Kemal Dervis, Jaime de Melo, and Sherman Robinson

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A GENERAL EQUILIBRIUM ANALYSIS OF FOREIGN EXCHANGE SHORTAGES IN A DEVELOPING ECONOMY[*]

Kemal Derviş, Jaime de Melo and Sherman Robinson

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 input–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.

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.

  [1] For a presentation of these contrasting views, see Findlay (1973, Chapter 10) and Diamond (1978).

This paper re-examines the foreign exchange gap issue and the debate between structuralists and neoclassicists by providing a quantitative assessment of the role of different 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 behavioural 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.[1] The next section describes the main features of the model, concentrating on the specification of foreign trade. Section II describes the alternative adjustment mechanisms to be considered and Sections III and IV present the empirical results. Finally, conclusions follow in Section V.

I. 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 optimising behaviour of various actors in the economy: producers, consumers, and the government (the latter not assumed to be a formal 'optimiser'). The parameter values and initialisation 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 stylised one which attempts to capture the main structural interactions between the internal and external sectors in a 'typical' semi-industrial economy.

The equations of the flexible exchange rate version of the model are summarised 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.[2] 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 minimise the cost of acquiring a given

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[1] For a survey of *CGE* models, see Dervis *et al.* (1981). Chenery and Raduchel (1971) used a related small, non-linear model to analyse the foreign exchange gap issue, but did not explicitly model market mechanisms or focus on different policy regimes.

[2] See Armington (1969).

Table 1

Equations of the Flexible Exchange Rate Model

I. *Prices*

(1) $PM_i = \overline{PW}_i\,(1+tm_i)\,ER$

(2) $PWE_i = PD_i/[(1+te_i)\,ER]$

(3) $P_i = (PD_i+PM_i\,M_i/D_i)/f_i(M_i/D_i,\,1)$

(4) $PN_i = PD_i - \Sigma_j P_j a_{ji} - td_i PD_i$

(5) $\Sigma\Omega_i P_i = \overline{P}$

ER	exchange rate,
tm_i	tariff rate,
$\overline{PW}_i$	world price of imports,
PM_i	domestic price of imports,
te_i	export subsidy rate,
PD_i	domestic price,
PWE_i	world price of exports,
P_i	composite good price,
td_i	indirect tax rate,
a_{ji}	input–output coefficients,
PN_i	net price or value added,
Ω_i	price index weights,
$\overline{P}$	exogenous level of aggregate price index,
M_i	imports,
D_i	domestic demand for domestic production.

II. *Production and Employment*

(6) $X_i^S = \bar{A}_i F_i\,(\overline{K}_i, L_i)$

(7) $L_i = \lambda_i\,(L_{1i}, \ldots, L_{mi})$

(8) $PN_i\,(\partial X_i^S/\partial L_{ki}) = W_k$

(9) $L_k^D = \Sigma_i L_{ki}$

(10) $L_k^D - \overline{L}_k^S = 0$

$\bar{A}_i$	productivity parameter in production,
$\overline{K}_i$	exogenous sectoral capital stock,
L_{ki}	labour of category k in sector i,
L_i	aggregate labour in sector i,
W_k	average wage of labour category k,
L_k^D	total demand for labour category,
$\overline{L}_k^S$	exogenous labour supply for category k.

III. *Foreign Trade*

(11) $E_i = \bar{E}_i\,(\Pi_i/PWE_i)^{\eta_i}$

(12) $M_i/D_i = g_i\,(PD_i/PM_i)$

(13) $\Sigma_i \overline{PW}_i\,M_i - \Sigma PWE_i E_i - \overline{F} = 0$

$\bar{E}_i, \eta_i$	parameters of export demand function,

Π_i	exogenous world price of other-country goods,
$\overline{F}$	exogenous net inflow of foreign exchange.

IV. *Income and Investment*

(14) $R_L = \Sigma\Sigma_{ik} W_k L_{ki}(1-t_k)$

(15) $R_K = \Sigma_i(PN_i X_i - \Sigma_k W_k L_{ki})\,(1-tk_i)$

(16) $R_G = \Sigma\Sigma_{ik} t_k W_k L_{vi} + \Sigma_i tk_i\,(PN_i X_i^S$
$- \Sigma_k W_k L_{ki}) + \Sigma tm_i\,\overline{PW}_i\,ER\,M_i$
$- \Sigma_i te_i PWE_i\,ER\,E_i + \Sigma_i td_i$
$\qquad X_i^S PD_i + \overline{FER}$

(17) $TINV = \overline{S}_L R_L + \overline{S}_K R_K + \overline{S}_G R_G$

(18) $Y_i = \theta_i\,TINV$

(19) $Z_i = \Sigma_j b_{ij} Y_j$

t_k	tax rate on labour income, category k,
R_L	after-tax labour income,
rk_i	tax rate on non-wage income in sector i,
R_K	after-tax capital income,
R_G	government revenue net of export subsidies,
$\overline{S}_L, \overline{S}_K, \overline{S}_G$	exogenous savings rates,
$TINV$	total investment,
Y_i	investment by sector of destination,
θ_i	sectoral investment allocation shares,
b_{ij}	capital composition coefficents,
Z_i	investment by sector of origin.

V. *Product Markets*

(20) $C_i = C_{iL} + C_{iK} + C_{iG}$

(21) $C_{ij} = \bar{q}_{ij}\,(1 - \overline{S}_j)R_j/P_i$ $j = L, K, G$

(22) $V_i = \Sigma_j a_{ij} X_j^S$

(23) $D_i = d_i\,(Z_i + C_i + V_i)$

(24) $d_i = 1/f_i\,(M_i/D_i,\,1)$

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

(26) $X_i^D - X_i^S = 0$

C_{ij}	consumption, sector i, demander j,
C_i	consumption demand, sector i,
$\bar{q}_{ij}$	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.

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]

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'.[2]

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 labour, 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.[3]

Equations (6) to (10) describe the labour market. The production technology is two-level CES in labour and capital, with intermediate goods required by fixed input–output coefficients (equation (22)). The labour markets always

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[1] 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.

[2] The magnitude of the export demand elasticity depends not only on the country's market share, but also on the degree of product differentiation characterising 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.

[3] For a survey of different approaches to solving CGE models and a description of our approach, see Dervis et al. (1981).

clear, with no open unemployment.[1] 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 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 normalisation 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 inter-mediate goods.

In the flexible exchange rate model, the real variables depend only on relative prices and hence the choice of price normalisation 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 ex-change 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.[2]

II. 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 ($\bar{F}$ 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

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[1] Other specifications of the labour markets (e.g. rigid wages and open unemployment) are certainly feasible and have been used in other CGE models.

[2] 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 behaviour 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 liberalisation, 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'.

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 m.. :-hing excess supply of domestic goods creating upward pressure on the exchange rate, ER.[1] Given the fixed overall price level, this exerts downward pressure on domestic prices as a whole. However, as will be shown in Section IV, 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 1970s, 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 $\Sigma \overline{PW}_i M_i^*$ where M_i^* is obtained from equation (12).[2] 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 balance in dollars must remain fixed across experiments. Realised 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 expenditure of foreign exchange.

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

$$RM = TFEX / \Sigma \overline{PW}_i M_i^*.$$

A simple rationing rule is to allocate foreign exchange to the various sectors in proportion to desired imports M_i^*. Actual realised imports are then obtained by multiplying desired imports in each sector by the overall excess demand

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[1] Note that it is an upward pressure because the exchange rate is expressed in £'s per dollar.
[2] Using an asterisk to denote a desired quantity.

parameter, RM. The particular quantity adjustment mechanism outlined above is clearly a stylised and simplified story.[1] We call it 'fixprice' rationing to underline the fact that the user price of foreign exchange remains fixed in spite of an overall shortage.[2] It is appropriate for countries where imports of producer goods are tied to user-specific quotas and licences, 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 that emerges in this parallel market and ER is the official exchange rate, the user cost of imports will now be:

$$PM_i = \underbrace{PW_i \quad ER}_{\substack{\text{The price of} \\ \text{imports in} \\ \text{domestic} \\ \text{currency}}} + \underbrace{PW_i ER \quad tm_i}_{\substack{\text{The value of the} \\ \text{tariff}}} + \underbrace{PW_i ER \quad PR}_{\substack{\text{The value of the} \\ \text{premium due to} \\ \text{rationing}}}$$

Viewed in this way, the premium acts as a variable, but sectorally uniform, import surcharge. Under rationing with premium, producers adjust by cost minimising 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.[3] Desired imports are again equal to actual imports because the price

[1] Note that being forced off their demand curve for imports, each demander should solve a new quantity-constrained maximisation 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.

[2] Note that domestic prices and wages are not fixed, in contrast with other recent rationing models. See Malinvaud (1977) and Muellbauer and Portes (1978).

[3] 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.

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.[1] 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.

III. MACROECONOMIC EFFECTS OF ALTERNATIVE ADJUSTMENT MECHANISMS

This and the following section present a quantitative analysis of the three adjustment mechanisms described ·above.[2] 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% of GDP.

To analyse 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 of adjustment policies. The low elasticity case is closer to the fixed 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.[3]

Table 2 presents the macroeconomic results. Consider first the flexible exchange rate case. There is a 21·5 % devaluation when we assume low trade elasticities and a much smaller 8·7 % devaluation with high trade elasticities, which highlights the role of trade elasticities in determining the required

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[1] For a full description of exchange control regimes, see Bhagwati (1978).

[2] The empirical model used here is based on Dervis and Robinson (1978). The data base and parameter estimation are described in that paper.

[3] 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.

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.

Table 2

Macroeconomic Impact of Alternative Adjustment Mechanisms

(% Changes from Base Run)

	Devaluation		Premium Rationing		Fixprice Rationing	
	Low (E-1)	High (E-4)	Low (E-·)	High (E-5)	Low (E-3)	High (E-6)
Exchange rate	21·5	8·7	—	—	—	—
User price of imports*	21·5	8·7	71·6	32·0	—	—
Dollar price of exports†	−17·1	−6·6	−2·7	−1·2	−0·7	−0·4
Imports (volume and dollar value)	−9·3	−8·2	−19·6	−20·4	−21·5	−22·4
Exports (volume)	44·6	37·0	5·6	4·8	0·7	0·9
Exports (value)	21·5	27·1	2·7	3·8	0·2	1·0
Non-agricultural wage	−1·1	−0·5	−9·7	−5·0	−2·3	−1·2
GDP	−0·4	−0·3	−1·3	−1·0	−2·4	−1·3

* Weighted average using import share weights.
† Weighted average using export share weights.

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% 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 appreciated. This result also emphasises 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% for devaluation with high elasticities and 17·1% 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% 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 minimising 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 cost of exports and import substitutes while fixprice rationing goes further by interfering with the equalisation 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.

IV. 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

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[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.

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_i, 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_i, 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_i, in turn, leads to a fall in demand.[1] 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 categorisation of sectors according to their role in foreign trade.[2]

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 characterised 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

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[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.

[2] 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 3

Structure of the Economy in the Base Run

	Sectoral shares in total output	Ratio of imports to domestic goods	Ratio of imported to total intermediate inputs	Ratio of exports to total output	Trade substitution elasticities (High)	Export demand elasticities (High)
	(1)	(2)	(3)	(4)	(5)	(6)
Agriculture	21·5 %	1·6 %	8·4 %	1·6 %	6·0	4·0
Consumer goods	17·2	1·5	3·8	10·9	2·0	4·0
Intermediate goods	14·4	26·5	19·5	3·8	1·5	6·0
Capital goods	5·5	56·7	29·6	0·8	0·75	6·0
Construction	6·1	—	15·3	—	—	—
Infrastructure and services	35·3	1·6	8·4	5·0	0·5	4·0

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. 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.[1] 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.

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 % of

[1] See Dervis *et al.* (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-industrialised countries to include a distinction between sectors that do and do not compete with foreign products.

desired imports and so producers and consumers are forced into using domestic goods. A useful way to visualise 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 summarises the results on resource allocation of the alternative adjustment mechanisms.[1] 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 devaluation (*DEV*) which, from Table 2, raises the user price of imports by 8·7% and lowers the average dollar price of exports by 6·6%. 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.[2] 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% while the average dollar price of exports only falls by 1·2%. 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 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 (shown in Table 2). Thus capital goods output does not fall despite a fall in its net price of 5·4%. Because their output price has fallen, sectors such as

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[1] Only the high-elasticity results are reported in Table 4 since nothing fundamentally different is involved with low-elasticities.

[2] 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

(% Changes from Base Solution, High Elasticity Experiments)

Experiment	Net prices			Output			Imports			Exports		
	(DEV)	(PREM)	(FIX)	(DEV)	(PREM)	(FIX)	(DEV)	(PREM)	(FIX)	(DEV)	(PREM)	(FIX)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Agriculture	−0·6	−1·9	−3·5	0·0	0·0	0·0	−40·3	−81·0	−45·4	40·4	4·6	11·3
Consumer goods	0·4	−5·0	−2·1	1·5	−0·2	−1·1	−18·2	−45·7	−38·9	36·0	6·3	5·7
Intermediate goods	2·8	1·9	12·2	0·4	1·0	3·8	−6·6	−18·1	−18·5	29·7	−28·4	−33·7
Capital goods	−2·0	−5·4	21·2	−0·8	0·3	10·1	−6·5	−15·3	−20·8	52·7	−15·7	−59·7
Construction	−1·8	−6·5	−3·4	−1·8	−1·8	−3·3	0·0	0·0	0·0	0·0	0·0	0·0
Infrastructure and services	−0·7	−5·6	−2·5	0·0	0·1	−0·8	−5·8	−16·6	−37·0	39·8	15·9	7·1

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.[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 % 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.

V. 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

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[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.

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.

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Date of receipt of final typescript: January 1981

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