRANSFER_{INST,ROW} + FSAV. \end{aligned} \tag{56}$$

---

10 In a dynamic model, depreciation in period $t$ would reduce the capital stock in period $t + 1$. In this static model, the depreciation variable *DEPRECIA* does not enter any other equations. Household incomes, savings, and investments are all measured in gross terms in the model; they are not net of depreciation.

## SUPPLY — DEMAND BALANCE AND CLOSURE

For the model to be complete we must specify system constraints that it must obey. These are embedded in the supply-demand equilibrium conditions and the chosen closure rule. In a neoclassical model describing a competitive market economy, prices adjust to clear factor and product markets.

Factor market equilibrium conditions have already been described. Wages adjust to clear labor markets (Equation 11). Capital is assumed to be sectorally fixed.

With respect to goods markets, even though we do distinguish among composite consumer goods, domestically produced goods sold on the domestic market, and total domestic output, we need to specify the equilibrium conditions only for composite goods: for each composite good *i*, supply must equal demand:[11]

$$XT_i = INT_i + CD_i + GD_i + ID_i + GID_i + DST_i, \tag{57}$$

where $CD_i$ is total household consumption of commodity I:

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[11] Notice that from Equation 16 the ratio of imports to domestic sales is the same for all categories of imports. Therefore the market-clearing conditions for domestic sales are automatically satisfied. (Mathematically, this can be shown by multiplying both sides of Equation 28 by the ratio $XPD_i/XT_i$.) Furthermore adding exports to both sides of the market-clearing equation for domestic sales, one obtains market-clearing conditions for domestic output.

$$CD_i = \sum_h CDHH_{i,h}. \tag{58}$$

Total GDP (*YGDP*) is equal to value-added plus indirect taxes:

$$YGDP = \sum_j PVA_j * XPTACT_j + PRODTX + TARIFF + DUTY + DSALETX + ISALETX - DEPRECIA. \tag{59}$$

The Niger model includes 578 variables altogether (Table 4).[12] Table 5 lists 519 equations, and each equation is matched with an endogenous variable contained in the equation. Although the model equations are solved simultaneously and in general each variable is found in more than one equation, the pairing of equations and variables is useful for understanding the structure of the model.

Only 518 (519 - 1) equations are independent; the 519th equation is redundant by Walras' Law.[13] Thus one equation can be dropped. This leaves 578 variables and only 518 equations. More restrictions to the model, in the form of more equations or more exogenous variables, are necessary to "close" the model.

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[12] The GAMS solution algorithm used requires that the model be set up in the general form of maximizing an objective function given a set of constraints. Thus one other equation is added (*OBJ*), defining the objective variable *OMEGA* as a constant. See Condon, Dahl, and Devarajan (1987).

[13] Walras' Law states that under certain conditions for the production and demand functions, satisfied by the functional forms chosen here, if there are k commodities and the excess demand equations for k-1 of the commodities are satisfied (equal to zero), then the excess demand equation for the kth commodity will also be satisfied. Intuitively, this can be seen by considering that if total income in the economy equals total expenditure, then knowing expenditure on k-1 commodities and total expenditure is sufficient to determine the expenditure on the kth commodity. See Henderson and Quandt (1980), Varian (1978), and Dervis, de Melo, and Robinson (1979).

**Table 4 — Variables of the Niger CGE Model**

| Variable | Number of Variables | | Exogenous | Corresponding Equation |
|---|---|---|---|---|
| | Symbol | Number | | |
| PPD | I | 14 | | EQUIL |
| PM | I (IM) | 11 | | PMDEF |
| PE | I (IT) | 9 | | PEDEF |
| PK | IACT | 20 | | PKDEF |
| PPT | I | 14 | | SALES |
| PPTACT | IACT | 20 | | PPTDEF |
| PC | I | 14 | | ABSORPTION |
| PVA | IACT | 20 | | ACTP |
| PINDEX | | 1 | | PINDXDEF |
| PWM | I (IM) | 11 | 11 | |
| PWE | I (IT) | 9 | | ESUPPLY |
| TM | I (IM) | 11 | 11 | |
| ER | | 1 | 1 | |
| XT | I | 14 | | ARMINGTON, XSN |
| XPT | I | 14 | | XPTDEF |
| XPD | I | 14 | | CET, XXDSN |
| XPTACT | IACT | 20 | | ACTIVITY |
| E | I (IT) | 9 | | EDEMAND |
| M | I (IM) | 11 | | COSTMIN |
| K | IACT | 20 | 20 | |
| WA | LC | 2 | | LMEQUIL |
| LS | LC | 2 | 2 | |
| L | IACT, LC | 40 | 12 | |
| INT | I | 14 | | INTEQ, INTEQCOMM |
| MARGXTOT | | 1 | | MARXDEF |
| MARGMTOT | | 1 | | MARGMDEF |
| MARGDTOT | | 1 | | MARGDDEF |
| DST | I | 14 | | DSTEQ |
| CD | I | 14 | | CDEQ |
| CDHH | I x H | 98 | | CONHHEQ |
| TRANHH | H | 7 | | TRANHHEQ |
| SAVHH | H | 7 | | SAVHHEQ |
| YGDP | | 1 | | GDP |
| ACTSAL | IACT | 20 | | ACTSALDEF |
| RETK | KC | 6 | | RETKDEF |
| LCSAL | LC | 2 | | LCSALDEF |
| Y | H | 7 | | YHDEF |
| YENTF | | 1 | | YENTFDEF |
| YINFIN | | 1 | | YINFINDEF |
| ENTFSAV | | 1 | | SAVENTFEQ |
| INFINSAV | | 1 | | SAVINFINEQ |
| TOTHHSAV | | 1 | | TOTHHSAVEQ |
| GD | I | 14 | | GDEQ |
| ID | I | 14 | | IEQ |
| GR | | 1 | | GREQ |
| TARIFF | | 1 | | TARIFFDEF |
| PRODTX | | 1 | | PRODTXDEF |
| DUTY | | 1 | | DUTYDEF |
| DSALETX | | 1 | | DSALETXDEF |
| ISALETX | | 1 | | ISALETXDEF |
| DIRTX | | 1 | | DIRTXDEF |
| GDTOT | | 1 | 1 | |
| VGOVIVT | | 1 | | VGOVIVTDEF |
| GOVIVT | | 1 | 1 | |
| GOVSAV | | 1 | | GRUSE |
| GID | I | 14 | | GIDEF |
| DEPRECIA | | 1 | | DEPREQ |
| SAVINGS | | 1 | | TOTSAV |
| FSAV | | | 1 | CAEQ |
| DK | IACT | 20 | | PRODINV |
| DKTOT | | 1 | | DKTOTDEF |
| OMEGA | | 1 | | OBJ |
| TOTDSTK | | 1 | | TOTSTKDEF |
| **Total** | | **578** | **60** | |

Table 5 - Equations of the Niger CGE Model

| Equation Name | | Number of Equations | | Variable |
|---|---|---|---|---|
| | | Symbol | Number | |
| PMDEF | 1 | IM | 11 | PM(IM) |
| PEDEF | 2 | IT | 9 | PE(IT) |
| SALES | 3 | I | 14 | PPT(I) |
| ACTP | 4 | IACT | 20 | PVA(IACT) |
| ABSORPTION | 5 | I | 14 | PC(I) |
| PKDEF | 6 | IACT | 20 | PK(IACT) |
| PPTDEF | 7 | IACT | 20 | PPTACT(IACT) |
| XPTDEF | 8 | I | 14 | XPT(I) |
| PINDXDEF | 9 | | 1 | PINDEX |
| ACTIVITY | 10 | IACT | 20 | XPTACT(IACT) |
| PROFITMAX | 11 | | 28 | L(IACT,LC) |
| LMEQUIL | 12 | LC | 2 | WA(LC) |
| EDEMAND | 13 | IT | 9 | E(IT) |
| CET | 14 | IT | 9 | XPD(IT) |
| ESUPPLY | 15 | IT | 9 | PWE(IT) |
| ARMINGTON | 16 | IM | 11 | XT(IM) |
| COSTMIN | 17 | IM | 11 | M(IM) |
| XXDSN | 18 | INX | 5 | XPD(INX) |
| XSN | 19 | INM | 3 | XT(INM) |
| INTEQ | 20 | J-1 | 13 | INT(J) |
| INTEQCOMM | 21 | | 1 | INT("COMM-P") |
| MARGXDEF | 22 | | 1 | MARGXTOT |
| MARGMDEF | 23 | | 1 | MARGMTOT |
| MARGDDEF | 24 | | 1 | MARGDTOT |
| CONHHEQ | 25 | I*H | 98 | CDHH(I,H) |
| TRANHHEQ | 27 | H | 7 | TRANHH(H) |
| LCSALDEF | 28 | LC | 2 | LCSAL(LC) |
| RETKDEF | 29 | KC | 6 | RETK(KC) |
| ACTSALDEF | 30 | IACT | 20 | ACTSAL(IACT) |
| YHDEF | 31 | H | 7 | Y(H) |
| SAVHHEQ | 32 | H | 7 | SAVHH(H) |
| GDEQ | 33 | I | 14 | GD(I) |
| GREQ | 34 | | 1 | GR |
| TARIFFDEF | 35 | | 1 | TARIFF |
| DUTYDEF | 36 | | 1 | DUTY |
| PRODTXDEF | 37 | | 1 | PRODTX |
| DSALETXDEF | 38 | | 1 | DSALETX |
| ISALETXDEF | 39 | | 1 | ISALETX |
| DIRTXDEF | 40 | | 1 | DIRTX |
| GRUSE | 41 | | 1 | GOVSAV |
| YENTFDEF | 42 | | 1 | YENTF |
| SAVENTFEQ | 43 | | 1 | ENTFSAV |

**Table 5 — Equations of Niger CGE Model (Continued)**

| Equation Name | | Number of Equations: Symbol | Number of Equations: Number | Variable |
|---|---|---|---|---|
| YINFINDEF | 44 | | 1 | YINFIN |
| SAVINFINEQ | 45 | | 1 | INFINSAV |
| IEQ | 46 | I | 14 | ID(I) |
| GIDEF | 47 | I | 14 | GID(I) |
| VGOVIVTDEF | 48 | | 1 | VGOVIVT |
| PRODINV | 49 | IACT | 20 | DK(IACT) |
| TOTSTKDEF | 50 | | 1 | TOTDSTK |
| DSTEQ | 51 | I | 14 | DST(I) |
| TOTSAV | 52 | | 1 | SAVINGS |
| TOTHHSAVEQ | 53 | | 1 | TOTHHSAV |
| DEPREQ | 54 | | 1 | DEPRECIA |
| DKTOTDEF | 55 | | 1 | DKTOT |
| CAEQ | 56 | | 1 | FSAV |
| EQUIL | 57 | I | 14 | PPD(I) |
| CDEQ | 58 | I | 14 | CD(I) |
| GDP | 59 | | 1 | YGDP |
| OBJ | | | 1 | OMEGA |
| Total equations | | | 519 | |
| Exogenous variables | | | | |
| ER.FX | | | 1 | |
| K.FX | | IACT | 20 | |
| PWM.FX | | IM | 11 | |
| LS.FX | | LC | 2 | |
| L.FX(LC,IACT) | | | 12 | |
| TM.FX(IM) | | IM | 11 | |
| FSAV.FX | | | 1 | |
| GDTOT.FX | | | 1 | |
| GOVIVT.FX | | | 1 | |
| Total exogenous variables | | | 60 | |
| Total restrictions (Equations + Exogenous Variables) | | | 579 | |
| **Total Variables** | | | 578 | |

**Note:** One equation is redundant by Walras' Law; equation 26 of this paper and the variable $YD_h$ are not in the model code, but are given in this paper to make the presentation cleaner.

A number of restrictions are implicit from the above presentation of the equations of the model. For certain activities (mostly agricultural activities), no skilled labor enters production. In these (12) cases, no labor demand are equations specified and labor demand has to be set to zero. Total supply of labor for both labor types is also fixed exogenously. Capital stock in each of the 20 activities is specified as an exogenous variable, with its level set equal to the base case value. World import prices (expressed in foreign currency) for the 11 imported goods are also fixed. Finally, in the GAMS code, TM is specified as a variable (in order to make it easy to run policy simulations involving changes in tariff rates), but it is fixed exogenously for all 11 imported commodities. This leaves 574 (518 + 12 + 2 + 20 + 11 + 11) restrictions (518 independent equations and 56 exogenous variables) for 578 variables.

The remaining four restrictions determine the closure of the model. Typically, the real values of government investment and government expenditure are set exogenously. Of the three remaining variables—the aggregate price index (*PINDEX*), the nominal exchange rate (*ER*), and foreign savings (*FSAV*)—two must be fixed exogenously. Fixing both *PINDEX* and *ER* sets the real exchange rate (*ER/PINDEX*) and allows foreign savings to be determined endogenously. Letting foreign savings vary across policy simulations, however, makes comparison of the real income results hard to interpret. (There is often a tradeoff between higher foreign savings [more foreign debt] and higher current income.) A more common closure is to fix *ER* and *FSAV* and let *PINDEX* vary. This closure perhaps mostly closely simulates Niger's situation: the country has limited access to foreign capital markets, and membership in the CFA zone prohibits nominal exchange rate changes.

Other closures are possible as well. However, a solution to the model does not necessarily exist for all possible values of a given set of exogenous variables. For example, since together *ER* and *PINDEX* define the real exchange rate and essentially determine the current account balance (the negative of the level of foreign savings, *FSAV*), there may not be a solution to the model if *ER* and *PINDEX* are set at their base levels, *FSAV* is fixed at a level 50 percent below its base value, and another formerly exogenous variable, e.g., the tariff on manufactured imports, is made endogenous. Although the system of equations would still involve 578 variables and 578 restrictions, no level of tariff on manufactured goods could reduce total imports enough to improve the current account balance by 50 percent.

Other closures could be implemented with minor changes to the model. One possibility would be to fix private investment exogenously and allow the marginal propensity to save of one or more household groups to vary in order to achieve the savings-investment balance.

## A NOTE ON CES PRODUCTION FUNCTIONS

An alternative functional form to model production is the CES (constant elasticity of substitution) production function. In the Cobb-Douglas production function, the elasticity of substitution (the change in the ratio of the factor inputs with respect to a change in the ratio of the factor prices) is constrained to be one. In the CES production function, the elasticity of substitution $\sigma$ is equal to $1/(1+\rho)$.[14]

$$Q = AD\left[\sum_{LC} \alpha_{LC} L_{LC}^{-\rho} + (1-\sum_{LC} \alpha_{LC}) K^{-\rho}\right]^{-1/\rho}. \tag{60}$$

In the CES version, the model solves for labor demand by each activity using the first-order conditions for profit-maximization, which equate the value of marginal product of each factor to the factor payment.

$$\frac{\partial Q}{\partial L_{LC}} = \alpha_{LC} AD^{-\rho} Q^{1+\rho} / L_{LC}^{1+\rho} = W/p \tag{61}$$

$$\frac{\partial Q}{\partial K} = (1-\sum_{LC} \alpha_{LC}) AD^{-\rho} Q^{1+\rho} / K^{1+\rho} = r/p. \tag{62}$$

Taking the ratio of equations 61 and 62 gives the first-order condition used in the model:

$$\left(\frac{\alpha_{LC}}{1-\sum_{LC} \alpha_{LC}}\right) \frac{K^{1+\rho}}{L_{LC}^{1+\rho}} = \frac{W_{LC}}{r} \tag{63}$$

or

$$\frac{K}{L_{LC}} = \left(\frac{(1-\sum_{LC} \alpha_{LC})}{\alpha_{LC}}\right)^{\sigma} \left(\frac{W_{LC}}{r}\right)^{\sigma}, \tag{64}$$

where $\sigma = 1/(1+\rho)$.

---

[14] For clarity, the subscripts indicating activity (*j*) are omitted in the equations in this section. Also, *XPTACTj*, the output of activity *j*, is written as *Q*.

These same first-order conditions are used in the calibration of the model as well:

$$\alpha_{LC} = \lambda_{LC} / (1 + \sum_{LC} \lambda_{LC}) \tag{65}$$

where

$$\lambda_{LC} = (W_{LC} / r)\,(L_{LC} / K)^{1+\rho}. \tag{66}$$

Returns to capital $r$ are defined by rearranging terms from equation 62:

$$r = (1 - \sum_{LC} \alpha_{LC}) \cdot AD^{-\rho} \cdot K^{-\rho-1} \cdot PVA \cdot Q^{1+\rho}. \tag{67}$$

One major advantage of the CES function is that it allows the user to specify the short-run elasticity of supply. For a Cobb-Douglas function, elasticity of supply is determined by the labor share in value-added. Labor demand is found from the first-order conditions:

$$\partial Q / \partial L_j = \alpha A L^{\alpha-1} K^{1-\alpha} = W/P. \tag{68}$$

Solving for $L$:

$$L = [(W/P)\,(1/\alpha A)]^{1/\alpha-1}\, K. \tag{69}$$

Substituting Equation 69 into the production function gives:

$$Q = A\,(W/P)^{\alpha/\alpha-1}\,(1/\alpha A)^{\alpha/\alpha-1}\, K. \tag{70}$$

Assuming a fixed capital stock and no change in the nominal wage,[15] the elasticity of supply is then:

$$\partial \ln Q / \partial \ln P = \frac{-\alpha}{\alpha - 1} = \epsilon_s. \qquad (71)$$

For a sector where labor accounts for most of the value added, e.g., agriculture, this elasticity is very large. For example, if $\alpha = .9$ then $\epsilon_s = 9$; if $\alpha = .8$, $\epsilon_s = 4$.

With a CES function the short-run elasticity of supply is related to the elasticity of substitution. Intuitively, if labor does not easily substitute for capital, a change in output price can lead to only small changes in output in the short-run when capital is fixed and only labor inputs can vary. Because the algebraic expression relating the short-run elasticity of supply to the elasticity of substitution and other CES parameters is very complex, the supply elasticities shown in Table 6 were estimated numerically, using the marginal productivity condition for labor demand (equation 61) and the production function (Equation 60).

If CES production functions are used in the model, the production function in Equation 60 replaces Equation 10, and Equation 64 replaces the first-order condition in Equation 11. In addition, Equation 67 is added for each of the 20 activities in the model, defining the new variable for returns to capital $RETR_j$.

---

[15] A fixed nominal wage is a reasonable assumption only when the production sector under consideration employs only a small percentage of total labor in the economy.

**Table 6** — Supply Elasticities with Cobb-Douglas and CES Production Functions

| | Elasticity of Substitution $\sigma = 1/1+\rho$ | Labor Share of Value Added | Supply Elasticity |
|---|---|---|---|
| Cobb-Douglas | 1.0 | .9 | 9.00 |
| CES | | | |
| $\rho = -.5$ | 2.0 | .9 | 18.25 |
| $\rho = 0$ | 1.0 | .9 | 9.00 |
| $\rho = 9$ | 0.1 | .9 | 0.90 |
| Cobb-Douglas | 1.0 | .7 | 2.33 |
| CES | | | |
| $\rho = -.5$ | 2.0 | .7 | 4.69 |
| $\rho = 0$ | 1.0 | .7 | 2.33 |
| $\rho = 9$ | 0.1 | .7 | 0.23 |

**ENDOGENOUS LABOR SUPPLY**

Another modification to the model is adding an equation for labor supply. In Equation 72, labor supply of each skill type $lc$ is a function of the change in the real wage rate $(WA_{lc}/PINDEX)$:

$$LS_{lc} = LS0_{lc} * ((WA_{lc}/PINDEX) / (WA0_{lc}/PINDEX0))**BLE_{lc}. \quad (72)$$

If $BLE_{lc}$ is set equal to zero, labor supply is fixed at the base level $LS0_{lc}$. As $BLE_{lc}$ is increased, labor supply becomes more elastic and increases in aggregate demand lent to increased labor employment.

**PARAMETER VALUES**

Most parameters in the model come from the social accounting matrix itself. The values for the substitution elasticities in the trade equations are in most cases estimates corresponding to parameter values used in applications for sub-Saharan African countries. Condon, Dahl, and Devarajan (1987) provide examples. Elasticities of substitution in the CES production functions are generally less than unity, making partial equilibrium elasticities of supply lower than if Cobb Douglas functions were used. Further refinement of these parameters as data becomes available is a high priority for future work with the model.

## 4. SIMULATION RESULTS

In this section, results of a number of simulations of various external shocks and changes in government policies are presented.[16] The scenarios modeled are designed to reflect the economic environment and policy choices during the period of Niger's uranium export boom of the late 1970s and early 1980s and the stabilization and structural adjustment measures in the years that followed.

Five simulations are presented. The first three simulations show the effects of decreased uranium export revenues and foreign borrowing, drought, and appreciation in the FCFA/Naira real exchange rate, respectively.[17] Simulations 4 and 5 model the effects of two hypothetical policy options: a real exchange rate devaluation of 10 percent and a 10 percent decline in government current expenditures.

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[16] In the model simulations, CES production functions and an endogenous labor supply are used.

[17] Each of these simulations compares simulated policies with the 1987 base solution of the model. Thus, in order to simulate increases in an exogenous variable from 1980 to 1987, the value of the exogenous variable is decreased in the model run, representing the change in value with respect to the 1987 base. In the text and tables, however, the first three simulations are described as if the simulations had been run using a base year in the early eighties.

**IMULATION 1: DECREASE IN FOREIGN BORROWING AND URANIUM REVENUES**

The large increase in uranium export revenues in the late 1970s combined with a surge of foreign borrowing by the government of Niger and parastatals greatly increased Niger's supply of foreign exchange.[18] Uranium export revenues increased from 8 billion 1987 FCFA in 1972 to 140 billion FCFA 1987 in 1980, stimulating investment, imports, and domestic incomes. The subsequent decline by 50 billion 1987 FCFA between 1979-1981 and 1987, mainly caused by a decline in export volumes, was a major factor in the economic crisis of the early to mid-1980s.

In addition, net foreign borrowing dropped off dramatically as earlier loans came due, world credit markets tightened, and the value of Niger's collateral (projected future export earnings) dropped with the world spot price of uranium. Long-term capital inflows, which had risen from 6 billion 1987 FCFA in 1972 to 78 billion 1987 FCFA in 1981, fell by 38 billion 1987 FCFA between 1979-1981 and 1987.

The total decline in foreign exchange availability between 1980 and 1987 caused by both the drop in foreign borrowing and uranium export revenues thus was 88 billion 1987 FCFA. Government investment also fell in the 1980s following a surge in the late 1970s. Average real government investment in 1979-1981 was 57 billion 1987 FCFA higher than in 1987. A smaller change in foreign savings, equal to 21 billion 1987 FCFA (approximately one-fourth of

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[18] Technically, as a member of the CFA zone, Niger has unlimited access to foreign exchange through the French Treasury. In practice, use of this source of foreign exchange is limited by Central Bank (BCEAO) restrictions on bank credit to member country governments and other credit ceilings. Increased export earnings and foreign capital inflows increased Niger's capacity to import, and in this sense, represents an increase in supply of foreign exchange.

historical values), is modeled in simulation 1, along with a decrease in real government investment by the same amount.

In simulation 1, the decline in foreign savings reduces the pool of funds for investment in the country. Decreased government investment expenditures reduce demand for construction services and manufactured goods. The drop in total savings is less than the exogenous decline in government investment so that private investments increased, spurring demand for livestock products and for mining research. But lower overall demand for investment goods and services leads to lower prices in the domestic economy, especially for nontraded goods and services, such as construction. The domestic price level as measured by the GDP deflator falls 10.4 percent (Table 7); thus, the real exchange rate depreciates, making imported goods relatively more expensive than domestic goods. At the same time, lower incomes resulting from the decline in investment spending also reduce import demand and increase export supply. Imports, dampened by lower investment demand, depreciation of the real exchange rate and lower incomes, fall by 7.6 percent; exports rise by 3.5 percent.

All household groups in the economy suffer as a result of the decline in foreign capital inflows; the urban high income group loses the most (Table 8). Real incomes of the urban high income households fall by 9.3 percent as lower output of construction services contributes to a decrease in skilled labor demand and a fall in real wages of skilled labor by 7.3 percent. Real wages of unskilled labor fall also, but by only 2.2 percent. Rural high income households have slightly greater declines in real incomes than rural low income households because as incomes in the overall economy fall, returns to

Table 7 — Niger: Macro-Economic Variables: Simulation Results

| | SIM1 Decreased Foreign Savings | SIM2 Drought | SIM3 Appreciation FCFA/Naira | SIM4 10% Real Devaluation | SIM5 10% Cut Current Gov't Expenditures |
|---|---|---|---|---|---|
| | | | (Percent) | | |
| Real GDP | -1.54 | -4.64 | -0.13 | -2.22 | -0.43 |
| Private consumption | -4.11 | -5.48 | -1.24 | -3.03 | -1.38 |
| Government consumption | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total real investment | -8.87 | -1.08 | 6.57 | -26.83 | 13.95 |
| Private | 50.21 | -2.69 | 18.55 | -68.05 | 35.38 |
| Government | -27.45 | 0.00 | 0.00 | 0.00 | 0.00 |
| Government revenue | 9.16 | -3.40 | 10.25 | -1.83 | 0.57 |
| Exports (mn $) | 16.32 | -17.38 | -46.10 | 23.28 | 1.48 |
| (percent change) | 3.50 | -3.47 | -8.71 | 4.82 | 0.31 |
| Imports (mn $) | -53.01 | -17.38 | -46.11 | -69.00 | 1.48 |
| (percent change) | -7.58 | -2.62 | -6.66 | -10.68 | 0.23 |
| Foreign savings (mn $) | -69.33 | 0.00 | 0.00 | -92.29 | 0.00 |
| (percent change) | -29.86 | 0.00 | 0.00 | -56.66 | 0.00 |
| CPI | -7.20 | -0.01 | -8.17 | 0.00 | -0.68 |
| GDP deflator (PGDP) | -10.37 | 0.10 | -8.38 | -0.54 | -0.89 |
| ER/PGDP | 11.52 | 0.00 | 9.09 | 10.67 | 1.00 |

Table 8 — Niger: Income Distribution Simulation Results

| | 1987 Base Household Income | SIM1 Decreased Foreign Savings | SIM2 Drought | SIM3 Appreciation FCFA/Naira | SIM4 10% Real Devaluation | SIM5 10% Cut Current Gov't Expenditures |
|---|---|---|---|---|---|---|
| | (bn FCFA) | (Percent) | | | | |
| Urban1 (High Income) | 89.97 | -9.31 | -4.61 | 0.17 | -6.22 | -6.35 |
| Urban2 (Low Income) | 49.36 | -6.08 | -5.56 | -1.87 | -5.03 | -1.05 |
| Urban3 (Semiurban) | 20.61 | -4.11 | -8.08 | -1.37 | -2.35 | -1.17 |
| Rural North High Income | 84.28 | -3.88 | -3.42 | -2.32 | -3.22 | -0.27 |
| Rural North Low Income | 107.27 | -3.55 | -6.67 | -2.01 | -2.38 | -0.91 |
| Rural South High Income | 112.52 | -3.38 | -4.07 | -2.26 | -2.60 | -0.53 |
| Rural South Low Income | 69.57 | -3.18 | -5.86 | -2.10 | -1.97 | -0.90 |
| Total | 533.56 | -4.75 | -5.11 | -1.72 | -3.40 | -1.67 |

informal sector capital decline, reducing incomes of owners of capital. Total household incomes fall by 4.8 percent in real terms while real GDP falls onlyby 1.5 percent because the decline in the CPI is 3.2 percent less than the decline in the GDP deflator.[19]

As a consequence of the real exchange rate depreciation, production increases in most tradeable sectors, and decreases in most nontradeable sectors (Table 9). Thus, output of export crops increases by 7.3 percent while the nontradeable construction sector contracts by almost 19 percent.

Overall, the informal sector, much of it concentrated in nontradeable service activities, contracts 2.4 percent while output of the formal sector is essentially unchanged. Within a given sector, such as commerce, informal sector output declines while formal sector output increases because sharply lower costs of skilled labor reduce production costs relatively more in the formal sector.

## SIMULATION 2: DROUGHT

The 1984 drought was devastating for Niger's livestock economy. Cattle stock fell by 40 percent between 1983 and 1984, and by a total of 60 percent between 1983 and 1987.[20] Food production per capita fell 21.7 percent

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[19] Higher prices of imports in this scenario directly raise the CPI, but have no direct effect on the GDP deflator.

[20] No complete livestock survey has been conducted in Niger. Government estimates of the drop in the number of head of cattle are only rough approximations and may overstate the decline in livestock population. Large numbers of livestock may have been moved further south (to Nigeria) during the drought and since have been brought back to Niger.

Table 9 — Niger: Sectoral Outputs: Simulation Results

| Sector | Sim1 Decreased Foreign Savings | Sim2 Drought | Sim3 Appreciation FCFA/Naira | SIM4 10% Real Devaluation | Sim5 10% Cut Current Gov't Expenditures |
|---|---|---|---|---|---|
| Cereals | 0.1 | 0.8 | 0.3 | 0.3 | 0.2 |
| Export Crops | 7.3 | 4.5 | -8.0 | 6.0 | 0.7 |
| Other Crops | -0.5 | 0.5 | 0.2 | -0.3 | -0.3 |
| Livestock | 1.2 | -21.6 | -0.7 | -0.9 | 0.7 |
| Forestry,Fishing | -5.8 | 1.0 | 1.1 | -2.7 | 0.5 |
| Mining | 2.5 | 0.9 | 1.9 | 1.5 | 1.0 |
| Meat Processing | -3.6 | -13.2 | 0.5 | 1.7 | -2.6 |
| Food Processing | | | | | |
| Formal | -0.8 | -3.6 | -0.2 | -0.7 | 1.3 |
| Informal | -0.7 | -0.8 | -0.7 | 0.4 | -1.2 |
| Manufacturing | | | | | |
| Formal | 0.2 | 0.1 | 1.2 | -1.6 | 2.6 |
| Informal | 0.1 | 1.7 | 1.7 | 0.2 | -0.5 |
| Construction | | | | | |
| Formal | -18.1 | -1.7 | 1.6 | -11.3 | 6.2 |
| Informal | -20.5 | 1.2 | 4.5 | -8.2 | 3.4 |
| Commerce | | | | | |
| Formal | 2.9 | 0.5 | -1.3 | -0.1 | 4.1 |
| Informal | 0.2 | 1.1 | -0.3 | -0.6 | 0.2 |
| Transport | | | | | |
| Formal | 1.3 | -0.0 | -0.6 | 0.3 | 2.1 |
| Informal | -1.9 | 0.2 | -0.1 | -2.0 | -2.0 |
| Private Services | | | | | |
| Formal | -0.2 | -0.8 | -1.1 | -1.2 | 2.7 |
| Informal | -1.9 | 0.3 | -0.1 | -1.5 | -0.7 |
| Public Services | -0.0 | -0.0 | 0.0 | -0.0 | -9.8 |
| Agriculture | 0.4 | -7.6 | -0.8 | 0.0 | 0.2 |
| Formal | -1.4 | -0.1 | 0.6 | -1.1 | -0.3 |
| Informal | -2.4 | -1.7 | 0.3 | -0.9 | -0.5 |
| Total Output | -1.3 | -2.8 | 0.1 | -0.7 | -0.2 |

between 1983 and 1984, but recovered to nearly the 1983 level in 1985, a year of more normal rains.

The decline in the number of livestock had a large adverse effect on the entire economy through a number of channels. In the national accounts, the output of the livestock sector mainly consists of milk products, slaughtered cattle (considered as inputs in the meat processing industry), exports of livestock on the hoof, and increases in the number of head of productive livestock (treated as an investment good). Of course, a decline in the number of livestock directly reduces milk production and in the medium-term, inputs to the meat processing industry.[21] Exports also decline in the medium-term, as does the ability of the herd to increase rapidly in absolute size.

These above medium-term effects are generally captured in the CGE model. The short-term dynamics of selling off herds during the initial stages of the drought and other herd management strategies are not captured in a static framework. Another important effect, which is missing as well, is the impact of the decline in household wealth represented by the loss of livestock on consumption, savings, and investment behavior.

In simulation 2, the 40 percent decrease in the stock of capital in the livestock sector is modeled, simulating the historical decline in the livestock herd caused by the drought.

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[21] In the short-term, farmers may slaughter their livestock and sell the meat if food and water are inadequate to keep the herd alive. Many animals, however, die too far from large markets for the owner to be able to sell the meat.

A decrease in the number of livestock by 40 percent decreases production of livestock products by 21.6 percent.[22] Lower livestock production leads to a 37.8 percent decline in the volume of livestock exports, and a slight 12.6 percent increase in the world (Nigerian) export price. Livestock exports account for only 11.5 percent of export receipts in the base SAM, so the change in the value of the total exports is only 3.5 percent. (Uranium exports, which account for 60.0 percent of export revenues in the base SAM, change little.) With only a small change in foreign exchange earnings and with foreign savings fixed at the base level, imports fall by only 1.7 percent. The real exchange rate appreciates by just 2.6 percent.

Cattle owners of course suffer the greatest loss of wealth in this scenario; their real incomes fall as well. High income rural households in the north see their incomes fall by 3.4 percent; incomes of high income cattle-owning labor households in the south fall by 4.1 percent. Households dependent on labor incomes suffer the most as the economy contracts. Real incomes of the rural poor fall by 5.9 to 6.7 percent. The urban poor and semi-urban households, who are almost entirely dependent on wage labor, suffer a decline in real incomes of 5.6 and 8.1 percent, respectively.

All productive sectors of the economy contract in this scenario, except for export crops and mining. Apart from the 21.6 percent decrease in the livestock sector, the largest output declines are in the meat processing

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[22] The decline in the output of the livestock sector depends mainly on the shares of value-added paid to capital and labor in the sector, the elasticity of substitution between capital and labor, and the elasticity of supply of labor. For this simulation, only the elasticity of substitution for the livestock sector is reduced to 0.2. Only if the elasticity of substitution between capital and labor were 0, would a 40 percent decline in livestock capital stock cause a 40 percent decline in sectoral output.

sector (down 13.2 percent). There is little difference between the response of the formal and informal sectors.

**SIMULATION 3: APPRECIATION OF THE FCFA/NAIRA REAL EXCHANGE RATE**

Nigeria's macroeconomic policies greatly influenced economic conditions in Niger in the 1980s. In the early 1980s, Nigeria enjoyed substantial oil export revenues. Higher real incomes in Nigeria increased Nigeria's demand for Niger's exports. Domestic inflation in Nigeria soared as the oil revenues were spent in the domestic economy, and even on the parallel market, its real exchange rate (Naira/FCFA) appreciated.[23] From Niger's standpoint, the real exchange rate (FCFA/Naira) had depreciated, making imports from Nigeria expensive (on the parallel market) and boosting Nigeria's demand for Niger's exports.

Later in the decade, as world oil prices fell and Nigeria undertook its own macroeconomic reforms, real incomes in Nigeria dropped sharply and the real exchange rate (Naira/FCFA) depreciated. Between 1979-1981 and 1987, the real exchange rate (parallel market FCFA/Naira) appreciated from 98.5 to 187.1. As a result, Niger's exporters received about 50 percent less in real terms for their exports of cowpeas and livestock. Imports from Nigeria were 50 percent less expensive in real terms.

Simulation 3 models the effects of an appreciation in the CFA franc/Naira real exchange rate. World (Nigeria's) prices of cowpeas and livestock are reduced by 30 percent. World prices of imports of manufactured

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[23] Official market transactions, conducted with a greatly overvalued Naira, likely accounted for only a small share of trade between Nigeria and Niger.

goods and cereals are reduced by only 7 percent, reflecting the estimated share of Niger's total imports of these commodities coming from Nigeria (about 22 percent).

The 30 percent appreciation in the real exchange rate vis à vis the Nigerian Naira lowers the prices of livestock and cowpeas, so that cowpea production falls by 8.0 percent and exports decline by 12.8 percent. Livestock production decreases by 0.7 percent and livestock exports fall by 16.8 percent. Overall, total export earnings fall 8.7 percent. As lower revenues reduce incomes and domestic spending, the price level falls by 8.2 percent. The overall real exchange rate depreciates, discouraging imports despite the lower prices of goods imported from Nigeria.

Urban households gain relative to rural households in this scenario as the terms of trade worsen for rural households (the prices of export crops and livestock fall relative to prices of imports and urban goods). Only the incomes of the urban I (high income) households rise in real terms. The increase in output of manufacturing and formal construction activities increases demand for skilled labor, raising the real wage by 1.0 percent and Urban I household incomes by 0.2 percent.

## SIMULATION 4: REAL EXCHANGE RATE DEVALUATION

Nominal exchange rate devaluations, undertaken in an attempt to influence the real exchange rate, play a role in most countries' stabilization and structural adjustment efforts. Niger's membership in the UMOA precludes a change in the overall real exchange rate through a nominal devaluation (with appropriate complementary fiscal policies). An implicit 10 percent devaluation through an increase in all import tariffs by 10 percent and a uniform export subsidy of 10 percent would also likely meet with objections from the other UMOA countries. Moreover, given the porous borders with Nigeria and other neighboring countries, practical implementation of the policy would be extremely difficult. Nevertheless, the lack of this option is often mentioned as a constraint on Niger's ability to undertake macroeconomic adjustment without large declines in domestic absorption.

In simulation 4, the real exchange rate is devalued by 10 percent and the level of foreign savings is made endogenous in the model. The real exchange rate devaluation boosts prices of tradeable goods and services relative to nontradeables. Exports increase by 4.8 percent and imports decrease by 10.7 percent so that the trade deficit falls by 91.6 million dollars (56.7 percent). The decline in foreign savings reduces the funds available for domestic investment, which drops by 26.8 percent. With the reduced inflow of foreign capital, real GDP also decreases slightly (2.2 percent). Output of tradeable goods sectors generally increases, while nontradeable sectors experience a decline in output. In particular, construction sharply declines as total investment falls. Although the livestock sector produces tradeable goods, its output declines by 0.9 percent in spite of a 20.8 percent increase in exports and a 2.7 percent increase in final consumption (mostly milk products). The reason is that investment demand for livestock products falls.

Real incomes fall for all household groups by a total of 3.4 percent. The highest income groups in both the rural and urban areas suffer the biggest percentage decline in real incomes. The decline in real incomes for urban I households is explained in large part by the decline in investment and demand for construction services connected with a drop in real wages for skilled labor by 3.9 percent. The decline in investment is also responsible for the lower incomes of rural cattle owners, whose returns from livestock holdings fall as investment demand for livestock falls.

**SIMULATION 5: REDUCED GOVERNMENT CURRENT EXPENDITURES**

Shortfalls in uranium export taxes and other revenues have in recent years forced cutbacks in planned government expenditures. To date, current expenditures have largely been spared from cutbacks. During the 1980s, real current government expenditures (apart from interest payments on debt) actually increased slightly. In the future, reductions in current expenditures may be needed to avoid large cuts in government investment if revenues decline.

In simulation 5, a reduction of 10 percent in real government current expenditures is modeled. The reduction in current expenditures frees up savings in the economy, enabling total investment to increase by 14.0 percent in real terms (a 35.4 percent increase in real private investment). Spending thus shifts away from government salaries (accruing mainly to skilled urban labor) and toward livestock, construction, and manufactured goods.

Real GDP falls slightly, by 0.4 percent. Real incomes of urban high income households fall by 6.4 percent mainly because of lower wage earnings by skilled labor. Rural incomes are affected little, falling by between 0.3 and 0.9 percent. These income distribution results suggest that reducing government current expenditures would have high costs for one of the most politically influential groups in the country, urban skilled workers: one reason why the government of Niger may have chosen to maintain current expenditures at relatively high levels during the 1980s.

# 5. CONCLUSIONS

The simulations in the previous chapter illustrate the complexity of the interactions in the Nigerian economy and indicate the magnitudes of the effects of external shocks and policy reforms during the 1980s. The model simulations are not precise results. The database could be improved in many respects, in particular regarding unrecorded trade, rural incomes, and consumption and savings parameters. Moreover, comparative static simulations cannot fully capture the dynamic aspects of adjustments involving investment and economic growth. Nevertheless, the policy simulations indicate a number of important results and shed insight into how the uranium boom, subsequent macroeconomic policy reforms and external shocks affected household income distribution in Niger.

Results of simulation 1 suggest that the impact of the large decrease in foreign exchange earnings and capital inflow associated with the end of the uranium boom in the early 1980s hurt urban households more than rural households as the investment boom ended and the decline in the construction sector led to reductions in real wages for skilled labor. Rural households suffered as well, mainly because real wages fell for unskilled labor.

Looked at another way, the results of simulation 1 also suggest that the earlier increase in foreign exchange availability in the late 1970s benefited urban households relatively more because of the positive demand-side effects of the investment boom. Whether these households were better or worse off in the mid-1980s than before the investment boom cannot be answered without accounting for changes in the capital stock arising from the surge in investment.

Simulation 2 suggests that in the medium term, the 1984 drought had little effect on the real exchange rate since livestock exports account for only 11.5 percent of total export revenues. Nonetheless, the effects of a decline in livestock output and rural incomes reverberate throughout the economy. The decline in urban household incomes is similar to that of rural households without cattle. It also appears that the effects of the drought on real GDP appear to have been larger than the effects of the decline in foreign savings or changes in the real exchange rate.

The appreciation of the FCFA/Naira real exchange rate in the mid-1980s hurt rural households, whose incomes are greatly influenced by the prices of export goods (livestock and cowpeas) and cereals (simulation 3). Urban households gain relative to rural households, but only urban high income households enjoy an increase in real incomes.

Simulation 4 suggests that a depreciation in the real exchange rate would significantly reduce the trade deficit, reduce real output only slightly, and lower household incomes (because of the effects of lower investment spending). Such a change in the real exchange rate may not be feasible within the rules of the UMOA, however.

Cutting current government expenditures by 10 percent (simulation 5) would free up domestic savings and allow a 14 percent increase in total domestic investment. In the short run, GDP would rise slightly; higher investment levels would spur growth in the medium term as well. This policy change could have high political costs, however. Urban high income households experience a 10 percent drop in real income as government spending on salaries is cut.

Finally, all the simulations point to the central and complex role of livestock in the Nigerian economy: as an investment good, an intermediate input, a source of export earnings, and as a consumer good.

## FURTHER RESEARCH ISSUES

The comparative static simulations presented in this paper provide useful insights into distributional aspects of macroeconomic adjustment and policy reform, but do not address dynamic issues, particularly the effects of investment on future output and the impact of the timing of shocks and reforms. A better understanding of investment is especially important, given the size of the investment boom in the early 1980s, the marked contrast in the composition of public and private investment in Niger, and policy concerns about future investments.

Modeling of the dynamics of the livestock sector also deserves more consideration given its role in private investment, rural income generation and export earnings, and the massive upheavals caused by droughts.

Further modifications to the model might include adding noncompetitive imports as a separate commodity and explicitly modeling price rigidities of the formal sector. Better rural consumption data and behavioral parameters (especially savings rates), may also become available from ongoing analysis of rural household budget survey data. More data on the behavior of labor markets would enable better estimates of labor supply equations and parameters.

Unfortunately, the external shocks experienced by Niger's economy in the 1980s — drought, sharp movements in the terms of trade, and variations in the FCFA/Naira real exchange rate and in Nigeria's export demand — are likely to continue in the 1990s. The range of policy choices will also continue to be constrained by geography, institutional arrangements, and the structure of the economy. There are no quick fixes to restore rapid, sustainable income growth, but whatever policy measures are chosen to adjust to a changing external environment and to spur economic growth, the policy effects on income distribution, and especially the real incomes of the poorest households, should be taken into consideration. This effort at modeling the effects of external shocks and policy measures on households is a basic step in adding distributional considerations to macro- and sectoral policy analysis.

## APPENDIX
## GAMS COMPUTER CODE FOR NIGER CGE MODEL

```
$TITLE NIGER CGE MODEL 02/03/92  NER4.GMS
$OFFSYMLIST OFFSYMXREF
*CES PRODUCTION FUNCTIONS F(K,L1,L2)
* REAL GOVT IVT AND LABOR SUPPLY FUNCTIONS ADDED 1/31/92
* TRANSFERS NETTED OUT
* NER4.GMS HAS NEW NUMBERS FOR LABOR INPUT TO BOUCHERIES
 SET IACT             BRANCHES   /CEREAL       1 MIL SORGHO RIZ ETC.
                                  CULTEX       2 CULTURES D'EXPORTATION
                                  AUTCULT      3 AUTRES CULTURES
                                  ELEV         4 ELEVAGE
                                  SYLV         5 SYLVICULTURE ET PECHE
                                  MINE         6 INDUSTRIE MINIERE
                                  BOUCHER      7 BOUCHERIE
                                  ALIMF       8A IND. ALIMENTAIRE FORMELLE
                                  ALIMI       8B IND. ALIMENT. INFORMELLE
                                  MANIFF      9A IND. MANIFAC. FORMELLE
                                  MANIFI      9B IND. MANIF. INFORMELLE
                                  BTPF       10A BAT. ET T.P. FORMEL
                                  BTPI       10B BAT. ET T.P. INFORMEL
                                  COMF       11A COMMERCE FORMEL
                                  COMI       11B COMMERCE INFORMEL
                                  TRNSPF     12A TRANSPORT FORMEL
                                  TRNSPI     12B TRANSPORT INFORMEL
                                  SERVF      13A SERVICE FORMEL
                                  SERVI      13B SERVICE INFORMEL
                                  SERVPU     14  SERVICE PUBLIC /

     I                PRODUITS           /  CERL-P, CUEX-P, AUTC-P, ELEV-P,
                                            SYLV-P, MIN-P, BOUC-P, ALIM-P,
                                            MANF-P, BAT-P, COM-P, TRAN-P,
                                            SERV-P, ADPU-P /
     IEX(I)           PRODUITS EXPORTABLES
     IM(I)            PRODUITS IMPORTABLES
     INM(I)           PRODUITS NONIMPORTABLES
     INX(I)           PRODUITS NONEXPORTABLES

     LC               TRAVAIL         / QELEV, QBAS /

     KC               CAPITAL         / KFORM, KINF, TERNR, TERNP, TERSR, TERSP /

     INST             INSTITUTIONS    / URB1    URBAINS RICHES
                                        URB2    URBAINS PAUVRES
                                        URB3    SEMI URBAINS
                                        RUNR    MENAGES RURAUX NORD RICHES
                                        RUNP    MENAGES RURAUX NORD PAUVRES
                                        RUSR    MENAGES RURAUX SUD RICHES
                                        RUSP    MENAGES RURAUX SUD PAUVRES
                                        ENTF    ENTREPRISES FORMELLES
                                        INFIN   INST FINANCIERES
                                        ADPUB   ADMINISTRATION PUBLIQUE
                                        RDM     RESTE DU MONDE /

     H(INST)          MENAGES        / URB1, URB2, URB3, RUNR, RUNP, RUSR, RUSP /
```

```
    T              TIME           / 1,2,3,4,5 /
    ALIAS (I,J)
    ALIAS (IACT,JACT)
    ALIAS (INST, INSTJ)
    ALIAS (LC,LC1)
*PARAMETERS

 PARAMETER   DELTA(I)     COEF PROPORTION FONCTION ARMINGTON           (UNITE)
             AC(I)        PARAMETRE DIMEN FONCTION ARMINGTON           (UNITE)
             RHOC(I)      EXPOSANT FONCTION ARMINGTON                  (UNITE)
             RHOT(I)      EXPOSANT FONCTION CET                        (UNITE)
             AT(I)        PARAMETRE DIMEN FONCTION CET                 (UNITE)
             GAMMA(I)     COEF PROPORTION FONCTION CET                 (UNITE)
             ETA(I)       ELASTICITE DE DEMANDE D'EXPORTATION          (UNITE)
             AD(IACT)     PARAMETRE DIMEN FONCTION PRODUCTION          (UNITE)
             CLES0(I,H)   LES CONSTANTES FONCT CONSOM MENAGES HH       (UNITE)
             CLES(I,H)    PARTS BUDGET ALLOUEES CONSOM PAR MENAGE      (UNITE)
             GLES(I)      PART CONSOM I PAR ETAT                       (UNITE)
             DEPR(IACT)   LES TAUX DE DEPRECIATION DU K PAR SECT       (UNITE)
             DSTR(I)      RATIO VAR STOCK SUR PRODUIT BRUT             (UNITE)
             KIO(IACT)    PART DES INVEST PAR SECT DE DESTINATION      (UNITE)
             S0(H)        CONSTANTES FONCTION EPARGNE MENAGES          (UNITE)
             TM0(I)       TARIFS DOUANIERS                             (UNITE)
             TE(I)        TAUX DE TAXES A L'EXPORT                     (UNITE)
             TDIR(H)      TAUX D'IMPOSITION DIRECT DES MENAGES         (UNITE)
             MPS(H)       PROPENSION MARGINALE A EPARGNER DES MENAGES  (UNITE)
             TPROD(IACT) LES TAUX DE TAXES INDIRECTES SUR PRODUCTION   (UNITE)
             ALPHL(IACT,LC) PART RELATIVE TRVAIL DANS FONCT PRODUCT    (UNITE)
             MARGD(I)     TAUX DE MARGES COMM SUR VENTES INTERIEURES   (UNITE)
             MARGM(I)     TAUX DE MARGES COMM SUR LES IMPORTATIONS     (UNITE)
             MARGX(I)     TAUX DE MARGES COMM SUR LES EXPORTATIONS     (UNITE)
             DSALRATE(I) TAUX DE TAXES SUR VENTES DE PROD INTERIEURS   (UNITE)
             ISALRATE(I) TAUX DE TAXES SUR VENTES DES PROD IMPORTES    (UNITE)
             FLAGCOM(I)  VARIABLE MUETTE SIGNALANT LE COMMERCE         (UNITE)
             GIO(I)       LES PARTS D'INVEST PUB PAR PRODUITS          (UNITE)
             SIGMAQ(IACT) ELASTICITE SUBSTITUTION CAPITAL TRAVAIL      (UNITE)
             RHOQ(IACT)    EXPOSANT FONCTION PRODUCTION CES            (UNITE)
             BLE(LC)       ELASTICITE OFFRE  TRAVAIL                   (UNITE)
             CESFLAG(IACT) VARIABLE MUETTE SIGNALANT BRANCHES CES      (UNITE)

*VARIABLES MUETTES POUR STOCKER DONNEES DE BASE

             OUTSUM(IACT) PRODUCTION  TOTALE PAR SECTEUR     ('87 MDS Fcfa)
             M0(I)        VOLUME DES IMPORTS                 ('87 MDS Fcfa)
             E0(I)        VOLUME DES EXPORTS                 ('87 MDS Fcfa)
             XPT0(I)      OFFRE DOMESTIQUE EN VOL DES 14 PROD ('87 MDS Fcfa)
             XPTACT0(IACT) OFFRE SECTORIELLE EN VOLUME       ('87 MDS Fcfa)
             K0(IACT)     QTITE STOCKS DE K PAR SECTEUR      ('87 MDS Fcfa)
             ID0(I)       VOLUME D'INVEST PRIVE EN PROD I    ('87 MDS Fcfa)
             GID0(I)      VOLUME D'INVEST PUB EN PROD I      ('87 MDS Fcfa)
             DST0(I)      VARIATION DE STOCKS K PAR PROD     ('87 MDS Fcfa)
             INT0(I)      VOLUME DE CONSOM INTERMEDIAIRE DE I ('87 MDS Fcfa)
             XPD0(I)      VOLUME VENTE BIEN I SUR MARCHE DOM ('87 MDS Fcfa)
             XT0(I)       QTITE OFFERTE DU BIEN COMPOSITE    ('87 MDS Fcfa)
             PWE0(I)      PRIX MOMDIAL DES EXPORTS DE I             (UNITE)
             PWM0(I)      PRIX MONDIAL DES IMPORTS DE I             (UNITE)
             PPD0(I)      PRIX DE BIENS DOMESTIQUES                 (UNITE)
             PPTACT0(IACT) PRIX AUX PRODUCTEURS PAR ACTIVITE        (UNITE)
             PPT0(I)      PRIX AUX PRODUCTEURS POUR LES 14 PRODUITS (UNITE)
             PC0(I)       PRIX A LA CONSOMMATION                    (UNITE)
             PE0(I)       PRIX DES EXPORTS DE I SUR MARCHE DOM      (UNITE)
             PM0(I)       PRIX DES IMPORTS DE I SUR MARCHE DOM      (UNITE)
             PK0(IACT)    PRIX DU CAPITAL PAR SECTEUR               (UNITE)
             PVA0(IACT)   PRIX DE LA VALEUR AJOUTEE PAR SECTEUR     (UNITE)
             QD(IACT)     VAR INTERMEDIAIRE POUR CALCULER AD(I)     (UNITE)
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          XLLB(IACT,LC) VAR INTERMEDIAIRE (MATRICE TRAV SS ZEROS)   (UNITE)
          WA0(LC)      TAUX DE SAL MOY PAR CAT DE MO ('87 Mlions Fcfa PR SAL)
          LD(LC)       EMPLOI                                (1000 PERSONNES)
          LS0(LC)      OFFRE DE TRAVAIL PAR CAT DE TRVEURS  (1000 PERSONNES)
          CDHH0(I,H)   CONSOMMATION PAR MENAGES                ('87 MDS Fcfa)
          Y0(H)        REVENU DES MENAGES                          (MDS Fcfa)
          SAVHH0(H)    EPARGNE DES MENAGES                         (MDS Fcfa)
          CD0(I)       CONSOMMATION DU PRODUIT I                   (MDS Fcfa)
          INDWT(I)     PONDERATIONS POUR CALCULER IND PRIX            (UNITE)
          DENOM        DENOMINATEUR DE L'INDICE DE PRIX            (MDS Fcfa)
          PINDEX0      L'INDICE DES PRIX A LA CONSOMMATION EN 1987   (UNITE)
          RETR0(IACT) REVENU DU CAPITAL                            (MDS FCFA)
          KCES(IACT,LC) VARIABLE ARTIF POUR CALCULER ALPHL            (UNITE)
                       ;
*DONNEES DE BASE

 WA0("QELEV")      = 1.82147371   ;
 WA0("QBAS") = 0.13527335  ;


*POUR MODELE DYNAMIQUE,CHANGER SCALAIRES EN VECTEURS OU MATRICES
 SCALAR
ER0     TAUX DE CHANGE REEL    ('000 FMG PER DOLLAR)   / 0.300 /
GR0     RECETTE DE L'ETAT      ('87 MDS Fcfa)        / 90.125 /
GDTOT0  CONSOM PUBLIQUE        ('87 MDS Fcfa)        / 109.006 /
CDTOT0  CONSOM PRIVEE          ('87 MDS Fcfa)        / 518.149 /
FSAV0   EPARGNE EXTERIEURE     ('87 Mlions DOLLARS)     / 162.870 /
DKTOT0  INVEST PRIVE TOTAL     ('87 MDS Fcfa)         /35.784 /
GOVIVT0 INVEST PUBLIC          ('87 MDS Fcfa)         /54.979/
DIRTX0  TAXE DIRECTE PAR MENAG ('87 MDS Fcfa)        /10.645/
YGDP0   PIB                    ('87 MDS Fcfa)        / 681.513 / ;

BLE("QELEV") = 0.1 ;
BLE("QBAS") = 0.5 ;
```

TABLE IO(I,JACT) COEFFICIENTS TECHNIQUES ENTREES-SORTIES (UNITY)

| | CEREAL | CULTEX | AUTCULT | ELEV | SYLV | MINE | BOUCHER |
|---|---|---|---|---|---|---|---|
| CERL-P | 0.03635877 | 0 | 0 | 0.00003539 | 0 | 0 | 0 |
| CUEX-P | 0 | 0.17278872 | 0 | 0 | 0 | 0 | 0 |
| AUTC-P | 0 | 0 | 0.00631642 | 0 | 0 | 0.0307586 | 0 |
| ELEV-P | 0.02066768 | 0.02065404 | 0.02067352 | 0 | 0 | 0 | 0.8209326 |
| SYLV-P | 0 | 0 | 0 | 0 | 0.02052686 | 0 | 0 |
| MIN-P | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BOUC-P | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ALIM-P | 0 | 0 | 0 | 0.00318498 | 0 | 0 | 0 |
| MANF-P | 0.03772627 | 0.03773981 | 0.03772257 | 0.00804501 | 0.02501711 | 0.30747637 | 0.00068601 |
| BAT-P | 0 | 0 | 0 | 0.00012976 | 0 | 0.00611882 | 0 |
| COM-P | 0 | 0 | 0 | 0 | 0 | 0.00001097 | 0 |
| TRAN-P | 0 | 0 | 0 | 0.00005898 | 0 | 0.13685111 | 0.00209511 |
| SERV-P | 0 | 0 | 0 | 0.00424664 | 0 | 0.03686646 | 0.00038936 |
| ADPU-P | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| + | ALIMF | ALIMI | MANIFF | MANIFI | BTPF | BTPI |
|---|---|---|---|---|---|---|
| CERL-P | 0.25702889 | 0.00202605 | 0 | 0.00014455 | 0 | 0 |
| CUEX-P | 0 | 0 | 0 | 0 | 0 | 0 |
| AUTC-P | 0.00593443 | 0 | 0.01119902 | 0.00570954 | 0.00040211 | 0 |
| ELEV-P | 0.13347602 | 0.0366136 | 0 | 0 | 0 | 0 |
| SYLV-P | 0 | 0.00115774 | 0.00230309 | 0.01062407 | 0.01546792 | 0.46746169 |
| MIN-P | 0 | 0 | 0 | 0.00625158 | 0.07374742 | 0 |
| BOUC-P | 0 | 0.2211288 | 0 | 0.00018068 | 0 | 0 |
| ALIM-P | 0.05720401 | 0.08176556 | 0.00908931 | 0.01832111 | 0.00308286 | 0 |
| MANF-P | 0.17706003 | 0.12575977 | 0.55093179 | 0.24869006 | 0.34865828 | 0.08844161 |
| BAT-P | 0.00262671 | 0 | 0.00537975 | 0 | 0.01066938 | 0 |
| COM-P | 0 | 0 | 0 | 0 | 0.01914055 | 0 |
| TRAN-P | 0.000681 | 0.00448625 | 0.01162096 | 0.00484227 | 0.02924698 | 0.00393913 |
| SERV-P | 0.018387 | 0.02416787 | 0.01809072 | 0.01318975 | 0.1072836 | 0.11148284 |
| ADPU-P | 0 | 0 | 0 | 0 | 0.00136718 | 0 |

| + | COMF | COMI | TRNSPF | TRNSPI | SERVF | SERVI | SERVPU |
|---|---|---|---|---|---|---|---|
| CERL-P | 0 | 0.02780604 | 0 | 0 | 0 | 0 | 0 |
| CUEX-P | 0.02302832 | 0.00323067 | 0 | 0 | 0 | 0 | 0 |
| AUTC-P | 0 | 0.03356926 | 0 | 0 | 0 | 0 | 0 |
| ELEV-P | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SYLV-P | 0 | 0.00481258 | 0 | 0 | 0 | 0.00505436 | 0.00319877 |
| MIN-P | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BOUC-P | 0.0199814 | 0.03038315 | 0 | 0 | 0 | 0.00001657 | 0 |
| ALIM-P | 0.00824273 | 0.04363261 | 0.00438264 | 0 | 0 | 0 | 0.00009408 |
| MANF-P | 0.05667276 | 0.00431499 | 0.20813578 | 0.34095166 | 0.19636824 | 0.17121835 | 0.17993998 |
| BAT-P | 0.00612592 | 0 | 0.00107574 | 0 | 0.01381515 | 0 | 0.00699024 |
| COM-P | 0.00695981 | 0 | 0.00199211 | 0 | 0.00018098 | 0 | 0.01592797 |
| TRAN-P | 0.04624908 | 0.06029098 | 0.07562054 | 0.02571184 | 0.05477799 | 0.00530293 | 0.08197307 |
| SERV-P | 0.22322717 | 0.01322718 | 0.05546038 | 0.06904104 | 0.08657095 | 0.0199357 | 0.01600324 |
| ADPU-P | 0.00250168 | 0 | 0.00023905 | 0 | 0.00006033 | 0 | 0.00002822 |

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TABLE IMAT(I,JACT) MATRICE DE LA COMPOSITION DU CAPITAL (UNITE)

| | CEREAL | CULTEX | AUTCULT | ELEV | SYLV | MINE | BOUCHER |
|---|---|---|---|---|---|---|---|
| ELEV-P | 0 | 0 | 0 | 0.691603 | 0 | 0 | 0 |
| MIN-P | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| MANF-P | 0 | 0 | 0 | 0 | 0 | 0 | 0.733333 |
| BAT-P | 0 | 0 | 0 | 0.308396 | 0 | 0 | 0.266666 |

| + | ALIMF | ALIMI | MANIFF | MANIFI | BTPF | BTPI |
|---|---|---|---|---|---|---|
| ELEV-P | 0 | 0 | 0 | 0 | 0 | 0 |
| MIN-P | 0 | 0 | 0.148019 | 0 | 0 | 0 |
| MANF-P | 0.749347 | 0.571428 | 0.637400 | 0.579411 | 0.747965 | 0.571428 |
| BAT-P | 0.250652 | 0.428571 | 0.214580 | 0.420588 | 0.252034 | 0.428571 |

| + | COMF | COMI | TRNSPF | TRNSPI | SERVF | SERVI | SERVPU |
|---|---|---|---|---|---|---|---|
| ELEV-P | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MIN-P | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MANF-P | 0.748148 | 0 | 0.748055 | 0.580985 | 0.748858 | 0.578947 | 0 |
| BAT-P | 0.251851 | 0 | 0.251944 | 0.419014 | 0.251141 | 0.421052 | 0 |

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TABLE KTYPE(KC,IACT) STOCK DU CAPITAL PAR ACTIVITE (1987 MDS FCFA)

| | CEREAL | CULTEX | AUTCULT | ELEV | SYLV | MINE | BOUCHER |
|---|---|---|---|---|---|---|---|
| KFORM | 0 | 0 | 0 | 0 | 0 | 227.985 | 0 |
| KINF | 0 | 0 | 0 | 0 | 0 | 0 | 64.722 |
| TERNR | 8.729 | 2.963 | 3.412 | 117.035 | 3.413 | 0 | 0 |
| TERNP | 26.175 | 8.873 | 10.228 | 18.517 | 10.252 | 0 | 0 |
| TERSR | 27.115 | 9.048 | 29.464 | 78.246 | 7.771 | 0 | 0 |
| TERSP | 23.099 | 7.701 | 25.099 | 6.612 | 6.625 | 0 | 0 |

| + | ALIMF | ALIMI | MANIFF | MANIFI | BTPF | BTPI |
|---|---|---|---|---|---|---|
| KFORM | 20.558 | 0 | 142.2 | 0 | 93.258 | 0 |
| KINF | 0 | 10.365 | 0 | 69.183 | 0 | 46.33 |

| + | COMF | COMI | TRNSPF | TRNSPI | SERVF | SERVI | SERVPU |
|---|---|---|---|---|---|---|---|
| KFORM | 49.886 | 0 | 40.158 | 0 | 26.522 | 0 | 170.066 |
| KINF | 0 | 215.435 | 0 | 50.405 | 0 | 96.55 | 0 |

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TABLE SHRKC(KC,IACT) LA PART DU CAPITAL PAR ACTIVITE (UNITE)

| | CEREAL | CULTEX | AUTCULT | ELEV | SYLV | MINE | BOUCHER |
|---|---|---|---|---|---|---|---|
| KFORM | | | | | | | |
| KINF | | | | | | | |
| TERNR | | | | | | | |
| TERNP | | | | | | | |
| TERSR | | | | | | | |
| TERSP | | | | | | | |

| + | ALIMF | ALIMI | MANIFF | MANIFI | BTPF | BTPI |
|---|---|---|---|---|---|---|
| KFORM | | | | | | |
| KINF | | | | | | |

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TABLE ZZA(*,IACT) DIVERS PARAMETRES ET DONNEES INITIALES POUR 20 ACTIVITES

| | CEREAL | CULTEX | AUTCULT | ELEV | SYLV | MINE | BOUCHER |
|---|---|---|---|---|---|---|---|
| XPTACTO | 70.932 | 23.821 | 56.836 | 84.773 | 23.384 | 91.194 | 53.935 |
| DEPR | | | | | | | |
| TPROD | 0.829 | 0.278 | 0.664 | 0.994 | 0.039 | 4.774 | 0.146 |
| KIO | 0 | 0 | 0 | 16.375 | 0 | 5.688 | 0.015 |
| SIGMAQ | .112 | 0.112 | 0.177 | 0.999 | 0.112 | 0.137835 | 0.500 |
| RETR | 6.338 | 1.804 | 7.875 | 24.735 | 2.228 | 22.682 | 4.598 |
| CESFLAG | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| + | ALIMF | ALIMI | MANIFF | MANIFI | BTPF | BTPI |
|---|---|---|---|---|---|---|
| XPTACTO | 10.279 | 6.91 | 56.88 | 27.673 | 37.303 | 18.532 |
| DEPR | | | | | | |
| TPROD | 1.255 | 0.086 | 0.88 | 0.513 | 0.343 | 0.118 |
| KIO | 0.383 | 0.021 | 3.155 | 0.34 | 4.67 | 0.007 |
| SIGMAQ | 0.824402 | 0.303416 | 1.288161 | 0.309981 | 0.506559 | 0.701828 |
| RETR | 1.443 | 1.279 | 15.410 | 7.128 | 7.164 | 3.488 |
| CESFLAG | 1 | 1 | 1 | 1 | 1 | 1 |

| + | COMF | COMI | TRNSPF | TRNSPI | SERVF | SERVI | SERVPU |
|---|---|---|---|---|---|---|---|
| XPTACTO | 31.179 | 134.647 | 25.099 | 31.503 | 16.576 | 60.344 | 106.291 |
| DEPR | | | | | | | |
| TPROD | 4.982 | 5.996 | 0.717 | 2.758 | 1.333 | 1.961 | -0.022 |
| KIO | 2.565 | 0 | 1.929 | 0.284 | 0.219 | 0.133 | 0 |
| SIGMAQ | 0.856898 | 1.031565 | 0.610761 | 0.640204 | 0.429239 | 0.595787 | 0.243019 |
| RETR | 8.807 | 66.599 | 8.618 | 8.432 | 4.346 | 25.128 | 24.176 |
| CESFLAG | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

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TABLE WDIST(IACT,LC)
               QELEV        QBAS
CEREAL             0 0.92805015
CULTEX             0 0.92805015
AUTCULT            0 0.92805015
ELEV               0 0.92805015
SYLV               0 0.92805015
MINE      1.37855406 5.88438127
BOUCHER            0 0.92805015
ALIMF     1.37855406 5.88438127
ALIMI              0 0.92805015
MANIFF    1.37855406 5.88438127
MANIFI             0 0.92805015
BTPF      1.37855406 5.88438127
BTPI               0 0.92805015
COMF      1.37855406 5.88438127
COMI               0 0.92805015
TRNSPF    1.37855406 5.88438127
TRNSPI             0 0.92805015
SERVF     1.37855406 5.88438127
SERVI              0 0.92805015
SERVPU    0.74604419 3.57794037
  ;

TABLE XLE(IACT,LC) EMPLOI PAR BRANCHE ET PAR CATEGORIE DE M.O. ('000 PERSONNES)
               QELEV        QBAS
CEREAL             0      454387
CULTEX             0      129297
AUTCULT            0      355415
ELEV               0      459716
SYLV               0      159725
MINE            5274        4082
BOUCHER            0       37781
ALIMF            280         216
ALIMI              0       16807
MANIFF          1910        1477
MANIFI             0       91684
BTPF            2263        1751
BTPI               0       19794
COMF            1643        1271
COMI               0      256961
TRNSPF          2257        1746
TRNSPI             0       52469
SERVF           1620        1254
SERVI              0      168026
SERVPU         22725       39104
  ;
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TABLE OUTMAT(IACT,J) MATRICE DE PRODUCTION EFFECTIVE (MDS 1987 FCFA)

| | CERL-P | CUEX-P | AUTC-P | ELEV-P | SYLV-P | MIN-P | BOUC-P | ALIM-P |
|---|---|---|---|---|---|---|---|---|
| CEREAL | 70.932 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CULTEX | 0 | 23.821 | 0 | 0 | 0 | 0 | 0 | 0 |
| AUTCULT | 0 | 0 | 56.836 | 0 | 0 | 0 | 0 | 0 |
| ELEV | 0 | 0 | 0 | 84.773 | 0 | 0 | 0 | 0 |
| SYLV | 0 | 0 | 0 | 0 | 23.384 | 0 | 0 | 0 |
| MINE | 0 | 0 | 0 | 0 | 0 | 91.194 | 0 | 0 |
| BOUCHER | 0 | 0 | 0 | 0 | 0 | 0 | 53.935 | 0 |
| ALIMF | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.279 |
| ALIMI | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.91 |
| MANIFF | | | | | | | | |
| MANIFI | | | | | | | | |
| BTPF | | | | | | | | |
| BTPI | | | | | | | | |
| COMF | | | | | | | | |
| COMI | | | | | | | | |
| TRNSPF | | | | | | | | |
| TRNSPI | | | | | | | | |
| SERVF | | | | | | | | |
| SERVI | | | | | | | | |
| SERVPU | | | | | | | | |

| + | MANF-P | BAT-P | COM-P | TRAN-P | SERV-P | ADPU-P |
|---|---|---|---|---|---|---|
| CEREAL | | | | | | |
| CULTEX | | | | | | |
| AUTCULT | | | | | | |
| ELEV | | | | | | |
| SYLV | | | | | | |
| MINE | | | | | | |
| BOUCHER | | | | | | |
| ALIMF | | | | | | |
| ALIMI | | | | | | |
| MANIFF | 56.88 | 0 | 0 | 0 | 0 | 0 |
| MANIFI | 27.673 | 0 | 0 | 0 | 0 | 0 |
| BTPF | 0 | 37.303 | 0 | 0 | 0 | 0 |
| BTPI | 0 | 18.532 | 0 | 0 | 0 | 0 |
| COMF | 0 | 0 | 31.179 | 0 | 0 | 0 |
| COMI | 0 | 0 | 134.647 | 0 | 0 | 0 |
| TRNSPF | 0 | 0 | 0 | 25.099 | 0 | 0 |
| TRNSPI | 0 | 0 | 0 | 31.503 | 0 | 0 |
| SERVF | 0 | 0 | 0 | 0 | 16.576 | 0 |
| SERVI | 0 | 0 | 0 | 0 | 60.344 | 0 |
| SERVPU | 0 | 0 | 0 | 0 | 0 | 106.291 |

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TABLE ZZ(*,I) DIVERS PARAMETRES ET DONNEES INITIALES

| | CERL-P | CUEX-P | AUTC-P | ELEV-P | SYLV-P | MIN-P | BOUC-P | ALIM-P |
|---|---|---|---|---|---|---|---|---|
| MO | 11.313 | 0.066 | 6.249 | 1.457 | 0.383 | 5.124 | 0.111 | 18.682 |
| EO | 1.809 | 17.804 | 3.715 | 16.667 | 0.103 | 86.991 | 0.124 | 1.692 |
| SIGC | 2 | 2 | 0.9 | 2 | 0.9 | 2 | 0.9 | 0.9 |
| SIGT | 2 | 2 | 0.9 | 2 | 0.9 | 2 | 0.9 | 0.9 |
| ETA | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| PPDO | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| TMO | 0.295 | 0.146 | 0.187 | 0.043 | 0.028 | 1.045 | 0.011 | 1.337 |
| GLES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DST | -3 | 0.478 | 0.843 | 3.703 | 1.903 | 0.8 | 0 | -0.005 |
| ID | 0 | 0 | 0 | 11.325 | 0 | 6.155 | 0 | 0 |
| GID | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TE | 0 | 0.221 | 0 | 0 | 0 | 1.466 | 0 | 0 |
| MARGD | 8.12 | 5.841 | 21.072 | 37.329 | 3.515 | 0.013 | 5.211 | 4.353 |
| MARGM | 3.082 | 0.032 | 1.211 | 0.584 | -0.081 | 1.027 | 0.027 | 4.643 |
| MARGX | | | | | | | | |
| DSALETX | 0.436 | 0 | 0.487 | 0.931 | 0.011 | 0 | 0.579 | 0.536 |
| MSALETX | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| FLAGCOM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GIO | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| + | MANF-P | BAT-P | COM-P | TRAN-P | SERV-P | ADPU-P |
|---|---|---|---|---|---|---|
| MO | 139.815 | 0 | 0 | 4.848 | 5.752 | 0 |
| EO | 16.034 | 0 | 0 | 0 | 0 | 0 |
| SIGC | 0.7 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| SIGT | 0.7 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| ETA | 4 | 4 | 4 | 4 | 4 | 4 |
| PPDO | 1 | 1 | 1 | 1 | 1 | 1 |
| TMO | 1.322 | 0 | 0 | 0 | 0 | 0 |
| GLES | 0 | 0 | 0 | 0 | 0.0366952 | 0.9633047 |
| DST | 7.734 | 0 | 0 | 0 | 0 | 0 |
| ID | 9.783 | 8.521 | 0 | 0 | 0 | 0 |
| GID | 11.978 | 43.001 | 0 | 0 | 0 | 0 |
| TE | 0 | 0 | 0 | 0 | 0 | 0 |
| MARGD | 12.941 | 0 | 0 | 0 | 0 | 0 |
| MARGM | 29.28 | 0 | 0 | 0 | 0 | 0 |
| MARGX | | | | | | |
| DSALETX | 17.579 | 0 | 0 | 0 | 0 | 0 |
| MSALETX | 0 | 0 | 0 | 0 | 0 | 0 |
| FLAGCOM | 0 | 0 | 1 | 0 | 0 | 0 |
| GIO | 11.978 | 43.001 | 0 | 0 | 0 | 0 |

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TABLE TRANSFER(INST,INSTJ) MATRICE DES TRANSFERTS (Mlions 1987 FCFA)

| | URB1 | URB2 | URB3 | RUNR | RUNP | RUSR | RUSP | ENTF | INFIN | ADPUB | RDM |
|---|---|---|---|---|---|---|---|---|---|---|---|
| URB1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2.339 | 0.713 | 0 | 1.481 |
| URB2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 22.844 | 0 |
| URB3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RUNR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RUNP | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RUSR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RUSP | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ENTF | 1.743 | 0 | 0 | 0 | 0 | 0 | 0 | 0.183 | 9.319 | 0 | 0 |
| INFIN | 2.293 | 0 | 0 | 0 | 0 | 0 | 0 | 13.343 | 0.048 | 5.702 | 0 |
| ADPUB | 8.262 | 0 | 0 | 0 | 0 | 0 | 0 | 12.376 | 2.521 | 5.187 | 34.655 |
| RDM | 16.396 | 0 | 0 | 0 | 0 | 0 | 0 | 5.431 | 3.31 | 19.618 | 0 |

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TABLE CLES(I,H) PROPENSIONS MARGINALES (OU MOYENNES) A CONSOMMER (UNITE)

| | URB1 | URB2 | URB3 | RUNR | RUNP | RUSR | RUSP |
|---|---|---|---|---|---|---|---|
| CERL-P | 0.110696 | 0.162216 | 0.177432 | 0.104080 | 0.245665 | 0.150280 | 0.195839 |
| CUEX-P | 0.006623 | 0.009764 | 0.014316 | 0.008401 | 0.019819 | 0.012128 | 0.015797 |
| AUTC-P | 0.075870 | 0.111717 | 0.157680 | 0.040093 | 0.094815 | 0.220243 | 0.286937 |
| ELEV-P | 0.005634 | 0.008296 | 0.114486 | 0.295856 | 0.036818 | 0.125529 | 0.016231 |
| SYLV-P | 0.025265 | 0.037216 | 0.024848 | 0.025544 | 0.027922 | 0.022773 | 0.022467 |
| MIN-P | 0.026958 | 0.016620 | 0 | 0 | 0 | 0 | 0 |
| BOUC-P | 0.106875 | 0.061357 | 0.110604 | 0.113792 | 0.124398 | 0.101449 | 0.100082 |
| ALIM-P | 0.051339 | 0.070290 | 0.073137 | 0.075258 | 0.082278 | 0.067098 | 0.066186 |
| MANF-P | 0.406236 | 0.345193 | 0.122057 | 0.125588 | 0.137294 | 0.111964 | 0.110455 |
| BAT-P | 0.006084 | 0.006468 | 0.002523 | 0.002582 | 0.002811 | 0.002295 | 0.002271 |
| COM-P | 0.030405 | 0.044819 | 0.051880 | 0.053396 | 0.058383 | 0.047618 | 0.046974 |
| TRAN-P | 0.020350 | 0.029861 | 0.055714 | 0.057341 | 0.062675 | 0.051116 | 0.050431 |
| SERV-P | 0.123374 | 0.088324 | 0.094540 | 0.097290 | 0.106343 | 0.086727 | 0.085557 |
| ADPU-P | 0.004285 | 0.007853 | 0.000776 | 0.000773 | 0.000773 | 0.000774 | 0.000766 |

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TABLE ZZH(*,H) DIVERS PARAMETRES CONCERNANT LES MENAGES

| | URB1 | URB2 | URB3 | RUNR | RUNP | RUSR | RUSP |
|---|---|---|---|---|---|---|---|
| SAVHHO | 12.590 | -22.844 | 0 | 7.979 | 1.261 | 5.333 | 0.450 |
| MPSH | 0.1 | 0.03 | 0.03 | 0.1 | 0.03 | 0.1 | 0.03 |
| TDIR | 10.645 | 0 | 0 | 0 | 0 | 0 | 0 |
| Y0 | 89.967 | 49.356 | 20.605 | 84.276 | 107.267 | 112.519 | 69.573 |

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TABLE CDHHO(I,H) CONSOMMATION FINALE DES MENAGES (MDS 1987 FCFA)

| | URB1 | URB2 | URB3 | RUNR | RUNP | RUSR | RUSP |
|---|---|---|---|---|---|---|---|
| CERL-P | 7.387 | 11.712 | 3.656 | 7.941 | 26.042 | 16.108 | 13.537 |
| CUEX-P | 0.442 | 0.705 | 0.295 | 0.641 | 2.101 | 1.3 | 1.092 |
| AUTC-P | 5.063 | 8.066 | 3.249 | 3.059 | 10.051 | 23.607 | 19.834 |
| ELEV-P | 0.376 | 0.599 | 2.359 | 22.573 | 3.903 | 13.455 | 1.122 |
| SYLV-P | 1.686 | 2.687 | 0.512 | 1.949 | 2.96 | 2.441 | 1.553 |
| MIN-P | 1.799 | 1.2 | 0 | 0 | 0 | 0 | 0 |
| BOUC-P | 7.132 | 4.43 | 2.279 | 8.682 | 13.187 | 10.874 | 6.918 |
| ALIM-P | 3.426 | 5.075 | 1.507 | 5.742 | 8.722 | 7.192 | 4.575 |
| MANF-P | 27.109 | 24.923 | 2.515 | 9.582 | 14.554 | 12.001 | 7.635 |
| BAT-P | 0.406 | 0.467 | 0.052 | 0.197 | 0.298 | 0.246 | 0.157 |
| COM-P | 2.029 | 3.236 | 1.069 | 4.074 | 6.189 | 5.104 | 3.247 |
| TRAN-P | 1.358 | 2.156 | 1.148 | 4.375 | 6.644 | 5.479 | 3.486 |
| SERV-P | 8.233 | 6.377 | 1.948 | 7.423 | 11.273 | 9.296 | 5.914 |
| ADPU-P | 0.286 | 0.567 | 0.016 | 0.059 | 0.082 | 0.083 | 0.053 |

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TABLE SHRKCHH(KC,INST) REPARTITION DU CAPITAL ENTRE LES MENAGES (UNITE)

| | URB1 | URB2 | URB3 | RUNR | RUNP | RUSR | RUSP |
|---|---|---|---|---|---|---|---|
| KFORM | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| KINF | 0.134554 | 0.203519 | 0.038576 | 0.331001 | 0.052360 | 0.221290 | 0.018696 |
| TERNR | 0 | 0.022752 | 0.017286 | 0.959961 | 0 | 0 | 0 |
| TERNP | 0 | 0.022789 | 0.017319 | 0 | 0.959890 | 0 | 0 |
| TERSR | 0 | 0.022742 | 0.017283 | 0 | 0 | 0.959974 | 0 |
| TERSP | 0 | 0.022755 | 0.017263 | 0 | 0 | 0 | 0.959981 |

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TABLE SHRLCHH(LC,H) REPARTITION DES SALAIRES ENTRE LES MENAGES (UNITE)

| | URB1 | URB2 | URB3 | RUNR | RUNP | RUSR | RUSP |
|---|---|---|---|---|---|---|---|
| QELEV | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| QBAS | 0.016753 | 0.080839 | 0.050405 | 0.103732 | 0.311192 | 0.236020 | 0.201055 |

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*CALCUL DES PARAMETRES ET COEFFICIENTS POUR CALIBRAGE

 XPTACTO(IACT)  = ZZA("XPTACTO",IACT);
 OUTSUM(IACT) = SUM(J,OUTMAT(IACT,J)) ;
 OUTMAT(IACT,J) = OUTMAT(IACT,J)/OUTSUM(IACT) ;
 XPTO(J)     = SUM(IACT, OUTMAT(IACT,J)*XPTACTO(IACT) ) ;
 RHOC(I)     = (1/ZZ("SIGC",I)) - 1 ;
 RHOT(I)     = (1/ZZ("SIGT",I)) + 1;
 ETA(I)      = ZZ("ETA",I);
 MARGD(I)    = ZZ("MARGD",I)/XPTO(I) ;
 MARGX(I)    = MARGD(I) ;
 MO(I)       = ZZ("MO",I)+ZZ("TMO",I) ;
 EO(I)       = ZZ("EO",I) ;
 IEX(I)      = YES$EO(I);
 IM(I)       = YES$MO(I);
 INM(I)      = NOT IM(I);
 INX(I)      = NOT IEX(I);
 MARGM(IM)   = ZZ("MARGM",IM)/MO(IM) ;
 TMO(IM)     = ZZ("TMO",IM)/ZZ("MO",IM);
 TE(IEX)     = ZZ("TE",IEX)/(ZZ("EO",IEX)-ZZ("TE",IEX));
 EO(I)       = ZZ("EO",I)/( (1+MARGX(I))*(1+TE(I)) );
 XPDO(I)     = XPTO(I) - EO(I) ;
 DSALRATE(I) = ZZ("DSALETX",I)/XPDO(I) ;
 ISALRATE(I) = (ZZ("MSALETX",I)/MO(I))$MO(I) ;
 XTO(I) = (1+MARGD(I)+DSALRATE(I))*XPDO(I) + (1+MARGM(I)+ISALRATE(I))*MO(I);

 TRANSFER(INST,INSTJ) = 0;
 SAVHHO(H)   = ZZH("SAVHHO",H);
 MPS(H)      = ZZH("MPSH",H);
 YO(H)       = ZZH("YO",H);
 TDIR(H)     = ZZH("TDIR",H)/YO(H);
 SO(H)       = SAVHHO(H) - MPS(H)*YO(H) ;
 GLES(I)     = ZZ("GLES",I);
 PPDO(I)     = ZZ("PPDO",I);
 PMO(I)      = PPDO(I) ;
 PEO(I)      = PPDO(I)*(1+MARGX(I)) ;
 PWMO(I)     = PMO(I)/((1+TMO(I))*ERO) ;
 PWEO(I)     = PEO(I)*(1+TE(I))/ERO ;
 PPTACTO(IACT)  = 1.0 ;
 PPTO(I)     = PPDO(I) ;
 PCO(I) = PPDO(I) ;
 DSTO(I) = ZZ("DST",I);
 DSTR(I) = DSTO(I)/XPTO(I);
 IDO(I)  = ZZ("ID",I);
 GIDO(I) = ZZ("GID",I);
 FLAGCOM(I) = ZZ("FLAGCOM",I) ;
 GIO(I) = ZZ("GIO",I)/GOVIVTO ;

 XLE(IACT,LC) =XLE(IACT,LC)*.001 ;
 XLLB(IACT,LC) = XLE(IACT,LC) + (1 - SIGN(XLE(IACT,LC)));

 DEPR(IACT)     = ZZA("DEPR",IACT);
 TPROD(IACT)  = ZZA("TPROD",IACT)/XPTACTO(IACT);
 KO(IACT)     = SUM(KC, KTYPE(KC,IACT));
 PKO(IACT) = PPTACTO(IACT);
 PVAO(IACT) = PPTACTO(IACT) - SUM(J, IO(J,IACT)*PCO(J) ) - TPROD(IACT);
 LSO(LC) = SUM(IACT, XLE(IACT,LC) );
 CDO(I)=SUM(H,CDHHO(I,H)) ;
 DENOM= SUM(I,PCO(I)*CDO(I)) ;
 INDWT(I)=CDO(I)/DENOM ;
 SHRKC(KC,IACT) = KTYPE(KC,IACT)/KO(IACT) ;

 DKTOTO  = SUM(I, IDO(I)) ;
 KIO(IACT)      = ZZA("KIO",IACT)/DKTOTO ;
*## PARAMETRES ASSOCIES A LA FONCT DE PROD CES
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 SIGMAQ(IACT) = ZZA("SIGMAQ",IACT);
 RHOQ(IACT) = (1/ZZA("SIGMAQ",IACT)) - 1;
 RETRO(IACT) = ZZA("RETR",IACT)/KO(IACT) ;
 CESFLAG(IACT) = ZZA("CESFLAG",IACT);

 DISPLAY RHOQ,RETRO ;
*CALIBRAGE DE TOUS LES PARAMETRES DE DIMENSION ET DE PROPORTION

* DELTA PROVENANT DE L'EQ COSTMIN, XTO DE L'ABSORPTION , AC DE ARMINGTON

 DELTA(IM)$MO(IM) = (PMO(IM)*(1+MARGM(IM)+ISALRATE(IM))/(PPDO(IM)*(1+MARGD(IM)+DSALRATE(IM)) ))
     *(MO(IM)/XPDO(IM))**(1+RHOC(IM)) ;
 DELTA(IM) = DELTA(IM)/(1+DELTA(IM)) ;
 AC(IM)    = XTO(IM)/(DELTA(IM)*MO(IM)**(-RHOC(IM))
     + (1-DELTA(IM))*XPDO(IM)**(-RHOC(IM)))**(-1/RHOC(IM)) ;

* INTO PROVENANT DE INTEQ, GAMMA DE ESUPPLY, ALPHL DE PROFITMAX

 INTO(J)   = SUM(IACT, IO(J,IACT)*XPTACTO(IACT) );
 GAMMA(IEX) = 1/(1 + PPDO(IEX)/(PEO(IEX)/(1+MARGX(IEX)) )
     *(EO(IEX)/XPDO(IEX))**(RHOT(IEX) - 1) ) ;
* ALPHL(LC,IACT)$(PVAO(IACT) NE 0)
*            =  (WDIST(IACT,LC) * WAO(LC) * XLE(IACT,LC)) /(PVAO(IACT)*XPTACTO(IACT));

* AD PROVENANT DE OUTPUT, LD DE PROFITMAX, AT DE CET
*######## FUNCTION DE PRODUCTION CES ##############
 KCES(IACT,LC)$((RETRO(IACT) NE 0) AND (KO(IACT) NE 0) AND(CESFLAG(IACT) EQ 1)) =
  (WDIST(IACT,LC)*WAO(LC)/RETRO(IACT))*(XLE(IACT,LC)/KO(IACT))**(1+RHOQ(IACT));
 ALPHL(IACT,LC) = KCES(IACT,LC)/(1 + SUM(LC1,KCES(IACT,LC1)));
 ALPHL(IACT,LC)$((PVAO(IACT) NE 0) AND (CESFLAG(IACT) EQ 0))
           =  (WDIST(IACT,LC) * WAO(LC) * XLE(IACT,LC)) /(PVAO(IACT)*XPTACTO(IACT));
 QD(IACT)$(CESFLAG(IACT) EQ 1) = (SUM(LC,( ALPHL(IACT,LC)*XLE(IACT,LC)**(-RHOQ(IACT))$(XLE(IACT,LC) GT 0)))
           +(1-SUM(LC1,ALPHL(IACT,LC1)))*KO(IACT)**(-RHOQ(IACT)))**(-1/RHOQ(IACT));
 QD(IACT)$(CESFLAG(IACT) EQ 0) = PROD(LC,XLLB(IACT,LC)**ALPHL(IACT,LC))
            *(KO(IACT)**(1-SUM(LC,ALPHL(IACT,LC))) );
 AD(IACT)$(QD(IACT) NE 0) = XPTACTO(IACT)/QD(IACT);

PARAMETER ALPHTEST(IACT,LC);

  ALPHTEST(IACT,LC)$ALPHL(IACT,LC) = (ALPHL(IACT,LC)/(1 - SUM(LC1,ALPHL(IACT,LC1))))**(-SIGMAQ(IACT));

DISPLAY ALPHL,ALPHTEST,KCES,AD;
*########## FIN CALIBRAGE FONCT PROD CES ############
* QD(IACT)  = (XLLB(IACT,"QELEV")**ALPHL("QELEV",IACT))
* *(XLLB(IACT,"QBAS")**ALPHL("QBAS",IACT))*(KO(IACT)**(1 - SUM(LC, ALPHL(LC,IACT))) ) ;
* AD(IACT)$(QD(IACT) NE 0)  = XPTACTO(IACT)/QD(IACT);
* LD(LC) = SUM(IACT,
*(XPTACTO(IACT)*PVAO(IACT)*ALPHL(LC,IACT)/(WDIST(IACT,LC)*WAO(LC)))$WDIST(IACT,LC));
 AT(IEX) = XPTO(IEX)/( GAMMA(IEX)*EO(IEX)**RHOT(IEX)
  + ( 1-GAMMA(IEX) )*XPDO(IEX)**RHOT(IEX))**(1/RHOT(IEX)) ;

 CLES(I,H) = (PCO(I)*CDHHO(I,H))/( YO(H)-SO(H) -MPS(H)*YO(H) -TDIR(H)*YO(H)
             - SUM(INST,TRANSFER(INST,H)));
 CLESO(I,H) = PCO(I)*CDHHO(I,H) - CLES(I,H)*( YO(H)-SO(H) -MPS(H)*YO(H) -TDIR(H)*YO(H)
                  - SUM(INST,TRANSFER(INST,H)) ) ;


*DEFINITION DU MODELE - VARIABLES

 VARIABLES

*BLOC DES PRIX
   PPD(I)    PRIX DE VENTE DOM SORTIE USINE                     (UNITE)
   PM(I)     PRIX CAF IMPORT SUR MARCHE DOM                     (UNITE)
   PE(I)     PRIX FOB DES EXPORT SUR MARCHE DOM                 (UNITE)
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| | | |
|---|---|---|
| PPE(I) | PRIX DOM AUX PRODUCTEURS DES PROD D'EXPORT | (UNITE) |
| PK(IACT) | TAUX DE RENTE DU CAPITAL PAR SECTEUR | (UNITE) |
| PPT(I) | PRIX MOYEN SORTIE USINE DU PROD I | (UNITE) |
| PPTACT(IACT) | PRIX MOYEN DE PRODUCTION PAR ACTIVITE | (UNITE) |
| PC(I) | PRIX DES BIENS COMPOSES c.a.d DES VENTES TOTALES | (UNITE) |
| PVA(IACT) | PRIX DE LA VAL AJOUTEE PAR SECTEUR | (UNITE) |
| PINDEX | INDICE GENERAL DES PRIX | (UNITE) |
| PWM(I) | PRIX MONDIAL DES IMPORTATIONS | (UNITE) |
| PWE(I) | PRIX MONDIAL DES EXPORTATIONS | (UNITE) |
| TM(I) | TARIFS DOUANIERS PAR BIEN | (UNITE) |
| ER | TAUX DE CHANGE REEL | ('000Fcfa PER DOLLAR) |
| *BLOC DE PRODUCTION | | |
| XT(I) | OFFRE DES BIENS COMPOSES | ('87 MDS Fcfa) |
| XPT(I) | PRODUCTIONS DOMESTIQUES PAR PRODUIT | ('87 MDS Fcfa) |
| XPD(I) | VALEUR VENTES DOM SORTIE USINE | ('87 MDS Fcfa) |
| XPTACT(IACT) | PRODUCTION DOMESTIQUE PAR SECTEUR | ('87 MDS Fcfa) |
| E(I) | EXPORTATIONS DES PRODUITS | ('87 MDS Fcfa) |
| M(I) | IMPORTATIONS PAR PRODUIT | ('87 MDS Fcfa) |
| *BLOC DE FACTEURS | | |
| K(IACT) | STOCK DE CAPITAL PAR SECTEUR | ('87 MDS Fcfa) |
| WA(LC) | TAUX SAL MOYEN PAR CAT DE M.O | (Mlions Fcfa PAR PERSON) |
| RETR(IACT) | REVENUS DU CAPITAL PAR BRANCHES | (MDS Fcfa courants) |
| LS(LC) | OFFRE DE TRAVAIL PAR CAT DE M.O | (1000 PERSONS) |
| L(IACT,LC) | EMPLOI PAR SECTEUR ET PAR CAT DE M.O | (1000 PERSONS) |
| *BLOC DE DEMANDE | | |
| INT(I) | UTILISATION INTERMEDIAIRES | ('87 MDS Fcfa) |
| MARGXTOT | MARGE COMMERCIALE SUR EXPORTS | ('87 MDS Fcfa) |
| MARGMTOT | MARGE COMMERCIALE SUR LES IMPORTS | ('87 MDS Fcfa) |
| MARGDTOT | MARGE COMMMERCIALE SUR LES BIENS DOM | ('87 MDS Fcfa) |
| DST(I) | VARIATION DES STOCKS PAR SECTEUR | ('87 MDS Fcfa) |
| CD(I) | CONSOMMATION FINALE PRIVEE DES MENAGES | ('87 MDS Fcfa) |
| CDHH(I,H) | CONSOMMATION FINALE PRIVEE PAR MENAGE | ('87 MDS Fcfa) |
| TRANHH(H) | TRANSFERTS PAR LES MENAGES | ('87 MDS Fcfa) |
| SAVHH(H) | EPARGNE PAR MENAGE | ('87 MDS Fcfa) |
| YGDP | PIB PRIVE | ('87 MDS Fcfa) |
| ACTSAL(IACT) | SALAIRES PAR ACTIVITE | ('87 MDS Fcfa) |
| RETK(KC) | REVENU DU CAPITAL PAR TYPE DE CAPITAL | ('87 MDS Fcfa) |
| LCSAL(LC) | SALAIRES PAR CAT DE TRAVAIL | ('87 MDS Fcfa) |
| Y(H) | REVENU PAR MENAGE | ('87 MDS Fcfa) |
| YENTF | REVENU DE L'ENTERPRISE FORMELLE | ('87 MDS Fcfa) |
| YINFIN | REVENU DE L'INSTITUTION FINANCIERE | ('87 MDS Fcfa) |
| ENTFSAV | EPARGNE DE L'ENTERPRISE FORMELLE | ('87 MDS Fcfa) |
| INFINSAV | EPARGNE DE L'INSTITUTION FINANCIERE | ('87 MDS Fcfa) |
| TOTHHSAV | EPARGNE TOTALE DES MENAGES | ('87 MDS Fcfa) |
| GD(I) | DEMANDE DE CONSOM FINALE PAR ETAT | ('87 MDS Fcfa) |
| ID(I) | DEMANDE FINALE POUR INVEST PRODUCTIF | ('87 MDS Fcfa) |
| GR | RECETTE DE L'ETAT | ('87 MDS Fcfa) |
| TARIFF | RECETTE DOUANIERE | ('87 MDS Fcfa) |
| PRODTX | RECETTE DE LA TAXE INDIRECTE SUR PRODUCTION | ('87 MDS Fcfa) |
| DUTY | RECETTE DE LA TAXE A L'EXPORTATION | ('87 MDS Fcfa) |
| DSALETX | RECETTE DES TAXES SUR VENTE DES BIENS DOM | ('87 MDS Fcfa) |
| ISALETX | RECETTE DES TAXES SUR BIENS IMPORTES | ('87 MDS Fcfa) |
| DIRTX | RECETTE DE L'IMPOT DIRECT | ('87 MDS Fcfa) |
| GDTOT | CONSOM TOTALE DE L'ETAT EN VOLUME | ('87 MDS Fcfa) |
| GOVIVT | INVEST PUBLIC TOTAL EN VOLUME | ('87 MDS Fcfa) |
| VGOVIVT | INVEST PUBLIC TOTAL EN VALEUR | (MDS Fcfa) |
| GOVSAV | EPARGNE PUBLIQUE | ('87 MDS Fcfa) |
| GID(I) | DEMANDE D'INVEST DE L'ETAT PAR PRODUIT | ('87 MDS Fcfa) |
| DEPRECIA | DEPENSE TOTALE D'AMORTISSEMENT | ('87 MDS Fcfa) |
| SAVINGS | EPARGNE TOTALE | ('87 MDS Fcfa) |
| FSAV | EPARGNE EXTERIEURE | ('87 Mlions DOLLARS) |
| DK(IACT) | VOLUME DE L'INVEST PAR SECTEUR DE DESTINATION | ('87 MDS Fcfa) |
| DKTOT | INVESTISSEMENT TOTAL | ('87 MDS Fcfa) |
| TOTDSTK | VARIATION TOTALE DES STOCKS | ('87 MDS Fcfa) |

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*INDICATEUR DE BIEN ETRE POUR LA FONCTION OBJECTIVE
   OMEGA     VARIABLE REPRESENTANT FONCTION OBJECTIVE    ('87 MDS Fcfa);

 PC.LO(I) = .01 ;PPD.LO(I) = .01 ; PM.LO(IM) =.01; PWE.LO(IEX) = .01 ; PK.LO(IACT) = .01 ; PPT.LO(I) = .01 ;
 XT.LO(I)
= .01 ;  XPT.LO(I) = .01 ; XPTACT.LO(IACT) = .01 ; M.LO(IM) = .01 ; XPD.LO(IEX) = .01 ;
   WA.LO(LC) = .01 ;
 INT.LO(I) = 0.0 ; YGDP.LO = .01 ;  Y.LO(H) = .01; YENTF.LO = .01 ; E.LO(IEX) = .01 ; L.LO(IACT,LC) = 0.01 ;
 PE.LO(IEX) = .01 ;RETR.LO(IACT)=.0001;
*DEFINITION DU MODELE - EQUATIONS

 EQUATIONS
*BLOC DE PRIX
   PMDEF(I)          DEFINITION DES PRIX DOM DES IMPORT                (UNITE)
   PEDEF(I)          DEFINITION DES PRIX DOM DES EXPORT                (UNITE)
   ABSORPTION(I)     VALEUR DES VENTES DOM                        ('87 MDS Fcfa)
   SALES(I)          PRODUCTION DOM EN VALEUR                     ('87 MDS Fcfa)
   ACTP(IACT)        DEFINITION DU  PRIX DE L'ACTIVITE                 (UNITE)
   PKDEF(IACT)       DEFINITION DU PRIX DES BIENS D'INVEST             (UNITE)
   PPTDEF(IACT)      DEFINITION DU PRIX AUX PRODUCTEURS                (UNITE)
   PINDXDEF          DEFINITION DE L'INDICE GENERAL DE PRIX            (UNITE)
*BLOC DE PRODUCTION
   KDEF(IACT)        AGGREGATION DU CAPITAL PAR ACTIVITE          ('87 MDS Fcfa)
   ACTIVCES(IACT)    FONCTION DE PRODUCTION CES                   ('87 MDS Fcfa)
   ACTIVITY(IACT)    AUTRE FONCTION DE PRODUCTION                 ('87 MDS Fcfa)
   RATIOKL(IACT,LC) CONDITIONS PREMIER ORDRE AVEC CES             (1000 PERSONNES)
   RETURN(IACT)      REVENUS DU CAPITAL PAR BRANCHE                  (MDS Fcfa)
   PROFITMAX(IACT,LC) CONDITION PREMIER ORDRE POUR PROFIT MAX     (1000 PERSONNES)
   LSDEF(LC)         DEFINITION DE L'OFFRE DE MAIN D'OEUVRE       (1000 PERSONNES)
   LMEQUIL(LC)       EQUILIBRE MARCHE DU TRAVAIL                  (1000 PERSONNES)
   CET(I)            FONCTION DE TRANSFORMATION  (CET)            ('87 MDS Fcfa)
   EDEMAND(I)        DEMANDE D'EXPORT                                  (UNITE)
   ESUPPLY(I)        OFFRE D'EXPORT                                    (UNITE)
   ARMINGTON(I)      FONCTION D'AGGREGATION DE BIENS COMPOSES     ('87 MDS Fcfa)
   COSTMIN(I)        CONDITION P.O. POUR MINIM. COUT BIEN COMPOSE      (UNITE)
   XXDSN(I)          VENTE DOMESTIQUE DES BIENS NON ECHANGES      ('87 MDS Fcfa)
   XSN(I)            OFFRE AGGREGEE DE BIENS NON ECHANGES         ('87 MDS Fcfa)
   XPTDEF(I)         DEFINITION DU NIVEAU DE PROD PAR BIEN        ('87 MDS Fcfa)
*BLOC DE DEMANDE
   INTEQ(J)          CONSOM INTERMED TOTALE EN BIEN J             ('87 Mds Fcfa)
   MARGXDEF          DEFINITION MARGE TOTALE SUR EXPORTATION      ('87 Mds Fcfa)
   MARGMDEF          DEFINITION MARGE TOTALE SUR IMPORTATION      ('87 Mds Fcfa)
   MARGDDEF          DEFINITION MARGE TOTALE SUR BIENS DOMEST     ('87 Mds Fcfa)
   INTEQCOMM         UTILISATION INTERMEDIAIRE DU COMMERCE        ('87 Mds Fcfa)
   DSTEQ(I)          VARIATION DE STOCKS                          ('87 Mds Fcfa)
   CDEQ(I)           FONCTION CONSOM PRIVEE                       ('87 Mds Fcfa)
   CONHHEQ(I,H)      FONCTION DE CONSOMMATION PAR MENAGE          ('87 Mds Fcfa)
   TRANHHEQ(H)       TRANSFERT DES MENAGES VERS AUTRES INSTITUTIONS   (Mds Fcfa)
   GDP               PIB PRIVE                                    ('87 Mds Fcfa)
   ACTSALDEF(IACT)   DEFINITION DES SALAIRES TOTAUX PR ACTIVITE   ('87 Mds Fcfa)
   RETKDEF(KC)       DEFINITION DES REV. DE K. PR CATEGORIE       ('87 Mds Fcfa)
   LCSALDEF(LC)      DEFINITION DES SAL. TOTAUX PR CAT. DE M.O    ('87 Mds Fcfa)
   YHDEF(H)          REVENU PAR MENAGE                            ('87 Mds Fcfa)
   YENTFDEF          REVENU DES ENTREPRISES FORMELLES             ('87 Mds Fcfa)
   YINFINDEF         REV. DES INSTITUTIONS FINANCIERES            ('87 Mds Fcfa)
   GDEQ(I)           FONCTION DE CONSOM DE L'ETAT                 ('87 Mds Fcfa)
   GREQ              RECETTE DE L'ETAT                            ('87 Mds Fcfa)
   TARIFFDEF         RECETTE DOUANIERE                            ('87 Mds Fcfa)
   PRODTXDEF         TAXES INDIRECTES SUR LA PROD. DOMESTIQUE     ('87 Mds Fcfa)
   DUTYDEF           TAXES A L'EXPORTATION                        ('87 Mds Fcfa)
   DIRTXDEF          TAXES DIRECTES                               ('87 Mds Fcfa)
   DSALETXDEF        TAXES SUR VENTE DES PROD DOMESTIQUES         ('87 Mds Fcfa)
   ISALETXDEF        TAXES VENTES SUR BIENS IMPORTES              ('87 Mds Fcfa)
*BLOC D'EPARGNE-INVESTISSEMENT
   SAVHHEQ(H)        EPARGNE PR CAT. DE MENAGES                   ('B7 Mds Fcfa)
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   SAVENTFEQ         EPARGNE DES ENTREPRISES FORMELLES           ('87 Mds Fcfa)
   SAVINFINEQ        EPARGNE DES INSTITUTIONS FINANCIERES        ('87 Mds Fcfa)
   TOTHHSAVEQ        EPARGNE TOTALE DES MENAGES                  ('87 Mds Fcfa)
   GRUSE             EPARGNE PUBLIQUE                            ('87 Mds Fcfa)
   GIDEF(I)          INVEST. PUBLIC PAR PRODUIT                  ('87 Mds Fcfa)
   DEPREQ            DEPENSE D'AMORTISSEMENT                     ('87 Mds Fcfa)
   TOTSAV            EPARGNE TOTALE                              ('87 Mds Fcfa)
   TOTDSTKDEF        DEFINITION DE LA VAR. TOTALE DES STOCKS     ('87 Mds Fcfa)
   VGOVIVTDEF        DEFINITION DE L'INVESTISSEMENT DU GOUVERNEMENT   (Mds Fcfa)
   PRODINV(IACT)     INVEST. PAR SECTEUR DE DESTINATION          ('87 Mds Fcfa)
   IEQ(I)            INVEST. PAR SECTEUR D'ORIGINE               ('87 Mds Fcfa)
   DKTOTDEF          DEFINITION DE L'INVESTISSEMENT TOTAL        ('87 Mds Fcfa)
*BALANCE DES PAYEMENTS
   CAEQ              BALANCE COURANTE                            ('87 Mlions DOLLARS)
*EQUILIBRE DU MARCHE
   EQUIL(I)          EQUILIBRE SUR LE MARCHE DES BIENS           ('87 Mds Fcfa)
*FONCTION OBJECTIVE
   OBJ               FONCTION OBJECTIVE                          ('87 Mds Fcfa)
  ;


*DEFINITION DU MODELE BLOC DE PRIX


 PMDEF(IM)..        PM(IM) =E= PWM(IM)*ER*(1 + TM(IM)) ;

 PEDEF(IEX)..        PE(IEX)*(1 + TE(IEX)) =E= PWE(IEX)*ER ;

 ABSORPTION(I)..    PC(I)*XT(I) =E= PPD(I)*(1+MARGD(I)+DSALRATE(I))*XPD(I)
                     + (PM(I)*(1+MARGM(I)+ISALRATE(I))*M(I))$IM(I) ;

 SALES(I)..         PPT(I)*XPT(I) =E= PPD(I)*XPD(I) + ((PE(I)/(1+MARGX(I)))*E(I))$IEX(I) ;

 ACTP(IACT)..       PPTACT(IACT)*(1-TPROD(IACT)) =E= PVA(IACT) + SUM(J, IO(J,IACT)*PC(J) ) ;

 PKDEF(IACT)..      PK(IACT) =E= SUM(J, PC(J)*IMAT(J,IACT) ) + 1-SUM(J,IMAT(J,IACT));

 PPTDEF(IACT)..     PPTACT(IACT)=E=SUM(J,PPT(J)*OUTMAT(IACT,J) ) ;

 PINDXDEF..         PINDEX=E=SUM(I,PC(I)*INDWT(I)) ;
```

$$A\left[\alpha_1 L_1^{-\rho} + \alpha_2 L_2^{-\rho} + (1-\alpha_1-\alpha_2)K^{-\rho}\right]^{-1/\rho}$$

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*BLOC DE PRODUCTION
*## FONCT PROD CES
 ACTIVCES(IACT)$(CESFLAG(IACT) EQ 1)..
   XPTACT(IACT) =E= AD(IACT)*( SUM(LC$WDIST(IACT,LC),(ALPHL(IACT,LC)*L(IACT,LC)**(-RHOQ(IACT)) ) )
      +(1 - SUM(LC1,ALPHL(IACT,LC1)))*K(IACT)**(-RHOQ(IACT)))**(-1/RHOQ(IACT));
 ACTIVITY(IACT)$(CESFLAG(IACT) EQ 0)..
       XPTACT(IACT) =E=AD(IACT)*PROD(LC$WDIST(IACT,LC),L(IACT,LC)*ALPHL(IACT,LC))
                    *K(IACT)**(1- SUM(LC,ALPHL(IACT,LC)) );
 RATIOKL(IACT,LC)$(WDIST(IACT,LC) AND (CESFLAG(IACT) EQ 1)).. (K(IACT)/L(IACT,LC)) =E=
          (ALPHL(IACT,LC)/(1 - SUM(LC1,ALPHL(IACT,LC1))))**(-SIGMAQ(IACT))
                *(WA(LC)*WDIST(IACT,LC)/RETR(IACT))**(SIGMAQ(IACT));
 PROFITMAX(IACT,LC)$(WDIST(IACT,LC) AND (CESFLAG(IACT) EQ 0))..
      WA(LC)*WDIST(IACT,LC)*L(IACT,LC) =E= XPTACT(IACT)*PVA(IACT)*ALPHL(IACT,LC);

 RETURN(IACT)$(CESFLAG(IACT) EQ 1).. RETR(IACT) =E= (1-SUM(LC,ALPHL(IACT,LC)))
             *AD(IACT)**(-RHOQ(IACT))*K(IACT)**(-RHOQ(IACT) -1)*PVA(IACT)*(XPTACT(IACT)**(1+RHOQ(IACT)) );
*### FIN PRODUCTION CES #################

* ACTIVITY(IACT)..  XPTACT(IACT) =E= AD(IACT) * PROD(LC$WDIST(IACT,LC),L(IACT,LC)**ALPHL(LC,IACT))
*                     *K(IACT)**(1 - SUM(LC, ALPHL(LC,IACT)) ) ;
* PROFITMAX(IACT,LC)$WDIST(IACT,LC)..  WA(LC)*WDIST(IACT,LC)*L(IACT,LC) =E=
*                                  XPTACT(IACT)*PVA(IACT)*ALPHL(LC,IACT) ;
```

```
LSDEF(LC)..        LS(LC) =E= LS0(LC) * ( (WA(LC)/PINDEX)/(WA0(LC)/PINDEX0) )**BLE(LC) ;

LMEQUIL(LC)..      SUM(IACT, L(IACT,LC)) =E= LS(LC) ;

CET(IEX)..          XPT(IEX) =E= AT(IEX)*( GAMMA(IEX)*E(IEX)**RHOT(IEX)
                  + ( 1-GAMMA(IEX))*XPD(IEX)**RHOT(IEX) )**(1/RHOT(IEX)) ;

EDEMAND(IEX)..      E(IEX)/E0(IEX) =E= ( PWE0(IEX)/PWE(IEX) )**ETA(IEX) ;

ESUPPLY(IEX)..      E(IEX)/XPD(IEX) =E= ( (PE(IEX)/(1+MARGX(IEX)))/PPD(IEX)
                     *(1 - GAMMA(IEX))/GAMMA(IEX))**(1/(RHOT(IEX)-1) ) ;

ARMINGTON(IM)..    XT(IM) =E= AC(IM)*(DELTA(IM)*M(IM)**(-RHOC(IM)) + (1-DELTA(IM))*XPD(IM)**(-RHOC(IM)))
                     **(-1/RHOC(IM)) ;

COSTMIN(IM)..      M(IM)/XPD(IM) =E= ( (PPD(IM)*(1+MARGD(IM)+DSALRATE(IM)) )/
                    (PM(IM)*(1+MARGM(IM)+ISALRATE(IM)) )*DELTA(IM)/(1-DELTA(IM)) )**(1/(1+RHOC(IM)));

XXDSN(INX)..       XPD(INX) =E= XPT(INX) ;

XSN(INM)..         XT(INM) =E= XPD(INM)*(1 + MARGD(INM) + DSALRATE(INM)) ;

XPTDEF(J)..        XPT(J) =E= SUM(IACT, XPTACT(IACT)*OUTMAT(IACT,J) ) ;

*BLOC DE DEMANDE

INTEQ(I)$(FLAGCOM(I) NE 1.)..  INT(I) =E= SUM(IACT, IO(I,IACT)*XPTACT(IACT) );

MARGXDEF..         MARGXTOT =E= SUM(I,(PE(I)*MARGX(I)/(1+MARGX(I))*E(I) )$IEX(I) ) ;
MARGMDEF..         MARGMTOT =E= SUM(I,(PM(I)*MARGM(I)*M(I) )$IM(I) ) ;
MARGDDEF..         MARGDTOT =E= SUM(I,(PPD(I)*MARGD(I)*XPD(I) )) ;
INTEQCOMM..        INT("COM-P") =E= SUM(IACT, IO("COM-P",IACT)*XPTACT(IACT) )
                              + (MARGXTOT + MARGMTOT +MARGDTOT)/PC("COM-P") ;          COMMER.

DSTEQ(I)..         DST(I) =E= DSTR(I)*XPT(I) ;

CONHHEQ(I,H)..     PC(I)*CDHH(I,H) =E= CLES0(I,H)
                         + CLES(I,H) * (Y(H)-SAVHH(H)-TRANHH(H)-TDIR(H)*Y(H)) ;
TRANHHEQ(H)..      TRANHH(H) =E= SUM(INST,TRANSFER(INST,H)) ;
CDEQ(I)..          CD(I) =E= SUM(H, CDHH(I,H)) ;

GDP..              YGDP =E= SUM(IACT, PVA(IACT)*XPTACT(IACT)) - DEPRECIA
                          +  PRODTX + TARIFF + DUTY + DSALETX + ISALETX ;

ACTSALDEF(IACT).. ACTSAL(IACT) =E= SUM(LC, (WA(LC)*WDIST(IACT,LC)*L(IACT,LC) )$WDIST(IACT,LC) ) ;

RETKDEF(KC)..      RETK(KC) =E= SUM(IACT, (PVA(IACT)*XPTACT(IACT)-ACTSAL(IACT))*SHRKC(KC,IACT) ) ;
LCSALDEF(LC)..     LCSAL(LC) =E= SUM(IACT, (WA(LC)*WDIST(IACT,LC)*L(IACT,LC) )$WDIST(IACT,LC) ) ;
YHDEF(H)..         Y(H) =E= SUM(LC, LCSAL(LC)*SHRLCHH(LC,H)) + SUM(KC, RETK(KC)*SHRKCHH(KC,H))
                         + SUM(INST,TRANSFER(H,INST)) + ((ER-ER0)/ER0)*TRANSFER(H,"RDM") ;
YENTFDEF..         YENTF =E= SUM(INST,TRANSFER("ENTF",INST)) + RETK("KFORM")
                        - (PVA("SERVPU")*XPTACT("SERVPU") - ACTSAL("SERVPU") )
                         + ((ER-ER0)/ER0)*TRANSFER("ENTF","RDM")  ;
YINFINDEF..        YINFIN =E= SUM(INST,TRANSFER("INFIN",INST))
                         + ((ER-ER0)/ER0)*TRANSFER("INFIN","RDM");

* YHDEF(H)..        Y(H) =E= SUM(LC, LCSAL(LC)*SHRLCHH(LC,H)) + SUM(KC, RETK(KC)*SHRKCHH(KC,H))
*                         + SUM(INST,TRANSFER(H,INST)) ;
* YENTFDEF..        YENTF =E= SUM(INST,TRANSFER("ENTF",INST)) + RETK("KFORM") ;
* YINFINDEF..       YINFIN =E= SUM(INST,TRANSFER("INFIN",INST)) ;

SAVHHEQ(H)..       SAVHH(H) =E= S0(H) + MPS(H)*Y(H) ;
SAVENTFEQ..        ENTFSAV =E= YENTF - SUM(INST,TRANSFER(INST,"ENTF")) ;
SAVINFINEQ..       INFINSAV =E= YINFIN - SUM(INST,TRANSFER(INST,"INFIN")) ;
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TOTHHSAVEQ..      TOTHHSAV =E= SUM(H,SAVHH(H)) ;

GREQ..            GR =E= TARIFF + DUTY + PRODTX + DSALETX + ISALETX + DIRTX
                     + (PVA("SERVPU")*XPTACT("SERVPU") - ACTSAL("SERVPU") )
                     + SUM(INST,TRANSFER("ADPUB",INST)) + ((ER-ERO)/ERO)*TRANSFER("ADPUB","RDM") ;
* GREQ..           GR =E= TARIFF + DUTY + PRODTX + DSALETX + ISALETX + DIRTX
*                     + SUM(INST,TRANSFER("ADPUB",INST)) ;

GRUSE..           GR =E= SUM(I, PC(I)*GD(I)) + GOVSAV + SUM(INST, TRANSFER(INST,"ADPUB")) ;

GDEQ(I)..         GD(I) =E= GLES(I)*GDTOT ;

TARIFFDEF..       TARIFF =E= SUM(IM, TM(IM)*M(IM)*PWM(IM) )*ER ;

PRODTXDEF..       PRODTX =E= SUM(IACT, TPROD(IACT)*PPTACT(IACT)*XPTACT(IACT) );

DUTYDEF..         DUTY =E= SUM(IEX, TE(IEX)*E(IEX)*PE(IEX) ) ;
DIRTXDEF..        DIRTX =E= SUM(H,TDIR(H)*Y(H)) ;
DSALETXDEF..      DSALETX =E= SUM(I,DSALRATE(I)*PPD(I)*XPD(I)) ;

ISALETXDEF..      ISALETX =E= SUM(IM, ISALRATE(IM)*M(IM)*PM(IM) ) ;

DEPREQ..          DEPRECIA =E= SUM(IACT, DEPR(IACT)*PK(IACT)*K(IACT) ) ;

TOTSAV..          SAVINGS =E= TOTHHSAV + GOVSAV + DEPRECIA + FSAV*ER + ENTFSAV + INFINSAV ;

TOTDSTKDEF..      TOTDSTK =E= SUM(J, DST(J)*PC(J)) ;

VGOVIVTDEF..      VGOVIVT =E= SUM(I,PC(I)*GID(I)) ;

PRODINV(IACT)..   PK(IACT)*DK(IACT) =E= KIO(IACT)*(SAVINGS - TOTDSTK - VGOVIVT) ;

GIDEF(I)..        GID(I) =E= GOVIVT*GIO(I) ;

DKTOTDEF..        DKTOT =E= SUM(IACT, DK(IACT)) ;

IEQ(I)..          ID(I) =E= SUM(IACT, IMAT(I,IACT)*DK(IACT));

CAEQ..            SUM(IM, PWM(IM)*M(IM)) + (1/ER)*SUM(INST, TRANSFER('RDM',INST))
                   =E= SUM(IEX, PWE(IEX)*E(IEX)) + (1/ER)*SUM(INST, TRANSFER(INST,'RDM')) + FSAV ;

*EQUILIBRE DES MARCHES

EQUIL(I)..        XT(I) =E= INT(I) + CD(I) + GD(I) + ID(I) + GID(I) + DST(I) ;

*OBJ..            OMEGA =E= PROD(I$CLES(I,"URB1"),
*                      CDHH(I,"URB1")**CLES(I,"URB1")) ;
OBJ..             OMEGA =E= 10 ;

*MONTAGE DU MODELE - INITIALISATION

XT.L(I) = XTO(I) ; XPT.L(I) = XPTO(I); XPTACT.L(IACT) = XPTACTO(IACT);
XPD.L(I) = XPDO(I);
CDHH.L(I,H) = CDHHO(I,H); CD.L(I)=CDO(I);
M.L(I) = MO(I); E.L(I) = EO(I); ID.L(I) = IDO(I); GID.L(I) = GIDO(I);
DST.L(I) = DSTO(I); INT.L(I) = INTO(I);
PPD.L(I) = PPDO(I); PM.L(I) = PMO(I); PE.L(I) = PEO(I);
PC.L(I) = PCO(I); PPT.L(I) = PPTO(I); PPTACT.L(IACT)= PPTACTO(IACT); PK.L(IACT) = PKO(IACT);
PVA.L(IACT) = PVAO(IACT); PWE.L(I) = PWEO(I);  PINDEXO =1; PINDEX.L = PINDEXO;
WA.L(LC) = WAO(LC); L.L(IACT,LC)= XLE(IACT,LC); GR.L = GRO; DIRTX.L = DIRTXO;
YGDP.L = YGDPO ;
FSAV.L = FSAVO ; TM.L(IEX) = TMO(IEX) ; Y.L(H) = YO(H);
TRANHH.L(H) = SUM(INST,TRANSFER(INST,H));
LS.L(LC) = LSO(LC); LCSAL.L("QELEV")=69.165; LCSAL.L("QBAS")=304.766;
GD.L("SERV-P") = 4.000 ; GD.L("ADPU-P") = 105.006;
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 TARIFF.L =4.414; DUTY.L = 1.687;
 PRODTX.L = 28.644; DSALETX.L=20.559; ISALETX.L= 0;
 SAVINGS.L= 103.219; SAVHH.L(H) = SAVHHO(H); TOTHHSAV.L = SUM(H,SAVHHO(H));
 DKTOT.L = DKTOTO; TOTDSTK.L = 12.456;
 DK.L(IACT)=KIO(IACT)*(SAVINGS.L-TOTDSTK.L-GOVIVTO); VGOVIVT.L = GOVIVTO ;
 YENTF.L = 68.470; YINFIN.L = 0 ;
 ENTFSAV.L = 68.470; INFINSAV.L = 0; GOVSAV.L = -18.881;

 ACTSAL.L(IACT)=SUM(LC,WAO(LC)*WDIST(IACT,LC)*XLE(IACT,LC));
 RETK.L("KFORM")=92.646; RETK.L("KINF")=116.652; RETK.L("TERNR")=14.636;
 RETK.L("TERNP")=6.582; RETK.L("TERSR")=15.390; RETK.L("TERSP")=6.372;
 MARGDTOT.L=SUM(I,MARGD(I)*XPDO(I)); MARGMTOT.L=39.805; MARGXTOT.L=98.395-MARGDTOT.L;
 INT.L("COM-P")=140.878;RETR.L(IACT)=RETRO(IACT);
 OMEGA.L = 10;

*BOUCLAGE

 ER.FX = ERO ;
* PINDEX.FX = 1.0 ;
 K.FX(IACT)    = KO(IACT);
 PWM.FX(I) = PWMO(I);
* LS.FX(LC) = LSO(LC);
 TM.FX(IM) = TMO(IM);
 TM.FX(INM)= TMO(INM);
 FSAV.FX    = FSAVO ;
* FSAV.LO = -INF ;
* FSAV.UP = +INF ;
  GDTOT.FX  = GDTOTO ;
  GOVIVT.FX = GOVIVTO;
 M.FX(INM) = 0;
 L.FX("CEREAL","QELEV")=0; L.FX("CULTEX","QELEV")=0;
 L.FX("AUTCULT","QELEV")=0; L.FX("ELEV","QELEV")=0;
 L.FX("SYLV","QELEV")=0; L.FX("BOUCHER","QELEV")=0;
 L.FX("ALIMI","QELEV")=0; L.FX("MANIFI","QELEV")=0;
 L.FX("BTPI","QELEV")=0;  L.FX("COMI","QELEV")=0;
 L.FX("TRNSPI","QELEV")=0; L.FX("SERVI","QELEV")=0;
 E.FX(INX) = 0;


*  OPTIONS ITERLIM=1, LIMROW=100, LIMCOL=100 ;
  OPTIONS ITERLIM=2000,LIMROW=0,LIMCOL=0 ;
 MODEL NERCES  MODEL /
   PMDEF, PEDEF, ABSORPTION, SALES, ACTP, PKDEF, PPTDEF, PINDXDEF,ACTIVCES, ACTIVITY,
RATIOKL,PROFITMAX,RETURN,
   LSDEF, LMEQUIL, CET, EDEMAND, ESUPPLY, ARMINGTON, COSTMIN, XXDSN, XSN, XPTDEF, INTEQ, MARGXDEF, MARGMDEF,
   MARGDDEF, INTEQCOMM, DSTEQ, CONHHEQ, TRANHHEQ, CDEQ, GDP, ACTSALDEF, RETKDEF, LCSALDEF, YHDEF,
   YENTFDEF, YINFINDEF, SAVHHEQ, SAVENTFEQ, SAVINFINEQ, TOTHHSAVEQ, GREQ,
   GRUSE, GDEQ, TARIFFDEF, PRODTXDEF, DUTYDEF, DIRTXDEF, DSALETXDEF, ISALETXDEF, DEPREQ, TOTSAV,
   TOTDSTKDEF, VGOVIVTDEF, PRODINV, GIDEF, DKTOTDEF, IEQ, EQUIL, OBJ / ;

 SOLVE NERCES MAXIMIZING OMEGA USING NLP;

 PARAMETER  XDGR(I,*)  TAUX DE VARIATION DE LA PRODUCTION            (POURCENT)
            IMGR       TAUX DE VARIATION DES IMPORTATIONS            (POURCENT)
            EXGR       TAUX DE VARIATION DES EXPORTATIONS            (POURCENT)
            CDGR       TAUX DE VARIATION DE LA CONSOMMATION          (POURCENT)
            YGR(H,*)   TAUX DE VARIATION DU REVENU DES MENAGES      (POURCENT)
            REALYGR(H,*) TAUX DE VARIATION DU REVENU DES MENAGES    (POURCENT)
            GDPGR      TAUX DE VARIATIDN DU PIB                      (POURCENT)
            REALGDPGR  TAUX DE VARIATION DU PIB REEL                 (POURCENT)
            PVAGR      TAUX DE VARIATION DU PRIX DE LAVALEUR AJOUTEE (POURCENT)
            PWEGR      TAUX DE VARIATION DES PRIX A L'EXPORTATION    (POURCENT)
            PCPI       L'INDICE DES PRIX A LA CONSDMMATIDN             (UNITE)
            PGDP       L'INDICE DEFLATEUR DU PIB                          (UNITE)
            PGDPO      L'INDICE DEFLATEUR DU PIB EN 1987                  (UNITE)
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          TOTIVT      INVESTISSEMENT TOTAL PUBLIQUE ET PRIVE       (MLRD 1987 FCFA)
          TOTIVTO     INVESTISSEMENT TOTAL PUBLIQUE ET PRIVE 1987  (MLRD 1987 FCFA)
          REALWAGR    TAUX DE VARIATION DES SALAIRES REELS        (POURCENTAGE)
          GDPDENOM    DENOMINATEUR POUR CALCULER PGDP              (MILLIARDS FCFA)
          GDPWT(IACT) PONDERATIONS POUR CALCULER PGDP              (UNITE)
          REALGDP     PIB REEL
          ERDEF       TAUX DE CHANGE  DEFLATE
           ;


 GDPDENOM = SUM(JACT,PVA0(JACT)*XPTACT0(JACT)) ;
 GDPWT(IACT) = (PVA0(IACT)*XPTACT0(IACT))/GDPDENOM ;
 PGDP = SUM(IACT,GDPWT(IACT)*PVA.L(IACT)) / SUM(IACT,GDPWT(IACT)*PVA0(IACT)) * 100 ;
 PGDP0 = 100. ;
 YGR(H,"REVENUE") = 100*(Y.L(H)/Y0(H)-1) ;
 REALYGR(H,"REALINC") = 100*(((Y.L(H)/PINDEX.L)/(Y0(H)/PINDEX0))-1) ;
 REALGDP = 100*( YGDP.L/PGDP);
 REALGDPGR = 100*((YGDP.L/PGDP)/(YGDP0/PGDP0)-1) ;
 REALWAGR(LC, "REALWAGE") = 100*((WA.L(LC)/PINDEX.L)/(WA0(LC)/PINDEX0)-1) ;
 TOTIVT = GOVIVT.L + DKTOT.L ;
 TOTIVTO = GOVIVTO + DKTOTO ;
 XDGR(I,"PROD") =100*(XPT.L(I)/XPT0(I) - 1);
 IMGR(IM,"IMPORTS") =100*(M.L(IM)/M0(IM) - 1);
 EXGR(IEX,"EXPORTS") = 100*(E.L(IEX)/E0(IEX) - 1);
 CDGR(I,"CONS") = 100*(CD.L(I)/CD0(I) - 1)$CD0(I) ;
 GDPGR = 100*(YGDP.L/YGDP0 - 1) ;
 PVAGR(IACT,"PVA") = 100*(PVA.L(IACT)/PVA0(IACT) - 1);
** CHANGE PWE0 BACK TO HISTORICAL LEVELS **
* PWE0("CUEX-P")=PWE0("CUEX-P")/1.3 ;
* PWE0("ELEV-P")=PWE0("ELEV-P")/1.3 ;
 PWEGR(IEX,"PWE") = 100*(PWE.L(IEX)/PWE0(IEX) - 1);
 PCPI =100* PINDEX.L ;
 ERDEF    = 100*(ER.L/PGDP);

 PARAMETER GOVREVGR    VARIATION DES RECETTES DE L'ETAT  (POURCENT)
           TARIFFGR    VARIATION DES RECETTES DOUANIERES (Mds Fcfa)
           INDTAXGR    VAR DES RECETTES FISCALES INDIRECTES SUR LA PROD  (Mds Fcfa)
           EXPORTOTO   TOTAL DES EXPORTATIONS 1984 (MN US DOLLARS)
           IMPORTOTO   TOTAL DES IMPORTATIONS 1984 (MN US DOLLARS)
           EXPORTOT  . TOTAL DES EXPORTATIONS (MN US DOLLARS)
           IMPORTOT    TOTAL DES IMPORTATIONS (MN US DOLLARS)
           CDTOT       TOTAL CONSOMMATION PRIVEE  ;

 GOVREVGR =(( GR.L - GR0)/GR0)*100 ;
 TARIFFGR = TARIFF.L - 4.414 ;
 INDTAXGR = PRODTX.L - 28.644  ;
 EXPORTOTO = SUM(I,PWE0(I)*E0(I)) ;
 IMPORTOTO = SUM(I,PWM0(I)*M0(I)) ;
 EXPORTOT = SUM(I,PWE.L(I)*E.L(I)) ;
 IMPORTOT = SUM(I,PWM.L(I)*M.L(I)) ;
 CDTOT    = SUM(I,CD.L(I));

 DISPLAY  REALGDP,YGDP0,REALGDPGR,PGDP,CDTOT,CDTOTO,GDTOT.L,GDTOTO,TOTIVT,TOTIVTO,DKTOT.L,DKTOTO
          GOVIVT.L,GOVIVTO,EXPORTOT,EXPORTOTO,IMPORTOT,IMPORTOTO,FSAV.L,FSAV0
          GR.L,GR0,ERDEF,PCPI ;
 DISPLAY  REALYGR, REALWAGR;
 DISPLAY  XPTACT.L,XPTACT0;
 DISPLAY  XDGR, IMGR, EXGR, CDGR, YGR, GDPGR, PVAGR, PWEGR  ;
 DISPLAY  GOVREVGR,TARIFFGR,INDTAXGR ;
* DISPLAY EXPORTOT, IMPORTOT, FSAV.L, EXPORTOTO, IMPORTOTO, FSAV0 ;
* DISPLAY TOTIVT, TOTIVTO, DKTOT.L, DKTOTO, FSAV.L, FSAV0,CDTOT,CDTOTO ;

 SET C   GDPRESULTS  / LEVEL, ABS-CHANGE, PCT-CHANGE / ;
 PARAMETER  GDPAGG(*,C)  AGGREGATS DES COMPTES NATIONAUX ;
 GDPAGG("CONS","LEVEL") = CDTOT ;
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GDPAGG("CONS","ABS-CHANGE") = CDTOT-CDTOTO ;
GDPAGG("CONS","PCT-CHANGE") = (CDTOT/CDTOTO - 1)*100 ;
GDPAGG("GOVC","LEVEL") = GDTOT.L ;
GDPAGG("GOVC","ABS-CHANGE") = GDTOT.L-GDTOTO ;
GDPAGG("GOVC","PCT-CHANGE") = (GDTOT.L/GDTOTO -1)*100 ;
GDPAGG("GOVIVT","LEVEL") = GOVIVT.L ;
GDPAGG("GOVIVT", "ABS-CHANGE") = GOVIVT.L-GOVIVTO ;
GDPAGG("GOVIVT", "PCT-CHANGE") = (GOVIVT.L/GOVIVTO -1)*100 ;
GDPAGG("PRIVIVT", "LEVEL") = DKTOT.L ;
GDPAGG("PRIVIVT", "ABS-CHANGE") = DKTOT.L-DKTOTO ;
GDPAGG("PRIVIVT", "PCT-CHANGE") = (DKTOT.L/DKTOTO - 1)*100 ;
GDPAGG("VSTOCK", "LEVEL") = SUM(I,DST.L(I)) ;
GDPAGG("VSTOCK", "ABS-CHANGE") = GDPAGG("VSTOCK","LEVEL") - SUM(I,DSTO(I)) ;
GDPAGG("VSTOCK", "PCT-CHANGE") = (GDPAGG("VSTOCK","LEVEL")/SUM(I,DSTO(I)) -1)*100 ;
GDPAGG("EXPORTS", "LEVEL") = EXPORTOT*ER.L ;
GDPAGG("EXPORTS", "ABS-CHANGE") = EXPORTOT*ER.L - EXPORTOTO*ERO ;
GDPAGG("EXPORTS", "PCT-CHANGE") = (EXPORTOT*ER.L/(EXPORTOTO*ERO) -1)*100 ;
GDPAGG("IMPORTS", "LEVEL") = IMPORTOT*ER.L ;
GDPAGG("IMPORTS", "ABS-CHANGE") = IMPORTOT*ER.L - IMPORTOTO*ERO ;
GDPAGG("IMPORTS", "PCT-CHANGE") = (IMPORTOT*ER.L/(IMPORTOTO*ERO) -1)*100 ;
GDPAGG("TOTAL", "LEVEL") = CDTOT + GDTOT.L + GOVIVT.L + DKTOT.L + EXPORTOT*ER.L
  - IMPORTOT*ER.L + SUM(I,DST.L(I)) ;
GDPAGG("TOTAL", "ABS-CHANGE") = GDPAGG("TOTAL","LEVEL") - YGDPO ;
GDPAGG("TOTAL", "PCT-CHANGE") = (GDPAGG("TOTAL","LEVEL")/YGDPO - 1)*100 ;
DISPLAY GDPAGG ;

*** RESULTAT SOUS FORME DE M.C.S ***
PARAMETER  ACTCOL(IACT), ACTROW(IACT), CHECK ;
ACTCOL(IACT) = SUM(I,IO(I,IACT)*PC.L(I)*XPTACT.L(IACT) )
             + SUM(LC, WA.L(LC)*WDIST(IACT,LC)*L.L(IACT,LC) )
             + SUM(KC,SHRKC(KC,IACT)) * (PVA.L(IACT)*XPTACT.L(IACT)-ACTSAL.L(IACT))
             + TPROD(IACT)*PPTACT.L(IACT)*XPTACT.L(IACT) ;
ACTROW(JACT) = SUM(I, OUTMAT(JACT,I)*XPTACT.L(JACT)*PPTACT.L(JACT) ) ;
CHECK = SUM(IACT, (ACTROW(IACT)-ACTCOL(IACT))*(ACTROW(IACT)-ACTCOL(IACT)) ) ;
DISPLAY ACTCOL, ACTROW, CHECK ;

PARAMETER COMMCOL(I), COMMROW(I) ;
COMMCOL(I) = SUM(JACT, OUTMAT(JACT,I)*XPTACT.L(JACT)*PPT.L(I) )
           + PPD.L(I)*MARGD(I)*XPD.L(I) + PM.L(I)*MARGM(I)*M.L(I) +
PE.L(I)*MARGX(I)/(1+MARGX(I))*E.L(I)
           + PPD.L(I)*DSALRATE(I)*XPD.L(I) + PM.L(I)*ISALRATE(I)*M.L(I)
           + PWM.L(I)*ER.L*TM.L(I)*M.L(I) + PE.L(I)*TE(I)*E.L(I)
           + PWM.L(I)*ER.L*M.L(I) ;
COMMROW(I) = SUM(IACT,IO(I,IACT)*PC.L(I)*XPTACT.L(IACT) )
           + SUM(H,PC.L(I)*CDHH.L(I,H))
           + (MARGDTOT.L+MARGMTOT.L+MARGXTOT.L)$(FLAGCOM(I) EQ 1)
           + GD.L(I)*PC.L(I) + E.L(I)*PE.L(I)*(1+TE(I))
           + ID.L(I)*PC.L(I) + DST.L(I)*PC.L(I) + GID.L(I)*PC.L(I) ;
CHECK = SUM(I, (COMMROW(I)-COMMCOL(I))*(COMMROW(I)-COMMCOL(I)) ) ;
DISPLAY COMMCOL, COMMROW, CHECK ;

PARAMETER LABCOL(LC), LABROW(LC),KAPCOL(KC), KAPROW(KC) ;
LABCOL(LC) = SUM(H,LCSAL.L(LC)*SHRLCHH(LC,H) ) ;
LABROW(LC) = SUM(IACT, WA.L(LC)*WDIST(IACT,LC)*L.L(IACT,LC) ) ;
KAPCOL(KC) = SUM(H,RETK.L(KC)*SHRKCHH(KC,H)) ;
KAPCOL("KFORM") = RETK.L("KFORM") ;
KAPROW(KC) = SUM(IACT,SHRKC(KC,IACT) * (PVA.L(IACT)*XPTACT.L(IACT)-ACTSAL.L(IACT)) );
CHECK = SUM(LC, (LABCOL(LC)-LABROW(LC))*(LABCOL(LC)-LABROW(LC)) )
      + SUM(KC, (KAPCOL(KC)-KAPROW(KC))*(KAPCOL(KC)-KAPROW(KC)) ) ;
DISPLAY LABCOL, LABROW, KAPCOL, KAPROW, CHECK ;

PARAMETER HHCOL(H), HHROW(H), INSTCOL(INST), INSTROW(INST) ;
HHCOL(H) = SUM(I,PC.L(I)*CDHH.L(I,H)) + SUM(INST,TRANSFER(INST,H))
         + TDIR(H)*Y.L(H) + SAVHH.L(H) ;
HHROW(H) = SUM(LC,LCSAL.L(LC)*SHRLCHH(LC,H) ) + SUM(KC,RETK.L(KC)*SHRKCHH(KC,H))
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         + SUM(INST,TRANSFER(H,INST)) + (ER.L-ERO)/ERO*TRANSFER(H,"RDM") ;
*HHROW(H) = SUM(LC,LCSAL.L(LC)*SHRLCHH(LC,H) ) + SUM(KC,RETK.L(KC)*SHRKCHH(KC,H))
*          + SUM(INST,TRANSFER(H,INST)) ;
INSTCOL("INFIN") = SUM(INST,TRANSFER(INST,"INFIN")) + INFINSAV.L;
INSTCOL("ENTF") = SUM(INST,TRANSFER(INST,"ENTF")) + ENTFSAV.L;
INSTCOL("ADPUB") = SUM(I, PC.L(I)*GD.L(I)) + GOVSAV.L + SUM(INST, TRANSFER(INST,"ADPUB")) ;
INSTCOL("RDM") = SUM(I,E.L(I)*PE.L(I)*(1+TE(I)) ) + SUM(INST,TRANSFER(INST,"RDM"))
         + (ER.L-ERO)/ERO*SUM(INST,TRANSFER(INST,"RDM"))+ FSAV.L*ER.L ;
INSTROW("INFIN") = SUM(INST,TRANSFER("INFIN",INST))
       + (ER.L-ERO)/ERO*TRANSFER("INFIN","RDM");
INSTROW("ENTF")  = RETK.L("KFORM") + SUM(INST,TRANSFER("ENTF",INST))
       + (ER.L-ERO)/ERO*TRANSFER("ENTF","RDM")
       - (PVA.L("SERVPU")*XPTACT.L("SERVPU") - ACTSAL.L("SERVPU") ) ;
INSTROW("ADPUB") = TARIFF.L + DUTY.L + PRODTX.L + DSALETX.L + ISALETX.L + DIRTX.L
       + SUM(INST,TRANSFER("ADPUB",INST)) + ((ER.L-ERO)/ERO)*TRANSFER("ADPUB","RDM")
       + (PVA.L("SERVPU")*XPTACT.L("SERVPU") - ACTSAL.L("SERVPU") ) ;

*INSTCOL("RDM") = SUM(I,E.L(I)*PE.L(I)*(1+TE(I)) ) + SUM(INST,TRANSFER(INST,"RDM"))
*          + FSAV.L*ER.L ;
*INSTROW("INFIN") = SUM(INST,TRANSFER("INFIN",INST)) ;
*INSTROW("ENTF")  = RETK.L("KFORM") + SUM(INST,TRANSFER("ENTF",INST)) ;
*INSTROW("ADPUB") = TARIFF.L + DUTY.L + PRODTX.L + DSALETX.L + ISALETX.L + DIRTX.L
*        + SUM(INST,TRANSFER("ADPUB",INST)) ;

INSTROW("RDM") = SUM(I,PWM.L(I)*ER.L*M.L(I)) + SUM(INST,TRANSFER("RDM",INST)) ;

CHECK = SUM(H, (HHCOL(H)-HHROW(H))*(HHCOL(H)-HHROW(H)) )
      + SUM(INST,(INSTCOL(INST)-INSTROW(INST))*(INSTCOL(INST)-INSTROW(INST)) ) ;
DISPLAY HHCOL, HHROW, INSTCOL, INSTROW, CHECK ;

PARAMETER SAVROW, IVTCOL ;
SAVROW = SUM(H,SAVHH.L(H)) + ENTFSAV.L + INFINSAV.L + GOVSAV.L + FSAV.L*ER.L ;
IVTCOL = SUM(I, PC.L(I)*(ID.L(I)+DST.L(I)+GID.L(I)) ) ;
DISPLAY SAVROW, IVTCOL ;
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