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A Policy Model for Tunisia with Real and Financial Flows

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Country economists and developing country decisionmakers can use this model to analyze fiscal, debt, and incomes policies — and to derive implications for the exchange rate and for the availability of credit to the private sector. The extended model generates a complete flow of funds for each time period, along with projections of national accounts in current and constant prices. Elements of the extended model can be suppressed, changed, or further extended, making it a flexible tool for country economic analysis.

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This model was developed to provide a macro-economic framework for Tunisia's structural adjustment program and a flexible tool for further country economic analysis. As currently specified, it is designed to analyze fiscal, debt, and incomes policies, while deriving implications for the exchange rate and for the availability of credit to the private sector. Several policy experiments are carried out to illustrate this focus, and suggestions are offered for variations in model closure and detail.

The core model is a one-sector computable general equilibrium model that assumes imperfect substitution in production for export and domestic use — and imperfect substitution in expenditure on imports and domestically pro-

duced goods. It is based on a social accounting matrix and distinguishes government budgetary receipts and expenditures from such flows in the rest of the economy. A link with the Bank's country debt model is provided by assuming a fixed dollar resource gap for the projected years.

The extended model generates — for each time period — a complete flow of funds, along with projections of national accounts in current and constant prices. It distinguishes seignorage, or the growth in real money demand, from the inflation tax and can be used to define the growth in base money consistent with a target price level or, alternatively, an endogenous price level consistent with growth in base money.

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A POLICY MODEL FOR TUNISIA WITH
REAL AND FINANCIAL FLOWS

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A POLICY MODEL FOR TUNISIA WITH REAL AND FINANCIAL FLOWS

I. Introduction

Origin and purpose of the model

1. This paper describes a policy model for Tunisia with real and financial flows. The model was developed to provide (i) a macroeconomic framework for Tunisia's structural adjustment program; (ii) an analytical tool for a forthcoming case study on fiscal aspects of external debt; and (iii) a country model for the responsible Country Operations Department. The main purpose of the model is to introduce important analytical and policy variables into a consistent accounting framework which could be used to provide projections of real and financial flows. In particular, the model is designed to analyze fiscal, debt, and exchange rate issues. It can also be used to derive an endogenous price level and to distinguish seignorage and the inflation tax.

2. The model consists of a core computable general equilibrium (CGE) module which is extended to incorporate the existing tools of the country economist--namely, the detailed debt projections of the Revised Minimum Standard Model (RMSM) and the Holsen-type flow-of-funds model. The full model was developed as a practical tool--capable of reproducing the Tunisian Government's projections for the VIIth Plan (1987-91) and generating a number of counterfactual scenarios. It may, therefore, be of interest to others who plan to develop an economy-wide model for practical country-economic work.

3. In particular, the model was used to project a realistic macroeconomic scenario and provide a consistent set of indicators for monitoring Tunisia's structural adjustment program.¹ The indicators focus on three sets of goals--economic growth, external balance and debt reduction, and internal balance (employment and inflation). The projected assumptions about government policy and the external environment are defined so that the actual outcome can be explained and compared to the projected results. In addition, the model was used to explore the likely effects of alternative external and internal-policy developments. Several policy experiments illustrate this use.

4. To facilitate exposition, a more aggregated version of the original model is presented here. It omits the sectoral detail of the original model, but nevertheless distinguishes exports, imports, and non-traded goods. It also omits some of the disaggregated budgetary and external payments flows. An explanation of the closure rules chosen for Tunisia is accompanied by an indication of alternative closure rules and variations in modeling detail. One variation involves a more careful specification of the inflation tax, and Annex A provides an econometric estimate of the demand for money in Tunisia that can be used in projecting the increase in base money consistent with a target inflation, or the inflation implied by the increase in base money. Annex B describes some of the data and specification issues that arise

1/ The indicator tables developed with the model are included as Annex II in the President's Report on a Proposed Structural Adjustment Loan to Tunisia (May 20, 1988) Report No. P-4808-TUN.

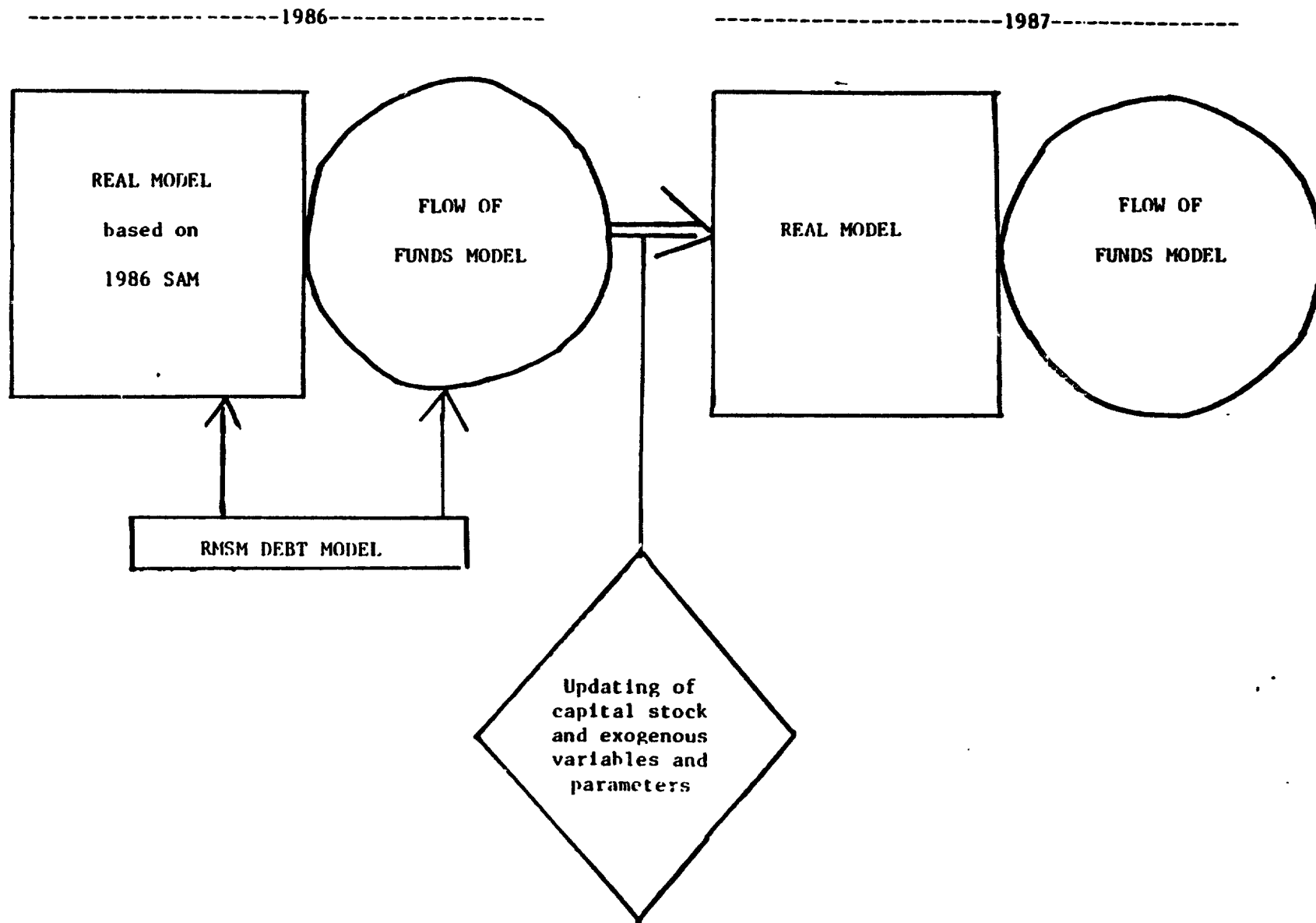
with sectoral disaggregation. Annex C provides a short description of the computer software used for the model and a listing of the program for the base year.

Overview of the model

5. The interest of this model is that it integrates key policy variables into a single, economy-wide model that conforms to the Bank's analytical needs to support a structural adjustment program--including detailed debt and debt service projections--and typical country-level data availabilities. This is facilitated by a link between the RMSM debt model and the core CGE model of the real economy, which provides current and constant price projections of the national accounts. Core model projections are made by obtaining successive within-period solutions after updating factor stocks, productivity parameters and exogenous variables. The extended model provides a complete flow-of-funds accounting system.

6. Figure 1 is a diagram of the model. The rectangle represents the input from RMSM; the square, the CGE core model; and the circle, the flow-of-funds extension. The key constraint in the within-period model is the level of foreign resource flows, which must be set a priori for any given scenario. Elements of the extended model can be suppressed, changed, or further extended, making it a flexible tool for country economic analysis. In particular, the model can be implemented in the core or the extended version, for one time period or multiple periods, for one sector or multiple sectors, and with or without econometric estimates for key parameters such as seignorage or investment demand.

FIGURE 1: DIAGRAM OF THE TUNISIA MODEL -DYNAMIC FLOW



7. A number of policy variables are incorporated in the model, even in the aggregated version:

Budgetary revenues (direct taxes, trade taxes, other indirect taxes)

Budgetary expenditures (government consumption, fixed investment, current and capital transfers)

Foreign borrowing level

International reserves level

Exchange rate

Money supply/price level

Credit availability for the non-government sector

Wage level

The policy measures are explicit or implicit, depending on the model closure. Simulation of alternative scenarios shows the impact of external shocks and the trade-offs among alternative policy measures.

8. Table 1 presents the flow-of-funds accounts produced by the extended policy model to illustrate the accounts and variables covered in the analysis. There are six accounts (Tables A-F)--the national accounts, the consolidated central government budget, the central bank, other financial institutions, the balance of payments (rest of the world), and the non-government,² non-financial sector. Each account satisfies a budget constraint (sources = uses of funds), and shows the variables that are included in the model. A characteristic of the flow-

^{2/} "Non-government" includes public enterprises, which could not be separated out from the private sector in a consistent way.

TABLE 1

TUNISIA POLICY MODEL: FLOW OF FUNDS PROJECTIONS

TABLE A : NATIONAL ACCOUNTS

(IN MILL. DINARS)

		1986	1987	1988	1989	1990	1991
	<u>SOURCES</u>	9696.2	10662.9	11497.9	12639.8	13995.5	15566.2
CGV	GOVERNMENT CONSUMPTION	1072.6	1171.3	1271.6	1372.1	1481.3	1599.3
CNGV	NON-GOVERNMENT CONSUMPTION 1/	4813.5	5264.3	5804.5	6302.3	6977.7	7820.7
IG	GOVERNMENT INVESTMENT (N.A)	357.0	374.9	389.8	405.4	421.7	438.5
ING	NON-GOVERNMENT INVESTMENT 2/	1292.0	1135.5	1305.6	1545.4	1790.0	1999.3
PE.E	EXPORTS GNFS	2161.2	2716.9	2726.4	3014.6	3330.8	3708.4
	<u>USES</u>	9696.2	10662.9	11497.9	12639.8	13995.5	15566.2
Y	DOMESTIC INCOME (GDP)	7025.2	7850.5	8444.8	9311.0	10331.7	11518.6
PM.M	IMPORTS GNFS	2671.0	2812.4	3053.1	3328.8	3663.8	4047.6

1/ TOTAL CONSUMPTION TAKEN FROM NATIONAL ACCOUNTS. NON-GOVERNMENT CONSUMPTION IS RESIDUAL.
 2/ INCLUDING CHANGES IN STOCKS.

TABLE B: CONSOLIDATED GOVERNMENT BUDGET

		(IN MILL. DINARS)					
		1986	1987	1988	1989	1990	1991
SOURCES		2012.4	2156.0	2287.0	2423.4	2582.4	2742.2
DTAX	DIRECT TAXES (INCL. OTHER TAXES)	454.6	511.8	544.3	597.9	661.1	732.0
ITAX	NET INDIRECT TAXES	921.0	984.8	1070.8	1166.0	1281.5	1414.8
OILR	OIL REVENUES	312.8	318.0	306.9	306.2	308.1	311.0
PCB	PROFITS OF CENTRAL BANK 1/	47.6	74.0	75.2	84.1	91.8	100.4
DOHCB	CHANGE IN OTHER ITEMS OF CENTRAL BANK 2/	5.7	0.0	0.0	0.0	0.0	
OR	OTHER REVENUES NET OF OTHER SUBSIDIES/TRANSFERS	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0
TOTAL REVENUE		1642.7	1789.6	1898.2	2055.2	2243.5	2459.2
DBGD	CHANGE IN GOV. NET DOMESTIC BORROWING	151.4	132.5	18.6	-29.2	33.5	69.1
DBGF	CHANGE IN GOV. NET FOREIGN BORROWING 3/	218.3	233.9	370.2	397.4	305.4	213.9
USES		2012.4	2156.0	2287.0	2423.4	2582.4	2742.2
CGV	GOVERNMENT CONSUMPTION	1072.5	1171.3	1271.6	1372.1	1481.3	1569.3
NGD	GOV. INTEREST PAYMENTS ON DOMESTIC DEBT	71.4	73.5	78.4	78.0	78.2	81.5
NGF	INTEREST PAYMENTS ON FOREIGN DEBT 3/	117.8	142.6	153.5	174.2	207.5	229.2
IG	GOVERNMENT INVESTMENT (N.A)	367.0	374.9	389.8	405.4	421.7	438.5
DOHFI	CHANGE IN OTHER ITEMS OF FIN. INST. 2/	136.6	0.0	0.0	0.0	0.0	0.0
EKO	OTHER CAPITAL EXPENDITURES	257.1	393.7	393.7	393.7	393.7	393.7

- 1/ FOR THE BASE YEAR 1986, ACTUAL TRANSFERS FROM THE CENTRAL BANK TO THE CONSOLIDATED CENTRAL GOVERNMENT BUDGET EXCEEDED PCB (OR NET INTEREST RECEIPTS) PLUS DOHCB. THE EXCESS IS INCLUDED IN "OTHER REVENUES".
- 2/ USED FOR CALIBRATION IN BASE YEAR ONLY. NOTE THAT A CHANGE IN STOCKS, E.G. DOHCB OR DBGD, IS INDICATED BY AN INITIAL D RATHER THAN THE GREEK DELTA.
- 3/ 1986 DATA ARE TAKEN FROM WORLD BANK DRS, WITH DBGD AND NGD ADJUSTED FOR DIFFERENCES WITH TUNISIAN DATA.

TABLE C: CENTRAL BANK

(IN MILL. DINARS)

	1986	1987	1988	1989	1990	1991
SOURCES						
DMB	8.0	86.8	62.5	91.1	107.4	124.8
NCCB	53.6	59.2	58.8	58.9	58.7	56.1
USES						
DNFA	-157.7	60.3	100.9	52.0	151.8	168.6
DCCB	160.0	28.5	-38.4	39.1	-44.4	-43.8
PCB	47.8	74.0	75.2	84.1	91.8	100.4
DOHCB	6.7	0.0	0.0	0.0	0.0	0.0

1/ CHANGE IN RESERVES FROM BOP IS USED FOR CHANGE IN NET FOREIGN ASSETS. AMOUNT APPEARING IN CENTRAL BANK BALANCE SHEET FOR 1988 WAS EQUAL TO -172 MD.

TABLE D: FINANCIAL INSTITUTIONS

(IN MILL.DINARS)

	1986	1987	1988	1989	1990	1991
SOURCES						
DDEP	229.0	358.3	258.1	376.1	443.1	515.3
DCCB	180.0	26.6	-38.4	39.1	-44.4	-43.8
NGD	71.4	73.6	78.4	78.0	78.2	81.5
DOTHFI	138.6	0.0	0.0	0.0	0.0	0.0
USES						
DBGD	151.4	132.5	18.6	-29.2	33.5	69.1
DBNGD	392.0	286.6	220.6	463.5	384.7	427.8
NCCB	53.6	59.2	58.9	58.9	58.7	56.1

1/ USED FOR CALIBRATION IN BASE YEAR ONLY.

TABLE E: REST OF THE WORLD

(IN MILL. DINARS)

		1986	1987	1988	1989	1990	1991
	SOURCES	2771.8	3166.4	3445.9	3692.2	4158.0	4586.7
PM.M	IMPORTS GNFS	2671.0	2812.4	3053.1	3328.8	3663.8	4047.6
NGF	GOV. INTEREST ON FOREIGN DEBT	117.8	142.6	153.5	174.2	207.5	229.2
NNGF	NON-GOV. INTEREST ON FOREIGN DEBT	140.7	151.1	138.4	137.2	134.9	141.3
DNFA	CHANGE IN NFA OF CENTRAL BANK	-157.7	60.3	100.9	52.0	151.8	168.6
	USES	2771.8	3166.4	3445.9	3692.2	4158.0	4586.7
PE.E	EXPORTS GNFS	2161.2	2716.9	2726.4	3014.6	3330.8	3708.4
NCBF	NET CB INTEREST RECEIPTS FROM ABROAD	-6.0	14.8	16.3	25.2	33.1	44.3
NFT	NET FACTOR RECEIPTS/TRANSFERS	214.6	255.4	221.8	232.9	257.7	269.7
DFIO	DIRECT FOREIGN INVESTMENT, GRANTS & OTHERS	150.5	-37.8	123.2	134.6	174.5	203.0
DBGF	CHANGE IN GOV. NET FOREIGN BORROWING	218.3	233.9	370.2	397.4	305.4	213.9
DBNGF	CHANGE IN NON-GOV. NET FOREIGN BORROWING	33.2	-16.8	-12.0	-112.5	56.5	147.4

TABLE F: NON-GOVERNMENT NON-FINANCIAL SECTOR

		(IN MILL. DINARS)					
		1986	1987	1988	1989	1990	1991
	SOURCES	8072.6	8711.6	9392.1	10423.2	11598.8	12960.2
Y	DOMESTIC INCOME (GDP)	7025.2	7850.5	8444.8	9311.0	10331.7	11518.6
EKO	OTHER CAPITAL EXPENDITURES	257.1	393.7	393.7	393.7	393.7	393.7
NFT	NET FACTOR RECEIPTS/TRANSFERS	214.6	255.4	221.8	232.9	257.7	269.7
DFIO	DIRECT FOREIGN INVESTMENT, GRANTS & OTHERS	150.5	-37.8	123.2	134.8	174.6	203.0
DBNGF	CHANGE IN NON-GOV. NET FOREIGN BORROWING	33.2	-16.8	-12.0	-112.5	56.6	147.4
DBNGD	CHANGE IN DOMESTIC CREDIT TO NON-GOV.	392.0	266.6	220.6	463.5	384.7	427.8
	USES	8072.6	8711.6	9392.1	10423.2	11598.8	12960.2
CNGV	NON-GOVERNMENT CONSUMPTION	4813.5	5264.3	5804.6	6302.3	6971.7	7820.7
ING	NON-GOVERNMENT INVESTMENT	1292.0	1135.5	1305.6	1545.4	1790.0	1999.3
DDEP	CHANGE IN DEMAND & TIME DEPOSITS	229.0	358.3	258.1	376.1	443.1	515.3
DMB	CHANGE IN MONEY BASE	8.0	86.8	62.5	91.1	107.4	124.8
NNGF	NON-GOV. INTEREST ON FOREIGN DEBT	140.7	151.1	138.4	137.2	134.9	141.3
DTAX	DIRECT TAXES (INCL. OTHER TAXES)	464.6	511.8	544.3	597.9	661.1	732.0
ITAX	INDIRECT TAXES	921.0	984.8	1070.8	1166.0	1281.5	1414.8
OILR	OIL REVENUES	312.8	318.0	306.9	306.2	308.1	311.0
OR	OTHER REVENUES NET OF OTHER SUBSIDIES/TRANSFERS	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0

of-funds accounts is that each variable is entered twice--once as a "source" and once as a "use". The accounts are generated in nominal terms, but constant price national accounts are subsequently derived.

9. The core CGE model defines the national accounts (Table A) and the current accounts of the consolidated government budget (Table B) and the balance of payments (Table E). The model can be used alone or extended to incorporate financial flows. Aside from the national accounts identity itself, the core model reflects two key assumptions. The first assumption is that investment is savings determined:

$$I = SG + SNG + ER * F\$, \quad (1)$$

where I is investment; SG, government (budgetary) savings; SNG, non-government savings; ER, the exchange rate; and F\$, the current account deficit expressed in foreign currency.³ Given the importance of fiscal policy and the external debt overhang in Tunisia--as in many of the Bank's borrowing countries--the model distinguishes the budgetary and external payment flows which influence SG and ER * F\$.

10. The second assumption behind the core model is that the government sets a target for the current account dollar deficit (F\$), which it achieves through a flexible exchange rate.³ This assumption is a good approximation to the development planning approach, where F\$ is seen as a key factor in both internal and external balance. Once F\$ is set, equation 1 implies that changes in the exchange rate will affect domestic savings and investment so that F\$ is reached. A fixed F\$ is also a convenient closure rule, which permits the integration of output from the RMSM debt model into a policy simulation model.

3/ Alternative assumptions are discussed in Section II under variations in closure and detail.

11. The link with the RMSM debt model can be explained in terms of the following equation for a fixed dollar resource gap, or net import level:⁴

$$(\overline{PM\$} \cdot M - \overline{PE\$} \cdot E) = \overline{F\$} - \overline{NGF\$} - \overline{NNGF\$} + \overline{NCBF\$} + \overline{NFT\$} \quad (2)$$

This equation is included in the core CGE model, but all the barred variables originate in RMSM. Tunisia is assumed to be a price-taker in both its export and import markets, and international prices (PE\$, PM\$) are projected on the basis of anticipated world market trends. The current account deficit, F\$, is set based on desired and/or feasible levels of foreign borrowing and changes in international reserves, which are themselves fixed in the RMSM debt model. The fixed dollar resource gap is then defined residually taking into account RMSM projections of international interest payments (NGF\$, NNGF\$) and receipts (NCBF\$), as well as other net current receipts/transfers (NFT\$).

12. Equation 2 is used to determine the exchange rate consistent with the fixed resource gap. This is possible since both E and M are determined endogenously as a function of the exchange rate elsewhere in the core CGE model. In fact, although initial projections of imports and exports, consistent with the fixed resource gap, are used in RMSM, a fixed resource gap is compatible with different levels of M and E. The equilibrium levels of M and E projected in the core CGE model will differ from the RMSM projections as they will depend on a variety of factors, including their elasticities with respect to the exchange rate.

^{4/} A bar identifies an exogenously determined variable entering the core CGE model.

In general, low elasticities will require a significant movement in the exchange rate to achieve the fixed resource gap, and high elasticities, only a small movement.

13. The extended model incorporates the capital accounts of the budget (Table B) and of the balance of payments (Table E), the accounts of the central bank (Table C) and other financial institutions (Table D), and the account for the non-government, non-financial sector (Table F), which is defined residually. It features two additional key assumptions. The first is based on the simplified accounting rule that is typically the basis for IMF financial programming. This rule states that the change in credit to non-government (ΔBNGD) will equal the difference between: (a) the increase in base money (ΔMB) and bank deposits (ΔDEP), net of reserve accumulation (ΔNFA), and (b) the increase in government borrowing (ΔBGD):

$$\Delta\text{BNGD} = (\Delta\text{MB} + \Delta\text{DEP} - \Delta\text{NFA}) - \Delta\text{BGD} \quad (3)$$

Ignoring interest flows and other items net, this equation is equivalent in Tunisia to the combined budget constraints of the Central Bank (Table C):

$$\Delta\text{CCB} = \Delta\text{MB} - \Delta\text{NFA} \quad (3a)$$

and other financial institutions (Table D):

$$\Delta\text{BNGD} = \Delta\text{DEP} + \Delta\text{CCB} - \Delta\text{BGD} \quad (3b)$$

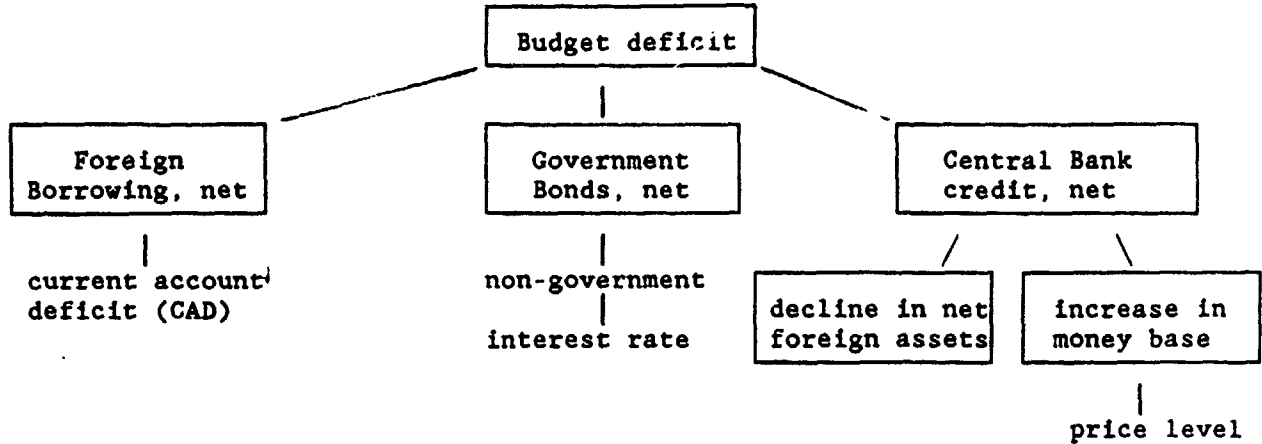
where ΔCCB represents the change in Central Bank credit to other financial institutions.

14. Figure 2 illustrates the difference between the standard model of budgetary financing and how the Tunisia model has been adapted to reflect the institutional characteristics of that country. As shown in Figure 2A, the standard model assumes three options for financing the

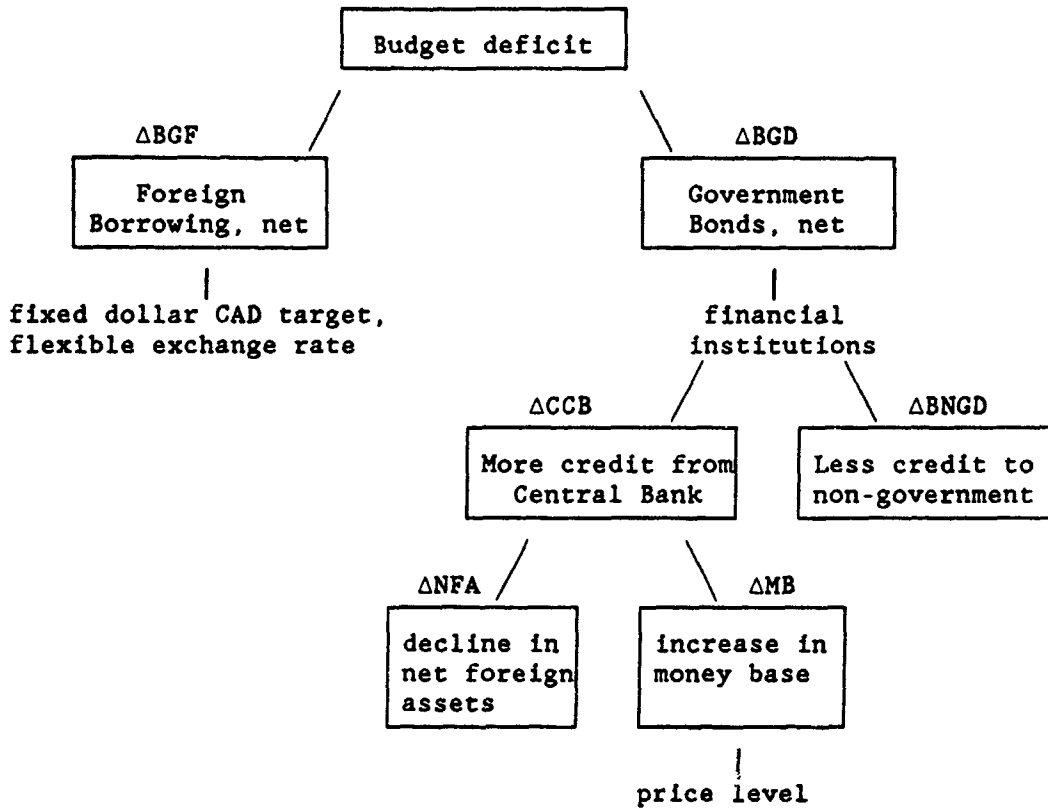
Figure 2

FINANCING THE BUDGET DEFICIT

A. STANDARD MODEL



B. TUNISIA MODEL



deficit: foreign borrowing, government bonds which are sold to the general public, and credit from the Central Bank. This last can be financed by the local currency counterpart to a drawdown in net foreign assets or by an increase in money base.

15. As shown in Figure 2B, the financing of the budget deficit occurs somewhat differently in Tunisia, for institutional reasons. First, given Tunisia's sizeable external debt, the government sets a fixed dollar target for the current account deficit, and hence a fixed level of foreign borrowing. This target is to be achieved by a flexible exchange rate. Second, there is virtually no direct monetization of the deficit through Central Bank credit. And third, government bonds are not sold to the private sector, so there is no direct interest rate effect through this mechanism.⁵

16. The portion of the Tunisian budget deficit not covered by foreign borrowing is financed largely in the form of government development bonds (BGD) placed with the financial institutions--mainly the banks. With liquidity thus restricted, the banks must either curb credit to the non-government sector (BNGD) or replenish their liquidity through credit from the Central Bank (CCB). During 1985 and 1986, credit from the Central Bank was largely financed through the drawdown of net foreign assets (NFA). Fortunately, the strong export performance in 1987 helped to replenish reserves; otherwise, additional credit could

5/ In the past, interest rates have been fixed administratively. Now, the government is introducing some flexibility in interest rates, but little is known about interest sensitivities. Interest rates are used in the model for accounting purposes, without any behavioral consequences.

only be financed by issuing new currency--an indirect monetization of the deficit. Since there is a risk that this financing method will be resorted to increasingly in the future, a money demand function is incorporated in the extended model to distinguish between the demand for real base money and the inflation tax.

17. Thus, the second key assumption of the extended model is that there is equilibrium in the money market, and hence a consistent link between money and prices. The change in supply of base money (ΔMB) is set equal to the change in demand, which is a function of the demand for real base money, or seignorage, and the inflation tax:

$$\Delta MB = f(\text{seignorage}, \Delta P) \quad (4)$$

18. Since the Central Bank of Tunisia is assumed to exercise full control of the money supply--through its residual adjustment of ΔCCB (equation 3a)--it can achieve its target inflation. Of course, ΔCCB will in turn influence the financial resources of the banking system, and hence total credit available for the government and non-government sectors. There is, then, a one-for-one trade off in credit to government and non-government, and the cost of a higher government deficit is lower credit to the non-government sector. Thus, for a given level of foreign borrowing, the incorporation of the money demand function permits a perspective on the trade-offs between revenue mobilization, expenditure reduction, the inflation tax, and restricted credit to the private sector as alternative policies in the adjustment effort.

19. The following two sections present, in more detail, the core CGE model for the real sector (Section II) and the extended model incorporating financial flows (Section III). A further extension of the

model to incorporate a separate investment function (with residual foreign or domestic savings) would enrich the behavioral content of the model. Given the flow-of-funds detail of the extended model, in which private sector credit (ΔBNGD) is derived residually, it would be particularly interesting to investigate the link between credit availability and private sector investment in Tunisia, as was done for Turkey by Chhibber and van Wijnbergen (1988). Some suggestions on how these and other micro-macro linkages might be formally introduced into the model are given in Bourguignon, Branson, and de Melo (1988).

II. The Real Model

The SAM and other data

20. A social accounting matrix (SAM) for the base year is required to calibrate the equations of the real model. The minimum needs for the Tunisia model are shown in Table 2, which is constructed from budgetary and national accounts data. As usual (see Pyatt and Round, 1985), receipts are shown in rows and expenditures in columns. Thus, each column and row in the matrix represents an account; and, since the sums of the corresponding rows and columns of a SAM must be equal, each account is subject to a budget constraint.

21. The core model, and therefore the SAM, distinguishes two factors of production: capital and labor; two institutions: government (actually, the consolidated central government budget) and non-government (the rest of the economy); a separate capital account for these two institutions; one activity (gross output at factor cost); four commodities: domestically produced goods for domestic use, imports, exports, and a composite good, which is an aggregation of the first two;

AGGREGATED SOCIAL ACCOUNTING MATRIX FOR TUNISIA 1986

TABLE 2

(IN MILL. DINARS)

FACTOR OF PRODUCTION	INSTITUT. CURR. ACC.	NET INDIRECT TAXES	CAPITAL ACCOUNT		ACTIVITIES		PRODUCTION ACCOUNT - COMMODITIES		REST OF THE WORLD	TOTAL REVENUES	TOTAL EXPENDIT				
			GOV. NON-GOV.	TRADE TAXES	GOVERN. N-GOV.	SAVINGS SAV.BC SAV.AC	DOMESTIC IMPORTS	EXPORTS				COMPOSITE			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
LABOR	815.6								1885.9						
CAPITAL															
INST. CURR. ACC.															
3 GOVERNMENT															
4 NON-GOV.	2701.5	3089.9	400.2						312.8						
NET IND. TAXES															
5 TRADE TAXES															
6 OTH. TAXES									437.3						
CAPITAL ACC.															
7 GOV. SAVINGS		381.0													
8 N-GOV. SAV. BC			708.3												
9 N-GOV. SAV. AC															
COMMODITIES															
11 DOMESTIC															
12 IMPORTS															
13 EXPORTS															
14 COMPOSITE															
15 REST OF WORLD															
16 TOT. EXPEND.	2701.5	3089.9	4400.2	322.6	598.4	357.0	1268.0	10644.1	8926.7	3148.2	12074.9	2929.5	58806.7	0.0	58806.7

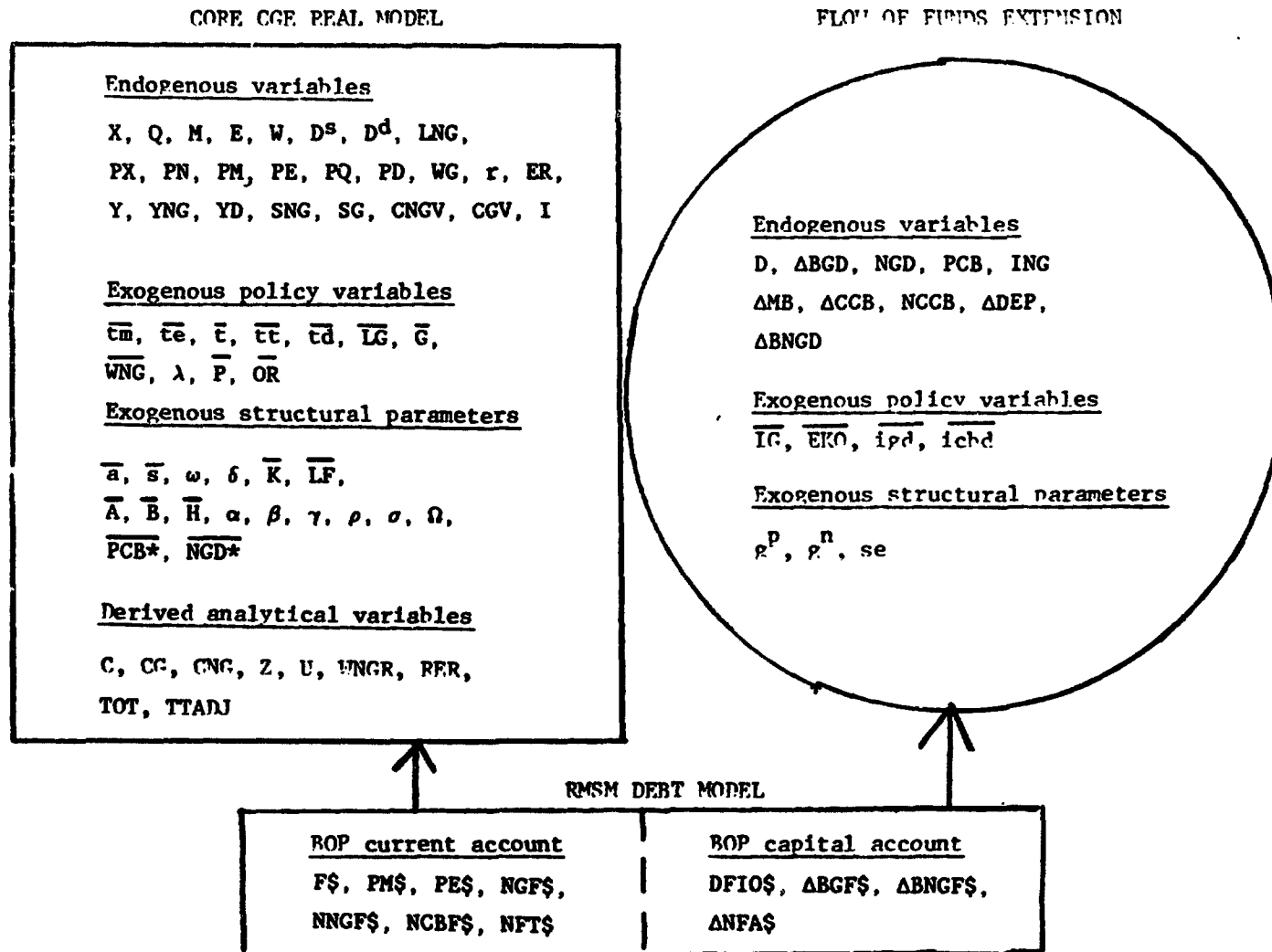
and the rest of the world. Net indirect taxes on the various commodities are shown in rows 5 and 6, and government salaries are shown at the intersection of row 1 and column 3. The intersections of row/column 3/4 and 4/3 show respectively direct taxes and transfers between government and non-government on a net basis.

22. Row/column 8 is non-standard for a SAM and is used to show non-government savings and potential non-government investment before crowding-out (BC) by government investment. Row/column 9 is used to show non-government investment after crowding-out (AC). This distinction is required where savings do not equal investment by the same institution. In the base year, the amount of government crowding out is shown to be negative by 24 million dinars (see the intersection of row 7 and column 8), as government savings are higher than government investment.

23. The SAM entries establish the base year values for all the variables which are defined as flows as well as for parameters such as the effective tax and interest rates and the distribution shares for the production function, import demand, and export supply functions. Supplementary data are required on employment and capital stock to define the factor inputs for the production function. Elasticities of substitution and transformation take into account partial country estimates where available but generally reflect plausible global responses and cross-country evidence.

Model specification

24. Figure 3 provides a diagram of the within-period core CGE model, with an indication of the variables determined and the links with both the RMSM debt model and the flow of funds extension. As explained



* PCB and NGD are defined endogenously in the extended model.

a/ See Table 3 for definition of variables and parameters.

previously, the output of the RMSM debt model is entered exogenously into the policy model, with current account variables entering directly into the CGE model and capital account variables entering into the flow-of-funds extension. The dinar value of these dollar amounts is affected by the endogenously determined exchange rate.

25. Endogenous variables in the core CGE model are identified in Figure 3 as quantities, prices, and values. Exogenous policy variables consist of factors affecting budgetary revenues and current expenditures; the non-government average wage, which is influenced by minimum wage levels; and the target inflation rate. Additional policy variables in the flow-of-funds extension include budgetary capital expenditures and interest rates on government bonds and Central Bank credit. These, as well as other policies affecting financial flows, will ultimately affect the residual amount of credit available to firms and households.

26. Table 3 gives the complete set of equations and variables used for the within-period core CGE model and shows the updating required for the intertemporal linkages. An important feature of the model is the production of both a current and constant price series for the national accounts. Constant price accounts are used to show changes in the real economy, and current price accounts are used for the flow of funds analysis. The core CGE model consists of 25 equations, which can be grouped under six headings as follows:

a) Production technology

27. The supply of non-government gross output (1) is given by a constant elasticity of substitution (CES) production function with capital and labor as inputs. It has the property of constant returns to

Table 3

THE CORE CGE MODEL FOR TUNISIA
WITH BUDGET AND EXTERNAL FLOWS

I. EQUATIONS 1/

A. Within period

a) Production technology

$$(1) \quad X = \bar{A} [\alpha ((LNG))^{-\rho} + (1-\alpha) (\bar{K})^{-\rho}]^{-1/\rho}$$

$$(2) \quad W = \bar{a}X$$

$$(3) \quad PX = (PD \cdot D^S/X) + (PE \cdot E/X)$$

$$(4) \quad PN = PN_0 \cdot \bar{P} \quad \text{(used as numeraire)}$$

b) Factor markets

$$(5) \quad WG = \lambda \overline{WNG}$$

$$(6) \quad r = [PN(1-\omega) \cdot X - WNG \cdot LNG]/K$$

$$(7) \quad LNG = \bar{A} \frac{(-\rho/1+\rho)}{[\frac{\alpha \cdot PN (1-\omega)}{WNG}]}^{(1/1+\rho)} \cdot X$$

c) Domestic product market

$$(8) \quad D^d = \bar{B}(\sigma-1) \cdot (1-\beta)^\sigma \cdot [PQ/PD(1+\bar{\tau})]^\sigma \cdot Q$$

$$(9) \quad D^S = \bar{H}(\Omega-1) \cdot \gamma^{-\Omega} \cdot [PD/PX]^\Omega \cdot X$$

$$(10) \quad D^d = D^S \quad \text{(determines PD)}$$

$$(11) \quad PQ = ((1+\bar{\tau}) PD \cdot D^d/Q) + (PM \cdot M/Q)$$

$$(12) \quad PQ \cdot Q = CGV + CNGV + I + PQ \cdot W \quad \text{(determines Q)}$$

d) Foreign Trade

$$(13) \quad PM = ER \cdot \overline{PM\$} \cdot (1 + \overline{tm}) \cdot (1 + \overline{\tau t})$$

1/ A bar over a variable e.g. \overline{NGD} , means that this variable is exogenous to the model. Exogenous variables which become endogenous in the model extension are subsequently shown without a bar. (Bars are also used on roman letters to indicate parameters).

$$(14) \quad PE = ER \cdot \overline{PE\$} / (1 + \overline{te})$$

$$(15) \quad M = \overline{B}(\sigma-1) \cdot \beta^\sigma \cdot (PQ/PM)^\sigma \cdot Q$$

$$(16) \quad E = \overline{H}(\Omega-1) \cdot (1-\gamma)^{-\Omega} \cdot (PE/PX)^\Omega \cdot X$$

$$(17) \quad \overline{F\$} = \overline{PM\$} \cdot M - \overline{PE\$} \cdot E + \overline{NGF\$} + \overline{NNGF\$} - \overline{NFT\$} - \overline{NCBF\$} \quad (\text{determines ER})$$

e) Income and consumption

$$(18) \quad Y = PN \cdot X + WG \cdot \overline{LG} + ITAX$$

$$(19) \quad YNG = (1-\omega)PN \cdot X + WG \cdot \overline{LG} + ER \cdot (\overline{NFT\$} + \overline{NCBF\$} - \overline{NNGF\$})$$

$$(20) \quad YD = (1-\overline{td}) YNG - \overline{OR} - \overline{PCB} + \overline{NGD}$$

$$(21) \quad CNGV = YD - SNG - WG \cdot \overline{LG}$$

$$(22) \quad CGV = WG \cdot \overline{LG} + PQ \cdot \overline{G}$$

f) Savings and investment

$$(23) \quad SNG = \overline{s} \cdot YD$$

$$(24) \quad SG = DTAX + ITAX + OILR + \overline{PCB} + \overline{OR} - CGV - \overline{NGD} - (ER \cdot \overline{NGF\$})$$

$$(25) \quad I = SNG + SG + (ER \cdot \overline{F\$})$$

B. Analytical variables and definitions

$$RER = ER \cdot (\overline{PE\$}/PD) \text{ or weighted average of } \overline{PE\$} \text{ and } \overline{PM\$} \text{ over PD.}$$

$$TOT = (\overline{PE\$}/\overline{PM\$})$$

$$TTADJ = (\overline{PE\$} \cdot E) / (\overline{PM\$}/\overline{PM\$}_0) - (\overline{PE\$}_0 \cdot E)$$

$$WNGR = \overline{WNG}/\overline{P}$$

$$U = \overline{LF} - LNG - \overline{LG}$$

$$C = Y/P + ER_0 (\overline{PM\$}_0 \cdot M - \overline{PE\$}_0 \cdot E) - Z$$

$$CG = \overline{G} + WG_0 \cdot \overline{LG}$$

$$CNG = C - CG$$

$$Z = I/PQ$$

definitions

$$ITAX = (\overline{tm} + \overline{tt} + \overline{tt} \cdot \overline{tm}) (ER \cdot \overline{PM\$} \cdot M) + (\overline{t} \cdot PD \cdot D^d) \div (\overline{te} \cdot PE \cdot E)$$

$$DTAX = \bar{t}d \cdot YNG$$

$$OILR = \omega \cdot PN \cdot X$$

$$CGV = PQ \cdot \bar{G} + WG \cdot \bar{LG}$$

C. Dynamic linkages

Real Capital stock

$$K_t = (1-\delta) K_{t-1} + Z_t$$

Balance of payments current account variables to be obtained from RMSM

$$\begin{array}{cccc} \overline{PM\$} & \overline{NGF\$} & \overline{NCBF\$} & \overline{F\$} \\ \overline{PE\$} & \overline{NNGF\$} & \overline{NFT\$} & \end{array}$$

Other exogenous variables and parameters to be updated

$$\begin{array}{ccc} \overline{WNG} & \overline{NGD} & \bar{A} \\ \bar{P} & \overline{PCB} & \\ \overline{LF} & \overline{OR} & \\ \overline{LG} & \bar{G} & \end{array}$$

II. DEFINITION OF VARIABLES

Prices

- PM, PM\$: Domestic and world price for imports
- PE, PE\$: Domestic and world price for exports
- PX : producer price of gross output
- PN : net price (and numeraire)
- PQ : composite good price
- PD : price of domestically produced goods for domestic use
- WNG, WG : average nominal wage for non-government and government workers

r : average return on capital
ER : nominal exchange rate
P : GDP deflator/100

Quantities

X : non-government product supply
Q : composite good or gross expenditure volume
M : import demand
E : export supply
CG, CNG, C : government, non-government, and total consumption
G : government purchases of non-labor goods and services
Z : volume of investment
W : intermediate demand
D^s, D^d : supply of and demand for non-traded goods
LF : labor supply
LNG, LG : demand for non-government labor, demand for government labor
K : capital stock

Values

Y : gross domestic product
YNG : income of non-government sector
YD : disposable income of non-government sector
SNG, SG : national savings of non-government and government
CNGV, CGV : consumption of non-government and government
I : level of investment
F\$: current account \$ deficit (foreign savings)

NGF\$, NNGF\$: foreign \$ interest payments by government and non-government
NCBF\$: central bank net \$ interest receipts
NFT\$: other net \$ current receipts, including workers remittances, and other current services and transfers in the balance of payments
NGD	: domestic interest payments by government
PCB	: profits of the Central Bank
OR	: other budgetary revenues net of other current transfers

Parameters

\bar{a}	: I-O coefficient
$\bar{A}, \bar{B}, \bar{H}$: shift parameters for CES and CET functions
\bar{s}	: savings rate of the non-government sector
λ	: wage differential for government workers
α, β, γ	: distribution parameters for CES and CET functions
ρ	: CES production function exponent (derived from assumed elasticity of substitution between capital and labor)
σ	: CES Armington import function exponent (derived from assumed income compensated price elasticity of demand for imports)
Ω	: CET export function exponent (derived from assumed income compensated price elasticity of supply of exports)
\bar{t}_m, \bar{t}_e	: import tariffs, export taxes
\bar{t}, \bar{t}_t	: net indirect taxes on domestic goods and imports
\bar{t}_d	: direct taxes
ω	: government direct share in value-added
δ	: depreciation rate for capital stock

Analytical and definitional variables

RER	: real exchange rate
TOT	: international terms of trade
TTADJ	: terms of trade adjustment
U	: unemployment
WNGR	: real wage
ITAX	: indirect taxes net of subsidies
DTAX	: direct taxes
OILR	: government oil revenues
CGV, CNGV	: value of government and non-government consumption

scale, and profit maximizing behavior ensures that value added is exhausted by distribution to the factor inputs. The fixed-coefficient technology for intermediate inputs (2) defines intermediate good demand and is reflected in the shift parameter (A) in (1) by calibration in the base year.⁶ The price of gross output (3) is shown to be a weighted average of the prices of its two uses, domestic supply and export.⁷ The net price (4), or price of value added, is set equal to its value in the base year ($PN = (1-a) * PX$) and thereafter used as the numeraire. It is adjusted in subsequent years in line with its index, the GDP deflator. There is no link between money and prices in the core CGE model, and this index must be entered exogenously.

b) Factor markets

28. Government labor demand (LG) is set exogenously by government policy, as is the government wage (5) which is assumed to be a constant multiple of the non-government wage. With a fixed capital stock within period, the return to capital (6) is defined residually to exhaust the value added of non-government. The wage of non-government workers is assumed here to be fixed in nominal terms, to reflect directly the government's planned nominal increase in the minimum wage; however, it could also be fixed in real terms or by wage indexation based on lagged changes in the price level. With a fixed wage, the demand for non-

6/ The shift parameters A, B and H are used to reconcile non-linear equations with accounting identities in the base year. Variations in a shift parameter from year to year can be used to reflect technological change.

7/ All prices and the exchange rate are set equal to one in the base year except $PM\$, PE\$, PM, PE, PN$, which are fixed parametrically to satisfy accounting identities.

government labor (7) is given by the first order condition for profit maximization--that the wage equal the value of the marginal product of labor--as derived from the above production function.

c) Domestic product market

29. The demand for domestically produced goods for the domestic market, D, is derived from the demand for the composite good, Q, which aggregates imports and D under the Armington assumption of imperfect substitutability. The derived demand for D (8) is thus the first order condition of the CES function for Q. The supply of D (9) satisfies the first order condition of a constant elasticity of transformation (CET) function for X, reflecting imperfect substitution in production for the domestic and export markets. The price of D is determined through the market clearing equation (10) for supply and demand. The price of the composite good, Q, is a weighted average of its two component prices (11), and the volume of Q is determined through the market clearing equation (12), which shows the demand for Q in terms of government and non-government consumption, investment, and intermediate good demand.

d) Foreign trade

30. The domestic prices of imports (13) and exports (14) depend on the exogenously given world market prices adjusted by trade and other indirect taxes and the endogenous exchange rate. This is the traditional, small-country assumption. Like D, the quantity of imports (15) is derived from the demand for Q. The effect of quantitative restrictions is reflected in the parameters of the demand function; an explicit treatment is suggested in para 37 below. The quantity of exports (16) is given by the first order condition of the CET function

and responds to the relative prices for export and domestic use. The exchange rate is derived endogenously to produce the volume of imports and exports consistent with a target "resource gap", or net import level (17).

e) Income and consumption

31. Gross domestic product at market prices (18) is defined as the sum of value added by non-government; value added by government, as measured by government wage payments; and net indirect taxes. Non-government income (19) is defined as total value added, less the government's share of oil profits, plus non-government net factor service income from abroad and current transfers. Non-government disposable income (20) is defined net of direct taxes and other government revenues. The value of non-government consumption (21) is equal to the portion of disposable income which is not saved and not spent on government services. The value of government consumption (22) is equal to government payments for wages and goods and services.

f) Savings and investment

32. Non-government savings (23) is assumed to be a constant fraction of disposable income, since the estimated marginal savings rate is not significantly different from the average savings rate. Government budgetary savings (24) reflect the evolution of direct and indirect revenues and current expenditures. Nominal investment (25) is savings determined.

33. In addition to the 25 equations just described, Table 3 defines several analytical variables--namely the real exchange rate, the international terms of trade, the terms of trade adjustment (for calculating gross national income and savings at constant prices for the

Bank's standard attachments), the real wage, unemployment, real consumption and real investment. The last two are required to complete the national accounts in constant prices. The definitions are used to simplify the expressions of some within-period equations. For projections, the dynamic linkages requires updating the value of real capital stock, the balance of payments variables, and other exogenous variables and parameters, as shown at the end of Table 3.

Variations in closure and detail

34. The model closure features an exogenously determined foreign resource gap, and hence foreign borrowing level; an exogenous nominal wage rate and price level, and hence real wage; and a fixed non-government savings rate. Domestic interest rates are specified as fixed in nominal terms. The exchange rate, employment, and investment, which is savings driven, are all determined endogenously.

35. Several alternative model closures could be substituted for the one specified here. A more Keynesian view of the Tunisian economy would put emphasis on investment incentives, with savings adjusting residually. Investment might, for example, be specified as a function of the expected rate of return and the relative cost of borrowing. It might also be specified in terms of credit availability --which is here recommended for monitoring through the flow-of-funds analysis. Econometric work should be carried out to investigate the plausibility of these hypotheses for any given country. Once the determinants of investment have been identified, the closure rule can be modified to allow the residual calculation of domestic savings. Residual calculation of foreign savings would only be possible through discrete iteration between the RMSM debt model and the policy model.

36. A common alternative specification to a flexible exchange rate is a fixed exchange rate. This can be accommodated along with the target fixed dollar resource gap by assuming achievement of the latter through adjustments in quantitative restrictions. Although estimates of the premia on imports accruing to the private sector from import rationing are difficult to obtain, equation (17) in Table 3 can be used to identify the change in premia required to obtain a target dollar resource gap with a fixed exchange rate. Such a closure rule might be appropriate, for example, under circumstances of a windfall in foreign exchange availabilities simulated below. As explained above, a scenario calling for a fixed exchange rate and an endogenous dollar resource gap could only be achieved with this model by discrete iterations between the debt and policy models.

37. A more classical view of the economy might lead to an alternative closure rule for employment. Instead of specifying a fixed average wage and endogenous employment, it would be possible to specify an upward sloping supply curve of labor and an endogenously determined wage. This specification did not seem appropriate for Tunisia under present circumstances of high unemployment.

38. The most obvious modification in detail would be the disaggregation of the model presented here into two or more activities. This would require the following data inputs: (i) an intermediate consumption table; (ii) detailed national accounts, giving factor payments, imports, exports, and net indirect taxes by sector; (iii) sectoral investment allocation and demand shares; (iv) sectoral consumption shares by government and non-government; and (v) sectoral employment and capital stock. The original model in support of

Tunisia's structural adjustment program was implemented for three sectors--agriculture, energy, and other--and therefore gives considerably richer results than the illustrative experiments shown here for one activity. Data and specification issues in sectoral disaggregation are discussed in Annex B.

Policy analysis

39. Table 4 reports on several within-period experiments to illustrate the potential for policy analysis. Column 1 provides the actual 1986 values for the base case, and columns 2-4 show the percent changes associated with each experiment. In the first experiment, the

Table 4

WITHIN-PERIOD POLICY EXPERIMENTS FOR THE CORE MODEL

	(1) BASE CASE	(2) INCRS IN CAD (\$300 m)	(3) 5% INCRS IN REAL WAGE	(4) 10% INCRS IN GOV CONS
	Level (MD) -----percent change from base-----			
GDP @ market prices	7025	0	-1	1
Investment	1649	15	-4	-6
Consumption	5886	0	0	3
Exports GNFS	2161	-6	-2	0
Imports GNFS	2671	3	-1	0
National savings	1089	2	-6	-8
(government)	(381)	(6)	(-16)	(-26)
Foreign savings	560	34	0	0
Real exchange rate (\$/D) (trade weighted index)	100	4	0	0
	-----percent-----			
Unemployment rate	14.5	14.5	17.1	12.8

current account deficit (CAD) is increased by \$300 million, as a result of additional capital inflows. By definition, foreign savings rise, as does investment, which is savings determined. The additional financing permits a larger resource gap and an appreciation of the real exchange rate. Imports rise and exports drop. Government savings also rise, in part because of the higher tax receipts from customs duties and other indirect taxes on imports, but there is little effect on GDP as new investment will only change the capital stock, and hence output, in the subsequent period.

40. Although not shown in the table, the same experiment with lower elasticities of export supply and import demand is also of interest. This experiment leads to a stronger appreciation of the dinar, lower employment, and lower GDP. Investment is 7 percent higher than in the base case but 7 percent lower than in the same experiment with higher trade elasticities. This is due primarily to the negative tax effects--which influence government savings--of lower GDP and an exchange rate appreciation. In either case, the pay off to additional borrowing would depend on its long run cost and benefits.

41. In the second experiment, real wages--both government and non-government--are increased by 5 percent. As a result, the unemployment rate rises from 14.5 percent in the base case to 17.1 percent. GDP declines and is accompanied by lower exports and imports. The larger government wage bill leads to a drop in government savings, and thus in investment. In the third experiment, government increases consumption by 10 percent--namely, through higher employment and purchase of goods and services. This expansionary policy lowers the unemployment rate and raises GDP. However, higher budgetary current expenditures lower

government savings and hence investment. Thus, higher GDP in the current period will be achieved at the expense of a lower capital stock and future growth.

42. Within-period experiments can also be made with alternative tax rates. As shown in Table 3, the model distinguishes direct taxes, trade taxes, and other indirect taxes. The effects of variations in these tax rates are particularly interesting in a multi-sector model.

III. Incorporating Financial Flows

Data needs and data adjustments

43. The additional data needs for the completion of the flow-of-funds accounts presented in Table 1 are perhaps best seen by reviewing the list of new stock and flow variables in Table 5.⁸ They include aggregated assets and liabilities for the financial sector, capital account items for the budget and the balance of payments, and interest rates on domestic debt. The Central Bank is identified as a separate account because of its important role in holding international reserves and creating money base. Investment banks and specialized savings institutions are aggregated with deposit money banks to create a single comprehensive account for other financial institutions.

8/ The introduction of financial assets can also be illustrated by an expanded SAM, along the lines suggested by Taylor and Rosensweig, 1984. However, this requires the introduction of a set of asset accounts for each of the six economic agents. The resulting SAM is awkwardly large.

Table 5

THE EXTENDED CGE MODEL WITH A COMPLETE FLOW OF FUNDS

I. EQUATIONS 1/

A. Within period

a) Government budget

$$(26) \quad PCB = NCCB + ER \cdot \overline{NCBF\$}$$

$$(27) \quad NGD = \overline{igd} (2 \cdot BGD(-1) + \Delta BGD)/2$$

$$(28) \quad D = \overline{IG} + \overline{EKO} - SG$$

$$(29) \quad \Delta BGD = D - ER \cdot \overline{\Delta BGF\$}$$

b) Non-government investment

$$(30) \quad ING = I - \overline{IG}$$

c) Central Bank and other financial institutions

$$(31) \quad \Delta MB = (1 + \overline{g^P(+1)})(1 + se)MB(-1) - MB(-1)$$

$$(32) \quad \Delta CCB = \Delta MB - ER \cdot \overline{\Delta NFA\$}$$

$$(33) \quad NCCB = \overline{icbd} (2 \cdot CCB(-1) + \Delta CCB)/2$$

$$(34) \quad \Delta DEP = (1 + \overline{g^P})(1 + \overline{g^n})DEP(-1) - DEP(-1)$$

$$(35) \quad \Delta BNGD = \Delta DEP + \Delta CCB - \Delta BGD + NGD - NCCB$$

1/ PCB and NGD are endogenized in the extended model; otherwise all variables and equations remain the same as in Table 3. The variables DOTHCB and DOTHFI (see Tables 1C and D) are omitted here as they are only used for calibration in the base year. The expression (-1) indicates a lagged variable.

B. Analytical Variables

$$\overline{\text{nfam}} = \overline{\text{NFA\$}} / (\overline{\text{PM\$}} \cdot \overline{\text{M}})$$

$$\overline{\text{dody}} = \overline{\text{ER}} \cdot (\overline{\text{BGF\$}} + \overline{\text{BNGF\$}}) / \overline{\text{Y}}$$

$$\overline{\text{dode}} = (\overline{\text{BGF\$}} + \overline{\text{BNGF\$}}) / (\overline{\text{PE\$}} \cdot \overline{\text{E}})$$

$$\overline{\text{bngy}} = (\overline{\text{BNGD}} + \overline{\text{ER}} \cdot \overline{\text{BNGF\$}}) / \overline{\text{Y}}$$

C. Dynamic linkages

Balance of payments capital account variables to be obtained

$$\overline{\Delta\text{NFA\$}} \quad \overline{\text{DFIO\$}}$$

$$\overline{\Delta\text{BGF\$}}$$

$$\overline{\Delta\text{BNGF\$}}$$

Other exogenous variables to be updated

$$\overline{\text{IG}} \quad \overline{\text{EKO}}$$

Stocks to be updated

$$\overline{\text{MB}} \quad \overline{\text{BNGD}} \quad \overline{\text{NFA\$}}$$

$$\overline{\text{CCB}} \quad \overline{\text{DEP}} \quad \overline{\text{BGF\$}}$$

$$\overline{\text{BGD}} \quad \overline{\text{BNGF\$}}$$

II. DEFINITION OF VARIABLES

Interest rates and growth rates

$\overline{\text{igd}}$: nominal interest rate on government domestic debt

$\overline{\text{icbd}}$: nominal interest rate on Central Bank credit to financial institutions

$\overline{\text{se}}$: seignorage rate

$\overline{\text{g}^{\text{P}}}$: percent change in average annual GDP deflator, P

$\overline{\text{g}^{\text{n}}}$: percent change in real GDP, (Y/P)

Stock values

MB	: money base
CCB	: Central Bank credit to financial institutions
NFA\$: net foreign \$ assets of Central Bank
BGD	: government domestic debt
BGF\$: government foreign \$ debt
BNGD	: non-government domestic debt
BNGF\$: non-government foreign \$ debt
DEP	: deposits in financial institutions

Flow values 2/

IG, ING	: government, non-government investment
D	: deficit of consolidated government budget
EKO	: other capital expenditures of government budget
NCCB	: interest receipts by Central Bank on credit to financial institutions
DFIO\$: direct foreign investment, grants, and other

Analytical variables

nfam	: import coverage ratio
dody	: debt to GDP ratio
dode	: debt to exports ratio
bngy	: total non-government debt to GDP ratio

2/ Should also include changes in the above stocks, represented by Δ , e.g. Δ BGD.

Model specification

44. Table 5 gives the additional equations required to incorporate the complete flow-of-funds model into the core CGE model. For the within-period model, this requires 10 additional equations. Two of these, (26) and (27), define endogenously elements of the government budget that were previously defined exogenously, namely central bank profits and domestic interest payments (see equation 24 in Table 3). This is possible since the extended model accounts for changes in debt stocks. The government deficit (28) is then defined by introducing government investment and capital transfers. Net external borrowing by the government is fixed in dollars for any given scenario. Domestic borrowing from financial institutions in the form of development bonds (29) finances the residual deficit. Since total investment is given by available savings, non-government investment (30) is determined residually for a given level of government investment. Thus, there is an assumed one for one crowding out (or crowding in) of non-government by government investment.

45. Since the RMSM debt model calculates the foreign borrowing required for the desired change in net foreign assets of the central bank, consistency in the balance of payments as shown in Table 1E is already ensured. The remaining equations in the extended model define the financial flows among the central bank, other financial institutions, and the non-government, non-financial sector. A particularly important relationship is defined by equation (31). This equation describes the equilibrium condition in the money market, where the supply of new base money over the fiscal year (ΔMB) is set equal to the increased demand for real base money, or seignorage (see $* MB(-1)$),

and the inflation tax ($g^P(+1) * (1 + se) MB(-1)$).⁹ Since g^P is the increase in the average annual GDP deflator, this expression represents a six month lag in the relationship between money and prices.

46. A common assumption is that the seignorage rate is equal to real GDP growth. This assumption has been made in the experiments reported here. However, an econometric estimate of real money demand, as a function of real GDP and lagged inflation, can be used to derive a more precise estimate of the seignorage rate. Based on data for the period 1960-87, the following estimate of money demand was obtained:

$$\widehat{(MBa/P)} = 0.013t + 0.65(Y/P) - 0.70INF(-1)$$

(0.82) (2.80) (4.14)

where $\widehat{(MBa/P)}$ represents the desired level of real base money in the current period. Annex A provides the details of this estimate. The seignorage rate can then be defined as the percent change in the desired level of real base money compared to the level in the previous period:

$$se = \{[\widehat{(MBa/P)} - (MBa/P)(-1)] / (MBa/P)(-1)\}$$

Given se , which is assumed to be the same at the end of the year as at mid-year, equation (31) defines the increase in nominal base money consistent with the target inflation rate ($g^P(+1)$).

47. Once ΔMB has been determined, balance sheet equilibrium (see Table 1C and equation 26) will govern the net change in central bank credit to other financial institutions (32). This simple formula for ΔCCB abstracts from the details of the actual rediscounting

^{9/} Changes in base money (ΔMB) are assumed to be equivalent to changes in currency. This is a reasonable assumption for Tunisia since there are no required reserves associated with demand or time deposits.

arrangements. The remaining sources and uses of funds for financial institutions can then be defined by the last three equations in Table 5--(33), (34), and (35). Interest payments on central bank credit are indicated, as they contribute to central bank budgetary transfers. (Interest receipts on loans to non-government are assumed to just cover interest payments on deposits plus operating costs; thus, these items are not included.) Deposits are assumed to grow in line with nominal GDP, and available credit for the non-government sector is determined residually.¹⁰

Variations in closure and detail

48. The main variation in closure for the extended model would be the specification of a required increase in base money, to finance the government deficit, and an endogenous price level. This alternative would be appropriate for a country which has a less conservative monetary policy than the Tunisian authorities currently have. To see it, we can first rewrite equation (31) as follows:

$$\Delta MB(-1) = [P/P(-1)](1+se)MB(-2) - MB(-2)$$

where $(1+g^P)$ is expressed as $[(P/P(-1))]$. By rearranging terms, P can be defined endogenously for a given ΔMB :

$$P = \frac{MB(-2) + \overline{\Delta MB(-1)}}{(1+se)[MB(-2)/P(-1)]}$$

^{10/} The last two terms in equation (35) are not mentioned in the overview of the model (Section I) but represent the increase in net wealth of the financial institutions.

This expression also depends on the seignorage rate (se), which is discussed above.

49. One further point should be noted in connection with closure rules involving nominal as well as real relationships. The replacement of the simple assumption of seignorage in line with real GDP growth by an econometric estimate which takes other factors into account introduces a feed-back effect between nominal and real values. Such a feed-back effect is also introduced by fixing any other prices--such as wage rates, interest rates, or the exchange rate--in nominal terms. In the case of Tunisia, relatively stable prices have allowed the authorities to fix nominal wages and interest rates administratively. Where prices are more volatile, wage rates and interest rates should be respecified in real, rather than nominal, terms.

Policy analysis

50. Table 6 presents a base case for the Tunisian five year plan period, 1986-91, and three policy experiments. The first experiment reflects a hypothetical change in the external environment--namely a 10 percent increase in 1987 import prices, resulting in a 10 percent deterioration in the international terms of trade. Exports and imports both fall significantly, even though the real exchange rate depreciates slightly faster than in the base case. GDP and employment growth are lower, as is government saving and hence investment.

51. An important reason for including the flow-of-funds analysis is to determine whether credit to the non-government sector will be adequate. An analytical variable, bngy, was defined in Table 5 to indicate the ratio to GDP of total foreign and domestic credit to the non-government sector. The base case entails a decline in this ratio, from .86 in 1986 to .70 by

Table 6

POLICY EXPERIMENTS OVER THE PLAN PERIOD, 1986-91
WITH REAL AND FINANCIAL FLOWS

	(1) BASE CASE	(2) 10% DETERIOR- ATION IN TOT	(3) INCRS IN GOV CAP TRANS	(4) INCRS IN DEPOSIT MOBIL
	-----average annual % change-----			
GDP (constant prices)	3.9	3.7	3.9	3.9
Consumption	3.0	2.4	3.1	3.0
Investment	2.8	1.5	2.4	2.8
Exports GNFS	5.4	4.8	5.4	5.4
Imports GNFS	2.5	0.1	2.5	2.5
Employment	2.8	2.6	2.8	2.8
Real exchange rate (\$/D) depreciation	-1.1	-1.7	-1.1	-1.1
	-----as % of GDP at current prices in 1981-----			
National savings				
Government	4.8	4.5	4.3	4.8
Non-government	13.0	13.0	13.0	13.0
Total credit to non-government	.70	.69	.64	.74

1991. The decline is due in large part to the financial squeeze associated with a reduction in foreign borrowing and the proposed build-up, rather than draw-down, of net foreign assets. Other things being equal and assuming an increase in base money consistent with the target price level, reduced foreign borrowing shifts the burden of fulfilling credit needs to the domestic market. At the same time the build up of net foreign assets reduces liquidity in the domestic market by restricting Central Bank credit to other financial institutions.

52. Another constraint on credit to non-government is introduced by increased government borrowing from financial institutions in the second experiment, where a 50 percent increase in government capital transfers results in a further drop in the bngy credit ratio to .64. In fact, this experiment reflects the government's likely need for larger budgetary transfers to public enterprises over the plan period. The third experiment shows that even with a 2 percent higher rate of deposit mobilization, the credit ratio would be only .74 in 1991, compared to .86 in 1986. Thus, while the discussion here is based on very aggregated ratios, which depend on the choice of the base year and "neutral" assumptions that credit requirements will move in line with nominal GDP, declines of this magnitude point to the need for a more detailed inquiry into the adequacy of financing for the private sector--given the importance of its activities in employment creation and export growth--in the coming years.

ANNEX A: Estimating Money Demand

This annex describes the procedures followed in estimating the money demand function for the Tunisia policy model. As in most applications, real money demand is estimated as a function of real income and the opportunity cost of holding money. Data, covering the period 1960 to 1987, were extracted from the IMF's International Financial Statistics (IFS). As discussed in the text, reserve money (line 14 in the IFS) is used as the money variable since the purpose of including money demand in the Tunisia policy model is to estimate seignorage, i.e. the non-inflationary increase in base money. GDP (line 99b in the IFS) is used to represent the income variable. Government administered interest rates complicate the selection of an appropriate measure of the opportunity cost of holding money, so both interest rates and expected inflation were tried.

Annual data are used for all variables, since an attempt to construct quarterly estimates of GDP from quarterly data on industrial production failed due to the low correlation between the two. Annualized quarterly data are used for reserve money to better conform to the flow nature of GDP. Several other manipulations of the data were conducted prior to running the regressions. First, current values of money and GDP were converted to real 1980 values using the GDP deflator. Second, the variables were expressed in terms of natural logs in order to interpret the coefficients as elasticities. And third, they were expressed in terms of first differences in order to remove the trend effects from the coefficients. Tables A1 and A2 provide the raw data and calculations for the data used. The regressions were carried out using ordinary least squares.

When the deposit rate (line 601 in the IFS) was used for the opportunity cost of holding money, the regression of average annual base money (MBa/P) on income (Y/P) and the interest rate (R) yielded the following results:

$$\text{MBa/P} = -0.006 + 1.02(\text{Y/P}) - 0.87\text{R}$$

(0.25) (3.45) (0.29)

$$\bar{R}^2 = .29$$
$$\text{DW} = 2.28$$

While the signs of the coefficients in this regression are in the direction anticipated by economic theory, and the Durbin-Watson statistic is acceptable, the coefficient for the opportunity cost of money is insignificant and the overall goodness of fit adjusted for degrees of freedom is relatively low.

A second specification uses expected inflation to represent the true opportunity cost of holding money. The presumption here is that alternative uses of money--aside from savings deposits in the formal sector--exist, and their return is better reflected by expected inflation than by the government administered deposit interest rate. Under the assumption of a constant real interest rate, the elasticity of money demand with respect to expected

inflation can be interpreted as the interest elasticity of money demand. Experiments were made with current and future inflation, as measured by changes in the GDP deflator, as proxies for expected inflation; but the most significant results were found with inflation lagged by one period. Thus, it is assumed that inflationary expectations in the current period are formed by inflation in the previous period. 1/ This specification yielded significantly better results:

$$\text{MBa/P} = 0.013 + 0.65(\text{Y/P}) - 0.70\text{INF}(-1)$$

(0.82) (2.80) (4.14)

$$\bar{R}^2 = .55$$
$$\text{DW} = 1.86$$

Here we find an equation with coefficients that are both sensible, in terms of the anticipated results, and statistically significant. The overall goodness of fit is substantially better than that of the previous regression and the Durbin-Watson is still acceptable. Further improvements in the specification were attempted, but in the final analysis this second regression proved to be the most robust.

1/ Since a regression of current inflation on lagged inflation produces a coefficient which is significantly less than one, either (a) rational expectations do not hold or (b) the coefficient of lagged inflation in the money demand equation must be interpreted as the combined effect of the elasticity of money demand with respect to the expected interest rate and the elasticity of money demand with respect to lagged inflation. In the latter case, the implied interest elasticity of money demand would be considerably higher than the coefficient of .7 shown in the money demand equation.

TABLE A1: RAW DATA (Million Dinars)

YEAR/ IFSSUBJ	M RESERVE MONEY ANNUALIZED FROM QTRLY DATA	Y REAL GDP (1980 Prices) 99B.PZF	R DEPOSIT RATE (%) 60L..ZF	P GDP DEFLATOR (1980=100) 99BIPZF
1960	36.39	931.3	2.50	35.9
1961	43.87	1052.9	2.50	34.9
1962	44.29	1059.9	2.50	35.3
1963	46.18	1172.9	2.50	37.2
1964	49.81	1218.8	2.50	38.0
1965	50.73	1279.6	2.50	41.2
1966	58.08	1319.4	3.00	42.0
1967	60.24	1317.5	3.00	43.7
1968	64.94	1412.7	3.00	44.9
1969	74.23	1659.8	3.00	41.3
1970	76.72	1783.1	3.00	42.6
1971	91.06	1980.1	2.00	45.0
1972	110.12	2332.8	2.00	46.2
1973	126.69	2341.4	1.50	50.1
1974	155.58	2473.4	1.50	61.7
1975	197.52	2646.6	1.50	65.9
1976	215.28	2751.0	1.50	69.9
1977	224.56	2898.0	2.50	75.9
1978	256.77	3103.0	2.50	80.1
1979	294.14	3365.0	2.50	87.4
1980	316.13	3510.0	2.50	100.0
1981	397.95	3709.0	4.00	112.2
1982	471.40	3721.0	4.50	129.1
1983	577.51	3887.8	4.50	141.4
1984	673.07	4114.7	4.50	151.7
1985	714.61	4347.4	5.25	158.9
1986	761.23	4278.0	5.25	164.2
1987	752.43	4512.0	5.50	175.9

FILE:
TABL1

TABLE A2:
CALCULATIONS

YEAR/ IFSSUBJ	(MB/P)	LN(MB/P)	LN(MB/P) minus LN(MB/P) (-1)	LN(Y)	LN(Y) minus LN(Y) (-1)	LN(1+R/100)	LN(1+R/100) minus LN(1+R/100) (-1)	LN(P)	INF: LN(P) minus LN(P) (-1)	INF(-1): INF minus INF(-1)
1960	101.41	4.62	0.00	6.837	NA	0.025	NA	3.580	NA	NA
1961	125.87	4.84	0.22	6.959	0.123	0.025	0.0000	3.551	-0.029	NA
1962	125.41	4.83	0.00	6.968	0.007	0.025	0.0000	3.584	0.013	0.042
1963	129.41	4.86	0.03	7.067	0.101	0.025	0.0000	3.617	0.053	0.040
1964	130.95	4.87	0.01	7.106	0.038	0.025	0.0000	3.639	0.021	-0.032
1965	123.21	4.81	-0.06	7.154	0.049	0.025	0.0000	3.718	0.079	0.058
1966	138.42	4.93	0.12	7.185	0.031	0.030	0.0049	3.737	0.019	-0.060
1967	137.69	4.93	-0.01	7.183	-0.001	0.030	0.0000	3.778	0.042	0.023
1968	144.72	4.97	0.05	7.253	0.070	0.030	0.0000	3.804	0.025	-0.016
1969	179.52	5.19	0.22	7.414	0.161	0.030	0.0000	3.722	-0.082	-0.107
1970	180.24	5.19	0.00	7.488	0.072	0.030	0.0000	3.751	0.029	0.111
1971	202.41	5.31	0.12	7.591	0.105	0.020	-0.0098	3.806	0.055	0.026
1972	238.30	5.47	0.16	7.755	0.164	0.020	0.0000	3.833	0.027	-0.029
1973	252.72	5.53	0.06	7.759	0.004	0.015	-0.0049	3.915	0.081	0.05F
1974	252.01	5.53	0.00	7.813	0.055	0.015	0.0000	4.123	0.208	0.171
1975	284.54	5.65	0.12	7.881	0.068	0.015	0.0000	4.188	0.065	-0.143
1976	308.14	5.73	0.08	7.920	0.039	0.015	0.0000	4.247	0.058	-0.007
1977	295.95	5.69	-0.04	7.972	0.052	0.025	0.0098	4.329	0.083	0.024
1978	320.37	5.77	0.08	8.040	0.068	0.025	0.0000	4.384	0.055	-0.028
1979	338.66	5.82	0.05	8.121	0.081	0.025	0.0000	4.470	0.086	0.032
1980	318.13	5.78	-0.06	8.163	0.042	0.025	0.0000	4.605	0.135	0.049
1981	354.64	5.87	0.11	8.219	0.055	0.039	0.0145	4.720	0.115	-0.020
1982	365.10	5.90	0.03	8.222	0.003	0.044	0.0048	4.861	0.140	0.025
1983	408.40	6.01	0.11	8.268	0.044	0.044	0.0000	4.952	0.091	-0.049
1984	443.68	6.10	0.08	8.322	0.057	0.044	0.0000	5.022	0.070	-0.021
1985	449.72	6.11	0.01	8.377	0.055	0.051	0.0072	5.088	0.046	-0.024
1986	463.60	6.14	0.03	8.361	-0.016	0.051	0.0000	5.101	0.033	-0.014
1987	427.76	6.06	-0.08	8.414	0.053	0.054	0.0024	5.170	0.069	0.036

FILE:
TABL2

ANNEX B: Sectoral Disaggregation

The original Tunisia model programmed in GAMS-Hercules was implemented for three sectors--agriculture, energy, and other. The aggregated version, reprogrammed in GAMS-Minos and presented here, could also be implemented for multiple sectors. This Annex describes some of the data and specification issues that arise with sectoral disaggregation. Five categories of base year data are required: an intermediate consumption table, national accounts with sectoral detail, investment shares by origin and destination, consumption shares, and factor inputs. These are discussed in turn below. Table B1 shows a 3-sector SAM for 1986, and Table B2 gives all the sectoral parameters required to implement the model for one period.

1. Intermediate consumption table

A table showing sectoral intermediate demand for local plus imported products (the composite good) is required. If such a table is available for a typical year in the recent past, it can be updated to the desired base year by reconciling the old coefficients with the new row and column totals using the RASing technique (see Appendix A of Dervis, de Melo, and Robinson, 1982). For Tunisia, the 1980 input-output table has been updated to 1986 by this method.

2. National accounts

Detailed national accounts--providing factor payments, imports and exports, and net indirect taxes by sector--are also required. Sectoral factor payments need to distinguish between payments to capital and payments to labor. Data on sectoral exports are required to distinguish exports from domestic production for domestic use in the constant elasticity of transformation (CET) function for total output. The elasticities of transformation are relatively low for agriculture and energy for institutional reasons and higher for other.

Data on sectoral imports are required to specify the sectoral composite good, which features imperfect substitution between imports and domestic production for domestic use. With only one composite good per sector, the implicit assumption is that the import intensities of intermediate demand, final consumption, and investment are the same. The only exception made here is for investment demand for the sector, other, since capital goods are more import intensive. The elasticity of substitution between imports and domestic goods was assumed to be relatively high for energy, a fairly homogeneous sector, and relatively low for agriculture and other. The low elasticities of substitution are consistent with the relatively low substitution under a trade regime with substantial quantitative restrictions (QRs), although QRs should in principle be specified along the lines suggested in para 37.

Net indirect taxes include trade taxes and other indirect taxes minus subsidies. For 1986, total trade taxes were taken from the budget, and other indirect taxes (minus subsidies) are a residual to match the national accounts. Estimates of the sectoral distribution were made based on information on the type of tax.

Table B1: Aggregated Social Accounting Matrix for Tunisia 1986
(in million Tunisian dinars)

	FACTOR OF PRODUCTION		FIXED INV. CORR. ACC.		NET INDIRECT TAXES		CAPITAL ACCOUNT			ACTIVITIES				PRODUCTION ACCOUNT								REST OF THE WORLD	TOTAL REVENUES	TOTAL EXPENDITURE													
	LABOR	CAPITAL	GOV.	NON-GOV.	TRADE TAXES	OTHER TAXES	CORR. SERVICES	G-DEP. SAV.	N-G-DEP. SAV.	INDUSTRY	AGRIC.	CONSTR.	SERV.	COMMODITIES				COMMODITIES																			
														AGRIC.	INDUSTRY	OTHERS	IMPORTS	EXPORTS	AGRIC.	INDUSTRY	OTHERS				AGRIC.	INDUSTRY	OTHERS	OTHERS-1									
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31							
1 LABO			615.6																												2791.5	0.0	2791.5				
2 CAPT AL														466.3	17.0	1402.5																3889.9	0.0	3889.9			
3 NET CORR. ACC.																																					
4 NET TAXES			488.2	737.7	322.6	598.4								312.8																			1971.5	0.0	1971.5		
5 NET G-DEP.																																		288.6	0.0	288.6	
6 NET N-G-DEP.																																			6488.2	0.0	6488.2
7 CAPT. AC.																																					
8 GOV. SAV.			381.8																																357.8	0.0	357.8
9 NON-GOV. SAV.				788.3																															1288.0	0.0	1288.0
10 CORP. ACC.																																			288.6	0.0	288.6
11 IND. CORP.																																			154.6	0.0	154.6
12 AGRI. CORP.																																			1213.9	0.0	1213.9
13 CONSTR. CORP.																																			1669.8	0.0	1669.8
14 NET TAXES																																					
15 NET G-DEP.																																					
16 NET N-G-DEP.																																					
17 AGRI. CORP.																																					
18 IND. CORP.																																					
19 CONSTR. CORP.																																					
20 CORP. ACC.																																					
21 IND. CORP.																																					
22 AGRI. CORP.																																					
23 CONSTR. CORP.																																					
24 CORP. ACC.																																					
25 IND. CORP.																																					
26 AGRI. CORP.																																					
27 CONSTR. CORP.																																					
28 CORP. ACC.																																					
29 IND. CORP.																																					
30 REST OF WORLD			117.8	160.7																																	
31 NET EX. CORP.	2791.5	3889.9	1971.5	6488.2	322.6	598.4	357.0	1288.0	1282.0	288.6	154.6	1213.9	1669.8	1193.6	764.4	8786.1	1195.0	513.8	7387.9	187.4	268.4	2682.4	185.0	339.9	1764.3	1292.4	782.2	8381.6	1618.7	2929.5	62104.7	-8.1	62086.8				

Table B2: Sectoral Parameters

	<u>Agriculture</u>	<u>Energy</u>	<u>Other</u>
1. <u>Intermediate consumption</u>			
Agriculture*	.03	0	.07
Energy*	.04	.22	.05
Other*	.14	.06	.44
2. <u>CES production function</u>			
Labor share*	.50	.03	.37
Capital share*	.50	.97	.63
Elasticity of substitution	0	0	.4
3. <u>CET function</u>			
Export share*	.09	.46	.20
Domestic goods share*	.91	.54	.80
Elasticity of transformation	1.0	.8	2.0
4. <u>CES function for the composite good</u>			
Import share*	.15	.34	.24 <u>a/</u>
Domestic goods share*	.85	.66	.76 <u>a/</u>
Elasticity of substitution	.4	3.0	.6 <u>a/</u>
5. <u>Net indirect tax rates</u>			
Export taxes*	0	0	.004
Import duties*	.283	.138	.107
Other indirect taxes/dom*	.015	.270	.045
Other indirect taxes/imports*	.042	.204	.049
6. <u>Investment shares</u>			
Invest. allocation/gov.*	.39	0	.61
Invest. allocation/non-gov.*	.11	.12	.77
Invest. demand*	.02	0	.98
7. <u>Consumption shares</u>			
Average budget shares/gov.*	.04	.04	.92
Average budget shares/non-gov.*	.13	.02	.85
8. <u>Factor inputs</u>			
Labor ('000 persons)	477	3	1,378
Capital stock (TD mil)	2,992	1,752	15,258

* Parameters identified by an asterisk are taken directly from the 3-sector SAM shown in Table B1.

a/ A separate composite good was specified for investment demand from "other"--with an import share of .31 and an elasticity of substitution of .4.

3. Sectoral investment allocation and demand shares

The sectoral allocation of investment in the base year is required for both the government and the non-government sectors. In the model projections, these shares are maintained; however, they could be changed discretely or made a function of investment behavior in response to differential rates of return to capital across sectors. Data on sectoral demand from investment expenditure is required to define total demand for the composite goods. In the absence of other information, it is assumed here that the pattern of sectoral investment demand for government and non-government, and for each sector of destination, is identical. As shown in Table B1, a separate row/column for total investment goods is required to indicate the demand pattern of aggregate investment.

4. Consumption shares

Sectoral consumption shares of government are available as intermediate consumption demand in the government's 1986 input-output table, and non-government consumption shares are derived from the 1985 household consumption survey. The non-government shares can be used directly in projecting sectoral consumption demand or--as in the Tunisia model--in a linear expenditure system, that also requires sectoral estimates of subsistence minima and income elasticities of demand.

5. Factor inputs

The number of persons employed in each sector and the values of sectoral capital stock are required for the sectoral production functions. Together with sectoral factor payments, they provide the average sectoral wage and rate of return to capital. Sectoral depreciation rates are also needed to project increases in the capital stock over time.

ANNEX C: Description and Listing of the Computer Program

The original multi-sector CGE model developed for Tunisia was written in GAMS-Hercules and the flow-of-funds model in GAMS-Minos. GAMS, which stands for General Algebraic Modeling System, was developed at the World Bank and provides a solution algorithm for simultaneous linear and non-linear equations (see Kendrick and Meeraus, 1987). GAMS software is available for PC as well as the mainframe. GAMS-Hercules uses the "transaction values approach", which was also developed at the World Bank. For the multi-sector CGE model, GAMS-Hercules has an advantage in that once the basic data are available in a social accounting matrix (SAM), one needs only to specify the functional form, and the equations and calibration are generated by the program. It has a disadvantage in that it lacks transparency and makes use of specifications and normalization rules unfamiliar to most economists.^{1/} GAMS-Minos, which allows the modeler to introduce algebraic expressions directly, was used for the flow-of-funds model since the present technical limitations of GAMS-Hercules preclude side equations. The link with GAMS-Hercules for the within-period solution is a little awkward, however, as it is necessary to manually converge on the interest payments and end-of-year stocks for domestic debt.

The simplified version of the Tunisia model presented in this paper is programmed entirely in GAMS-Minos. The advantage of this program (see attached) is that the equation system is transparent and the flow-of-funds and real sector models are fully integrated. The remaining step required to make the model more user-friendly is a link between Lotus and GAMS-Minos which would permit input data to be downloaded from the Lotus version of the RMSM debt model to GAMS-Minos and output data to be down-loaded from GAMS-Minos to Lotus to produce the output tables. Such a program is currently under development, but for the present these data transfers have been carried out manually.

^{1/} It should also be noted that GAMS-Hercules has an error in the deflation of the constant price projections. We reprogrammed the derivation of the constant price national accounts to eliminate this error.

\$OFFSYMLIST OFFSYMXREF
 \$TITLE TUNISIAN CGE MODELB (EXTENDED VERSION WITH FINANCIAL FLOWS,FILE:1SECTB86) 1/

SET TI TIME PERIODS
 /86*91/

TA(TI) ACTUAL TIME PERIOD
 /86/

:

TA("86")=YES;

SCALAR

*1)STRUCTURAL PARAMETERS (ELASTICITIES, FUNCTION EXPONENT, SHIFT & SHARE PARA.)

*PRODUCTION FUNCTION PARAMETERS

ALPHA	SHARE PARAMETER IN PROD. FUNCTION	(UNITLESS)	
A	PRODUC. FN FUNCTION SHIFT PARAMETER	(UNITLESS)	
RHO	PRODUCTION FUNCTION EXPONENT	(UNITLESS)	
SIGMA	PRODUCTION FUNCTION ELASTICITY	(UNITLESS)	/0.5/
PHI	LABOR PRODUCTIVITY GROWTH	(UNITLESS)	/0.0/

*ARMINGTON FUNCTION PARAMETERS

BETA	ARMINGTON FUNCTION SHARE PARAMETER	(UNITLESS)	
B	ARMINGTON FUNCTION SHIFT PARAMETER	(UNITLESS)	
RHOC	ARMINGTON FUNCTION EXPONENT	(UNITLESS)	
SIGMAC	ARMINGTON TRADE ELASTICITY	(UNITLESS)	/1.5/

*CET FUNCTION PARAMETERS

GAMMA	CET FUNCTION SHARE PARAMETER	(UNITLESS)	
H	CET FUNCTION SHIFT PARAMETER	(UNITLESS)	
SIGMAT	CET TRADE ELASTICITY	(UNITLESS)	/1.5/
RHOT	CET FUNCTION EXPONENT	(UNITLESS)	

*2)IND. & DIRECT TAX RATES & GOVERNMENT OIL REVENUE

TD	DIRECT TAX RATE	(UNITLESS)	/0.077586059/
TM	TARIFF RATES	(UNITLESS)	/0.118345189/
TE	EXPORT DUTY RATES	(UNITLESS)	/0.00302/
T	IND. TAX RATES ON DOMESTIC GOODS	(UNITLESS)	/0.051511296/
TT	IND. TAX RATES ON IMPORTS	(UNITLESS)	/0.053931907/
OIL	OIL REVENUE RATE (IN TERM OF VA-ENE)	(UNITLESS)	/0.059146088/

*MISCELLANEOUS

LAMBDA	WAGE SCALE FOR GOVERNMENT WORKERS	(UNITLESS)	
S	AVERAGE PROPENSITY TO SAVE	(UNITLESS)	/0.128273389/
IO	INPUT-OUTPUT COEF.	(UNITLESS)	/0.503142586/

*3)DUMMIES TO HOLD INITIAL DATA (DEFINED BY SECTOR)

*VOLUMES

XO	VOLUME OF DOMESTIC OUTPUT BY SECTOR	(86 MILL DIN)	
EO	VOLUME OF EXPORTS	(86 MILL DIN)	/2154.7/
DDO	VOLUME OF DOMESTICALLY CONS. GOODS	(86 MILL DIN)	
QO	VOLUME OF COMPOSITE GOOD	(86 MIL. DIN)	
DSO	VOLUME OF DOMESTIC SALES	(86 MIL DIN)	/8489.4/
MO	VOLUME OF IMPORTS	(86 MIL DIN)	/3148.2/
ZO	VOLUME OF INV BY SECTOR OF ORIGIN	(86 MIL DIN)	/1649.0/
WO	VOLUME OF INTERMEDIATE INPUT DEMAND	(86 MIL DIN)	
GO	GOV. CONSUMPTION OF G & S	(86 MIL DIN)	/256.9/

1/ This version of the model includes a labor productivity parameter not shown in the equations of Table 3 or used in the policy experiment in Table 6.

KO	VOLUME OF CAPITAL STOCKS	(86 MIL DIN)	/20001.5/
LDNGO	EMPLOYMENT OR LAB. DEMAND BY NON-GOV.	(1000 PERS)	/1449.01/
LDGO	EMPLOYMENT OR LABOR DEMAND BY GOV.	(1000 PERS)	/409.01/
*PRICES			
PWEO	WORLD MARKET PRICE OF EXPORTS	(RESIDUAL)	
PWMO	WORLD MARKET PRICE OF IMPORTS	(RESIDUAL)	
PEO	DOMESTIC PRICE OF EXPORTS	(UNITY)	
PMO	DOMESTIC PRICE OF IMPORTS	(UNITY)	
PDO	DOMESTIC GOOD PRODUCER PRICE	(UNITY)	/1.00/
PXO	AVERAGE SALE PRICE	(UNITY)	
PQO	AVERAGE CONSUMER PRICE	(UNITY)	
PNO	VALUE ADDED PRICE BY SECTOR	(RESIDUAL)	
WNGO	NON-GOV. AVERAGE WAGE RATE BY SECTOR	(86 DIN PR WORKER)	
WGO	GOV. AVERAGE WAGE RATE	(86 DIN PR WORKER)	
RO	NON-GOV. AV. RETURN TO CAP. BY SECTOR	(86 DIN PR UNIT)	
ERO	NOMINAL EXCHANGE RATE	(DIN OVER DOL)	/0.794/
PO	GDP DEFLATOR		/1.00/
*EXTENDED VERSION OF THE STANDARD CGE			
IGDO	NOMINAL INTEREST RATE ON DOM GOV DEBT		/0.065/
ICBDO	NOMINAL INTEREST RATE ON CENTRAL BANK CREDIT		/0.060157/
*VALUES (THE FIRST THREE ARE USED ONLY IN CALIBRATION)			
SALNGO	NON-GOV. WAGE BILL	(86 MIL DIN)	/1885.9/
SALGO	GOV. WAGE BILL	(86 MIL DIN)	/815.6/
REVKO	NON-GOV. RETURNS TO CAPITAL	(86 MIL DIN)	/3089.9/
YNGO	NON-GOV INCOME	(86 MIL DIN)	/5859.3/
YO	GDP AT CURRENT PRICES	(86 MIL DIN)	/7025.2/
YLO	LAGGED GDP AT CURRENT PRICES	(86 MIL DIN)	/7139.2/
YDO	DISPOSABLE INCOME	(86 MIL DIN)	/5521.8/
CNGVO	PRIVATE CONSUMPTION	(86 MIL DIN)	/3997.9/
SNGO	NON-GOV. SAVING	(86 MIL DIN)	/708.3/
SGO	GOV. SAVING	(86 MIL DIN)	/381.0/
INVO	LEVEL OF INVESTMENT	(86 MIL DIN)	/1649.0/
PCBO	CENTRAL BANK PROFITS	(86 MIL DIN)	/53.3 /
OREVO	OTH. BUDG. REV. NET OF CURRENT TRANS.	(86 MIL DIN)	/-99.0/
NGDO	GOV INTEREST ON DOM DEBT	(86 MIL DIN)	/71.4/
NCBFO	CENTRAL BANK NET FOR. INTEREST	(86 MIL DOL)	/-7.3/
NFTO	OTHER NET FOR. SERV & TRANSFERS	(86 MIL DOL)	/270.32/
NGFO	GOV. INT. PAYMENTS ON FOREIGN DEBT	(86 MIL DOL)	/148.363/
NGNGFO	NON-GOV. INT. PAYM. ON FOREIGN DEBT	(86 MIL DOL)	/177.204 /
FO	FOREIGN SAVING	(86 MIL DOL)	/704.9118/
*EXTENDED VERSION OF THE STANDARD CGE			
NCCBO	CENTRAL BANK DOM INTEREST RECEIPTS	(86 MIL DIN)	/53.6/
IGO	GOV INVESTMENT	(86 MIL DIN)	/357.0/
INGO	NON-GOV INVESTMENT	(86 MIL DIN)	/1292.0/
EKOO	OTHER BUDGETARY CAPITAL EXPEND	(86 MIL DIN)	/257.1/
DO	GOV BUDGET DEFICIT	(86 MIL DIN)	/369.7/
DF100	DIRECT FOREIGN INVESTMENT & OTHER	(86 MIL DOL)	/189.5/
DMBO	CHANGE IN MONEY BASE	(86 MIL DIN)	/8.0/
DCCBO	CENTRAL BANK DOM CREDIT	(86 MIL DIN)	/160.0/
DBGDO	GOV DOM DEBT	(86 MIL DIN)	/151.4/
DBNGDO	NON-GOV DOM DEBT	(86 MIL DIN)	/392.0/
DDEPO	DEPOSITS	(86 MIL DIN)	/229.0/
DOTHCBO	OTHER ITEMS CENTRAL BANK	(86 MIL DIN)	/5.7/

DOTHFIO	OTHER ITEMS FINANCIAL INST.	(86 MIL DIN)	/136.6/
DNFAO	NFA OF CENTRAL BANK	(86 MIL DOL)	/-198.6/
DBGFO	GOV FOR DEBT	(86 MIL DOL)	/274.9/
DBNGFO	NON-GOV FOR DEBT	(86 MIL DOL)	/41.9/

*STOCK VALUES

MBLO	LAGGED MONEY BASE	(85 MIL DIN)	/731.0/
CCBLO	LAGGED CENTRAL BANK DOM CREDIT	(85 MIL DIN)	/811.0/
BGDLO	LAGGED GOV DOM DEBT	(85 MIL DIN)	/912.6/
BNGDLO	LAGGED NON-GOV DOM DEBT	(85 MIL DIN)	/3774.0/
DEPLO	LAGGED DEPOSITS	(85 MIL DIN)	/2821.0/
NFAO	NFA OF CENTRAL BANK	(86 MIL DOL)	/305.3/
BGFO	GOV FOR DEBT	(86 MIL DOL)	/3151.5/
BNGFO	NON-GOV FOR DEBT	(86 MIL DOL)	/2337.1/

;

*3)COMPUTATION OF PARAMETERS AND DUMMIES FOR CALIBRATION

*FUNCTION EXPONENT IN ARMINGTON, PRODUCTION & CET FUNCTIONS

RHOC = (1/SIGMAC)-1;
 RHO = (1/SIGMA)-1 ;
 RHOT = ((1/SIGMAT)+1);
 DISPLAY RHOC,RHO,RHOT;

*VOLUMES

DDO = DSO;
 QO = PDO*(1+T)*DDO + MO;
 XO = DSO + EO;
 WO = IO * XO;
 DISPLAY QO,DSO,XO,WO;

*PRICES

PMO = PDO;
 PEO = PDO;
 PQO = (PDO*(1+T) * DDO/QO) + (PMO * MO/QO);
 PXO = (PDO * DSO/XO) + (PEO *EO/XO);
 PWMO = PMO/((1+TM)*(1+TT)*ERO) ;
 PWEQ = PEO*(1+TE)/(ERO) ;
 PNO = PXO-(IO*PQO);
 WNGO = SALNGO/LDNGO;
 WGO = SALGO/LDGO;
 RO = REVKO/KO;
 DISPLAY PDO,PXO,PQO,PMO,PEO,PWMO,PWEQ,PNO,WNGO,WGO,RO;

*MISCELLANEOUS

LAMBDA = WGO/WNGO;
 DISPLAY LAMBDA;

*CALIBRATION OF ALL SHIFT AND SHARE PARAMETERS (A,B,H & ALPHA,BETA & GAMMA)

* GET BETA AND B FROM ARMINGTON EQUATION & IMPORT DEMAND

BETA=(PMO/(PDO*(1+T)))*(MO/DDO)**(1+RHOC);
 BETA=BETA/(1+BETA);
 B = QO/((BETA*MO**(-RHOC) + (1-BETA)*(DDO)**(-RHOC))*(-1/RHOC));

DISPLAY B,BETA,QO;

* GET GAMMA AND C FROM CET EQUATION & EXPORT SUPPLY
 GAMMA = (PDO/PEO) * (EO/DSO)**(RHOT-1);
 GAMMA = GAMMA/(1+GAMMA);
 H = XO/(((1-GAMMA)*(EO)**(RHOT) + GAMMA*(DSO)**(RHOT))**(1/RHOT));

DISPLAY H,GAMMA,XO;

* GET ALPHA AND A FROM COST MINIMIZATION (DERIVED DEMAND FOR INPUTS)
 ALPHA = 1/((KO/LDNGO)**(1+RHO)*(RO/WNGO)+1);
 A = XO/(ALPHA*LDNGO**(-RHO)+(1-ALPHA)*KO**(-RHO))**(-1/RHO);

DISPLAY ALPHA,A;

*4)MODEL DEFINITION - 68 VARIABLES

VARIABLES

*VOLUMES (12)

X	VOLUME OF DOMESTIC OUTPUT BY SECTOR	(86 MIL DIN)
E	VOLUME OF EXPORTS	(86 MIL DIN)
DS	VOLUME OF DOMESTIC SALES	(86 MIL DIN)
Q	VOLUME OF COMPOSITE GOOD	(86 MIL DIN)
DD	VOLUME OF DOMESTICALLY CONS. GOODS	(86 MIL DIN)
M	VOLUME OF IMPORTS	(86 MIL DIN)
Z	VOLUME OF INV BY SECTOR OF ORIGIN	(86 MIL DIN)
W	VOLUME OF INTERMEDIATE INPUT DEMAND	(86 MIL DIN)
K	VOLUME OF CAPITAL STOCKS	(86 MIL DIN)
LDNG	EMPLOYMENT OR LABOR DEMAND BY NON-GOV	(1000 PERS)
LDG	EMPLOYMENT OR LABOR DEMAND BY GOV	(1000 PERS)
G	GOV CONSUMPTION OF G & S	(86 MIL DIN)

*PRICES (15)

PWE	WORLD MARKET PRICE OF EXPORTS	(RESIDUAL)
PWM	WORLD MARKET PRICE OF IMPORTS	(RESIDUAL)
PE	DOMESTIC PRICE OF EXPORTS	(UNITY)
PM	DOMESTIC PRICE OF IMPORTS	(UNITY)
PD	DOMESTIC GOOD PRODUCER PRICE	(UNITY)
PX	AVERAGE SALE PRICE	(UNITY)
PQ	AVERAGE CONSUMER PRICE	(UNITY)
PN	VALUE ADDED PRICE BY SECTOR	(RESIDUAL)
WNG	NON-GOV. AVERAGE WAGE RATE BY SECTOR	(86 MIL DIN PR WORKER)
WG	GOV. AVERAGE WAGE RATE	(86 MIL DIN PR WORKER)
R	AVERAGE RETURN TO CAPITAL BY SECTOR	(86 MIL DIN PR UNIT)
ER	NOMINAL EXCHANGE RATE	(DIN OVER DOL)
P	GDP DEFLATOR	(UNITY)

*EXTENDED VERSION OF THE STANDARD CGE

IGD	NOMINAL INTEREST RATE ON GOV DOM DEBT
-----	---------------------------------------

ICBD NOMINAL INTEREST RATE ON CENTRAL BANK CREDIT

*VALUES (42)

Y	GDP AT CURRENT PRICES	(86 MIL DIN)
YL	LAGGED GDP AT CURRENT PRICES	(86 MIL DIN)
YD	DISPOSABLE INCOME	(86 MIL DIN)
YNG	NON-GOV. SAVING	(86 MIL DIN)
CNGV	PRIVATE CONSUMPTION	(86 MIL DIN)
SG	GOV. SAVING	(86 MIL DIN)
SNG	NON-GOV SAVING	(86 MIL DIN)
IN'	LEVEL OF INVESTMENT	(86 MIL DIN)
PCb	CENTRAL BANK PROFITS	(86 MIL DIN)
OREV	OTHER BUDG REV. NET OF CURRENT TRANS	(86 MIL DIN)
NGD	GOV INTEREST ON DOM GOV DEBT	
NCBF	CENTRAL BANK NET FOR. INTEREST	(86 MIL DOL)
NFT	OTHER NET FOR. SERV & TRANSFERS	(86 MIL DOL)
NGF	GOV. INT. PAYMENTS ON FOREIGN DEBT	(86 MIL DOL)
NNGF	NON-GOV INT. PAYMENTS ON FOREIGN DEBT	(86 MIL DOL)
F	FOREIGN SAVING	(86 MIL DOL)

*EXTENDED VERSION OF THE STANDARD CGE(26)

NCCB	CENTRAL BANK DOM INTEREST RECEIPTS
IG	GOV INVESTMENT
ING	NON-GOV INVESTMENT
EKO	OTHER BUDGETARY CAPITAL EXPEND
D	GOV BUDGET DEFICIT
DFIO	DIRECT FOR INVESTMENT & OTHER
DMB	CHANGE IN MONEY BASE
DCCB	CENTRAL BANK CREDIT
DBGD	GOV DOM DEBT
DBNGD	NON-GOV DOM DEBT
DDEP	DEPOSITS
DNFA	NFA CENTRAL BANK
DBGF	GOV FOR DEBT
DBNGF	NON-GOV FOR DEBT
DOTHCB	OTHER ITEMS CENTRAL BANK
DOTHFI	OTHER ITEMS FINANCIAL INST

*STOCK VALUES(8)

MBL	LAGGED MONEY BASE
CCBL	LAGGED CENTRAL BANK CREDIT
BGDL	LAGGED GOV DOM DEBT
BNGDL	LAGGED NON-GOV DOM DEBT
DEPL	LAGGED DEPOSITS
NFA	NFA CENTRAL BANK
BGF	GOV FOR DEBT
BNGF	NON-GOV FOR DEBT

*OBJECTIVE FUNCTION (1)

OMEGA OBJECTIVE FUNCTION

;

*DEFINITION OF LOWER BOUNDS

PM.LO=.01;PE.LO=.01;PWE.LO=.01;PWM.LO=.01;PD.LO=.01;PX.LO=.01;
PQ.LO=.01;PN.LO=.01;WNG.LO=.01;WG.LO=.01;R.LO=.01;ER.LO=.01;

X.LO=.01;E.LO=.01;DS.LO=.01;Q.LO=.01;DD.LO=.01;M.LO=.01;Z.LO=.01;
W.LO=.01;K.LO=.01;LDNG.LO=.01;G.LO=.01;CNGV.LO=.01;

MBL.LO=.01;CCBL.LO=.01;BGDL.LO=.01;BNGDL.LO=.01;DL.LO=.01;
NFA.LO=.01;BGF.LO=.01;BNGF.LO=.01;

*5)MODEL DEFINITION-34 EQUATIONS

EQUATIONS

*VOLUMES (9)

XEQ VOLUME OF DOMESTIC OUTPUT BY SECTOR (86 MIL DIN)
EEQ VOLUME OF EXPORTS (86 MIL DIN)
DSEQ VOLUME OF DOMESTIC SALES (86 MIL DIN)
QEQ VOLUME OF COMPOSITE GOOD (86 MIL DIN)
DDEQ VOLUME OF DOMESTICALLY CONS GOODS (86 MIL DIN)
MEQ VOLUME OF IMPORTS (86 MIL DIN)
ZEQ VOLUME OF INVESTMENT DEMAND (86 MIL DIN)
WEQ VOLUME OF INTERMEDIATE INPUT DEMAND (86 MIL DIN)
LDNGEQ EMPLOYMENT OR LABOR DEMAND BY NON-GOV (1000 PERS)

*PRICES (9)

PEEQ DOMESTIC PRICE OF EXPORTS (UNITY)
PMEQ DOMESTIC PRICE OF IMPORTS (UNITY)
PDEQ DOMESTIC GOOD PRODUCER PRICE (UNITY)
PXEQ AVERAGE SALE PRICE (UNITY)
PQEQ AVERAGE CONSUMER PRICE (UNITY)
PNEQ VALUE ADDED PRICE BY SECTOR (RESIDUAL)
WGEQ GOV AVERAGE WAGE RATE (86 MIL DIN PR WORKER)
REQ AVERAGE RETURN TO CAP. BY SECTOR (86 MIL DIN PR UNIT)
EREQ NOMINAL EXCHANGE RATE (DIN OVER DOL)

*VALUES (15)

YEQ GDP AT CURRENT PRICES (86 MIL DIN)
YNGEQ NON-GOV. INCOME (86 MIL DIN)
YDEQ DISPOSABLE INCOME (86 MIL DIN)
CNGVEQ PRIVATE CONSUMPTION (86 MIL DIN)
SNGEQ NON-GOV. SAVING (86 MIL DIN)
SGEQ GOV. SAVING (86 MIL DIN)
INVEQ LEVEL OF INVESTMENT (86 MIL DIN)

*EXTENDED VERSION OF THE STANDARD CGE

PCBEQ
NCCBEQ
DEQ
INGEQ
DBGDEQ
DNFAEQ
DCCBEQ
DBNGDEQ

*OBJECTIVE FUNCTION (1)

OBJ OBJECTIVE FUNCTION

*6)MODEL DEFINITION

*PRICES

PMEQ.. PM =E=PWM * ER * (1+TM)*(1+TT);
 PEEQ.. PE =E=(PWE*ER) / (1+TE);
 PQEQ.. PQ =E=((PD*(1+T)*DD) + (PM*M))/Q;
 PXEQ.. PX =E=(PD*DS + (PC*E))/X;
 PNEQ.. PN =E=PNO * P;
 REQ.. R =E=A**(-RHD)*(X/K)**(1+RHD)*(1-ALPHA)*PN*(1-OIL);
 WGEQ.. WG =E=LAMBDA * WNG;
 PDEQ.. DD =E=DS;
 EREQ.. (PWE*E) + NFT + NCBF + F=E=NGF + NNGF + (PWM*M);

*VOLUMES

XEQ.. X =E=A*(ALPHA*(1+PHI)*LDNG**(-RHO) + (1-ALPHA)*K**(-RHO))
 **(-1/RHO);
 LDNGEQ.. LDNG =E=A**(-RHO/(1+RHO))*((1+PHI)*ALPHA*PN*(1-OIL)/WNG)
 ** (1/(1+RHO))*X / (1+PHI);
 DSEQ.. DS =E=H**(-RHOT/(RHOT-1))*GAMMA**(-1/(RHOT-1))*(PD/PX)
 ** (1/(RHOT-1))*X;
 EEQ.. E =E=H**(-RHOT/(RHOT-1))*(1-GAMMA)**(-1/(RHOT-1))*(PE/PX)
 ** (1/(RHOT-1))*X;
 WEQ.. W =E=IO * X;
 ZEQ.. Z =E=INV/PQ;
 MEQ.. M =E=B**(SIGMAC-1) * BETA**(SIGMAC) * (PQ/PM)**(SIGMAC) * Q;
 DDEQ.. DD =E=B**(SIGMAC-1)*(1-BETA)**(SIGMAC)*(PQ/(PD*(1+T)))**(SIGMAC)
 *Q;
 QEQ.. PQ*Q =E=PQ*G + WG*LDG + CNGV + INV + PQ*W;

*VALUES

YEQ.. Y =E=(PN*X)+(TM+TT+TT*TM)*(ER*PWM*M)+(T*PD*DD)+(TE*PE*E)
 +(WG*LDG);
 YNGEQ.. YNG =E=(WNG*LDNG) + (WG*LDG) + (R*K) + (NFT+NCBF-NNGF)*ER;
 YDEQ.. YD =E=(1-TD)*YNG - (DREV-NGD+PCB);

CNGVEQ.. CNGV =E=(1-S) * (YD) - WG*LDG;
 SNGEQ.. SNG =E=S*YD;
 SGEQ.. SG =E=(TO*YNG) + (PWM*ER*M)*(TM+TT+TT*TM) + (OIL*PN*X)
 + (T*PD*DD) + (TE*PE*E) + (OREV-NGD+PCB) - (NGF*ER)
 - (PQ*G + WG*LDG);
 INVEQ.. INV =E=SNG + SG + (F*ER);

*EXTENDED VERSION OF THE STANDARD CGE 2/

PCBEQ.. PCB =E=NCCB + ER*NCCB + DOTHCB;
 NCCBEQ.. NCCB =E=ICBD + (2*CCBL + DCCB)/2;
 DEQ.. D =E=IG + (EKO+DOTHFI) - SG;
 DBGDEQ.. DBGD =E=D - (ER*DBGF);
 INGEQ.. ING =E=INV - IG;
 DNFAEQ.. DNFA =E=DBGF + DBNGF + DFID - F;
 DCCBEQ.. DCCB =E=DMB - (ER*DNFA) - DOTHCB;
 DBNGDEQ..DBNGD =E=DDEP + DCCB - NCCB - DBGD + NGD + DOTHFI;

*OBJECTIVE FUNCTION

OBJ.. OMEGA =E=0.10;

*7)MODEL SETUP - INITIALIZATION (34 ENDOGENOUS VAR. INCL. OMEGA)

*PRICES (9)

PD.L=PDO;PM.L=PMO;PE.L=PEO;PX.L=PXO;PQ.L=PQO;
 R.L=RO;WG.L=WGO;
 PN.L=PNO;
 ER.L=ERO;

*VOLUMES (9)

X.L=XO;Q.L=QO;DS.L=DSO;
 W.L=WO;Z.L=ZO;
 LDNG.L=LDNGO;
 DD.L=DDO;M.L=MO;
 E.L=EO;

*VALUES IN LOCAL CURRENCY (15)

INV.L=INVO;YNG.L=YNGO;YD.L=YDO;SNG.L=SNGO;SG.L=SGO;Y.L=YO;PCB.L=PCBO;
 NCCB.L=NCCBO;D.L=DO;DBGD.L=DBGDO;ING.L=INGO;DNFA.L=DNFAO;DCCB.L=DCCBO;
 DBNGD.L=DBNGDO;CNGV.L=CNGVO;

*8)CLOSURE (34 EXOGENOUS VARIABLES)

*PRICES (6)

2/ The equations in Table 5 for NCB, DMB, and DDEP are not included here; they are included in the program for subsequent years.

PWM.FX=PWMO;PWE.FX=PWEO;WNG.FX=WNGO;P.FX=PO;IGD.FX=IGDO;ICBD.FX=ICBDO;
 *VOLUMES (3)
 K.FX =KO;
 G.FX =GO;
 LDG.FX=LDGO;
 *VALUES IN LOCAL CURRENCY (14)
 OREV.FX=OREVO;IG.FX=IGO;EKO.FX=EKOO;DMB.FX=DMBO;DDEP.FX=DDEPO;
 DOTHCB.FX=DOTHCBO;DOTHFI.FX=DOTHFIO;YL.FX=YLO;MBL.FX=MBLO;DEPL.FX=DEPLO;
 CCBL.FX=CCBLO;BGDL.FX=BGDLO;BNGDL.FX=BNGDLO;NGD.FX=NGDO;
 *VALUES IN FOREIGN CURRENCY (11)
 F.FX=FO;NGF.FX=NGFO;NNGF.FX=NNGFO;NFT.FX=NFTO;
 NCBF.FX=NCBFO;DFIO.FX=DFIOO;DBGF.FX=DBGFO;DBNGF.FX=DBNGFO;NFA.FX=NFAO;
 BGF.FX=BGFO;BNGF.FX=BNGFO;

OPTIONS ITERLIM=1000,LIMROW=0,LIMCOL=0;

MODEL SECTOR1B SQUARE BASE MODEL / ALL/;

SOLVE SECTOR1B MAXIMIZING OMEGA USING NLP;

*DEFINITION OF ANALYTICAL VARIABLES

SCALAR

ITAX INDIRECT TAXES
 DTAX DIRECT TAXES
 LF LABOR FORCE /2173.0/
 LD TOTAL LABOR DEMAND (= TOTAL LABOR USE)
 U UNEMPLOYMENT LEVEL
 CG TOTAL GOV. CONSUMPTION AT CONSTANT PRICE
 CTOT TOTAL CONSUMPTION AT CONSTANT PRICE
 CNG TOTAL NON-GOV CONSUMPTION AT CONSTANT PRICE
 PCNG IMPLICIT DEFLATOR
 GAP DISCREPANCY BETWEEN PCNG & PQ
 WNGR REAL WAGE
 RER1 REAL EXCHANGE RATE #1
 RER2 REAL EXCHANGE RATE #2
 TOT TERM OF TRADE INDEX
 TTADJ TERMS OF TRADE ADJUSTMENT
 TRADE TOTAL TRADED GOODS
 NFAM IMPORT COVERAGE RATIO
 DODY DEBT TO GDP RATIO
 DODE DEBT TO EXPORT RATIO
 BNGD NON-GOV DOM DEBT
 BNGY TOTAL NON-GOV DOM DEBT OVER GDP

$$ITAX = (TM + TT + TT*TM)*(ER.L*PWM.L*M.L)+(T*PD.L*DD.L)+(TE*PE.L*E.L);$$

$$DTAX = TD*YNG.L;$$

$$LD = LDG.L + LDNG.L;$$

$$U = LF - LD;$$

$$WNGR = WNG.L/P.L;$$

CG =G.L + WGO*LDG.L;

CTOT =(Y.L/P.L) + ERO*(PWMO*M.L - PWEO*E.L) - Z.L;

CNG =CTOT - CG;

PCNG =CNGV.L/CNG;

GAP =PQ.L - PCNG;

TRADE =E.L + M.L;

RER1 =ER.L*(PWE.L)/(PD.L);

RER2 =ER.L*((PWE.L*E.L + PWM.L*M.L) / (TRADE)) / (PD.L);

TOT =PWE.L / PWM.L;

TTADJ =(PWE.L*E.L)/(PWM.L/PWMO) - (PWEO*E.L);

NFAM =NFA.L/(PWM.L*M.L);

DODY =ER.L*(BGF.L + BNGF.L)/Y.L;

DODE =(BGF.L + BNGF.L)/(PWE.L*E.L);

BNGD =DBNGD.L + BNGDL.L;

BNGY =(BNGD + (ER.L*BNGF.L)) / Y.L;

DISPLAY LD,U,WNGR,TOT,RER1,RER2,CG,CTOT,CNG,PCNG,GAP,NFAM,DODY,DODE,BNGY
ITAX,DTAX,TTADJ;

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