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MACROECONOMIC ADJUSTMENT
AND INCOME DISTRIBUTION:
A MACRO-MICRO SIMULATION MODEL

by

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Research programme on:
Adjustment Programmes and Equitable Growth



SUMMARY

This paper presents a macro simulation model to quantify the effects of stabilisation packages on the distribution of income and wealth. It is a macro-micro model since it combines macroeconomic aspects with the microeconomic optimising behaviour characteristic of computable general equilibrium models. It can be applied to many developing countries by changing the institutional characteristics that describe commodity markets, financial markets and labour markets. Since the simulation package incorporated quite a large number of closures, the model is referred to as a "maquette."

The paper closes with illustrative simulations of the maquette showing how the distribution of income and wealth of a primary exporting economy is likely to be affected by alternative fiscal, monetary and exchange rate policies in response to a reduction in the availability of external funds to finance a fiscal deficit.

PREFACE

In January 1987 the Development Centre initiated a research project on "Adjustment programmes and equitable growth" under the responsibility of Christian Morrisson. The importance of this issue is illustrated by the fact that many developing countries have embarked on adjustment programmes which often have negative effects in the short term, such as a reduction in employment and real wages, or a steep increase in the prices of staple foods after the withdrawal of subsidies, and we all know how serious the reactions to such measures can be.

But it may be objected that such adjustment is made necessary by earlier mistakes in economic policy, or that the fate of populations, particularly the poor, will be even worse in the medium and long term should this adjustment be rejected. It can also be maintained that the package of measures usually included in an adjustment programme must always be the same.

This research project is precisely intended to seek answers to questions raised by these controversies between the supporters and opponents of adjustment, such as: do the social costs of refusing to adjust exceed those of adjustment? Can a choice be made between various packages of measures with different social costs, or must the same adjustment programme be implemented everywhere?

The current difficulty in answering these questions arises because the appropriate instruments are not available: the main difficulty in estimating the social impact of adjustment is that the process comprises a number of macroeconomic measures, while the effects on incomes and poverty concern the microeconomic side. The macroeconomic models available could not be used to calculate the microeconomic effects of adjustment policy. For this reason the Development Centre asked F. Bourguignon, W. Branson and J. de Melo to construct the model discussed in this paper, which combines the microeconomic characteristics of a computable general equilibrium model with the usual components of a macroeconomic model. The application of this model to two economies (Côte d'Ivoire and Morocco) has already shown its usefulness: by means of simulations, we can compare the social costs of different adjustment programmes and estimate the costs of other strategies, such as refraining from adjustment or implementing stabilising measures that are more gradual but are being taken earlier. This model is therefore a new, extremely efficient analytical instrument making it possible for the first time to answer obviously important policy questions.

Louis Emmerij
President of the OECD Development Centre
March 1989

INTRODUCTION

This paper sets out the elements of a macro simulation framework to examine how aggregate demand and micro-oriented reform policies that accompany stabilization and structural adjustment programs affect the economy-wide distribution of income. The model includes a financial sector with a treatment of asset markets fairly representative of developing countries along with a more standard treatment of the real side of the economy. The model departs from other available simulation models in linking the short-run impacts of macroeconomic policies that affect the distribution of income through inflation, interest rate and other asset price changes with the more-often emphasized medium-run impacts of structural adjustment policies (i.e. incentive reforms) that affect the distribution of income through relative commodity and factor price changes. We refer to the resulting model as a macro-micro model because of this combination of macro elements with strong underlying micro underpinnings (1). The model is intended to be applicable to a relatively wide range of countries by changing the institutional characteristics that describe commodity markets (e.g. supply and demand elasticities, price or quantity clearing), financial markets (e.g. credit rationing, foreign exchange controls), and labor markets (e.g. extent of wage flexibility). Because of the relatively wide number of closures incorporated in the simulation package provided with the model, we refer to the model as a "maquette".

The remainder of the paper is organized as follows. Macro-micro linkages are schematically presented in chapter 1 where the main exogenous and endogenous variables appearing in the maquette. In chapter 2, we introduce the macro framework and the accounting identities that constrain it. In chapter 3, we lay out the financial sector of the model, a multi-dimensional sector. Chapter 4 develops the full structure of the model by bringing in the microeconomic framework by which aggregate supply is determined. The presentation relies on a one sector model to illustrate the main elements of the more complete model. Chapter 5 reports on simulations that illustrate how the model can be used to analyze the distributional impact of stabilization policies.

Chapter I

OUTLINE OF THE MACRO-MICRO LINKAGES IN THE MAQUETTE

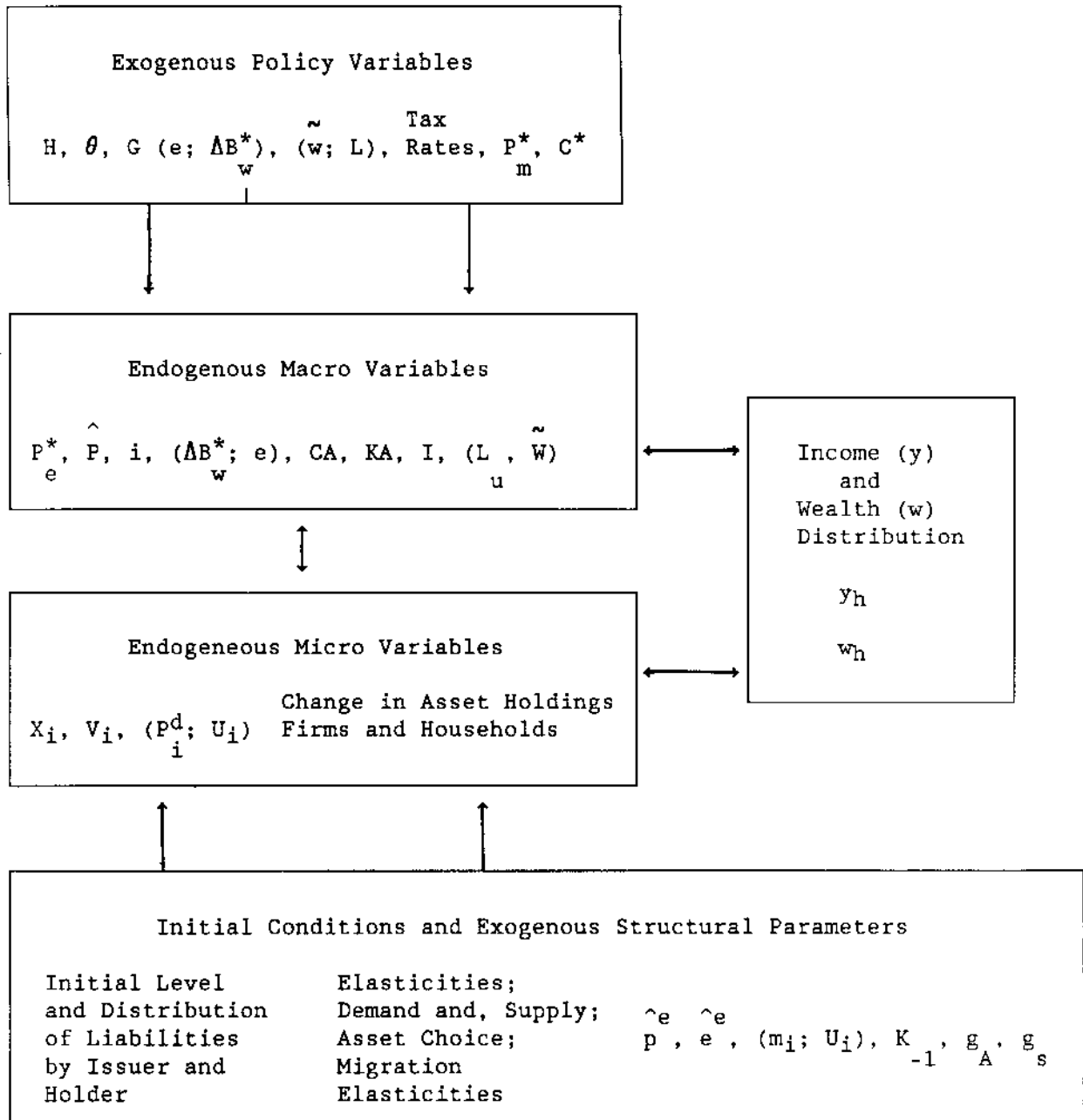
The recent adjustment packages supported by the IMF and World Bank have been the object of increasing scrutiny for their impact on income distribution (Cornia et al, 1987). Analytically, one can distinguish two interacting channels of these adjustment packages which may have adversely affected income distribution. The first, and more easily quantifiable channel, has to do with the medium to long-run effects of cuts in government expenditures and changes in production incentives brought about by changes in relative prices following changes in tariffs and other taxes. For a given mix of expenditure reduction, the extent of: relative price rigidities (e.g. fixed real wages or mark-up pricing); factor mobility (e.g. supply elasticities); and differences in consumption expenditure patterns across socioeconomic groups will determine the medium to long run distributional impacts of the resulting structural adjustment. De Melo and Robinson (1982) give a numerical exercise quantifying these various effects.

The second, and more difficult to quantify channel, comes from the short-run effects that stabilization programs have on the distribution of wealth (and income) via financial asset redistributions operating in increasingly integrated capital markets. In this new environment, foreign exchange controls are ineffective in preventing capital flight when expectations mount that a stabilization program will soon be abandoned. First noted by Diaz-Alejandro (1979, 1985) and further elaborated by others (Foxley 1983, Corbo, de Melo, and Tybout, 1986), unsuccessful stabilization programs with relatively high capital mobility have often allowed the holders of financial assets to shift their portfolios from domestic to foreign assets prior to a major devaluation, thereby realizing a capital gain. So far this short-run channel by which stabilization programs may affect the distribution of income and wealth has not been quantified.

The purpose of the maquette is to allow for a quantification of the interaction of these two channels through which adjustment packages affect the distribution of income and wealth. The first channel is captured by the multi-sector computable general equilibrium (CGE) models where distributional shifts mostly occur through relative price shifts. The second channel is captured by the standard IS-LM macro framework for an open economy (e.g. Tobin, 1969; Branson, 1979) where asset prices are endogenously determined. The maquette described here incorporates features from these two traditions (1).

How these two features interact and how adjustment policies work their way to affect the distribution of income and wealth is summarized in Figure 1 which shows the determination of a "period" equilibrium. The distribution of income and wealth at the household (socioeconomic group)

FIGURE 1. MACRO-MICRO LINKAGES AND INCOME DISTRIBUTION



Notation: See text particularly tables 0 and 2; h is a subscript indexed over households; i is a subscript indexed over sectors. Other subscripts do not represent indexes. Superscript e represents an expectation, an asterisk superscript a variable denoted in foreign currency units.

level is affected by the endogenously determined values for macroeconomic and microeconomic variables. (Variables determined at the microeconomic level have a sectoral subscript i). In turn, the jointly determined values of macroeconomic and microeconomic variables depend on the exogenously given values of policy variables and exogenous structural variables (elasticities, expectations, and initial conditions). Typically, the values of exogenous structural variables are given while the values of policy variables depend on the selected policy choices in the adjustment package. As can be seen from figure 1, household income (y_h) and wealth (w_h) distribution are jointly determined by the endogenous values of macroeconomic and microeconomic variables.

The exogenous policy variables in the maquette are: the level (G) and composition of nominal government expenditures; the money supply (H) and the degree of control of the money supply by the Central Bank (θ); the nominal exchange rate (e) or government borrowing abroad (ΔB_w^*); tax rates; the foreign interest rate (i^*); and import prices (P_m^*). This menu of policy variables thus allows the maquette to capture the major policy instruments applied in a typical adjustment package.

The endogenous macroeconomic variables determined in the maquette are: the foreign currency price of exports (P_e^*); inflation (\hat{P}); government foreign borrowing or the nominal exchange rate; the current (CA) and capital (KA) accounts; investment (I); unemployment (L_u) or the nominal/real wage (\tilde{w}). The microeconomic variables are: sectoral outputs (X_i); sectoral intermediate demands (V_i); relative prices (P_i^d) or sectoral capacity utilization rates (U_i) if exogenously specified mark-up rates (m_i) are in effect; and asset holdings.

The dynamics of the maquette are simple in the sense that the equilibrium solution values in any given period only depend on current and past values of endogenous and exogenous variables. The next three chapters describe the assumptions and functional form specifications which determine the "period" equilibrium described in Figure 1.

Chapter II

THE MACRO FRAMEWORK

This chapter introduces the macro framework underlying the maquette. First we introduce the assumptions about the number of financial units incorporated in the model, and assumptions about borrowing and lending for each of the financial units. Second we show the connections among the resulting national income, balance of payments and monetary accounts. Third, we discuss briefly in what directions to limit this accounting structure for developing countries with a limited available menu of financial transactions.

The notation we use for national income accounts is standard, and will be introduced as we proceed. For the more developed financial markets four assets are included: Money (H), government debt (B), real capital (K), and net foreign currency assets (B^*). The notation for financial sector liabilities and their holders is less familiar, and is summarized in table 0. We distinguish five financial units: government, households, firms, the banking system, and the foreign sector. Liabilities by issuer and notation for holders of liabilities are given in Table 0.A. We assume that governments do not lend, and that households do not borrow. The rest of the distribution of liabilities by issuer and by holder (denoted by subscript) is shown in Table 0.B. (The resulting monetary sector balance sheet is discussed in chapter 3 when the financial closure rules are introduced.)

We now turn to the identities which link the flow and stock variables in the maquette. These identities, along with assumptions about labor force growth, provide the constraints for the model. The purpose is to show the connections among the national income, balance of payments, and monetary accounts, and to make the point that the three accounting identities are interdependent.

The national income identity can be written as:

$$(3.1) \quad C + I + G + (X - M - TR) \equiv C + S + T,$$

where C is private consumption expenditure, I is gross private domestic investment, G is government purchases (exhaustive consumption plus investment), X and M are exports and imports of goods and non-factor services, TR is net transfers (i.e. it includes servicing of the external debt plus other factor payments abroad), S is private saving, and T is tax revenue. The national income identity can be rewritten as the flow-of-funds identity by subtracting consumption from both sides of (2.1) and rearranging:

$$(2.2) \quad (S-I) + (T-G) - (X-M-TR) \equiv 0.$$

TABLE 0. FINANCIAL SECTOR: NOTATION AND ASSUMPTIONS ON ASSET HOLDINGS

A. Notation

Liabilities by Issuer

Government Liabilities (bonds)	:	B
Rest of the World Liabilities	:	F
Firm Liabilities (Loans)	:	L
Bank Liabilities (Base Money)	:	H
Foreign Exchange Reserves	:	R

Subscripts for Holders of Liabilities

Households	:	h
Banks	:	b
Firms	:	f
World	:	w

Superscript * for foreign-currency denominated liabilities.

B. Assumption on Asset Holdings

		Lender				
		g	h	f	b	w
Borrower	Government (g)		B_h		B_b	B_w^*
	Household (h)					
	Firm (f)				L_b	L_w^*
	Banks (b)		H_h	H_f		
	Row (w)		F_h^*		R^*	

Here (S-I) is net private saving, (T-G) is the government budget surplus, and (X-M-TR) is the current-account surplus in the balance of payments.

The balance-of-payments identity is:

$$(2.3) \quad X - M - TR \equiv e(\Delta F_h^* - \Delta L_w^* + \Delta R^* - \Delta B_w^*)$$

Here $\Delta F_h^* - \Delta L_w^*$ is the net accumulation of foreign assets by the private sector, ΔR^* is the net accumulation by the Central Bank, i.e. reserves in foreign exchange, and ΔB_w^* is government borrowing abroad. Any of these can be negative. The nominal exchange rate e , is used to convert foreign asset or liability accumulation into home currency terms. If the exchange rate were freely floating, ΔR would be zero. If the exchange rate is fixed, ΔR must vary to clear the excess demand from the foreign exchange market. If capital controls exist, ΔF_h^* and ΔL_w^* would be exogenous, and in our case, set equal to zero. If the government deficit is fully financed at home, ΔB_w^* would be zero.

The budget deficit is assumed to be financed by government borrowing from: the Central Bank (ΔB_b); the private sector (ΔB_h); or abroad (ΔB_w^*):

$$(2.4) \quad G - T \equiv \Delta B_b + \Delta B_h + e \cdot \Delta B_w^*$$

with the exchange rate, e , translating foreign borrowing into home currency. The excess of private saving over domestic investment must flow into accumulation of monetary base (ΔH), government debt, or foreign assets:

$$(2.5) \quad S - I \equiv \Delta H_h + \Delta H_f + \Delta B_h + e(\Delta F_h^* - \Delta L_w^*) - \Delta L_b$$

Equations (2.3), (2.4), and (2.5) can be substituted into the flow-of-funds identity (2.2) to derive the consolidated monetary account:

$$\begin{aligned} (\Delta H + \Delta B_h) + e(\Delta F_h^* - \Delta L_w^*) - \Delta L_b - (\Delta B_b + \Delta B_h + e\Delta B_w^*) \\ - e(\Delta F_h^* - \Delta L_w^* + \Delta R - \Delta B_w^*) = 0, \end{aligned}$$

so that after cancelling terms, we have

$$(2.6) \quad \Delta H = \Delta B_b + e\Delta R + \Delta L_b$$

Thus the national income and balance-of-payments identities implicitly contain the monetary identity.

This accounting structure provides for the largest menu of financial transactions available in most developing countries. In many, we would limit the menu. Private capital movements can be precluded by setting $\Delta F_h^* = \Delta L_w^* = 0$. Foreign borrowing by the government is eliminated by setting $\Delta B_w^* = 0$. The domestic bond market is eliminated by setting $\Delta B_h = 0$. Finally, we can assume the Central Bank fixes the exchange-rate, e , and adjusts ΔR^* to achieve this. From equation (2.6) it is clear that this may imply some loss of monetary control.

Here (S-I) is net private saving, (T-G) is the government budget surplus, and (X-M-TR) is the current-account surplus in the balance of payments.

The balance-of-payments identity is:

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Here $\Delta F_h^* - \Delta L_w^*$ is the net accumulation of foreign assets by the private sector, ΔR^* is the net accumulation by the Central Bank, i.e. reserves in foreign exchange, and ΔB_w^* is government borrowing abroad. Any of these can be negative. The nominal exchange rate e , is used to convert foreign asset or liability accumulation into home currency terms. If the exchange rate were freely floating, ΔR would be zero. If the exchange rate is fixed, ΔR must vary to clear the excess demand from the foreign exchange market. If capital controls exist, ΔF_h^* and ΔL_w^* would be exogenous, and in our case, set equal to zero. If the government deficit is fully financed at home, ΔB_w^* would be zero.

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Chapter III

THE FINANCIAL SECTOR

This chapter presents the financial sector submodel. The most general form of the model includes portfolio demand equations for four assets, and the dynamics of their accumulation from the flows in the national income accounts. The four assets are money, bonds, foreign assets, and capital. In practice, the equities market is nonexistent in most developing countries. Consequently, in the maquette, we do not treat explicitly the equities market although it is presented here for completeness. The presentation is used to show that an increase in the price level raises interest rates and reduces equilibrium output demanded through several channels.

1. Specification of the Model

Specification of the financial sector adds a foreign asset to the Money-Securities-Capital Model of Tobin (1969). The private sector's demands for each asset are assumed in general to depend on the real returns on all four assets. Money is assumed to be held for transaction purposes. The remainder of wealth (less money) is distributed to bonds, capital, and foreign assets by the portfolio demand equations. With a total wealth constraint, the four portfolio demand functions contain only three independent relationships, implying adding-up constraints across the partial derivatives of the demand functions, as originally pointed out by Tobin (1969).

The real rates of return are specified as follows:

$$(3.1) \quad r_m = i_m - \hat{P}^e \quad (\text{money});$$

$$(3.2) \quad r_b = i - \hat{P}^e \quad (\text{bonds});$$

$$(3.3) \quad r_f = i^* + \hat{e} - \hat{P}^e \quad (\text{foreign assets})$$

$$(3.4) \quad r_k = R/P_E \quad (\text{capital})$$

Here \hat{P}^e is the expected inflation rate and \hat{e}^e is the expected rate of nominal depreciation, the i 's are nominal interest rates, with $i_m = 0$. The real profit rate is R and is given by the rate of return on capital over the cost of capital minus one from the supply side of the model (see Chapter 4) and P_E is the price of equities. With the expected rate of inflation given

exogenously to the financial sector, determination of nominal and real returns amount to the same thing.

The vector of four real returns can be written simply as $r = (r_m, r_b, r_k, r_f)$. Then, under our assumptions about household decision-making, the portfolio-balance equations of the households giving their demands for values of assets are given by (3.5)-(3.9):

$$(3.5) \quad H_h = P_h^d(r, y)$$

$$(3.6) \quad B_h/i = d(r) \left[W - H_h - P_E K \right]$$

$$(3.7) \quad eF_h^*/i^* = f(r) \left[W - H_h - P_E K \right] ; f + d = 1.$$

$$(3.8) \quad P_E K = k(r) \left[W - H_h \right]$$

where the wealth constraint is:

$$(3.9) \quad W \equiv H_h + P_E K + B_h/i + eF_h^*/i^* .$$

Note that the private sector's flow equilibrium condition given in equation (2.5) is the same as the time rate of change of the wealth constraint with $I = P_E \Delta K$. With the wealth constraint (3.9), and $r_m = -P^e$ given exogenously, equations (3.5) - (3.8) contain three interdependent relations in the two real returns r_b and r_k , and the exchange rate, e .

Figure 2(a) shows the decision-making about household asset holdings implied by equations (3.5) - (3.9). The tree approach indicating multi-level budgeting reflects the desire to keep the number of parameters to a minimum. For example, after the decision about money holdings, in a first stage households allocate savings between physical and financial assets. Because the equity market is not modelled in the maquette, the endogenously determined proportion of household savings allocated to physical capital is made available directly to firms according to details specified in chapter 4. In a second stage, an allocation is made between domestic and foreign assets depending on their expected relative returns.

Firms' financial requirements are shown in figure 2(b). As explained below, in disaggregating the private sector, we have chosen to concentrate on the firm's investment and financing rather than on commercial banks' decisions. Firms' financial requirements are for investment expenditures, working capital and interest payments on their stock of debt. In the absence of foreign exchange controls and in the presence of a domestic bond market (see section 3.4 for alternative financial closures), firms borrowing decisions are made in an analogous manner to household asset holdings. The equations that determine domestic and foreign debt shares are detailed in chapter 4 along with the equations that determine the household shares into non-monetary financial assets (k, g, f, d).

2. Comparative Statics

The assumptions that the own-derivatives $\partial h/\partial r_m$, $\partial d/\partial r_b$, $\partial f/\partial r_f$, and $\delta_k/\delta r_k$ are all positive, and the assumption that all cross derivatives are zero (i.e. all assets are gross substitutes) makes the comparative statics of the system determinate. We discuss here some of the more important comparative-static results.

An increase in the level of income increases the demand for money in equation (3.5) leading to an attempt to shift out of bonds in equation (3.6). This pulls up the bond rate r_b (pushes bond prices down). The rise in the bond rate leads to substitution out of K and F^* into B, raising r_k (P_E falls) and reducing the price of foreign assets, i.e. reducing the exchange rate e . Thus in this model we have a 4-dimensional LM surface, with an increase in y raising r_b and r_k , and reducing e for given asset supplies (2).

For given income and asset supplies, an increase in the price level p^d increases the demand for nominal balances H in equation (3.5), inducing a shift out of other assets into money. The shift away from B, K and F^* raises r_b and r_k and reduces e . This is the analog to an upward shift in the two-dimensional LM curve. All three effects work to reduce demand by reducing expenditure on durables and by reducing net exports (e down is appreciation). This contributes to a negative slope for the aggregate demand curve in (P^d, y) space.

An increase in expected inflation reduces real returns and raises e (depreciates the currency) in this model. Suppose that when P^e increases, i , r_k , and e all rise by the same amount in equations (3.1) - (3.4). This would hold the real returns on bonds, capital, and foreign assets unchanged, but the real return on money would have fallen. So demand would shift from money toward the other assets, reducing on balance r_b and r_k and increasing e . This effect of expected inflation on real interest rates was stressed by Mundell (1967).

3. Dynamics

The dynamics of the financial sector are driven over time by asset accumulation. This links the financial sector to the national income and flow-of-funds identities of section 3. The change in the money supply is given by equation (2.6). The change in the private sector bond stock is given by:

$$(3.10) \quad \Delta B_h = G-T - \Delta B_b - e\Delta B_w^*$$

The net accumulation of real capital is simply:

$$(3.11) \quad \Delta K = I(B/C-1) - \delta K,$$

where δ is the depreciation rate and the arguments in the investment demand function is detailed in table 2, equation 4.21. From equation 2.3, the accumulation of foreign assets in the private sector's portfolio is:

$$(3.12) \quad e\Delta F_h^* = X - M - TR + e\Delta B_w^* - e\Delta R^*.$$

Finally, the national wealth constraint in flow form is simply

$$(3.13) \quad \Delta W = S = I + (G-T) + X - M + TR.$$

So the equilibrium flows from the national income equation provide the stock dynamics of the financial sector.

4. Financial Market Closures

The model laid out above is not particularly specialized to developing countries. Below, we consider special cases that correspond more closely to the stylized descriptions of developing countries financial markets.

Before introducing the different financial closures in the model, we describe the simplified financial structure incorporated in the maquette, shown in Table 1. In developing the maquette, we had to decide which sectors to model in detail. In order to model explicitly the firms' investment and financing, we maintain the distinction between households (h) and firms (f) within the private sector. However, to avoid modeling the details of the process of creating inside money, we integrate the commercial banks and the Central Bank into an aggregate monetary survey, following IMF practice. Thus, in its present form, we are not able to capture the crowding out effect on private investment of government borrowing from commercial banks. In the monetary survey, we aggregate reserves (eR^*), Central Bank holdings of government debt (B_b), and lending to private firms L_b on the asset side, and total money holdings ($H_h + H_f$) on the liability side.

(a) Fixed Exchange Rates

In this case e would be taken as exogenous, and ΔR^* would become endogenous. In this case, if there were no capital controls, the Central Bank would be required to offset private capital flows by changes in reserves. This would make $e\Delta R^*$ in equation (3.12) the accommodating variable, and the Central Bank would have to accept the consequences for monetary policy from equation (2.6), i.e.

$$\Delta H = \Delta B_b + e\Delta R + \Delta L_b .$$

Adding capital controls would eliminate equation (3.7) and make the private capital account exogenous, equal to the permitted flow.

(b) No Bond Market

In many cases, a domestic market for government debt does not exist. This would eliminate equation (3.6) and r_b , by setting $B_h = 0$. In this case, the government would finance the entire deficit at the Central Bank or abroad:

$$G - T = \Delta B_b + e\Delta B_w^* .$$

Elimination of foreign borrowing would make ΔB_w^* zero and limit the government to money-finance.

TABLE 1. MONETARY SECTOR BALANCE SHEET

Assets	Liabilities
Rest of the World	
$eL_w^* + eB_w^*$	$eF_h^* + eR^*$
Government	
	$B_b + B_h + eB_w^*$
Monetary Survey	
$eR^* + B_b + L_b$	$H_h + H_f + \text{Net Worth } \underline{a/}$
Private Sector	
Firms H_f	$eL_w^* + L_b$
Households $H_h + eF_h^* + B_h$	

a/ Changes in Central Bank Net Worth are assumed to absorb changes in the home-currency value of foreign exchange reserves given by $R^* \Delta e$. Thus the latter do not affect the money supply.

(c) Credit Rationing

The model here has interest rates and the return on equity is determined by the financial markets. In most developing countries, at least some rates are set administratively, with credit rationed to favored borrowers at below-market ceiling rates. To represent credit rationing, eliminate equilibrium conditions (3.5)-(3.8) and replace them by a vector of ceiling rates $\bar{r} = (\bar{r}_b, \bar{r}_k, \bar{r}_f)$. Then, credit is rationed to investors, or more generally, to purchasers of durable goods.

Chapter IV

THE MULTI-SECTOR MODEL

This section lays out the micro model which determines supply and demand in each of the goods markets. The details of the macro-micro interactions are also specified along with the selected functional forms. To simplify exposition and notation the macro-micro linkages and the distributional mechanisms are treated separately. In section 5.1, we present the one-sector counterpart to the multi-sector model; in section 5.2 we describe income and asset distribution with an illustration of the mapping from functional to household income distribution taken from the numerical simulations in section 6.

1. Model Equations and Functional Forms

To simplify notation, the presentation is made for a one sector model, but the reader should think of accompanying subscripts for goods markets, labor markets, and household consumption and financial decisions. As a rule, no subscripts appear for sectors, nor for labor markets, but a subscript h is used to denote a variable indexed over households and a subscript t to indicate time is used in the description of dynamic linkages. A subscript -1 indicates a one period lag for the value of that variable and expectations about inflation and exchange rate changes are denoted by P^e and e^e . As before, variables expressed in foreign currency units have an asterisk superscript and Δ is the first difference operator.

In the description of the selected functional forms, the following conventions are used: A CES function with arguments X_1, X_2 is denoted: $Y = \text{CES}(X_1, X_2; A, \alpha, \sigma)$ with parameters following the semi-colon. The corresponding dual is denoted $P_Y = \text{CESD}(PX_1, PX_2; A, \alpha, \sigma)$; the same convention is followed for Leontief (L) and LES (LES) functions. Non-competitive imports are denoted by a subscript 0 and foreign currency denominated assets (prices) are denoted by an asterisk.

Firms, households and government decisions in goods markets are presented first. Next, asset market behavior by firms and households. Finally the market for foreign exchange which derives from goods and portfolio decisions. Alternative closures and dynamic linkages close the discussion.

The representative firm makes decisions about output supply and investment demand. Output decisions derive from the maximization of short-run profits. Technology is given by a constant returns to scale production function with short-run diminishing returns to labor, the only variable factor along with intermediate demand. Capital is fixed: once installed, it can only be varied through capacity increase or through depreciation.

TABLE 2. MODEL EQUATIONS

Technology

- (4.1) $X^S = A(t) L(VA, V_2)$ Leontief production function for gross output and value-added
- (4.2) $V_1 = CES_1 (V^d, V^m; \sigma_c, \gamma)$ CES intermediate aggregation function
- (4.3) $V_2 = L (V_1, M^{NC})$ Leontief intermediate technology
- (4.4) $VA = CES_2 (L_S, \bar{F}, U \bar{K}; \sigma_p, \alpha)$ CES aggregation function for value-added. (F = sector specific factors; U = capacity utilization rate; $0 < U < 1$)

Commodity Demand Definitions

- (4.5) $X^d = D^d + E^d$ Total demand
- (4.6) $D^d = V^d + I^d + G^d + C^d$ Domestic effective demand
- (4.7) $M^c = V^m + I^m + G^m + C^m$ Import demand for competitive imports
- (4.8) $Q = CES_1 (M^c, D^d; \bar{A}_2, \gamma, \sigma_c)$ Composite demand

Prices

- (4.9) $P^m = P_m^* \bullet (1 + \bar{t}_m)$ Import price (competitive imports)
- (4.10) $P_0^m = P_0^* \bullet (1 + \bar{t}_{m_0})$ Import price (non-competitive imports)
- (4.11) $P^e = P^* \bullet (1 + t_e) = P^d$ Export price
- (4.12) $P^d = \bar{P}^d (1 + \bar{t}_x)$ Tax inclusive domestic price
- (4.13) $P^n = P^d - a_x P^c - a_0$ Value-added price
- (4.14) $P^c = CESD(P^d, P^m)$ Composite price

Factor Demands, Wage Determination, and Expectations

- (4.15) $L_s^d = g_2 \left(\frac{W}{P^n} \right); U, \bar{F}, \bar{K}$ Labor demand for category s from short-run profit maximization
- (4.16) $\bar{L}_S = L_S^d + \bar{L}_G$ Wage determination; neoclassical full employment

$$(4.17) \quad w_{s,t} = \bar{w}_{s,t-1} + \hat{\Omega}P + (1-\Omega)(1+\hat{P}_e)$$

Wage indexation; s denotes a labor category

$$(4.18) \quad \hat{P}_e = \hat{P}_{-1}; \hat{e}_e = \hat{e}_{-1}$$

Adaptive price expectations (P is GDP deflator)

Commodity Demands

$$(4.19) \quad E^d = \bar{E}_0 (P^d/P_e)^{-z}; \quad z > 0$$

Export demand

$$(4.20) \quad \frac{D^d}{M^c} = g_1 \left(\frac{P^d}{P^m}; \gamma, \sigma_c \right)$$

Domestic use ratio

$$(4.21) \quad I_t = a \left\{ \frac{P^{nMP_k U}}{q(\delta + J^F)} - 1 \right\} = \left\{ \frac{B}{C} - 1 \right\}$$

Investment demand

(See text)

$$I_t \geq 0$$

$$(4.22) \quad J^F = \theta i + (1-\theta)(1 + \hat{e}_e) i^* - b\hat{p}_e$$

Opportunity cost of credit (θ is share of domestic component; b , a parameter)

$$(4.23) \quad M^{NC} = a_0 X$$

Non competitive imports

$$(4.24) \quad C = LES(P^C, Y^H, \mu, \phi); \quad \mu \in [1-s]$$

LES consumption demand (μ is marginal propensity to consume)

$$(4.25) \quad GE = \bar{G} P^C + \bar{w}_G L_G + \bar{I}_G P^C$$

Exogenous government expenditures

$$(4.26) \quad I = k \hat{\Delta} K$$

Investment by sector of origin (k is vector describing composition of capital across sectors)

$$(4.27) \quad q = k^* P^C$$

Price of capital goods

Flexible and Fix Price Commodity Market

(i) Price Adjustment

$$(4.28) \quad X^S = X^d$$

Market-clearing price

(ii) Quantity Adjustment

$$(4.29) \quad P_t^{d, \min} = \left\{ (p_{-1}^n \quad |_{-1} w_{-1}) m + |_{-1} w_t + a p_{-1}^d \right\} (1 + \hat{p}^e)$$

Mark-up pricing; l =unit labor requirement; m =minimum share of period $t-1$ profit margins required for period t ; a = input-output coefficients.

$$\left\{ \begin{array}{l} X^S(U) = X^d \quad \text{if } P^d = \bar{P}^d \\ \text{or} \\ X^S(I) = X^d \quad \text{if } P^d > \bar{P}^d \end{array} \right\}$$

Utilization rate adjustment in case of excess supply

Price adjustment in case of excess demand

Household Income and Saving

$$(4.30) \quad Y_h = w_s L + w_G \bar{L}_G + (PNX^S - WL_S) (1 - \omega)$$

ω is distributed share of profits

$$(4.31) \quad S_h = s Y_h - a_s \hat{W}_e$$

Household savings (a_s is semi-elasticity of savings with wealth)

$$(4.32) \quad P^C C = P^C \bar{C} + (Y_h - S_h - P^C C)$$

Household consumption; \bar{C} is exogenous consumption

$$(4.33) \quad W = H_h + B_h / i + e F_h / i^* + p E^k$$

Household wealth constraint

Portfolio Determination (g_1):

$$(4.34) \quad \frac{g_1}{1 - g_1} = \psi_1 \left[\frac{1+r}{J_F} \right]^{\epsilon_1}$$

Allocation between physical and financial assets

$$(4.35) \quad J_F = g_2 (1+i) + (1-g_2) (1+i^*) (1+\hat{e}^e)$$

Average nominal return on bonds

$$(4.36) \quad \bar{r} = P^n \cdot U \cdot \delta X / \delta K \cdot K / \bar{K}$$

Average nominal return on physical assets

$$(4.37) \quad \frac{g_2}{1 - g_2} = \psi_2 \left[\frac{(1+i)}{(1+i^*) (1+\hat{e}^e)} \right]^{\epsilon_2}$$

Allocation between domestic and foreign bonds

$$(4.38) \quad \ln H_h = \ln P^C + \alpha r + \beta \ln Y_h / P^C + \ln \bar{B}$$

Money demand; $\alpha < 0$; $\beta > 0$
 $r \equiv (1+i)/(1+\hat{p}^e) - 1$

$$(4.39) \quad g_3 = \frac{\Delta H_h}{S_h}$$

Household saving allocated to money

Household Savings Allocation

(4.40) $S_{h,k} \equiv S_h - \Delta H_h$ Household savings allocated to non-monetary assets

(4.41) $S_{h,k} = S_{h,k} +$ Household savings allocation to non-monetary assets

$g_1 S_{h,k} +$ Physical capital

$g_2(1-g_1) S_{h,k} +$ domestic bonds

$(1-g_2) (1-g_1) S_{h,k}$ foreign bonds

Firms' Investment Financing

(4.42) $H_f = \beta^F \left[\frac{J'_F}{1+\hat{p}^e} \right] \gamma_F \cdot P^d X^S$ Working capital requirements;
 $\gamma_F < 0$

where $J'_F = (1+i)\theta + (1+i^*)(1+\hat{e}^e)(1-\theta)$

(4.43) $S_f = w PN X^S - DP$ Firms savings (undistributed profits)

(4.44) $BF = q^I + \Delta H_f - S_f - g_1 S_{h,k}$ requirements to finance investment expenditures; $BF = \Delta L_b + e^e \Delta L_w^*$

(4.45) $DP = (\rho + i_{0-1}) L_b + (\rho + i_{-1}^*) e L_w^*$ Repayment of debt (ρ is exogenous repayment rate)

Firm Borrowing Allocation and Credit Rationing

(4.46) $\frac{g_4}{1-g_4} = \psi_4 \left[\frac{(1+i)}{(1+i^*)(i+\hat{e})} \right]^{-\epsilon_4}$ Borrowing allocation between domestic and foreign bonds

(4.47) $\Delta L_b = g_4 BF - \rho L_b$ Firm domestic net borrowing

(4.48) $\Delta L_w^* = (1-g_4) B_F / e - \rho L_w^*$ Firm foreign net borrowing

Credit rationing

(4.49) $q I^R = q^I - \text{Inf} (0, g_4 L^F - B^R)$ Effective demand for investment under rationing (see below)

Government Revenue and Deficit Financing

$$(4.50) \quad GR = P^d t_x X^S + \frac{\bar{P}_O^*}{P_O^*} t_m M^{Nc} + \frac{\bar{P}_m^*}{P_m^*} t_m M$$

Tax receipts

$$(4.51) \quad GD \equiv GE - GR \equiv \Delta B_b + \Delta B_h + e \Delta B_w^*$$

Financing of government deficit (implied by monetary and national income identities)

Market Equilibria

$$(4.52) \quad X^S = X^d$$

Goods market

Financial Markets

$$(4.53) \quad \Delta H \equiv \Delta B_b + \Delta L_b + \theta e CA$$

Money supply definition ($\theta = 0$; full sterilization; $\theta = 1$, no sterilization)

$$(4.54) \quad \Delta H = \Delta H_f + \Delta H_h$$

Money market equilibrium

$$(4.55) \quad \Delta B_h = 0;$$

No domestic bond market

$$(4.56) \quad \Delta F_h^* = L_w^* = B_w^* = 0$$

Foreign exchange control

$$(4.57) \quad i_0^R = i_0 + i_\lambda; \quad i_\lambda > 0$$

Credit rationing (shadow interest rate determination used to evaluate notional credit demands)

Foreign Exchange Market

$$(4.58) \quad CA = P_e^* E^d - P_O^* M^{Nc} - P_m^* M^c + i_{-1}^* (F_h^* - L_w^* - B_w^*)$$

Current account

$$(4.59) \quad KA = \overline{KF} - \Delta F_h^* + \Delta L_w^*$$

Capital account (\overline{KF} is exogenous capital flows)

Floating Exchange Rate (ΔB_w^* fixed)

$$(4.60) \quad CA + KA = 0$$

Fixed Exchange Rate (ΔB_w^* endogeneous)

$$(4.61) \quad \Delta B_w^* = -CA - \overline{KF} + \Delta F_h^* - \Delta L_w^*$$

Dynamics

Factors of Production

$$(4.62) \quad \bar{K}_t = K_{t-1} + I_{t-1} \quad \text{Capital stock definition}$$

$$(4.63) \quad \bar{L}_{s,t} = L_{s,t-1} (1+g_s) \quad \text{Labor force growth}$$

$$(4.64) \quad \bar{A}_t = A_{t-1} (1+g_a) \quad \text{Technical progress}$$

Note: All elasticities are constant elasticities and are defined as positive numbers.
Elasticities (ϵ_i) entering the asset demand functions are share elasticities, i.e.:

$$[\text{e.g. } \epsilon_1^1 \equiv \frac{\hat{g}}{1-g} / (J_F / r)].$$

Technology for gross output is given by a Leontief function between value-added VA_i and intermediate demand with intermediate demand a Leontief function for each supplying sector. Thus there is no substitution between the various components of intermediate demand. However, within a given sector, domestically and foreign produced goods are imperfect substitutes according to a CES aggregation function between the domestically and foreign-produced components (equation 4.2). As shown by the block of equations defining commodity demands, the same functional form and elasticities apply for all components of final demand (equation 6-8).

The price block includes the definition of tax and tariff inclusive domestic prices, and the value-added and composite prices which result from cost minimization (equations 13 and 14). The factor demand and wage determination block indicates the two alternatives in the labor market: (i) neoclassical wage determination and, (ii) wage indexation. Also note that government employment (and the government wage) are exogenous. Finally price (and exchange rate) expectations are taken to be adaptive with a one period lag.

Commodity demands come next. The domestic use ratio (equation 20) results from cost minimization under the CES functional form described in equation (4.8) and export demand has a constant foreign price elasticity of demand. Consumption demand by each household class results from the familiar LES after household savings have been deducted from disposable income (see equations 4.31 and 4.32 below). Government expenditures are fixed in nominal terms and the composition of a unit of capital is assumed to be identical across sectors (equation 4.26 and 4.27).

Investment demand is determined by the profit rate (equation 4.21). Such a functional form is consistent with formulations of investment demand in which there are costs of adjustment and investment decisions are irreversible (Nickell, 1978, chapter 4). However, with this specification, the model exhibits extreme fluctuations to changes in the relative profitability of investment caused by interest rate or expectation changes. For this reason, real investment is given by the quadratic expression

$$I_t/K_t = \gamma_1 \left[\left(\frac{B}{C} \right)^2 + \gamma_2 \left(\frac{B}{C} \right) \right]$$

where γ_1 and γ_2 are suitably selected parameters so that in equilibrium when $B/C = 1$, investment will be at a level which will ensure a rate of growth of net capital stock equal to g . The elasticity of investment with respect to a change in profitability, $\partial I/\partial(B/C)$, evaluated at $B/C = 1$ is equal to a predetermined value, e . The resulting shape of the investment function is depicted in Figure 3. Also note from equation 4.22 that the expectation of a change in inflation is not fully incorporated in the investment decision if $b < 1$.

Equations 28 and 29 describe the two market clearing mechanisms for commodity markets: (i) Walrasian price adjustment (equation 4.28) and; (ii) Keynesian mark-up pricing (equation 4.29) with endogenous capacity utilization. When there is full capacity utilization (i.e. $U_i = 1$), then prices adjust as under (i).

Household income includes labor income and the share of capital income after firms accounting for firms retained earnings. In addition to factor income, households receive income from their asset holdings (equation 4.30). (The details on the mapping from functional to household income are described below.) Household savings rates adjust to changes in wealth, so the marginal propensity to consume is endogenous (equation 4.31). The savings rates are not assumed to be responsive to interest rates. This assumption reflects the conflict between income and substitution effects of changes in interest rates on saving, and the resulting ambiguity in the empirical literature. Analytically, the assumption is not important, because investment is assumed to depend negatively on the interest rate. So in the maquette, excess private saving depends positively on the interest rate via investment.

The wealth constraint shows that households hold money domestic bonds and foreign bonds in their portfolio. Portfolio determination follows the multi-level determination discussed above. All elasticities entering the asset demand functions, ϵ_i , are share elasticities. The allocation of household savings is in two stages: first households allocate savings to money, then to non-monetary assets. Within non-monetary assets, the allocation rules described in equations (4.34)-(4.39) reflect the allocation structure described in figure 2(a). The allocation satisfies the financial wealth constraint (equations 4.40-41).

Firms investment financing is for working capital requirements and for investment expenditures. Equation (4.44) shows that firms can borrow domestic bonds and foreign bonds with the allocation between domestic and foreign bonds similar to the allocation decision by households (equations 4.46-48). When there is credit rationing (equation 4.49) investment is residually determined from the national income identity (equation 4.66) with shadow interest rate determination given by equation (4.58).

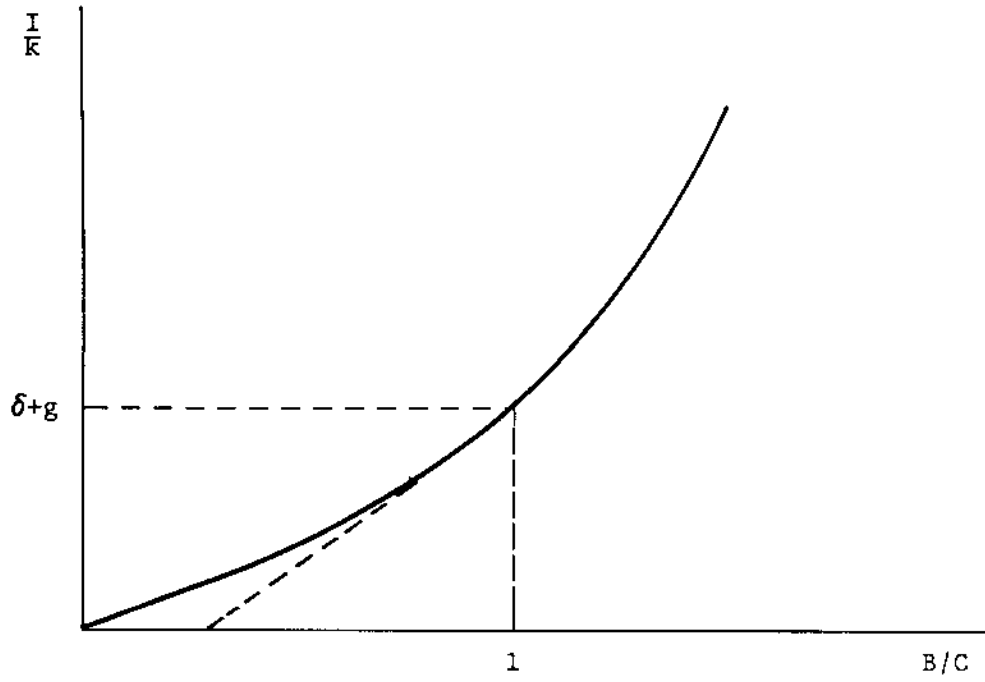
The government collects tax revenues and the government deficit is assumed to be met by borrowing from the Central Bank (ΔB_B), abroad (ΔB_W^*) and domestically (ΔB_H) (equation 4.51).

Equilibrium in the money market takes place under different financial market closures. For example, if there are foreign exchange controls, no foreign asset holdings are allowed for firms or households (equation 4.57). Also note that varying degrees of sterilization are accommodated in the money supply definition (equation 4.53).

The foreign exchange market includes the net demand for foreign exchange resulting from demand for goods and assets. The alternatives of a fixed and a floating exchange rates are given by equations (4.61) and (4.62).

In the numerical application of the maquette, the links between macro and micro components enter primarily through three channels: investment demand, wage indexation, and portfolio decisions. The demand for investment is a negative function of the opportunity cost of funds and the wage rate is usually indexed for modern sector employment with the degree of indexation depending on inflationary expectations. The third channel comes from the interaction of the capital and current accounts when

FIGURE 3. INVESTMENT DEMAND



the exchange rate is flexible. A fourth channel operates when firms are price-setters, in which case a fixed marked-up rate is imposed over variable costs. One can think of this mark-up pricing rule as a minimum price which firms can set because of some competitive imperfection.

2. Income Distribution and Sectoral Disaggregation

The focus on income distribution determines the level of sectoral and household disaggregation. It is expected that the disaggregation will vary according to the institutional characteristics of each country to which the maquette is applied to. To illustrate the mapping from functional income and asset distribution to household income and asset distribution, we give the mapping drawn from a representative primary exporting developing country used in the simulations reported in section 6. The representative economy is classified into 6 sectors, 5 primary factors of production and 6 households. Sectors are indexed over i , factors over j and households (or socioeconomic classes) over k . The description of sectors, factors and households is described in Table 3, in section 6. Let P_{kji} denote the share of class k in factor j employed in sector i (3). Then non-labor income of class k is given by:

$$Y_k^P = \sum_i \sum_j P_{kji} VMP_{ji} F_{ji}$$

where $VMP_{ji}F_{ji}$ is the marginal revenue product of factor j in sector i , F_{ji} . The same mapping is used to determine physical wealth allocation by class:

$$W_k^P = \sum_i \sum_j P_{kji} q_{ji} F_{ji}$$

where q_{ji} is the price of factor j in sector i (4).

The mechanisms by which policy changes affect the distribution of income and wealth are threefold. First, changes in factor rewards affect directly household income distribution. Household real incomes are further affected by changes in returns on financial assets since household incomes include income from financial holdings. Second, changes in relative product prices affect households' real incomes differentially because consumption expenditures are specified at the household level. Third, household wealth distribution is affected by capital gains and losses and by portfolio decisions (5).

Finally income distribution is affected by migration. Migration is at the household level. Denote by N_k the number of persons in household k . Then migration between class k and k' is given by:

$$\Delta N_k = (g_k - \sum_{k'} V_{kk'}) N_k + \sum_{k'} V_{k'k} N_{k'}$$

where g_k is the growth rate of population k and the migration elasticity $V_{kk'}$ is defined by:

TABLE 3. HOUSEHOLD OWNERSHIP OF PHYSICAL WEALTH

Sectors	Factors of Production	Households: Factor Ownership Shares a/						Firms			
		Capitalists	Big Farmers	Small Farmers	Landless Agr. Workers	Mfg. Workers	Informal Workers	Liabilities Assets	Working Capital Sales	Foreign Debt Total Debt	
Primary Export (1)	Land (*) Ag. Labor		75 10	25 40	50			0.05	0.3	0.2	
Agriculture (2)	Land (*) Ag. Labor		50 10	50 40	50			0.05		0.1	
Consumer Goods (3)	Capital (*) Modern Labor	80				100		0.30		0.3	
Intermediate + Capital Goods (4)	Capital (*) Modern Labor	80				100		0.30		0.3	
Non-Traded Formal (5)	Capital (*) Modern Labor	80				100		0.30		0.0	
Informal Non-Agriculture (6)	Informal Labor (*)						100			0.0	
Households: Distribution of Financial Wealth											
Foreign Assets Financial Wealth (7)		0.3								Debt/Exports	0.20
Domestic Bonds Non-Mon. Govt. Debt (8)		0.5	0.5							Money Supply Sales	0.45
Money/Income (9)		0.1	0.1	0.2	0.2	0.2	0.2			Domestic Bonds Govt. Debt	0.6

Notes: An asterisk indicates that the factor is sector specific.

a/ The distribution of factor income to households does not add up to 100 percent for sectors (3)-(5) because of retained earnings in those sectors.

Chapter V

ILLUSTRATIVE SIMULATIONS

1. Elasticity Specifications and Calibration

We now describe results of illustrative simulations from an application of the maquette to the hypothetical primary exporting economy introduced in section 5.2. The sectoral disaggregation is a stylized reflection of production structures typical of several primary exporting economies. The primary exporting sector sells all its output abroad. Most other exports originate in the consumer goods sector. Imports are mostly intermediates and capital goods. The informal non-agriculture sector is a non-traded sector which represents the self-employed: output is produced by informal workers which are paid their average value product. Manufacturing labor (sectors 3-5) is mobile across manufacturing; so is agricultural labor between the two agricultural sectors. For simplicity, in the simulations reported here, we assume no migration across the three labor categories in response to wage differential changes through time. This disaggregation across sectors, households, sectors and factor markets can be thought of as an approximation to the minimum disaggregation necessary to capture the channels through which the short to medium term effects of a typical adjustment package affect the distribution of income and wealth.

The selected elasticity specification is summarized in table 4. As is typical of such simulation exercises, the elasticities reflect a combination of averages of borrowed econometric estimates (e.g. for household consumption, technology, foreign trade) and guesstimates (e.g. portfolio response elasticities) (6).

The calibration procedure follows that common to CGE applications: initial prices and quantities are combined with exogenous variables, parameters (e.g. tax, rates, etc.) and elasticities (essentially those in table 3) to calculate share parameters and exogenous constants that validate the read in quantities and prices (7). The presence of assets in our model complicates calibration since income flows (and hence consumption decisions) depend on incomes earned (or interest paid for firms) from assets. Our calibration procedure recognizes this complication. Our calibration procedures also allow for compatibility of household savings rates and household ownership of capital. By compatibility is meant an ownership structure such that household shares in sectoral ownership would remain constant given the exogenous (and fixed) household savings rates. In the simulations reported below, we calibrate the model to the household ownership matrix described in Table 3. We also calibrate portfolio holdings by firms and households to the figures in Table 3 and the elasticities in Table 4 (8).

$$V_{kk'} = \text{Sup} \left\{ \left(\frac{Y_{kk'}}{Z_{kk'}} \right)^{z_{kk'}} - 1, 0 \right\}$$

In this expression $Z_{kk'}$ is the "normal" mean income differential between classes k and K' , and $z_{kk'}$ is the migration elasticity.

2. Simulation Results

The simulations are intended to illustrate some of the distributional implications of the foreclosing of external borrowing from commercial banks starting in 1982 since this is the background in which most stabilization programs took place. Initial-year values for the macroeconomic asset/flow aggregates are described in the bottom right corner of table 3. With an exogenous foreign interest rate of 8 percent, an initial domestic interest rate of 10 percent, and a combination of tax rates and the selected exogenous government expenditures, initial year fiscal deficit is 4.2 percent of GDP and initial current account deficit is 4.6 percent of GDP (9). These overall initial conditions are representative of initial conditions at the start of the debt crisis.

The definition of each one of the four simulations appears in Table 5. The base run represents conditions that would have prevailed, had the reduction in fiscal and current account deficits taken place with foreign financing available, flexible wages and prices (including the exchange rate) and no foreign exchange controls. The three experiments represent different scenarios by which foreign borrowing to finance the fiscal deficit is brought to zero by year 3. In E-1, adjustment is smooth with full wage, price and exchange rate flexibility. In E-2, adjustment is more difficult because of real wage resistance by manufacturing workers. Finally in E-3, the fiscal deficit is reduced by cutting government expenditures, maintaining a fixed exchange rate, and reducing money supply growth to zero until year 5. A mark-up pricing rule applies for all manufacturing sectors, with a mark-up rate of 10%. A mark-up rate of 10% means that firms will set prices (and adjust utilization rates) so that their profit margins do not fall by more than 10 percent. Finally in all experiments, expectations about inflation and devaluation are exogenously set equal to 3 percent, implying expectations of a constant real exchange. (This is not strictly true for E-3; see Table 5).

The macroeconomic results of the simulations appear in table 6 which gives average compounded annual growth rates for inflation, the nominal exchange rate and real GDP along with initial and terminal values for the nominal interest rate, fiscal and current account deficits, as well as initial and terminal values of the foreign debt to GDP ratio (10).

In the base run, external borrowing allows the economy to progressively reduce its current account deficit by half over 7 years while maintaining a constant fiscal-deficit-to-GDP ratio. External borrowing implies a growing foreign-debt-to-GDP ratio which reaches 34 percent of GDP in the terminal year. In the following simulations, the foreclosing of external borrowing implies that the foreign debt-to-GDP ratio only rises to 14 percent of GDP. The resulting cut in real expenditures is achieved by expenditure switching in E-1 with a larger real exchange rate devaluation than in the base run and a lower interest rate. With partial real wage rigidity, in E-2, the adjustment is somewhat more difficult: the real exchange rate devaluation is about the same as in E-1, but average GDP growth is 0.2 percentage points less than in E-1 because of unemployment. Finally, in E-3 growth is cut by 2 percentage points because of 30 percent idle capacity for capital in manufacturing and because of the combination of fiscal and monetary restraint.

TABLE 4. ELASTICITY SPECIFICATION

Households

Consumption

$0.40 < \text{expenditure elas} < 1.40$

$-1.25 < \phi \text{ (Frisch)} < -2.00$

$0.02 > S_h < 0.15$

a_s (proportion of wealth
change saved) 0.10

Capitalist and farmers'
population growth (0.01)

Portfolio

Money:

α (semi interest elasticity) -0.02

β (income elasticity) 0.6

Bonds ($\epsilon_2 = 1.0$)

Physical/Financial ($\epsilon_1 = 1.0$)

Firms

Technology

Production ($0.7 < \sigma_c < 1.1$)

Depreciation ($\delta = 0.02$)

Labor force growth (0.03)

Technical progress
($0.01 < g_A < 0.03$)

Portfolio

Working Capital ($\gamma = 1.0$)

Bonds ($\epsilon_4 = 1.0$)

Investment

Investment and elasticity to (B/C)
= (0.1)

Foreign Trade

Export demand ($2.0 < Z < 3.0$)

Import demand ($0.6 < \sigma_c < 1.5$)

TABLE 5. DEFINITION OF SIMULATIONS

Base Run	<ul style="list-style-type: none"> • Money supply growth = 5 percent per year; Full sterilization of capital flows. • Flexible exchange rate ; sterilization of capital flows. • Flexible modern sector wages. • Fiscal deficit financed by borrowing abroad (B); $B_0 = 30$, $B_1 = 28$; $B_2 = 26$, $B_3 = 24$, ... $B_6 = 18$.
E-1	<p>Reduction of fiscal deficit with flexible wages.</p> <ul style="list-style-type: none"> • Flexible exchange rate. • Public sector foreign borrowing: $B_0 = 30$, $B_1 = 20$; $B_2 = 10$; $B_3 = 0$, $B_4 = 0$, ..., $B_6 = 0$.
E-2	<p>Reduction of fiscal deficit with fixed modern sector wages.</p> <ul style="list-style-type: none"> • Same as E-2 but modern sector real wage fixed to year 1 real wage value.
E-3	<p>Reduction of fiscal deficit with fixed nominal exchange rate, fixed modern sector wages mark-up pricing in manufacturing, and reduced money supply growth.</p> <ul style="list-style-type: none"> • Money supply growth = 0 (yr 1 to yr 4; = 2.5, 3.5, 4.5 (yrs. 5 to 7)) • Same as E-2 but nominal exchange rate fixed • Across the board reduction in government expenditures (wages, investment and current consumption) • Mark-up pricing (manufacturing firms do not accept a drop in profit margins above 10 percent).

Note: In all experiments, expected inflation is exogenously set to 3 percent per annum; expected devaluation is also set equal to 3 percent except in E-3 when it is set equal to zero.

TABLE 6. MACROECONOMIC EFFECTS OF FISCAL DEFICIT ELIMINATION

	Base	E-1	E-2	E-3
GDP growth <u>a/</u>	6.5	5.8	5.6	3.5
Devaluation <u>a/</u>	2.5	5.1	5.0	0.0
Inflation <u>a/</u>	1.1	3.6	3.8	0.6
Foreign debt/GDP <u>b/</u>	(4.7; 34.7)	(4.7; 14.1)	(4.6; 14.1)	(4.6, 21.5)
Consolidated fiscal deficit/GDP <u>b/</u>	(4.2; 4.6)	(4.2; 1.0)	(4.2; 1.1)	(4.2; 0.6) <u>d/</u>
Current account deficit/GDP <u>b/</u>	(9.9; 3.9)	(9.9; 0.1)	(9.9; 0.1)	(9.9; 1.3)
Interest rate <u>b/</u>	(10; 14)	(10; 16)	(10; 16)	(10; 12)
Unemployment rate <u>c/</u>	(0; 0)	(0; 0)	(0; 1.6)	(0; 1.6)
Capacity utilization <u>e/</u>	(1,1)	(1,1)	(1,1)	(1,0.7)

a/ Average compounded annual growth rates.

b/ (initial, terminal) ratios to nominal GDP.

c/ Percent of total labor force: terminal year.

d/ + signifies fiscal surplus. The consolidated fiscal deficit includes interest paid on domestic and on foreign debt.

e/ Capacity utilization rates in the terminal year are for all manufacturing sectors, with each sector's weight given by its share in total manufacturing sector capital.

TABLE 7. REAL INCOME AND WEALTH: TERMINAL TO BASE YEAR RATIOS

Experiment\Household	Base		E-1		E-2		E-3		Wealth/Income (Year 1)
Income (Y); Wealth (W)	Y	W	Y	W	Y	W	Y	W	
Capitalists	1.22	0.96	1.18	0.80	1.18	0.77	1.11	1.41	9.1
Big Farmers	1.75	1.31	1.70	1.10	1.68	1.08	1.48	1.21	9.6
Small Farmers	1.41	1.02	1.37	0.86	1.35	0.84	1.20	0.98	7.0
Landless Agr. Workers	1.33	0.53	1.31	0.31	1.30	0.31	1.32	0.63	0.4
Manufacturing Workers a/	0.97	0.48	0.91	0.27	0.93	0.28	0.94	0.64	0.4
Self-Employed	1.43	0.60	1.33	0.29	1.29	0.25	1.00	0.59	0.4

Y = Average real income (corrected for unemployment)

W = Average real wealth

a/ Includes government workers, and unemployed

The effects of the different adjustment scenarios on the distribution of income and wealth are summarized in Table 7. Start with the evolution of real income in the base run. Big farmers derive most of their income from the ownership of land which is assumed to be in fixed supply. Hence they gain the most in relative terms, followed by the other owners of fixed assets, small farmers and capitalists with manufacturing workers' real income falling because of the combination of a higher cost of living index and a slowly rising real wage. Real wage indexation does not help because real incomes are distributed among the unemployed. The evolution of the distribution of wealth for workers whose sole asset is money is governed by inflation, falling the least when inflation is lowest. Capitalists and farmers hold between 10 and 20 percent of their wealth in financial assets. Hence the effects of capital gains/losses on total wealth is small although fluctuations in the distribution of wealth are magnified in comparison with fluctuations in the distribution of income.

NOTES

1. The financial sector is in the tradition of Tobin (1969), Branson (1979). The real sector is in the CGE tradition (Dervis et al, 1982) and income distribution is modelled as in Adelman and Robinson (1976) but in less detail. All markets are assumed to clear in the representative period and there are no lags. The model does not address the short-run dynamics of adjustment as in e.g. Khan and Zahler (1983). A simulation model with some of the micro-macro linkages developed here is described in Lewis (1985).
2. If we simplify the financial sector down to a traditional velocity equation for money demand = money supply, the financial (LM) sector reduces to a single LM curve, which can be used with an IS curve for the national income equilibrium condition to do a textbook derivation of an AD curve.
3. Because of undistributed profits by firms, the first three columns of P do not necessarily sum to unity. See table 3.
4. Financial wealth distribution is described in the bottom half of table 3 and is discussed further in section 7.
5. In addition, income distribution is also affected by migration between classes which are also included in the model. In the simulations reported below, there is no migration between classes.
6. A desirable step in specific country applications would be to combine of the shelf parameter selection with econometric estimates for elasticities deemed crucial in that particular application.
7. For a description of calibration procedures see Dervis et al, 1982 (appendix B) and Mansur and Whalley (1984).
8. The calibration is achieved by iterations involving at each step the recalculation of incomes inclusive of interest earned (paid) based on assumed values for prices, interest rates and expectations for the pre-simulation year. At each iteration, the calibrated parameter values and constants for technology and consumption behavior are maintained, but those for portfolios are recalculated until the desired portfolio holdings (given by the ratios in table 3) are the desired ones for the read in initial values for prices and quantities.
9. Both ratios are expressed as a fraction of current GDP. The current account deficit is not equal to the fiscal deficit because of initial asset holdings.
10. The breakdown of the financing of the fiscal deficit between domestic foreign borrowing and money creation is not shown since the focus here is not on the fiscal implications of stabilization. In all experiments, except E-1, domestic borrowing is less than 1 percent of GDP and positive monetary financing only occurs in the last three

CONCLUSIONS

This paper has presented a macro-micro simulation framework useful for the analysis of stabilization cum structural adjustment packages that are often supported by international agencies like the IMF and World Bank. The simulation framework does not address the short-run dynamics of a stabilization package although the different specifications about the menu of market adjustment mechanisms (e.g. real wage resistance, mark-up pricing and endogenous capacity utilization) allow for considerable flexibility in the use of the model. Likewise, even though expectations are formed exogenously and there are no intertemporal budget constraints, the flexibility incorporated in the various financial market closures would make it suitable for use for a relatively large number of countries.

The relatively detailed modelling of goods and financial markets accompanied by sectoral, household, and labor market disaggregation allow the model to trace out the likely quantitative impact of alternative stabilization packages on the distribution of income and wealth at the household level. Illustrative simulations at the end of the paper for a hypothetical primary exporting economy indicate the channels and likely distributional implications of representative stabilization packages.

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