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ABSTRACT

This paper presents a structural macro simulation model to quantify the effects of alternative stabilization packages on the distribution of income and wealth. The model combines the explicit microeconomic optimizing behavior characteristic of computable general equilibrium models with asset portfolio behavior of macroeconomic models in Tobin's tradition. In this model there are four main mechanisms by which policy changes affect the distribution of income and wealth. First changes in factor rewards affect directly household income distribution. Second, household real incomes are affected by changes in their respective cost of living indexes. Third, household real incomes are affected by changes in real returns on financial assets since household incomes include income from financial holdings. Fourth, household wealth distribution is affected by capital gains and losses.

Simulations with the model are carried out for a representative economy subject to the interest rate and terms-of-trade shocks of the early 1980s. The simulations suggest a large adverse impact on the distribution of income of a sharp contractionary package. The resulting distributional shifts are likely to endanger the sustainability of the package even though the distribution of income becomes more equal when normal policies are resumed. By contrast, the targeted expenditure cut programs advocated by the critics of contractionary packages result in a much less unequal distribution of income during the adjustment package, even though the distributional improvements of the targeted package are mostly reversed in the post-adjustment period. The simulations support the view that stabilization packages which do not have specific components targeted towards the poor will have a noticeable adverse effect on the distribution of income, which is likely to result in some form of permanent damage for those below the poverty line.

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1. Introduction

Declining terms-of-trade, rising real interest rates on external debt and a virtual halt of adjustment lending were the major contributors to the crisis environment under which were executed many adjustment programs supported by the World Bank and IMF. A characteristic of these programs has been the joint participation of the institutions and hence the simultaneous emphasis on stabilization and structural adjustment. Stabilization policies placed emphasis on demand management, while structural adjustment programs placed emphasis on supply-side effects. The two concepts, however, are not easily defined and separated: for example, exchange rate policies are a fundamental element of both Fund-supported stabilization packages and of Bank-supported structural adjustment packages.

Recently, distributional implications of these adjustment packages have received increasing scrutiny. In particular, they have been criticized for their lack of focus on the welfare of the poor. These adjustment packages have been criticized for seeking excessive reduction in aggregate demand, thus resulting in an unwarranted contraction of output, employment, and living standards of the poor. These adjustment programs have also been criticized for their lack of emphasis on mitigating the adverse distributional implications of external shocks on the poor. 1/

The most thorough critique is in Cornia, Jolly, and Stewart (1987) where a strong argument is also made for an activist role for adjustment programs. In their outline proposal for "Adjustment with a Human Face," Cornia et al. suggest a combination of expansionary macro policies and sectoral (and micro) policies that are targeted towards the poor and designed to increase equity and efficiency. In support of their targetting

approach, they cite evidence showing that increases in nutrition, education and health raise productivity and that small farms where the landless poor are located have higher productivity than large farms. They further offer suggestive time paths of adjustment and incomes of the poor under their proposed package in contrast with the standard adjustment packages they criticize (ch. 6).

While very informative and thoroughly researched, this approach offers no framework which ties the macro and micro policies they suggest. Neither is there a coherent analytical framework underlying the studies undertaken by the IMF and World Bank in response to this rising concern. 2/ For example, the sensible methodology proposed by Heller et al. (1988, ch. 3) is to: classify the poor across economically meaningful socioeconomic groups; describe how the policies included in a typical adjustment package are likely to affect these groups: then to speculate on how the poor fared during adjustment, usually without attempting to impute whether any change in their status was due to the effects of the adjustment program or to the (unsustainable?) preprogram situation (Heller et al., p. 8).

The purpose of this paper is to go a step beyond these earlier efforts by using counterfactual simulation analysis to derive orders of magnitude about the likely distributive implications of alternative adjustment strategies for the poor. Our analysis relies on the socio-economic classifications proposed in the studies cited above. The paper also relies on previous estimates of the magnitude of adjustment that was required during the period when the adjustment programs supported by the Bank and the Fund were in effect. These previous efforts allow us to build sensible base scenarios and counterfactuals as well as a representative classification of the poor by meaningful socieconomic groups.

The distinctive characteristic of our simulation model is that it links the short-run impact of macroeconomic policies that affect the distribution of income through inflation, the interest rate and other price changes, with the more-often emphasized medium-run impacts of adjustment policies (i.e. incentive reforms) that affect the distribution of income through relative commodity and factor price changes. We are therefore able to address many of the criticisms that have been raised against the recent adjustment packages (e.g. their lack of emphasis on supply response and their excessive use of demand management policies).

The remainder of the paper is organized as follows: Section 2 outlines the model which is described in fuller detail in the appendix. Section 3 discusses the stylized sectoral disaggregation, the socioeconomic classification and the initial income and asset distribution among socio-economic groups. The selection of counterfactuals is presented in section 4 and the simulation results in section 5.

2. Model Outline

The distinguishing characteristic of the model used for our counterfactual simulation analysis is its ability to capture the short and medium to long-run effects of stabilization and structural adjustment policies on the distribution of income. A full description of the model and of its various closures is in Bourguignon, Branson, and de Melo (1988). Functional forms and equations of a one sector model are in the appendix. Here we focus only on how we model income and asset distribution and the linkages between the macro and micro elements in the model.

Analytically, one can distinguish two interacting channels through which these adjustment packages 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, other taxes, and the exchange rate. For a given mix of expenditure reduction, the extent of relative price rigidities (e.g. fixed real wages or mark-up pricing), the extent of 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.

In addition to changes in the level of activity, 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 portfolio shifts operating in increasingly integrated capital markets. In these integrated markets, 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. Though the emphasis is not on short-run dynamics and

expectations, the simulation model developed here quantifies the interaction of these two channels through which the distribution of income and wealth is affected by adjustment packages. 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 conveniently 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 model described here incorporates features from these two traditions. 3/

We start with the mapping of the functional distribution of income into socieconomic groups at the microeconomic level, then we show how macro and sectoral policies affect the distribution of income and wealth. Next we discuss our treatment of the financial and government sectors, and close with a description of goods and factor markets.

2.1 Determination of Income and Wealth Distribution

Sectors are indexed over i, factors over j and socioeconomic classes over k. The description of sectors, factors and households is described in Table 3. Let P_{kji} denote the share of class k in factor j employed in sector i. Then non-labor income of class k is given by:

$$(2.1) \qquad Y_k = \sum_i \sum_j P_{kji} \, VMP_{ji} \, F_{ji}$$

where VMP_{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:

$$(2.2) \qquad W_k^p = \sum_i \sum_j P_{kji} \, q_{ji} \, F_{ji}$$

where q_{ji} is the price of factor j in sector i. (The number of factors sectors and households is discussed in section 3).

Households also hold financial assets. Aggregating over socieoconomic classes, the household sector (denoted by subscript h) holds the following financial assets: money, H_h, domestic bonds, B_h, and bonds denominated in foreign currency, F_h^*. The total wealth constraint is:

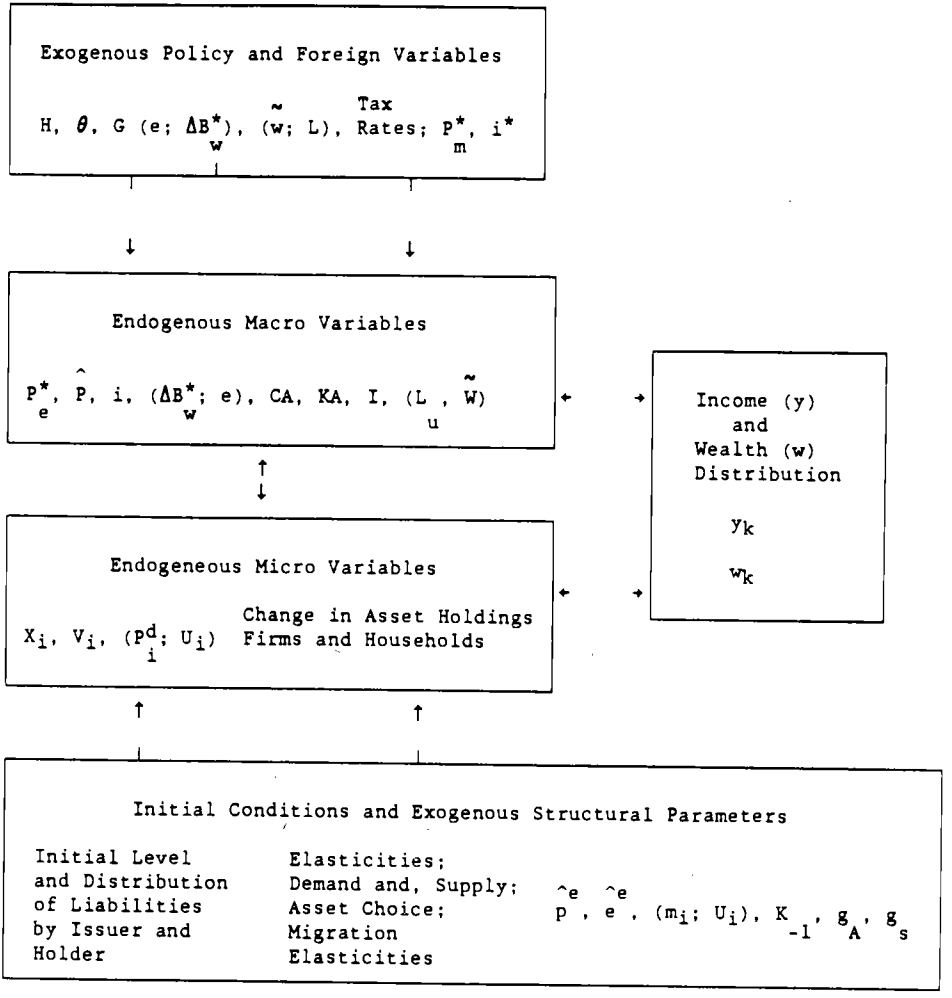
$$(2.3) \qquad W_h = W_h^P + H_h + B_h/i + eF_h^*/i^*$$

where i^* is an exogenous foreign interest rate and i is an endogenously determined domestic interest rate in the model.

The mechanisms by which policy changes affect the distribution of income and wealth are threefold. First, changes in factor rewards and employment affect directly income distribution by socioeconomic class (or household since the two are equivalent here). 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.

Now turn to a more specific description of how adjustment policies affect the distribution of income and wealth along the channels described above. The linkages are summarized in figure 1 which shows the determination of a "period" equilibrium. The distribution of income, Y_k, and wealth, W_k, at the household (socioeconomic group) level is affected by

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.

the endogenously determined values for macroeconomic and microeconomic variables. 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 invariant across simulations while the values of policy variables depend on the selected policy choices in the adjustment package.

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. Additional exogenous variables include: the foreign interest rate (i^*); import prices (P_m^*); and the level of foreign export demand. 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 sections describe the assumptions and functional form specifications which determine the "period" equilibrium described in Figure 1.

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	
$eR^* + B_b + L_b$		$H_h + H_f$ + Net Worth 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.

2.2 The Financial Sector

To capture the distributional implications of adjustment programs, we distinguish five financial units: government, households, firms, the consolidated banking system, and the foreign sector. We assume that governments do not lend and that households do not borrow. Because of thin or nonexistant equity markets in most developing countries, it is not included here, and the endogenously determined proportion of household savings allocated to physical capital is made directly available to firms. Household savings is first allocated to cash balances, the remainder being allocated in a first stage between bonds and physical assets. In a second stage, expenditure on bonds is allocated between domestic and foreign bonds. Firms' financial requirements are for investment expenditures, working capital, and interest payments on their stock of domestic and foreign debt. The distinction between firms and households allows us to separate productive and distributional implications of adjustment packages. 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. The resulting simplified financial structure is shown in Table 1.

2.3 The Government Sector

Critics of Bank-Fund supported programs point out that excessive reductions in government expenditures fall disproportionately on capital expenditures, and within current expenditures, disproportionately on health and education expenditures. In an analysis with a macroeconomic focus, it is not possible to capture meaningfully a direct link between type of government expenditure, productivity, and income distribution. Thus, we

treat sectoral productivity growth rates, g_A, as exogenous and invariant between simulations (although it would be easy to link productivity growth with say public and/or private investment if sufficient evidence were available at the aggregate level).

The government collects taxes, and disburses subsidies, on commodities. The government also employs government workers, paying these workers an exogenous wage. Changes in public sector employment and changes in public sector wages are part of aggregate demand management common to stabilization programs. The government also has exogenously determined investment and current expenditures. Both components of government expenditures are also part of expenditure reductions in the counterfactuals. Finally, the government deficit is financed by a mix of foreign borrowing ($e\Delta B^*_w$), borrowing from the private sector (ΔB_h), and borrowing from the Central Bank (ΔB_b) (see table 1).

The government's budget constraint is given by:

$$(2.4) \quad \bar{G}\bar{P}^C + \bar{W}_G\bar{L}_G + \bar{I}_G\bar{P}^C - (\Delta B_b + \Delta B_h + e\Delta B^*_w) =$$

$$\text{(Net indirect tax + Import tariff)} - i_{-1}(B_b + B_h) - (i^*_{-1}(eB^*_w)$$

In (2.4), the first three terms on the LHS are the three components of government expenditures described above (a bar over a varible, or a product of variables, indicates that the variable, or product of variables, is exogenous); the term in parenthesis on the LHS includes the three sources of financing of the fiscal deficit. The first two terms on the RHS are revenues from tax collection, and the last two terms are the payments on

the domestic and on the foreign issued components of the public sector's debt.

2.4 Goods and Factor Markets

Assumptions about goods and factor markets are summarized in table 2. The assumptions are familiar from the literature on CGE models. Because the model is short-run, capital once installed is fixed within the period: intersectoral capital mobility is achieved through time by capital stock depreciation. The technology for gross output assumes a separable production function for value-added and intermediates. For each sectoral demand, some substitution is allowed between the use of domestically produced goods in that sector and competitive imports to that sector. To save on parameter choice, the same elasticity of substitution between the domestic good and the competitive import is specified for all components of domestic final demand, hence expenditures are on a composite good with price p^c. Imports are available in perfectly elastic supply but foreign export demand may be less than infinitely elastic, so that the terms of trade may be endogenous. Thus a devaluation or a change in protection gives some scope for import substitution, but export expansion involves some deterioration in the terms of trade.

In the simulations, two closures are adopted with respect to the foreign sector. In one closure, the exchange rate is fixed, in which case government borrowing abroad is endogenous and given by:

$$\Delta B^*_w = - CA + \Delta F^*_h - \Delta L^*_w \qquad (2.5)$$

Table 2: FACTOR AND COMMODITY MARKETS

Factor Markets

Capital Stocks Fixed
Exogenous labor supply for each category (agricultural labor; modern sector labor; informal labor)

Goods Markets

Technology

- CES for Value Added
- Leontief for Intermediate Non-Competitive Imports

Final Demand

- CES between Imports and Domestically Produced Goods for all components of final demand
- LES for private consumption expenditures
- Exogenous Government Expenditures (see section 2.3)
- Export Demand: Constant foreign price elasticity of demand
- Investment Demand: function of the profit rate measured in terms of the opportunity costs of borrowed funds.

Market Clearing Assumptions

- Labor Markets:

  Exogenous market clearing wage for agricultural employment
  Exogenous nominal wage for government sector labor.
  Exogenous nominal wage for modern sector labor.
  Migration between informal labor and agricultural labor.

- Goods Market:

  Market Clearing Price Adjustment

Dynamics

Price Expectations: Exogenous
Exogenous labor force growth
Exogenous productivity growth

where CA is the interest inclusive current account expressed in foreign currency. In the other, government borrowing abroad is exogenous and the exchange rate adjusts so that:

$$(2.6) \qquad CA = -\overline{\Delta B}_w^* + \Delta F_h^* - \Delta L_w^*$$

In all simulations, we assume full sterilization so that the money supply is independent of the current account.

3. Sectoral and Household Disaggregation and Elasticity Specification

3.1 Sectoral and Household Disaggregation

The sectoral, socioeconomic, and factor market disaggregations reflect our focus on income distribution. The sectoral disaggregation and wealth ownership mapping according to equations 2.1-2.3 is described in Table 3. As suggested by Kanbur (1987), Heller et al. (1988), the poor are among the following socioeconomic groups: (1) landless rural labor who receive their income from the labor they supply to the primary export and agricultural sectors; (2) agricultural small holders (or small farmers) who receive their income from the land they own and from their supply of labor; (3) the urban informal sector here represented by informal workers who receive their income from their services in the informal non-agricultural sector where they are paid their average value product (no other factor is employed in that sector). In addition to these groups, the urban formal sector is represented here by the "modern labor" socieoconomic group, a group which includes government workers as well as labor employed in the three manufacturing sectors. The description of socioeconomic groups is completed by capitalists who receive their non-financial income from

several sources: land and natural resources in the primary export sector (e.g. mining activity); labor supply to the industrial sector; and income from the capital they own in all sectors. 4/ The distribution of physical and human wealth by socieconomic group, though arbitrary, is meant to be representative of the fact that households, when classified in such large socioeconomic groups, receive their income from several sources. 5/ This assumption that socioeconomic groups receive income from several sources mitigates the distributional effects of policy changes.

Initial distributions of financial assets and liabilities (see Table 3) are also made up but meant to be representative of an economy with a relatively low debt/equity ratio with private sector debt mostly concentrated in domestically issued debt. Only capitalists hold a fraction of their financial wealth abroad. Also capitalists and big farmers are the only socioeconomic groups holding domestic bonds. For the remaining socioeconomic groups, money is the only financial asset. Initial economy-wide financial ratios indicate an economy with a moderate initial stock of public foreign debt (13% of GDP or 60% of exports) and a small volume of internally held debt. Because firms' liabilities to the banking system are relatively low (about 10% of the value of the economy's capital stock), financial wealth is only about 10% of the value of physical wealth (land and capital).

In sum, the economy portrayed here is representative of a low-to-middle-income economy that splits its foreign exchange earnings from a primary export and light manufactures, with relatively large primary and informal sectors, and a simple financial sector. The initial distribution of income among socioeconomic groups is not too extreme since most socio-

Table 3: PRIVATE SECTOR DISTRIBUTION OF ASSETS AND LIABILITIES

Sectors		Factors of Production / Socio-economic Groups	Physical and Human Wealth Distribution by Socioeconomic Class: Capitalists	Big Farmers	Small Farmers	Landless Agricultural Workers	Modern Workers (Incl. Govt.)	Informal Workers	Firms: Liabilities / Assets	Working Capital / Sales	Foreign Debt / Total Debt
Primary Export	(1)	Land Agr. Labor	100			100			0.05	0.30	0.30
Agriculture	(2)	Land Agr. Labor		85 19	15 80	21			0.05	0.30	0.30
Consumer Goods	(3)	Modern Labor	33				67		0.30	0.30	0.30
Intermediate and Capital Goods	(4)	Modern Labor	16				84		0.30	0.30	0.30
Non-Traded Formal	(5)	Modern Labor	37				63		0.30	0.30	0.15
Informal Non-Agriculture	(6)	Informal Labor						100	0	0	0
All Sectors	(7)	Capital	39	8	12	2	0.5	2	Economy Wide Ratios		Values
			Financial Wealth Distribution by Socioeconomic Class								
Foreign Assets / Financial Wealth	(8)		0.3						Debt Exports		0.60
Domestic Bonds / Non-Mon.Finan.Assets	(9)		0.5	0.5					Money Supply / Sales		0.40
Money/Income	(10)		0.05	0.05	0.10	0.10	0.10	0.10			
Savings/Income	(11)		0.26	0.18	0.04	0.08	0.04	0.04	Domestic Bonds / Govt. Debt		0.10

economic groups earn income from more than one source. Finally, non-monetary financial wealth, concentrated in the hands of capitalists and big farmers is a small fraction of total wealth.

3.2 Elasticity Specification and Calibration

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 application: initial prices and quantities are combined with 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. 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/

4. Description of External Shocks and Adjustment Packages

The adjustment programs supported by the IMF and World Bank that were subject to the criticisms noted in the introduction took place in an unfavourable external environment. An indication of how unfavourable the

Table 4: ELASTICITY SPECIFICATION

Households

Consumption

$0.40 <$ expenditure elas < 1.40

$-1.25 < \phi$ (Frisch) < -2.00

$0.02 > S_h < 0.15$

a_s (proportion of wealth change consumed) = 0.10

Capitalist and farmers' population growth (0.01)

Portfolio

Money:

α (semi interest elasticity) = 0.02

β (income elasticity) = 0.6

Bond allocation ($\epsilon_2 = 1.0$)

Physical/Financial ($\epsilon_1 = 1.0$)

Firms

Technology

Capital-Labor subtitution elasticity in value-added ($0.7 < \sigma p < 1.1$)

Depreciation ($\delta = 0.04$)

Labor force growth (0.03)

Technical progress ($0.02 < g_A < 0.03$)

Portfolio

Working Capital ($\gamma = 1.0$)

Bonds ($\epsilon_4 = 1.0$)

Investment

Investment demand elasticity with respect to profits (B/C) = (0.1)

Foreign Trade

Price elasticity of foreign export demand ($2.0 < \zeta < 3.0$)

Price elasticity of import demand ($0.6 < \sigma c < 1.5$)

Expectations

$\hat{p}^e = e^e = 0.05$

Note: Intervals for elasticities refer to all sectors and all socio-economic classes.

All variables refer to parameters defined by the functional forms in the appendix. All parameter values remain unchanged across simulations.

environment was, is given by the magnitude of external shocks for 93 developing countries estimated at a loss of 5-6 percentage points of average GDP during 1982-6 compared with 1978-81. For the same group of countries, average GDP growth during the eighties was more than cut in half (to 2.3%) compared with average GDP growth during the seventies. For a smaller group of 30 countries recipients of IMF SAFs and World Bank SALs, average per capita consumption growth during 1982-5 was -0.6% compared with 1% during 1978-81. In addition to a sharp fall in consumption growth, average investment/GDP for the same group of countries fell by 4 percentage points to an average of 18.8% during 1982-5. 9/

This sharp deterioration in performance was greatly due to the limited access to foreign borrowing which would have helped cushion the effects of rising real interest rates and deteriorating terms-of-trade. Therefore we shall concentrate on the distributional implications of alternative packages taking as given this limited access to foreign borrowing. However, it is of interest to get an estimate of the effect of terms-of-trade and interest rate shocks, even if foreign borrowing had been available to cushion the impact of the shock. We do this by first simulating the model with no external shocks (called base run (BR)), then with external shocks and available foreign funds (E-1). The subsequent simulations, (labelled E-2 to E-5 in table 5 where the specifics of the policy experiments are detailed) provide several adjustment scenarios when foreign financing is not available. To save on space we do not describe in detail the results of the BR and E1 simulations since they refer to options that were not available during the period of adjustment. However, to give a feel of the magnitude of the shock we have simulated, and of what might

Table 5: DESCRIPTION OF POLICY EXPERIMENTS

Base Run (BR)		Yearly Growth Rate
$\hat{H}$	Money supply	10%
$\hat{L}_G$	Government employment	5%
$\hat{W}, \hat{W}_G$	Wages (Govt., modern labor)	10%
$\hat{GE}$	Government Expenditure (recurrent)	5%
$\hat{GI}$	Government Investment	10%
$\hat{ER}$	Rate of devaluation	5%
$\hat{P}_m^*$	World prices of imports	0%
i^*	Foreign interest rate	8%

External Shock: Foreign Borrowing, No Adjustment (E1)

(E1): Same as (BR) but

$\hat{P}_m^* = 10\%$; $i^* = 16\%$; $\hat{H} = 15\%$ for t = 2, ..., 5 (t=6,7: same as BR)

Adjustment: External Borrowing Reduction (E2)

(E2): Same as (E1) but

$\Delta L_G^* = 5.6\%$ a/ t = 2, ..., 7 (Exchange rate endogenous)

Adjustment with Cut in Government Expenditures (E3)

(E3): Same as (E2) but

$\hat{W}_G = \hat{GE} = \hat{GI} = 0$ t = 2, ..., 5 (t=6,7: same as BR)

Adjustment with Wage Freeze and Credit Squeeze (E4)

(E4): Same as (E3) but

$\hat{H} = 5\%$; $\hat{W} = 0\%$ t=2,...,5 (t=6,7: same as BR)

Adjustment with Targeted Expenditure Cuts and Targeted Subsidies (ES)

(E5) = (E1) +
- Public Works ($W_G L_G$ = constant); $\hat{W}=0$; t=2,...,5
- $\hat{GI} = \hat{GE} = 0$ t=2,...,5
- Raise import tariffs by 50%; t = 2,...,5
- Subsidy on sales of agricultural products of 20% t=2,...,5
- For t=6,7 variables have same values as in BR.

a/ Yearly borrowing expressed as a percentage of initial stock of foreign debt.

have happened had external borrowing not been foreclosed, the simulation results for BR and E-1 are summarized in tables 6 and 7.

In the absence of external shocks, average annual GDP growth over the seven simulation periods is 5.5% with unemployment rising from 4.2% to 5.5% because of our assumption of a yearly labor force growth of 4% and a yearly real wage increase for modern labor of about 5%. Under this scenario, external debt rises from 13% to 45% of GDP with the current account and fiscal deficits remaining at about 9% of GDP, estimates that are slightly higher than those prevailing before the outset of external shocks. In this favorable environment, the distribution of income becomes less unequal (table 7) with average per capita income rising by between 17% and 23% for all socioeconomic groups.

The effect of the external shock with foreign borrowing available (E-1), is to lower average yearly GDP growth by one percentage point and to nearly double the current account deficit because of the higher interest rate on external debt and the higher debt volume from having the fiscal deficit financed by foreign borrowing. Under this (unrealistic) scenario with no adjustment and available foreign funds the terminal year debt-to-GDP ratio rises to 72%. It is noteworthy that, by itself, the turn towards an unfavourable environment with little adjustment effort has a relatively strong effect on the distribution of income. Whereas in BR the relatively uniform expansion of real incomes in each socioeconomic group brings down real income inequality by the end of year 7, income inequality falls less because of the external shock (see the values of the Theil inequality index in table 7). Furthermore, real income per capita which rose at an average yearly rate of 3.4% now only rises at a rate of 0.08%, much less than GDP because of the effect of the debt service burden.

Now we simulate the effects of four packages representative of the range of selected adjustment policies. In all simulations we allow for a small (and fixed) amount of foreign borrowing which implies that the economy must adjust by a mixture of expenditure switching (via a real exchange rate depreciation) and expenditure reducing policies (cuts in the various components of government expenditure). The amount of fixed foreign borrowing is determined so that the foreign debt to GDP ratio follows approximately the same trajectory as in the absence of external shocks (probably an understatement of how binding the external constraint was).

Of the four packages, the first three represent increasingly contractionary macropolicies of the type often pursued under adjustment packages approved by the IMF and World Bank. The fourth package is our interpretation of what might have been the main elements of a targeted adjustment package advocated by the authors of "Adjustment with a Human Face." As indicated in table 6, all packages last 4 years and start at the beginning of period 2, with exogenous variables thereafter resuming their trend values in the no shock environment of the BR simulation. 10/ Also note that the first three packages are cumulative.

The first package (E2) consists simply of adjusting by devaluing the exchange rate without increasing government employee or modern sector wages. The next adjustment package (E3), adds a contractionary fiscal policy by freezing both components of government expenditures and public sector wages. Finally, the most contractionary adjustment package (E4) adds a wage freeze for modern labor and a sharp reduction in the growth of the money supply from 15% to 5% per year. By contrast, the adjustment program that seeks to minimize the adverse effects of adjustment on income

distribution (E5), combines the contractionary expenditure effects of E-3 with subsidies to the sale of agricultural products financed by a 50% increase in tariffs. In this adjustment program with targeted expenditure cuts, the government mitigates the adverse impact on employment of contractionary expenditures by a public works program in which public sector wages are cut, and public employment is expanded in such a way that the public sector wage bill remains frozen at its first year value.

5. Simulation Results

The results of the various adjustment packages on macroeconomic indicators and the distribution of income appear in tables 6 and 7. Because of the complexity of the model, only a few indicators are reported in those tables, and to save on space, much of the detailed interpretation is left to the reader. For example, we do not dwell on the differences in the terminal year fiscal deficit ratios in E3 and E4 (2.9% vs. 8.1%) which can be understood by comparing growth rates and interest rates in the two simulations.

5.1 Macro Outcomes

Not allowing the economy to raise its debt-to-GDP ratio in response to the external shock essentially doubles the "growth cost" of the external shock, 11/ as the average GDP growth is now 2 percentage points less than in BR, even though unemployment is at the same level as in E-1 (because the expansionary effect on employment of the fall in the real wage compensates for the lower output growth).

In the next two packages that include expenditure reducing policies, the contractionary effect is much stronger: with the most contractionary adjustment package including a wage freeze and a credit

Table 6: MACROECONOMIC INDICATORS

Indicator \ Experiment	End of Initial Year (1) Value	BR	E1	E2	E3	E4	E5
GDP Growth a/		5.5	4.5	3.5	3.1	1.9	3.3
INVR/GDP b/	25.1	22.6	23.3	18.9	22.9	19.0	18.5
Fiscal Deficit/GDPN b/	8.9	10.2	13.6	7.4	2.9	8.1	6.1
Trade Balance/GDPN b/	6.5	3.8	9.2	0.4	1.5	0.6	0.7
Current Account/GDPNb/	8.9	8.7	16.7	5.9	7.4	5.7	6.1
Money Growth a/		10	13.3	13.3	13.3	6.6	13.3
Inflation a/		7.1	7.3	8.8	5.7	3.8	8.4
Rate of Devaluation a/	5.0	5.0	5.0	10.8	7.3	3.8	9.4
Interest Rate c/	9.2	11.4	7.8	9.3	6.2	9.1	8.4
Unemployment Terminal Year c/	4.2	5.5	6.2	6.1	7.9	10.6	7.0
Public Foreign Debt/GDPN b/	13.0	45.1	71.6	44.8	45.1	44.2	43.2

Simulations:

BR = base run (no external shock)
E1 = external shock: foreign borrowing, no adjustment
E2 = E1 + foreign borrowing reduction only
E3 = E2 + cut in government expenditures
E4 = E3 + modern sector wage freeze and credit squeeze
E5 = E1 + targeted expenditure cuts and targeted subsidies

Notes:

GDP = real GDP
GDPN = current-price GDP
INVR = real investment (public + private)

a/ Average compounded annual growth rate.
b/ Terminal year ratio values.
c/ Terminal year percent value.

squeeze, unemployment doubles in spite of the lower real wage because of the contractionary effect on investment of higher real interest rates. Under this adjustment package, the economy expands so little that the fiscal deficit (expressed as a percent of nominal GDP) is hardly reduced because government tax collection is falling almost as rapidly as government expenditures. This simulation is an illustration, perhaps extreme, of the "overkill" criticism which IMF-type packages are often accused of (e.g. Dell 1982). By contrast, the less extreme adjustment package, (E2), sharply reduces the fiscal deficit with a much lower rate of unemployment. In the moderate (E3) package, a much lower, yet positive real interest rate results in a terminal year investment-to-GDP ratio that is 3 percentage points higher than in (E4).

The macroeconomic results of the targeted expenditure cut package, E5, are similar to those with expenditure cuts without targetting (E3): the growth rate and unemployment rate are close with a somewhat larger fiscal deficit reduction with the targeted expenditure cut package. In the targeted package, protection results in less real exchange rate depreciation and hence less induced terms-of-exchange trade loss through export expansion. This raises growth. In contrast, the investment-to-GDP ratio is as low as in the most contractionary package in spite of a much lower real interest rate. This is due to the higher cost of imported capital equipment under the more restrictive trade policy with higher protection. Whereas the lesser terms-of-trade loss, the lower real interest rate and increased employment all contribute to lessen the costgs of protection on growth, the higher cost of imported capital equipment reduces growth. On balance, however, the targeted expenditure package yields macroeconomic indicators that are about as favorable as in the

Table 7: AVERAGE PER CAPITA REAL INCOME BY SOCIOECONOMIC GROUP (RATIOS TO YEAR 1)

Experiment		Base Run (BR)			E-1		E-2		E-3		E-4		E-5	
Year		1 a/	5	7	5	7	5	7	5	7	5	7	5	7
Capitalists	(6.3) b/	3.07 (42.7)	1.12	1.19	0.84	0.96	0.76	0.90	0.77	0.91	0.72	0.81	0.76	0.94
Big Farmers	(9.6)	1.03 (15.1)	1.11	1.17	0.94	1.03	0.94	0.97	0.91	0.94	0.83	0.88	1.13	0.94
Small Farmers	(30.0)	0.33 (1.0)	1.12	1.21	1.00	1.06	1.03	1.03	1.00	1.00	0.97	0.94	1.24	1.00
Modern Workers c/	(27.6)	1.43 (3.9)	1.13	1.21	0.96	1.09	0.73	0.91	0.66	0.82	0.57	0.73	0.62	0.92
Landless Ag. Workers	(8.7)	0.30 (0.4)	1.17	1.23	1.00	1.10	1.07	1.03	1.00	1.00	1.00	0.93	1.27	1.00
Informal Workers	(17.8)	0.56 (0.8)	1.14	1.20	0.88	0.96	0.64	0.69	0.59	0.58	0.43	1.16	0.59	0.77
Economy-Wide Average Real Per Capita Income		0.91 (5.8)	1.14	1.22	0.93	1.05	0.79	0.91	0.76	0.87	0.67	0.86	0.79	0.91
Theil d/	e/	22.37	22.07	22.28	22.67	23.91	21.54	24.16	21.43	23.44	26.35	22.05	15.26	24.29
	f/	28.36	28.23	28.66	31.33	31.52	29.91	32.38	33.89	36.02	40.32	33.47	24.09	33.92
Head Count g/	e/	38.73	38.04	37.79	38.15	37.87	56.52	54.57	56.46	56.11	67.67	39.83	56.67	56.19
	f/	53.92	38.04	37.79	65.71	64.74	66.81	65.48	68.76	67.71	70.52	69.06	65.67	66.30
Poverty Gap h/	e/	5.35	2.75	1.68	5.62	3.95	7.85	6.41	10.04	7.71	14.74	7.40	4.55	8.21
	f/	6.64	2.75	1.68	9.62	6.27	14.08	11.19	17.91	14.30	23.91	12.69	10.04	11.64

a/ End of year. Year 1 are level values (real wealth in parentheses); all other values are ratios to year 1.

b/ Shares in total population in year 1 in parentheses.

c/ Includes unemployed and government workers.

d/ Theil inequality index; $T = \sum_i \left| v_i \ln (v_i/w_i) \right|$; v_i, w_i are income and population shares.

e/ Unemployed included among modern workers.

f/ Unemployed included among informal workers.

g/ Head-count ratio $H = \sum_{y_i < z_i} p_i \Big/ \sum_i a_i z_i$; $z_i = 0.44e$ Cost of living of class i; p_i = population shares.

h/ Poverty gap $G = \sum_{y_i < z_i} (z_i - y_i) p_i \Big/ \sum_i y_i p_i$; y_i = per capital income of class i.

Notes: H is discontinuous because we have assumed a uniform distribution of income among socioeconomic groups. The value of G indicates the share of income which would have to be redistributed to bring those below the poverty line up to the poverty line.

moderate package (E3), i.e. a slightly higher growth (and less terminal year unemployment) but a higher fiscal deficit. 12/

5.2 Income Distribution Outcomes

The distributional shifts resulting from the different adjustment packages appear in table 7. In Table 7, per capita real incomes at the end of each adjustment package (year 5) are contrasted with per capita real incomes at the outset of the adjustment package (i.e. at the end of year 1 which is identical under all adjustment packages). We view these ratios as rough indicators of the sustainability of a package on the social front. Thus, for the lower income groups (rural labor, small farmers and informal labor all have below average per capita real incomes), ratios below unity would be an indication of pressure from those socioeconomic groups to abandon the adjustment package as their real incomes would be lower 3 years after the package started.

Because the unemployment rate varies much across adjustment packages, our estimates of the distributional impact of alternative adjustment packages will be sensitive to where we place the unemployed. In the main part of table 7, we have included the unemployed among the modern worker socioeconomic group. However, an alternative would be to assume that the unemployed are mostly among the informal worker socioeconomic group. For this reason, we have reported two sets of inequality estimates for each one of our inequality measures at the bottom of table 7. All estimates of inequality are more pronounced when the unemployed are placed among the informal workers group.

All the adjustment packages entail a large negative annual growth in per capita real income ranging from -4% for E2 and E5 to -6.9% for E4.

Even the less contractionary packages (E2 and E5) yield a negative average real income per capita growth of -1.4% for the entire simulation (including two years of growth without contractionary policies). Even if, for a typical developing country, the estimates exaggerate somewhat the extent of per capita income loss during the adjustment period, it remains that the costs of adjustment in terms of per capita income loss are large whatever package is adopted. It is also clear that the pressure to abandon the packages was great. 13/

A further indication of the pressure to abandon adjustment efforts is given by the "head count" ratio, H, i.e., the fraction of the economically active population below a threshold real income level taken as a poverty line. Choosing the threshold line at $Z = 0.44$ places the small farmers and landless agricultural worker groups below the poverty line at the outset. Depending upon whether the unemployed are distributed among modern workers (informal workers), 39% (64%) of the population is below poverty at the end of year 1. 14/ Even in the less extreme case where the unemployed are distributed among modern workers, the share of population increases to over 50% of the population by year 5 at the end of each adjustment package. This increase in poverty comes from the informal workers who earn all their income in the non-traded informal sector. All adjustment packages involve a real exchange rate devaluation which lowers the real income earned by this group. The purchasing power of informal workers is further eroded by the increased cost of the traded goods that enter into their consumption basket. The position of modern workers deteriorates less than that of informal workers because their income is earned in both traded and non-traded sectors. If one reckons with the 43 percent fall in real income for modern workers by the end of the most

contractionary package, one can easily visualize why the contractionary packages advocated by the IMF are criticized for leading to socially unsustainable outcomes. Of course, the outcome is even worse if the unemployed belong mainly to the informal workers group. It is noteworthy that the most contractionary package is the only adjustment package in which the capitalists' relative position improves.

The distributional shifts during adjustment have some common patterns, regardless of the package. Informal workers always lose the most in relative terms for the reasons discussed above. The next group to lose the most is modern workers, mostly because we have arbitrarily distributed all the unemployed in that socioeconomic group. Small farmers and large farmers always improve in relative terms because their income is in traded sectors. Finally capitalists usually lose during adjustment but make up their loss in the post-adjustment period.

In terms of income distribution, the targeted expenditure cut program dominates by far the other packages at the end of year 5. However, by the end of year 7, this improvement is eroded. Indeed, it is the most contractionary package which yields the least unequal income distribution at the end of the seven year simulation. This reversal is due to the sharp relative improvement in the position of informal workers who recoup in the short-run from a resumption in more expansionary policies because there are no substitutes for what they produce when real incomes start growing again in response to the expansionary monetary and fiscal policies. This sharp swing is of course the reverse of the coin whereby informal workers suffer the most under contractionary policies. The reason for the sharp contrast between E4 and E5 when the unemployed are in the modern workers group is that in the contractionary package, the migration from the primary to the

informal sectors is much less (there are 4 percent fewer informal workers in year 5 under E4 than under E5). With fewer people, the informal sector gains even more from the resumption of more expansionary policies in E4 than in E5. The swing in inequality between years 5 and 7 is less sharp when the unemployed are included among the informal workers.

The head count ratio, H, ignores how poor the poor are. The poverty gap measure, G, also reported at the bottom of table 7, is sensitive to both the number of poor and to how poor they are. Also, unlike H, G is not discontinuous. The value of G indicates how much income would have to be given to those below the poverty line. The values for G in table 7 clearly show the superiority of the targeted expenditure cut adjustment program over the most contractionary package in terms of the amount of money that would have to be redistributed to eliminate poverty.

The distribution of wealth is also affected by the choice of adjustment package. Since the model does not include equity and land markets, our calculations of the distribution of real wealth use the real interest rate as a deflator for land and replacement lost for capital. Given the concentration of wealth in the hands of capitalists and big farmers, the sharpest wealth distributional shifts occur between these two groups as a result of shifts in the ratio of the replacement cost of investment goods to the real interest rate. Farmers benefit from the targeted expenditure cut package which raises the rent on land and capitalists from the most contractionary package because of the higher real interest rate. The shift in financial portfolios have little impact on wealth distribution because of their small share in total wealth.

In conclusion the issue of sustainability is one of timing: can the contractionary policy survive three years of sharply deteriorating

social indicators? If it can, then the simulations here suggest that the distribution of income would improve sufficiently in the years immediately following the end of the package. But the lower growth and sharper distributional shifts of the severely contractionary package suggest that it would face great pressures. It should also be stressed that the adverse distributional shift during adjustment, while transitory for those above the poverty line, can leave permanent damage (nutrition, health, education, etc.) for those below the poverty line.

b. Conclusions

This paper has presented a macroeconomic simulation framework to quantify the likely distributional shifts that would occur under different packages. The distinguishing feature of the model is that it links the micro elements by which structural adjustment policies affect income distribution through relative price shifts with the macro elements of the stabilization components of adjustment packages that affect income distribution through the level of economic activity. Because the model is fairly disaggregated across sectors, markets, and socioeconomic groups, expectations which may also affect income distribution are treated exogenously.

Simulations with the model were carried out for a representative economy subject to the interest rate and terms-of-trade shocks of the early eighties. The simulations suggest that the short-run effects on the distribution of income of a sharp contractionary package are large. These shifts are likely to endanger the sustainability of the package even though the distribution of income becomes more equal when normal policies are

resumed. (These reverse distributional shifts are not anticipated or discounted.) By contrast, the targeted expenditure cut programs advocated by the critics of contractionary packages result in a much less unequal distribution of income during the adjustment package, even though the distribution improvement is reversed in the post-adjustment period. Of course, the subsidy component of the targeted package could in principle be extended, but at the cost of continued distortion and/or future fiscal strain. In conclusion, insofar as the economy and simulation packages are representative, the paper supports the view that stabilization packages which do not have specific components targeted towards the poor, will have a noticeable adverse effect on the distribution of income, which is likely to result in some form of permanent damage for those below the poverty line.

Footnotes

1/ See Cornia, Jolly, and Stewart (1987), Taylor (1987).

2/ See World Bank (1986), Huang and Nicholas (1987), IMF (1986) and, more recently, Heller et al (1988). Kanbur (1987) is an exception. He develops practical measures to measure poverty at the household level using expenditure survey data.

3/ 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).

4/ Note that all sectors except primary export and informal non-agriculture use capital and that the ownership of capital across socioeconomic groups is the same for all sectors (and does not exhaust non-labor income because of retained earnings). This distributive sssumption is the result of our desire to calibrate the model so that capital ownership shares are consistent with the savings rates by socioeconomic groups at the bottom of table 3. (By consistent is meant that the distribution of capital across socioeconomic groups would remain constant if the share of savings allocated to capital remained equal to its base year value.)

5/ Figures for modern labor in table 3 refer to the case of full employment in the modern labor market. In case of unemployment of modern labor because of fixed wages, rationing falls on modern workers and not on capitalists. In that case, the corresponding shares in table 3 become endogenous.

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).

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/ All figures are from World Bank (1988). Also see Faini et al. (1988).

10/ In all packages, it is assumed that there is sufficient credibility in the monetary policy of the Central Bank (because money supply is kept from rising) so that the Central Bank has full control over the money supply and is therefore able to sterilize the effects of capital flows. Because our model is not well suited for adjustment under highly inflationary conditions -- no durable goods, portfolio decisions for incremental flows rather than for the total portfolio and exogenous expectations -- we do not consider an adjustment package that would rely heavily on the inflation tax.

11/ Of course, this does not account for the fact that the economy has a higher volume of debt than in BR.

12/ The slightly lower growth in E3 is also due to the shift towards consumption because of the strong wealth revaluation in that package. (Wealth changes are fairly similar for E2, E4 and E5.)

13/ Sachs (1986) contrasts the experience with adjustment of East Asian and Latin American countries, noting the pressures to abandon stabilization in Latin America because of the high income per capita loss during 1980-5 which he estimates at about 20% for 8 Latin American countries.

14/ Since the distribution of income is assumed to be uniform within each socioeconomic group, this is the only approach we can take to define poverty. It would be easy to postulate a lognormal distribution of income within each socioeconomic group as in de Melo and Robinson (1982). Such an approach, however, would not add much to the present discussion since within-group variance is exogenous and there is little information on variances among the socioeconomic classes defined here.

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Appendix

Description of the Model

This appendix describes the model outlined in section 1. It draws on an earlier paper, Bourguignon, Branson, and de Melo (1988) where a more complete discussion of the model is available. 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 $\hat{P}^e$ and $\hat{e}^e$. 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: $Y=CES(X_1, X_2; A, \alpha, \sigma)$ with parameters following the semi-colon. The corresponding dual is denoted $P_y = CESD(PX_1, PX_2; A, \alpha, \sigma)$; 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.

Table A1

Model Equations

Technology

(A.1)	$X^S = A(t)\ L(VA, V_2)$	Leontief production function for gross output and value-added
(A.2)	$V_1 = CES_1\ (V^d, V^m; \sigma c, \gamma)$	CES intermediate aggregation function
(A.3)	$V_2 = L\ (V_1, M^{NC})$	Leontief intermediate technology
(A.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

(A.5)	$X^d = D^d + E^d$	Total demand
(A.6)	$D^d = V^d + I^d + G^d + C^d$	Domestic effective demand
(A.7)	$M^c = V^m + I^m + G^m + C^m$	Import demand for competitive imports
(A.8)	$Q = CES_1\ (M^c, D^d; \overline{A_2}, \gamma, \sigma c)$	Composite demand

Prices

(A.9)	$P^m = P^*_m e\ (1 + \overline{tm})$	Import price (competitive imports

(A.10) $p^m_0 = \bar{P}^*_0 \; e \; (1+ \overline{tm}_0)$ — Import price (non competitive imports)

(A.11) $p^e = p^*_e \; e \; (1 + te) = p^d$ — Export price

(A.12) $p^d = \tilde{p}^d \; (1 + \overline{tx})$ — Tax inclusive domestic price

(A.13) $p^n = p^d - a_x p^c - a_0$ — Value-added price

(A.14) $p^c = CESD(p^d, p^m)$ — Composite price

Factor Demands, Wage Determination, and Expectations

(A.15) $L^d_s = g_2 \left(\frac{W}{p^n}\right); U, \bar{F}, \bar{K})$ — Labor demand for category s from short-run profit maximization

(A.16) $\bar{L}^S_S = L^d_S + \bar{L}_G$ — Wage determination; neoclassical full employment

(A.17) $W_{s,t} = \bar{w}_{s,t-1} + \Omega\hat{P} + (1-\Omega) \; (1+\hat{P}_e)$ — Wage indexation; s denotes a labor category

(A.18) $\hat{p}^e = \hat{P}_{-1}; \; \hat{e}^e = \hat{e}_{-1}$ — Adaptive price expectations (P is GDP deflator)

Commodity Demands

(A.19) $E^d = \bar{E}_0 \; (P^*_e/\bar{P}^*_w)^{-z}; \; z > 0$ — Export demand

(A.20) $\frac{D^d}{M^c} = g_1 \left(\frac{p^d}{p^m}; \gamma, \sigma_c\right)$ — Domestic use ratio

(A.21) $I_t = a \left\{ \frac{p^n MP_k U}{q(\delta + J^F)} - 1 \right\} = \left\{ \frac{B}{\bar{C}} - 1 \right\}$ — Investment demand (See text)

$I_t \geq 0$

(A.22) $J^F = \theta\, i + (1-\theta)\,(1 + \hat{e}^e)\, i^* - b\hat{p}^e$ — Opportunity cost of credit (θ is share of domestic component; b,a parameter)

(A.23) $M^{NC} = a_0 X$ — Non competitive imports

(A.24) $C = LES\,(P^C, Y^H, \mu, \phi);\ \mu \equiv 1-s$ — LES consmption demand (μ is marginal propensity to consume)

(A.25) $GE = \overline{GP^C} + \bar{w}_G \bar{L}_G + \overline{I_G P^C}$ — Exogenous government expenditures

(A.26) $I = k\,\Delta K$ — Investment by sector of origin (k is vector describing composition of capital across sectors)

(A.27) $q = k'\, P^C$ — Price of capital goods

Flexible and Fix Price Commodity Market

(i) Price Adjustment

(A.28) $X^S = X^d$ — Market-clearing price

(ii) Quantity Adjustment

(A.29) $p_t^{d,min} = \left\{ (p^m_{-1} - l_{-1}w_{-1})m + l_{-1}w_t + ap^d_{-1} \right\} (1+\hat{p}^e)$ — Mark-up pricing; l=unit labor requirement; m=minimum share of period t-1 profit margins required for period t; a=input-output coefficients.

$$\left\{ \begin{array}{l} X^S(U) = X^d \quad \text{if} \quad p^d = \bar{p}^d \\ \qquad \text{or} \\ X^S(1) = X^d \quad \text{if} \quad p^d > \bar{p}^d \end{array} \right\}$$

Utilization rate adjustment in case of excess supply

Price adjustment in case of excess demand

Household Income and Saving

(A.30) $Y_h = w_s L + \bar{w}_G \bar{L}_G + (PNX^S - W\bar{L}_S)(1-\omega)$ — ω is distributed share of profits

(A.31) $S_h = sY_h - a_s \hat{We}$ — Household savings (a_s is semi-elasticity of savings with wealth)

(A.32) $P^C C = P^C\bar{C} + (Y_h - S_h - P^C\bar{C})$ — Household consumption; $\bar{C}$ is exogenous consumption

(A.33) $W = H_h + B_h/i + eF_h/i^* + p_E^K$ — Household wealth constraint

Portfolio Determination (g_i):

(A.34) $\frac{g_1}{1-g_1} = \phi_1 \left[\frac{1+r}{J_F}\right]^{\epsilon_1}$ — Allocation between physical and financial assets

(A.35) $J_F = g_2(1+i) + (1-g_2)(1+i^*)(1+\hat{e}^e)$ — Average nominal return on bonds

(A.36) $\tilde{r} = PN \cdot U \cdot \delta X/\delta K \cdot K/\bar{K}$ — Average nominal return on physical assets

(A.37) $\frac{g_2}{1-g_2} = \phi_2 \left[\frac{(1+i)}{(1+i^*)(1+\hat{e}^e)}\right]^{\epsilon_2}$ — Allocation between domestic and foreign bonds

(A.38) $\ln H_h = \ln p^C + \alpha r + \beta \ln Y_h/p^C + \ln \bar{B}$ — Money demand; $\alpha<0$; $\beta>0$ $r \equiv (1+i)/(1+\hat{p}^e) - 1$

(A.39) $g_3 = \frac{\Delta H_h}{S_h}$ — Household saving allocated to money

Household Savings Allocation

(A.40) $S_{h,k} \equiv S_h - \Delta H_h$ — Household savings allocated to non-monetary assets

(A.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

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

(A.43) $S_f = w\, PN\, X^S - DP$ — Firms savings (undistributed profits)

(A.44) $BF = q^I + \Delta H_f - S_f - g_1 S_{h,k}$ — requirements to finance investment expenditures; $BF = \Delta L_b + e \cdot \Delta L^*_w$

(A.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

(A.46) $$\frac{g_4}{1-g_4} = \phi_4 \left[\frac{(1+i)}{(1+i^*)\ (\hat{i+e})} \right]^{-\epsilon_4}$$ Borrowing allocation between domestic and foreign bonds

(A.47) $$\Delta L_b = g_4 BF - \rho L_b$$ Firm domestic net borrowing

(A.48) $$\Delta L_w^* = (1-g_4)\ L_w^*/e - \rho L_w^*$$ Firm foreign net borrowing

Credit rationing

(A.49) $$q\ I^R = q^I - \text{Inf}\ (0,\ g_4 L^F - \bar{B}^R)$$ Effective demand for investment under rationing (see below)

Government Revenue and Deficit Financing

(A.50) $$GR = \tilde{P}^d tx\ X^S + \bar{p}_0^* tm_0 M^{Nc} + \bar{P}_m^* tm\ M$$ Tax receipts

(A.51) $$GD \equiv GE - GR \equiv \Delta B_b + \Delta B_h + e\Delta B_w^*$$ Financing of government deficit (implied by monetary and national income identities)

Market Equilibria

(A.52) $$X^S = X^d$$ Goods market

Financial Markets

(A.53) $$\Delta H \equiv \Delta B_b + \Delta L_b + \theta e\ CA$$ Money supply definition ($\theta = 0$; full sterilization; $\theta = 1$, no sterilization)

(A.54) $$\Delta H = \Delta H_f + \Delta H_h$$ Money market equilibrium

(A.55) $$\Delta B_h = 0;$$ No domestic bond market

(A.56) $\Delta F_h^* = L_w^* = B_w^* = 0$ — Foreign exchange control

(A.57) $i_0^R = i_0 + i_\lambda;\ i_\lambda > 0$ — Credit rationing (shadow interest rate determination used to evaluate notional credit demands)

Foreign Exchange Market

(A.58) $CA = P_e^* E^d - \bar{P}_0^* M^{Nc} - \bar{P}_m^* M^c + i_{-1}^* (F_h^* - L_w^* - B_w^*)$ — Current account

(A.59) $KA = \overline{KF} - \Delta F_h^* + \Delta L_w^*$ — Capital account ($\overline{KF}$ is exogenous capital flows)

Floating Exchange Rate (ΔB_w^* fixed)

(A.60) $CA + KA = 0$

Fixed Exchange Rate (ΔB_w^* endogeneous)

(A.61) $\Delta B_w^* = -CA - \overline{KF} + \Delta F_h^* - \Delta L_w^*$

Dynamics

Factors of Production

(A.62) $\bar{K}_t = K_{t-1} + I_{t-1}$ — Capital stock definition

(A.63) $\bar{L}_{s,t} = L_{s,t-1}\ (1+g_s)$ — Labor force growth

(A.64) $\bar{A}_t = A_{t-1}\ (1+g_a)$ — 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.:

[e.g. $\epsilon_1 \equiv \left(\frac{\hat{g}_1}{1-g_1}\right) / (\hat{J_F} / r)$].

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 putty-clay: once installed, it can only be varied through capacity increase or through depreciation.

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 A.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 (A.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 A.31 and A.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 A.26 and A.27).

Investment demand is determined by the profit rate (equation A.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

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

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 a quadratic function passing through th origin. Also note from equation A.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 A.28) and; (ii) Keynesian mark-up pricing (equation A.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 A.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 A.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 (A.34)-(A.39) reflect the allocation structure described in figure 2(a). The allocation satisfies the financial wealth constraint (equations A.40-41).

Firms investment financing is for working capital requirements and for investment expenditures. Equation (A.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 A.46-48). When there is credit rationing (equation A.49) investment is residually determined from the national income identity (equation A.66) with shadow interest rate determination given by equation (A.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 A.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 A.57). Also note that varying degrees of sterilization are accommodated in the money supply definition (equation A.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 (A.61) and (A.62).