A General Equilibrium Analysis of Foreign Exchange Shortages in a Developing Economy

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Prepared by: Kemal Dervis
Jaime de Melo
Sherman Robinson
Development Economics Department

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A GENERAL EQUILIBRIUM ANALYSIS
OF FOREIGN EXCHANGE SHORTAGES
IN A DEVELOPING ECONOMY

This paper examines the consequences of alternative adjustment mechanisms to foreign exchange shortages in semi-industrial economies. Three alternative adjustment policies to deal with a fall in foreign capital inflow are considered: devaluation of the real exchange rate, licenses issued to importers resulting in premia on imports and finally fixprice rationing whereby demanders of imports are forced to use domestically produced substitutes.

The analysis is conducted within the framework of a multi-sector computable general equilibrium model of a "representative" semi-industrial economy. The results indicate that adjusting by rationing is much more costly in terms of lost GDP than adjusting by devaluation. At the microeconomic level, the three adjustment mechanisms have very different effects on the sectoral structure of relative prices and production. In general, export-oriented consumer goods industries benefit from devaluation, while domestic capital and intermediate goods industries benefit from fixprice rationing. These structural differences should be considered in evaluating different policy regimes.

Prepared by: Kemal Dervis
Jaime de Melo
Sherman Robinson
Development Economics Department

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 The World Bank
 1818 H Street, N.W.
 Washington, D.C. 20433
 U.S.A.
Abstract

This paper examines the consequences of alternative adjustment mechanisms to foreign exchange shortages in semi-industrial economies. Devaluation is compared to two forms of import rationing within the framework of a computable general equilibrium model of a "representative" semi-industrial economy. The results indicate that adjusting by rationing is much more costly in terms of lost GDP than adjusting by devaluation. At the microeconomic level, the three adjustment mechanisms have very different effects on the structure of relative prices and production. These structural differences should be considered in evaluating different policy regimes.
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I. Introduction

An acute shortage of foreign exchange has been a recurring problem for many developing economies. In the development planning literature, the problem is usually discussed within the framework of the "two-gap" or "multi-gap" models developed and elaborated during the sixties. These models assume fixed import-output coefficients and limited possibilities for export expansion. As a result, a foreign exchange shortage becomes an almost absolute constraint on growth in that even if domestic savings were available in sufficient amounts to allow an increase in investment, the absence of the required complementary foreign exchange makes such an increase impossible. The neoclassical answer to this "structuralist" view has always been to stress the role of relative prices and, in particular, exchange rate adjustment as a means of overcoming any foreign exchange shortage.\(^1\) Stated simply, this view treats the alleged foreign exchange gap as only reflecting an overvalued real exchange rate. If the exchange rate is allowed to clear the foreign exchange market, there can be no foreign exchange gap.

\(^1\) For a presentation of these contrasting views, see Findlay (1973, Chapter 10) and Diamond (1977).

* We would like to thank Adrian Wood for helpful comments and criticisms. The views expressed in this article are the authors' and do not necessarily reflect those of the World Bank.
However, the experience of developing countries indicates that it is extremely difficult to achieve the necessary rise in the effective exchange rate to restore equilibrium in the foreign exchange market. As Krueger (1978) has documented for a group of developing countries, the typical pattern of adjustment policies often involves an unsuccessful devaluation followed by a return to various forms of foreign exchange rationing. The reasons why devaluations are often unsuccessful are myriad and much discussed in the literature (see Krueger (1978), Bruno (1979), Diaz-Alejandro et al (1979)), but the main point which we wish to pursue in this paper is that countries often rely on other policies whose quantitative impacts need to be systematically explored. In understanding different adjustment mechanisms, all students of trade and exchange rate policy in developing countries agree that the elimination of persistent foreign exchange imbalances requires substantial adjustments in the real sphere of the economy. While macroeconomic phenomena may be important, there must also be a reallocation of resources towards sectors where there is scope for import substitution and/or where exports can be expanded. The relationship between different policy regimes and these necessary structural adjustments provides the major focus of our analysis.

This paper reexamines the foreign exchange gap issue and the debate between structuralists and neoclassicists by providing a quantitative assessment of the role of assumptions about the values of key trade elasticities. Perhaps more importantly, the paper also seeks to complement the existing descriptive analysis of the consequences of
alternative adjustment mechanisms with a quantitative analysis that indicates the relative importance of different behavioral assumptions and policy regimes. The empirical analysis is based on a computable general equilibrium (CGE) model which is Walrasian in spirit and captures price mechanisms, market interactions and structural interdependence in a non-linear multi-sector framework. The next section describes the main features of the model, concentrating on the specification of foreign trade. Section III describes the alternative adjustment mechanisms to be considered and Sections IV and V present the empirical results. Finally, conclusions follow in Section VI.

II. Outline of the Model

The analysis is based on a nineteen-sector CGE model which endogenously determines relative commodity and factor prices so as to equate demands and supplies for commodities resulting from the independently pursued optimizing behavior of various actors in the economy: producers, consumers, and the government (the latter not assumed to be a formal "optimizer"). The parameter values and initialization of the model are based on Turkish data and the selection of adjustment mechanisms is inspired by the policies undertaken by Turkey and other developing countries during periods of foreign exchange shortages. The model should, however, be viewed as a stylized one which attempts to capture the main structural interactions between the internal and external sectors in a "typical" semi-industrial economy.

1/ For a survey of CGE models, see Dervis, de Melo and Robinson (1981). Chenery and Raduchel (1971) used a related small, non-linear model to analyze the foreign exchange gap issue, but did not explicitly model market mechanisms or focus on different policy regimes.
The equations of the flexible exchange rate version of the model are summarized in Table 1. The adaptations to the model required to incorporate a fixed exchange rate and alternative adjustment mechanisms are described in the next section. The specification of foreign trade and its interaction with the rest of the economy are the most important building blocks of the model. First, consider imports. Our fundamental assumption is that domestically produced and foreign goods of the same sector category are imperfect substitutes.\(^1\) This treatment is a compromise between the assumption of perfect substitutability found in trade theory and the assumption of perfect complementarity found in "two-gap" models. More specifically, define for each commodity category a "composite" commodity which is a CES aggregation of imports and domestic goods. Consumers and producers demand this composite commodity so that the demands for imports and domestic goods become derived demands just as the demands for factors are derived demands in the traditional production model. Assuming that demanders seek to minimize the cost of acquiring a given amount of the composite goods, the desired ratio of imports to domestic goods is derived from the first-order conditions and is a function of the ratio of prices (to the demander) of domestic and imported goods (equation (12) in Table 1). Solving the first-order conditions also yields the desired ratio of domestic to composite goods and, through the cost-function dual, the price of the composite good.

\(^1\) See Armington (1969).

\(^2\) However, given linear homogeneity, then \(f(M,D) = D f(M/D,1)\), and these latter two magnitudes can be expressed in terms of the trade aggregation function, \(f_i(M_i, D_i)\), evaluated at \((M_i/D_i, 1)\). Equations (3) and (24) show the relationships.
Table 1: Equations of the Flexible Exchange Rate Model

I. Prices

\( \Pi_{i} = \Pi_{i} \cdot (1 + t_{m_{i}}) \text{ER} \)

\( \Pi_{W} = \Pi_{D} / [(1 + t_{e_{i}}) \text{ER}] \)

\( \Pi_{i} = [\Pi_{D} + \Pi_{M_{i}} \cdot M_{i}/D_{i}] / f_{i}(M_{i}/D_{i}, 1) \)

\( \Pi_{N_{i}} = \Pi_{D} - \text{EP}_{i_{i}}^{} - \text{td}_{i} \cdot \Pi_{D} \)

\( \Delta_{i} \cdot \Pi_{D} = \Delta \)

\( \Pi_{N_{i}} = \Pi_{D}^{} / \Pi_{W_{i}} \)

\( \Pi_{N_{i}} = \Pi_{D}^{} - \text{EP}_{i_{i}}^{} / \Pi_{W_{i}} \)

\( \Pi_{N_{i}} = \Pi_{D}^{} - \text{EP}_{i_{i}}^{} / \Pi_{W_{i}} \)

ER : exchange rate,
\( t_{m_{i}} \) : tariff rate,
\( \Pi_{W} \) : world price of imports,
\( \Pi_{M_{i}} \) : domestic price of imports,
\( t_{e_{i}} \) : export subsidy rate,
\( \Pi_{D} \) : domestic price,
\( \Pi_{W_{i}} \) : world price of exports,
\( \Pi_{i} \) : composite good price,
\( \text{td}_{i} \) : indirect tax rate,
\( a_{i_{i}} \) : input-output coefficients,
\( \Pi_{N_{i}} \) : net price or value added,
\( f_{i} \) : price index weights,
\( \Delta_{i} \) : price index weights,
\( \Pi_{N_{i}} \) : exogenous level of aggregate price index,
\( \Pi_{M_{i}} \) : imports,
\( \Pi_{D_{i}} \) : domestic demand for domestic production.

II. Production and Employment

\( X_{i} = \tilde{A}_{i} \cdot \Pi_{i} \cdot \Pi_{W_{i}} / \Pi_{D_{i}} \)

\( L_{i} = \lambda_{i} (L_{i1}, ..., L_{m_{i1}}) \)

\( X_{i} = \Pi_{A_{i}} \cdot \Pi_{W_{i}} \cdot \Pi_{D_{i}} / \Pi_{M_{i}} \)

\( L_{i} = \Pi_{N_{i}} \cdot \Pi_{L_{i}} \cdot \Pi_{S_{i}} \)

\( L_{i} = \Pi_{S_{i}} \cdot \Pi_{L_{i}} \cdot \Pi_{S_{i}} \)

\( \tilde{A}_{i} \) : productivity parameter in production,
\( \Pi_{A_{i}} \) : exogenous sectoral capital stock,
\( L_{i} \) : labor of category \( k \) in sector \( i \),
\( \Pi_{D_{i}} \) : aggregate labor in sector \( i \),
\( \Pi_{L_{i}} \) : average wage of labor category \( k \),
\( L_{i} \) : total demand for labor category \( k \),
\( \Pi_{S_{i}} \) : exogenous labor supply for category \( k \).

III. Foreign Trade

\( E_{i} = \Pi_{i} \cdot (1 + t_{m_{i}}) \cdot \text{ER} \)

\( M_{i} / D_{i} = \Pi_{i} / \Pi_{W_{i}} \)

\( \Pi_{W_{i}} \cdot M_{i} - \Pi_{N_{i}} \cdot E_{i} - \Pi_{N_{i}} \)

\( \Pi_{N_{i}} \) : parameters of export demand function,
\( \Pi_{W_{i}} \) : exogenous world price of other-country goods,
\( \Pi_{N_{i}} \) : exogenous net inflow of foreign exchange.
Table 1 (Cont'd)

IV. Income and Investment

(14) \( R_L = \sum_{i,k} k k t (1-t_k) \)

(15) \( R_K = \sum_{i,k} k k (P_i N_i - E_i L_i) \)

(16) \( R_G = \sum_{i,k} k k (P_i X_i - E_i L_i) + \sum_{i,k} E_m X_i E R N_i \)

(17) \( TINV = s L L + s K K + s G G \)

(18) \( Y = \theta TINV \)

(19) \( Z_i = \theta_i Y_j \)

\( t_k \): tax rate on labor income, category k,
\( R_L \): after-tax labor income,
\( t_k \): tax rate on non-wage income in sector i,
\( R_K \): after-tax capital income,
\( R_G \): government revenue net of export subsidies,
\( S_L, S_K, S_G \): exogenous savings rates,
\( TINV \): total investment,
\( Y \): investment by sector of destination,
\( \theta \): sectoral investment allocation shares,
\( b_i \): capital composition coefficients,
\( Z_i \): investment by sector of origin.

V. Product Markets

(20) \( C_i = C_1 L + C_i K + C_i G \)

(21) \( C_{ij} = \tilde{q}_{ij} (1-\tilde{q}_{ij}) R_j / P_j \)

(22) \( V_i = \theta_i X_j \)

(23) \( D_i = d_i (Z_i + C_1 + V_i) \)

(24) \( d_i = 1/f_{ij} (N_i / D_i, 1) \)

(25) \( X_i^D = D_i + E_i \)

(26) \( X_i - X_i^D = 0 \)

\( C_i \): consumption, sector i, demander j,
\( C_i \): consumption demand, sector i,
\( q_i \): expenditure share parameters,
\( V_i \): intermediate demand,
\( d_i \): domestic demand ratio,
\( X_i^D \): total demand for domestic production.

Notes:

Endogenous variables are denoted by capital letters. Lower case letters (except d), Greek letters, and letters with a bar are exogenous variables or parameters.

In equations (3) and (24), \( f(-) \) denotes the CES trade aggregation function. In equation (12), \( g(-) \) is derived from the associated first order conditions. \( F(-) \) and \( \lambda(-) \) in equations (6) and (7) are CES functions.
Since imports are assumed to be in infinitely elastic foreign supply, world prices, $\overline{PW}_i$, are fixed and the country is "small" on the import side. Import prices to the domestic user are given in equation (1) and equal the world price times the exchange rate times one plus the tariff rate.

This treatment of imports conveys a certain autonomy to the domestic price system not found in models where domestically produced and foreign goods are perfect substitutes. The specification also has the advantage of allowing two-way trade. A pure non-traded sector whose relative price is entirely determined in the domestic market is one for which there are no imports or exports. For other sectors, the relative price depends on commercial policy embodied in the exchange rate, tariffs and subsidies. The relative importance of each of these factors in determining domestic prices depends on the relative importance of imports and exports in total domestic supply as well as on the trade substitution elasticity in the CES aggregation function.

Turning to exports, we assume a downward-sloping foreign demand curve for exports whose form is given in equation (11). $PWE_i$ is the foreign currency price of exports and is obtained by dividing the domestic price, $PD_i$, by the exchange rate multiplied by one plus the rate of export subsidy--equation (2). On the export side, the country is not assumed to be "small."\(^1\)

\(^1\) The magnitude of the export demand elasticity depends not only on the country's market share, but also on the degree of product differentiation characterizing products from other countries. Thus, the higher the market share or the more differentiated the product in question, the lower the export demand elasticity. Other specifications of export markets are also feasible and would not change the essential nature of the adjustment mechanisms we seek to capture. One could, for example, specify export supply functions and allow an endogenous wedge between domestic and export prices.
Built around this specification of foreign trade is a general equilibrium system with price-responsive demand functions and sectoral neoclassical production functions linked around an input-output core into a model that simultaneously determines quantities and prices. The core equations of the system are the excess-demand equations for labor, commodities and foreign exchange (equations (10), (26) and (13)). Once solved, the model determines wages, product prices and an exchange rate (in the flexible exchange rate version) which yield zero excess demands and hence clear these three markets.1/

Equations (6) to (10) describe the labor market. The production technology is two-level CES in labor and capital, with intermediate goods required by fixed input-output coefficients (equation (22)). The labor markets always clear, with no open unemployment.2/ Capital is assumed sectorally fixed. Investment—equations (17), (18) and (19)—is savings determined and its allocation by sector of destination is given by exogenously specified shares.

Equations (20) to (26) describe the product markets. The various demands (Z_i, V_i and C_i) are all for composite goods, with the demands for domestic goods being given by multiplying the composite good

1/ For a survey of different approaches to solving CGE models and a description of our approach, see Dervis, de Melo and Robinson (1981).

2/ Other specifications of the labor markets (e.g., rigid wages and open unemployment) are certainly feasible and have been used in other CGE models.
demand by the domestic demand ratio ($d_i$). Since the various supply and demand functions, and the $d_i$ ratios themselves, are all price sensitive, the excess-demand equations can be seen as functions of domestic prices and the exchange rate. With the balance of payments, equation (13), there are as many excess-demand equations as there are prices, wages and the exchange rate. However, by Walras' Law, the excess-demand equations are not independent and we require some price normalization rule to close the system. We have chosen to set an aggregate index of composite prices exogenously—equation (5)—which represents an overall index of prices to buyers in all markets, including imports and intermediate goods.

In the flexible exchange rate model, the real variables depend only on relative prices and hence the choice of price normalization is only a matter of a convenient choice of numeraire. However, as discussed in the next section, there are alternative specifications of adjustment mechanisms in which the exchange rate is fixed and balance of payments equilibrium is achieved by means of import rationing. In this case, the choice of the aggregate price index matters since it defines the "no-inflation" benchmark against which the exchange rate is fixed and will affect real variables in the solution. Our choice implies that the monetary authorities are fixing an overall price index that includes transactions in all product markets in the economy including imports, intermediate goods and final demand. The actual monetary mechanisms at work are not explicitly modelled in what is, after all, an essentially
Walrasian model. 1/

III. Alternative Adjustment Mechanisms to Foreign Payments Imbalances

To explore the role of alternative adjustment mechanisms, we assume a sudden shortfall in the "normal" flow of foreign resources ($F$ in equation (13)). Assuming that the country can no longer borrow and that foreign exchange reserves have run out, it faces a foreign exchange crisis and will somehow have to adjust to it. Three alternative adjustment mechanisms will be examined: (1) devaluation; (2) fixprice rationing; and (3) premium rationing.

Adjustment by Devaluation

Suppose that the country is initially in a position of internal and external equilibrium with the demands for all commodities and foreign exchange equal to their supplies. A shortfall in the inflow of foreign resources, $\bar{F}$, generates an excess demand for foreign exchange and a matching excess supply of domestic goods creating upward pressure on the exchange rate, $ER$. Given the fixed overall price level, this exerts downward

1/ A similar approach is used by Bruno (1976) and Jones and Corden (1976) who also assume that appropriate fiscal and monetary policies are pursued to maintain price stability and full employment. The assumption of full employment could be easily relaxed and investigated in this framework. Explicit consideration of monetary factors would be a considerably more difficult matter which would be better undertaken in a short-term macro model including asset behavior and expectations. Note, however, that the assumption of price stability is not without empirical support. After reviewing the evidence on twenty two devaluations in developing countries Krueger (1978, p. 146) concludes that "the net results of devaluation, import liberalization, and monetary and fiscal policy were such that, on balance, the percentage price increase in the several years following devaluation was no higher than before."
pressure on domestic prices as a whole. However, as will be shown in Section V, domestic prices do not fall uniformly. At this stage, it is sufficient to note that the upward adjustment in the real exchange rate is achieved by the combination of a fall in the price of domestically produced goods and a rise in the domestic currency price of both exports and imports.

Adjustment by Fixprice Rationing

In spite of a movement towards greater exchange rate flexibility in the 1970's, trade regimes based on fixed exchange rates and exchange controls remain characteristic of many developing countries. In such regimes, the exchange rate is not, at least initially, allowed to adjust. Instead, imports are rationed and we must try to model the rationing mechanism. Because there exists a multitude of different rationing schemes, we distinguish only two extreme cases: fixprice rationing and premium rationing.

In the absence of rationing, the total value of desired imports is \( \sum P_i W_i M^*_i \), where \( M^*_i \) is obtained from equation (12). With a fixed exchange rate there is nothing to guarantee that this sum does not exceed export earnings and net foreign resource inflows. Usually what is assumed in fixed exchange rate models is that changes in foreign exchange reserves or additional short-term borrowing make up any excess of desired expenditure over foreign exchange earnings. We assume that the country can no longer find additional funds and has run out of reserves, so the trade

\[^1/\] Using an asterisk to denote a desired quantity.
balance in dollars must remain fixed across experiments. Realized imports then amount to whatever is allowed by available foreign exchange revenues. Desired imports based on the customs clearance price (c.i.f. + tariffs) may, however, add up to a much larger magnitude than the sum of export earnings and foreign resource transfers. A rationing mechanism is then introduced to bring about an ex-post equality between receipts and expenditures of foreign exchange.

Let RM denote the ratio of total available foreign exchange TFEX, to total desired imports:

$$RM = \frac{TFEX}{\sum M_i^*}$$

A simple rationing rule is to allocate foreign exchange to the various sectors in proportion to desired imports $M_i^*$. Actual realized imports are then obtained by multiplying desired imports in each sector by the overall excess demand parameter, RM. The particular quantity adjustment mechanism outlined above is clearly a stylized and simplified story. We call it "fixprice" rationing to underline the fact that the

1/ Note that being forced off their demand curve for imports, behaviorally each demander should solve his particular constrained maximization problem. Strictly speaking, one should not maintain the two-stage formulation presented above where consumers are allowed to remain on their demand function for the composite good. This two-stage specification is easier to implement empirically and is justifiable in our particular model since sectors with large import ratios represent intermediate goods whose demand is by fixed coefficients and hence there is little scope for changing demand proportions in response to changes in relative composite prices.
user price of foreign exchange remains fixed in spite of an overall shortage. It is appropriate for countries where imports of producer goods are tied to user-specific quotas and licenses, where resale is prohibited, and where consumer goods imports are insignificant. What is crucial here is the assumption that the users of imports do not have to pay more than the c.i.f. + tariff price, so quantity allocations are directly channelled to users without going through some kind of auction or market system. The exchange rate is truly fixed: except for (fixed) tariffs and export subsidies, both exporters and importers pay ER units of domestic currency for one dollar's worth of imports. This implies that the entire burden of adjustment falls on domestic prices.

Adjustment by Premium Rationing

Alternatively, it is possible that under rationing a legal or semi-legal parallel "free" market develops for the scarce imports or, more directly, for the scarce foreign exchange. Let us define such a system as rationing by premium.

Assume again that the demand for imports exceeds the supply of foreign exchange necessary to buy those imports at a given fixed exchange rate. Now, contrary to the case of fixprice rationing, assume that the government tolerates the emergence of a parallel or "free" market for foreign exchange allocations. In that case, those who demand foreign exchange will bid up its price until at the new price demand again equals supply. If PR is the premium rate that emerges in this parallel market and ER is the official exchange rate, the user cost of imports will now be:

1/ Note that domestic prices and wages are not fixed, in contrast with other recent rationing models. See Malinvaud (1977) and Muelbauer and Portes (1978).
\[ PM_i = PW_i \cdot ER + PW_i ER \cdot tm_i + PW_i ER \cdot PR \]

<table>
<thead>
<tr>
<th>The price of imports in currency</th>
<th>The value of the premium due to rationing</th>
</tr>
</thead>
</table>

Viewed in this way, the premium acts as a variable, but sectorally uniform, import surcharge. Under rationing with premium, producers adjust by cost minimizing given domestic prices and premium-inclusive import prices. Neglecting distribution effects between the government and the private sector, such a mechanism works as if the exchange rate was flexible on the import side only.\(^1\) Desired imports are again equal to actual imports because the price mechanism has been allowed to adjust the demand for imports to the supply of foreign exchange.

The three adjustment mechanisms described above are somewhat extreme cases when compared to how adjustments actually take place.\(^2\) However by confining ourselves to these three possibilities in the following empirical illustration, we are able to bring out more sharply the contrasts between them, particularly at the microeconomic level.

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1/ There are also major distributional differences between the three adjustment mechanisms. We do not explore these effects in this paper, and they can have no impact on the demand side because all consumers are given the same average expenditure shares.

2/ For a full description of exchange control regimes, see Bhagwati (1978).
IV. Macroeconomic Effects of Alternative Adjustment Mechanisms

This and the following section present a quantitative analysis of the three adjustment mechanisms described above.\textsuperscript{1/}

We start from an equilibrium position where desired expenditures on imports are equal to the sum of export earnings and a $1.2 billion net foreign resource inflow. The "crisis" takes the form of a $600 million shortfall in the exogenous foreign resource transfer, amounting to about 3 percent of GDP.

To analyze the impact of foreign exchange shortage and the effects of the three alternative adjustment mechanisms, we discuss six experiments, two for each of the three adjustment mechanisms:

E-1: Devaluation, Low Trade Elasticities
E-2: Premium Rationing, Low Trade Elasticities
E-3: Fixprice Rationing, Low Trade Elasticities
E-4: Devaluation, High Trade Elasticities
E-5: Premium Rationing, High Trade Elasticities
E-6: Fixprice Rationing, High Trade Elasticities

By assuming, in each case, high and low values for the crucial trade substitution and export demand elasticities, we can evaluate the importance of elasticity pessimism and elasticity optimism in discussions on adjustment policies. The low elasticity case is closer to the fixed

\textsuperscript{1/} The empirical model used here is based on Dervis and Robinson (1978). The data base and parameter estimation are described in that paper.
coefficients view of the structuralist school. The high elasticity case, on the other hand, brings us closer to neoclassical trade theory models that tend to assume perfect substitutability between domestic goods and imports and very high export demand elasticities.\(^1\)

Table 2 presents the macroeconomic results. Consider first the flexible exchange rate case. There is a 21.5 percent devaluation when we assume low trade elasticities and a much smaller 8.7 percent devaluation with high trade elasticities, which highlights the role of trade elasticities in determining the required degree of exchange rate adjustment. The reduced need for relative price adjustment when elasticities are high is, of course, also reflected in the smaller change in import and export prices.

Under either kind of rationing the official exchange rate remains fixed. However, under rationing with premium, the user price of imports rises by 71.6 and 32.0 percent respectively with low and high elasticities. This rise is between three and four times greater than the rise in import prices that occurs with devaluation, reflecting the fact that the entire burden of adjustment has shifted to the import side. Thus imports become much more expensive to domestic users when there is rationing with premium than with devaluation, a fact that is not always

\(^1\) See Table 3 below for a summary of parameter values. The values for all nineteen sectors used in the experiments are available from the authors upon request. The "high" trade elasticities (reported in Columns 5 and 6 of Table 3), range from 6 for primary commodities to 0.75 for capital goods and 0.50 for services. The corresponding set of low elasticities is set equal to one third of the values for the high set. In turn, export elasticities range from 6 for manufactured goods in the "high" set to 2 for primary goods and processed agricultural goods in the "low" set.
### Table 2

**Macroeconomic Impact of Alternative Adjustment Mechanisms**

(Percent Changes from Base Run)

<table>
<thead>
<tr>
<th>EXPERIMENT</th>
<th>Devaluation Low (E-1)</th>
<th>High (E-4)</th>
<th>Premium Rationing Low (E-2)</th>
<th>High (E-5)</th>
<th>Fixprice Rationing Low (E-3)</th>
<th>High (E-6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exchange Rate</td>
<td>21.5</td>
<td>8.7</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>User Price of Imports&lt;sup&gt;1/&lt;/sup&gt;</td>
<td>21.5</td>
<td>8.7</td>
<td>71.6</td>
<td>32.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Dollar Price of Exports&lt;sup&gt;2/&lt;/sup&gt;</td>
<td>-17.1</td>
<td>-6.6</td>
<td>-2.7</td>
<td>-1.2</td>
<td>-0.7</td>
<td>-0.4</td>
</tr>
<tr>
<td>Imports (volume &amp; dollar value)</td>
<td>-9.3</td>
<td>-8.2</td>
<td>-19.6</td>
<td>-20.4</td>
<td>-21.5</td>
<td>-22.4</td>
</tr>
<tr>
<td>Exports (volume)</td>
<td>44.6</td>
<td>37.0</td>
<td>5.6</td>
<td>4.8</td>
<td>0.7</td>
<td>0.9</td>
</tr>
<tr>
<td>Exports (value)</td>
<td>21.5</td>
<td>27.1</td>
<td>2.7</td>
<td>3.8</td>
<td>0.2</td>
<td>1.0</td>
</tr>
<tr>
<td>Non-Agricultural Wage</td>
<td>-1.1</td>
<td>-0.5</td>
<td>-9.7</td>
<td>-5.0</td>
<td>-2.3</td>
<td>-1.2</td>
</tr>
<tr>
<td>GDP</td>
<td>-0.4</td>
<td>-0.3</td>
<td>-1.3</td>
<td>-1.0</td>
<td>-2.4</td>
<td>-1.3</td>
</tr>
</tbody>
</table>

<sup>1/</sup> Weighted average using import share weights.

<sup>2/</sup> Weighted averaged using export share weights.
appreciated. This result also emphasizes that the "black market" exchange rate (i.e., the official rate plus the premium) should not be taken to equal the underlying equilibrium exchange rate. Quite apart from considerations of risk that may stem from the extra-legal nature of the black (or parallel) market, the fact that exports do not usually benefit from the black market premium implies that the equilibrium exchange rate that would rule if adjustment were permitted on both the import and the export sides must be substantially below the parallel market rate that rules for imports when there is premium rationing.

In the case of fixprice rationing, the user cost of imports is kept constant by forcing users off their demand curves. Thus, from the point of view of the user price of imports, fixprice rationing and premium rationing represent two extreme cases, with devaluation in between. Fixprice rationing may, in fact, reflect a desire to avoid any rise in import prices. Public enterprises which may already be in a precarious financial situation often press for some form of fixprice rationing. Who exactly is forced off his demand curve and to what extent will vary widely from case to case. Our experiments reflect only one possible way to distribute the burden of adjustment.

The change in the terms of trade is determined entirely by the change in the average dollar price of exports, since the dollar price of imports is assumed to be exogenous. Variations in the average domestic price of exportables (not reported in Table 2) are small, so changes in the terms of trade are largely determined by changes in the exchange rate. Thus, the decline in the terms of trade is 6.6 percent for devaluation with high elasticities and 17.1 percent with low elasticities.
Corresponding to the changes in the user price of imports and the average dollar price of exports, there are changes in the volume of imports and exports which are shown in Table 2. Not surprisingly, the reduction in the volume of imports is greater when there is no expansion of exports, and it reaches 22.4 percent under fixprice rationing. It is especially interesting to note the wide range in the implied aggregate import and export demand elasticities (with respect to the average user price of imports and the average dollar price of exports) under each of the adjustment mechanisms. Our results indicate that one must be careful when speaking of such aggregate elasticities since their values are likely to vary widely depending on what is held fixed (and it is not always clear from statistical analyses which variables are held fixed).\(^1\)

Finally, note that GDP declines in all three cases. The decline is always greater when elasticities are low (i.e., the economy has more difficulty in adapting to a shortfall of foreign exchange). In terms of minimizing GDP changes, devaluation is the best and fixprice rationing is the worst adjustment policy. This result reflects the increasing violation of marginal efficiency conditions as one moves from devaluation to fixprice rationing. Premium rationing introduces a gap between the domestic resource

\(^1\) For a summary of cross-section evidence on aggregate elasticities with respect to trade incentives, see Balassa (1981, Chapter 3). It is noteworthy that the estimates of the import elasticities (0.4) and the export elasticities (1.3) stand roughly in the same ratio to each other as our analysis suggests.
cost of exports and import substitutes while fixprice rationing goes further by interfering with the equalization of the marginal productivity of imports across sectors. But there are, of course, a host of other factors that influence policy choice, not least of which is the sectoral impact of alternative adjustment policies. We turn in the next section to a discussion of resource allocation and sectoral production effects.

V. Resource Allocation Effects of Alternative Adjustment Mechanisms

To examine what is happening at the microeconomic level, it is necessary to consider carefully each sector's trade orientation, i.e., the relative importance of imports and exports at the sectoral level. Bearing in mind that in general sectors will have both exports and imports, it is easy to see that an adjustment via a devaluation (DEV) is neutral in the sense that it affects both exports and imports in each sector. On the other hand, adjustment via premia (PREM) and via fixprice rationing (FIX) are asymmetric since the foreign currency price of exports is not affected directly as it is by a devaluation. This asymmetry of the burden of adjustment between exports and imports is fundamental to an understanding of how resource allocation is affected by each one of the experiments.

Consider the sources of demand for each sector's output given in equation (25): domestic demand, $D_i$, and export demand, $E_i$. A devaluation, which raises the value of ER, leads both to an increase in foreign demand, $E_i$ (due to the fall in export prices expressed in currency units) and to an increase in domestic demand, $D_i$ (as
the price of imports, \( PM_1 \), rises and diverts demand to domestic substitutes. An adjustment via premium will not affect exports directly since \( ER \) remains fixed.

While the effect of a change in the exchange rate on the demand for exports is direct, the effect on domestic demand is indirect since it operates through the demand for the composite good. Therefore, the price of the composite good, \( P_1 \), defined in equation (3), must also be considered. An increase in the exchange rate or the application of a premium will raise the price of the composite good since the foreign currency price of imports is fixed and the domestic price of imports necessarily rises. A rise in \( P_1 \), in turn, leads to a fall in demand. However, the ultimate effects of the alternative adjustment mechanisms on resource allocation depend on how they are translated into changes in net prices and wages. The effect on wages is straightforward and depends on the relative factor intensities (in the direct and indirect sense). It is more difficult, however, to explain the change in net prices since they depend on both the domestic and composite prices. The analysis requires a categorization of sectors according to their role in

1/ Ignoring general-equilibrium and/or income effects, the extent of this fall in demand depends, of course, on the own-price elasticity of demand for the composite good. In the present application, demand equations for private and government final demands have constant expenditure shares (as does investment demand) which implies a unitary own-price elasticity of demand. Intermediate demand has a zero price elasticity of demand. Therefore, consumer goods and capital goods producing sectors will be more responsive to a change in composite prices than intermediate goods producing sectors.
foreign trade.  

Table 3 gives the necessary information to explore how different sectors will react to the different adjustment mechanisms. Sectors which are "exportables" have a high ratio of exports to domestic supply (i.e., consumer goods and, to a lesser extent, services). Sectors which are "non-tradables" have a low export ratio, a low ratio of imports to domestic goods in domestic use, and a low trade-substitution elasticity (i.e., construction). Sectors which are "import dependent" have a high ratio of imported to total intermediate inputs (i.e., intermediate goods, capital goods, and construction).

Sectors characterized by high shares of imports in total domestic use can be divided into import substitutes and import complements depending on the ease of substitution between domestic and foreign goods. This distinction reflects the traditional distinction between competitive and non-competitive imports, but it allows for variations in the degree of substitutability rather than specifying a dichotomous classification between perfect substitutes and perfect complements. An import substitute sector is one for which the price will rise if the price of imports rises. As the trade substitution elasticity rises, these sectors behave as the traditional perfect substitutes for competitive imports. If, on the contrary, the trade substitution elasticity is low, the sector behaves as if sectoral imports are complements.

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1/ In the discussion below, we have aggregated the results from the experiments with the nineteen-sector model and present them at a six-sector level, including: agriculture, consumer goods, intermediate goods, capital goods, construction, and infrastructure and services. The share of each of these sectors in total gross output is given in Table 3, Column 1. As with the other figures in that table, these shares refer to those prevailing in the base run prior to the $600 million foreign resource shortfall.
<table>
<thead>
<tr>
<th>Sector</th>
<th>Sectoral Shares in Total Output</th>
<th>Ratio of Imports to Domestic Goods</th>
<th>Ratio of Imported to Total Intermediate Inputs</th>
<th>Ratio of Exports to Total Output</th>
<th>Trade Substitution Elasticities (High)</th>
<th>Export Demand Elasticities (High)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>21.5%</td>
<td>1.6%</td>
<td>8.4%</td>
<td>1.6%</td>
<td>6.0</td>
<td>4.0</td>
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<tr>
<td>Consumer Goods</td>
<td>17.2</td>
<td>1.5</td>
<td>3.8</td>
<td>10.9</td>
<td>2.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Intermediate Goods</td>
<td>14.4</td>
<td>26.5</td>
<td>19.5</td>
<td>3.8</td>
<td>1.5</td>
<td>6.0</td>
</tr>
<tr>
<td>Capital Goods</td>
<td>5.5</td>
<td>56.7</td>
<td>29.6</td>
<td>0.8</td>
<td>0.75</td>
<td>6.0</td>
</tr>
<tr>
<td>Construction</td>
<td>6.1</td>
<td>-</td>
<td>15.3</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Infrastructure and Services</td>
<td>35.3</td>
<td>1.6</td>
<td>8.4</td>
<td>5.0</td>
<td>0.5</td>
<td>4.0</td>
</tr>
</tbody>
</table>
In this case, imports are non-competitive in the sense that a tariff on imports does not protect the corresponding domestic sector.

Whether or not a sector is an import substitute depends also on the elasticity of demand for the composite good. It can be shown in a partial equilibrium framework that if the trade substitution elasticity is less than the composite good demand elasticity, a rise in the import price (e.g., by a tariff) will lead to a fall in the domestic price. Such a sector is an import complement.

A sector which will be most strongly protected by a devaluation or premium on imports is one which is an import substitute and is not import dependent. Protection will always attract resources into such a sector. In the six-sector aggregation, the two sectors which have the highest import shares (intermediate and capital goods) are also the most import dependent. Intermediate goods have a higher trade-substitution elasticity and are less import dependent than capital goods, and so should be more protected by a devaluation or import premium. Construction, which is import dependent but non-tradable, will be adversely affected by any policy that raises import prices.

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1/ See Dervis, de Melo, and Robinson (1981), Chapter 6, for a proof. Diaz-Alejandro (1965, Chapter 2), and more recently Corden in several places, have strongly argued for the need to extend the standard tradable-home good dichotomy in the manufacturing sector of semi-industrialized countries to include a distinction between sectors that do and do not compete with foreign products.
In the case of fixprice rationing (FIX), the whole burden of adjustment falls on domestic prices since both the exchange rate and the user price of imports are held fixed. Thus, in the FIX experiment, actual imports are only 65 percent of desired imports and so producers and consumers are forced into using domestic goods. A useful way to visualize the adjustment mechanism is to think of rationing as an outward shift of the demand curve for the domestic good. The shift is largest for sectors which have a high import ratio, and the elasticity of demand for the domestic good is greatest for sectors which have a high trade substitution elasticity. Thus, fixprice rationing results in an increase in the domestic price of sectors which have a high import ratio and, for a given ratio, the adjustment in domestic prices is greater the lower is the trade-substitution elasticity (i.e., the more non-competitive are imports).

Note also that fixprice rationing has a different impact on intermediate input costs than does devaluation or premium rationing. Import-dependent sectors gain from fixprice rationing insofar as they are able to buy scarce imported intermediate goods at the fixed price. The final effect depends on the net impact on composite intermediate input prices of cheaper imports but higher domestic prices for import substitutes.

Table 4 summarizes the results on resource allocation of the alternative adjustment mechanisms. The table gives percentage changes from their base values of net prices (Columns 1-3), gross output (Columns 4-6), imports (Columns 7-9), and exports (Columns 10-12). Consider first the effect of a

1/ Only the high-elasticity results are reported in Table 4 since nothing fundamentally different is involved with low-elasticities.
devaluation (DEV) which, from Table 2, raises the user price of imports by 8.7 percent and lowers the average dollar price of exports by 6.6 percent.

From the discussion above, the exportable and import substitute sectors should draw resources from the rest of the economy—which, in fact, is what happens. Consumer and intermediate goods are the only sectors which show an increase in net price and gain in output after the devaluation. The net price of capital goods falls with the devaluation in spite of its high import share because of its low trade substitution elasticity (it is effectively an import complement) and its high degree of import dependence. Finally, note that the devaluation results in an across-the-board increase in exports.

In the premium rationing experiment (PREM), the burden of adjustment falls on imports and the user price of imports rises by 32 percent while the average dollar price of exports only falls by 1.2 percent. An immediate consequence is that the relative position of the exportable sectors will be most affected since there is no increase in demand for exports and no upward pressure on their price, as in the case of a devaluation. This effect is compounded by the substantial rise in intermediate-input costs for the import-dependent sectors. The final result is—with the exception of intermediate goods which are strong import substitutes—a general fall in net prices, with

1/ Infrastructure and services shows no fall in output even though its net price falls because there was also a fall in the wage rate.
Table 4

Sectoral Impact of Alternative Adjustment Mechanisms

(Percent Changes from Base Solution, High Elasticity Experiments)

<table>
<thead>
<tr>
<th>EXPERIMENT</th>
<th>Net Prices</th>
<th>Output</th>
<th>Imports</th>
<th>Exports</th>
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<tr>
<td></td>
<td>(DEV) (PREM) (FIX)</td>
<td>(DEV) (PREM) (FIX)</td>
<td>(DEV) (PREM) (FIX)</td>
<td>(DEV) (PREM) (FIX)</td>
</tr>
<tr>
<td>Agriculture</td>
<td>-0.6 -1.9 -3.5</td>
<td>0.0 0.0 0.0</td>
<td>-40.3 -81.0 -45.4</td>
<td>40.4 4.6 11.3</td>
</tr>
<tr>
<td>Consumer Goods</td>
<td>0.4 -5.0 -2.1</td>
<td>1.5 -0.2 -1.1</td>
<td>-18.2 -45.7 -38.9</td>
<td>36.0 6.3 5.7</td>
</tr>
<tr>
<td>Intermediate Goods</td>
<td>2.8 1.9 12.2</td>
<td>0.4 1.0 3.8</td>
<td>-6.6 -18.1 -18.5</td>
<td>29.7 -28.4 -33.7</td>
</tr>
<tr>
<td>Capital Goods</td>
<td>-2.0 -5.4 21.2</td>
<td>-0.8 0.3 10.1</td>
<td>-6.5 -15.3 -20.8</td>
<td>52.7 -15.7 -59.7</td>
</tr>
<tr>
<td>Construction</td>
<td>-1.8 -6.5 -3.4</td>
<td>-1.8 -1.8 -3.3</td>
<td>0.0 0.0 0.0</td>
<td>0.0 0.0 0.0</td>
</tr>
<tr>
<td>Infrastructure and Services</td>
<td>-0.7 -5.6 -2.5</td>
<td>0.0 0.1 -0.8</td>
<td>-5.8 -16.6 -37.0</td>
<td>39.8 15.9 7.1</td>
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consumer goods suffering the largest decline, compared with the devaluation experiment. However, the increase in intermediate input costs is more than offset by a decline in the wage rate (shows in Table 2). Thus capital goods output does not fall despite a fall in its net price of 5.4 percent. Because their output price has fallen, sectors such as consumer goods and infrastructure and services increase their volume of exports.

Finally, consider the impact of fixprice rationing (FIX). The effects of changes in incentives to import which previously worked indirectly via changes in the use prices of imports now become direct, with the burden of adjustment on domestic prices becoming magnified. Intermediate and capital goods—which have the highest import ratios, low export ratios, and low trade substitution elasticities—are the only sectors whose prices rise.\footnote{1} A comparison of net price and output changes with those from the premium rationing experiment (PREM) shows how much larger and more biased are adjustments by fixprice rationing compared to what happens with a price rationing system. Note that the capital goods sector expands by 10 percent under fixprice rationing whereas it shows little expansion under premium rationing. This result is due to the combination of low substitutability in use between imported and domestic capital goods and the large share that imported intermediates, whose price remains fixed, have in total production costs.

\footnote{1} Although domestic prices are not reported in Table 4, the magnitude of their increase for (PREM) and (FIX) can be assessed by examining the corresponding decline in exports in Columns 11 and 12.
VI. Conclusion

This paper illustrates the difficulties besetting policy makers in semi-industrial countries facing a shortage of foreign exchange. The adjustments in relative prices, including the real exchange rate, and in incomes necessary to restore equilibrium may be so dramatic that they are considered very undesirable or politically infeasible. Moreover, none of the alternative adjustment mechanisms provides any easy way out of the dilemma. Both fixprice and premium rationing schemes lead to large changes in relative prices and, at the economy-wide level, they are more costly. Even with high foreign trade elasticities, adjusting to an exogenous fall in foreign exchange inflow by means of rationing is three to four times more costly in terms of lost GDP than adjusting by means of devaluation. Assuming low foreign trade elasticities, and hence less flexibility, makes the contrast even more dramatic.

At the microeconomic level, the results show that the choice of adjustment policy has a strong impact on economic structure. In general, export-oriented consumer goods industries benefit from devaluation, while domestic capital and intermediate goods industries benefit from fixprice rationing. Indeed, it is precisely these differences in structural impact that may determine the choice of adjustment mechanism since politically relevant groups in the society may be affected differently by the various policies. Analysis of such distributional issues is beyond the scope of this paper, but is clearly important.
Our analysis lends support to the structuralist view that it is not sufficient to look at problems of adjustment only at the macroeconomic level. By incorporating the exchange control regimes typical of many developing countries in a general equilibrium model rich enough to capture important structural rigidities and imperfect substitution, it has proved possible to quantify and hence understand better the implications of following different policy regimes. Such a model, by focusing on microeconomic market mechanisms in a multi-sector framework, usefully complements more aggregated analyses which focus on macroeconomic flow-of-funds mechanisms. That both types of analysis indicate that there are no easy choices for policy makers should come as no surprise, but it is important to understand that problems of macroeconomic adjustment are usually linked with problems of structural adjustment.
References


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