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Stabilization Policies in Developing Countries with a Parallel Market for Foreign Exchange: A Formal Framework

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Abstract

The paper develops and tests a model of a developing economy that incorporates trade and capital restrictions, illegal transactions, a parallel foreign exchange market, currency substitution features, and forward-looking rational expectations. Temporary expansionary demand policies are associated with an increase in output and prices, a fall in the stock of net foreign assets, and a depreciation of the parallel exchange rate. The speed of adjustment is inversely related to the degree of rationing in the official foreign currency market. A once-for-all devaluation of the official exchange rate has no long-term effect on the premium.

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Summary

In this paper a short-term monetary model for a small, open developing economy with a sizable parallel market for foreign exchange is formulated and estimated, using a sample consisting of annual time series observations on a cross section of eight countries. The model incorporates illegal trade transactions, foreign exchange rationing, currency substitution features, and forward-looking rational expectations.

Various simulation exercises are conducted to quantify the impact of alternative policies on major macroeconomic variables. Anticipated expansionary credit and fiscal policies have a positive impact on real output and prices, a negative effect on net foreign assets, and are associated with a depreciation of the parallel exchange rate. The analysis shows that the adjustment process following a temporary shock is inversely related to the degree of rationing in the official market for foreign exchange. The higher the degree of rationing is, the lower will be the offsetting effect on the money supply coming through the balance of payments, and the higher the rate of depreciation of the parallel exchange rate generated by an expansionary policy. A once-for-all devaluation of the official exchange rate is associated in the short run with an output contraction, a rise in the inflation rate, a fall in net foreign assets, and a depreciation of the parallel rate. In the long run, the official devaluation results in a permanently higher price level and a more depreciated parallel exchange rate, but has no effect on the premium, as predicted by the perfect foresight, currency substitution models of Lizondo (1987) and Kharas and Pinto (1989).

I. Introduction

Widespread trade restrictions and foreign exchange controls have resulted in inefficient patterns of resource use and led to the emergence of parallel markets in goods and foreign currency in many developing countries. The evidence collected over the past few years has shown that current account restrictions (import licenses, foreign exchange allocations, import deposit requirements, etc.) create incentives for illegal transactions, such as smuggling and fake invoicing, as well as capital flight and capital inflows via unofficial channels.

Although official data on the volume of transactions in parallel currency markets 1/ are usually not available on a systematic basis, formal and informal evidence suggests that the major sources of foreign exchange supply are smuggling, overinvoicing of imports and underinvoicing of exports, workers' remittances from abroad (as in Turkey, for example), and tourism (as in Argentina and Brazil). The relative importance of various sources in total supply is, however, generally unknown. 2/ Similarly, no direct information on the composition of foreign exchange demand in parallel currency markets is in general available. The existence of rationing in the official foreign exchange market in many developing countries suggests, however, that in most countries the illegal demand for foreign currency arises for both current and capital account transactions. Unsatisfied demand at the official rate spills into the parallel

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1/ By definition, a currency parallel market is one in which foreign exchange transactions are conducted outside official channels (including officially recognized financial institutions and authorized foreign exchange dealers). Such a market is often illegal, albeit officially tolerated in many countries.

2/ Researchers have usually had to resort to "indirect" techniques to measure the importance of parallel market transactions. For example, the extent to which traders engage in fake invoicing can, in principle, be measured by partner country trade-data comparison techniques. To investigate the scale of underinvoicing or overinvoicing of exports, for instance, one would need to look at the ratio of exports to major partner countries, as shown by domestic data, to the corresponding imports as recorded in partner country data. When this ratio is less than unity, the evidence points to capital flight. To be able to make these partner-country comparisons, however, it is important to adjust the trade data for transport costs, timing of transactions, and classification of transactions. See Gupta (1984) and McDonald (1985) for recent attempts to use these procedures.

market. 1/

The parallel market rate usually includes a scarcity premium that reflects the underlying excess demand pressures that the restrictions are intended to contain. Parallel exchange rates, being market-determined, have tended to show large fluctuations, reflecting short-run changes in the underlying supply and demand curves. Table 1 presents estimates of the degree of variability of official and parallel exchange rates in a group of ten developing countries, over the period 1974-86. The Table shows that parallel market rates have in general exhibited a substantially higher degree of volatility than official rates. This is partly due to the important role of non-economic factors (political risk, domestic crises, international tensions) in the short-run behavior of parallel exchange rates, as well as to the fundamentally forward-looking nature of expectations on illegal currency markets.

The purpose of this paper is to examine the implications of the existence of illegal trade transactions and parallel currency markets for short-run policy making in developing countries, using a macroeconomic model that incorporates currency substitution features and forward-looking rational expectations. Most macroeconomic models for developing countries so far have used backward-looking expectational schemes. 2/ Developments in macroeconomic theory since the early 1970s have, however, repeatedly stressed the role of forward-looking expectations in the conduct of stabilization policy. 3/ To the extent that expectations of future outcomes are altered when a stabilization package is adopted, its effects would not depend solely on the magnitude of the announced policy changes and the

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1/ However, Pitt (1984) has shown that foreign exchange controls and current account restrictions are not a necessary condition for the existence of a parallel currency market. If legal trade requires the sale or purchase of legal foreign exchange, the existence of a positive tariff is sufficient to induce illegal trade activities and foreign currency transactions.

2/ A notable exception is the simulation model recently developed by Montiel, Ul Haque, and Symansky (1989). The specification of their model differs however substantially from the one adopted here.

3/ See Fischer (1988) for a concise discussion, and Minford and Peel (1983) or Hoover (1988) for a broader perspective. Although the Muthian concept of rational expectations remains controversial (see for example the discussion by Akerlof and Yellen, 1987), recent developments in macroeconomics for developing countries have in general adopted it--or its deterministic equivalent, perfect foresight.

Table 1. Variability 1/ in Official and Parallel exchange rates, 1974-86

Country	Official rate	Parallel rate
Bangladesh	7.56	22.01
Greece	38.15	41.84
India	1.64	1.94
Korea	184.15	189.49
Malaysia	0.26	0.37
Morocco	1.97	1.98
Nigeria 2/	0.27	0.53
Pakistan	2.11	3.20
Singapore 3/	0.14	0.15
Tunisia	0.15	0.17
Zambia 2/	2.04	2.58

Source: Appendix I.

1/ Standard deviation of the quarter-to-quarter rate of change of the official and parallel exchange rates.

2/ October 1970 - December 1986.

3/ July 1973 - December 1986.

coefficients relating policies to ultimate objectives based on past historical experience. For example, an announced reduction in the rate of growth of the money stock could lead to an immediate fall in inflation if it caused agents to revise downward their expectations of the future rate of inflation. Conversely, if the policy change is not viewed as credible, inflation could persist much longer than the underlying estimated relationship would indicate, and the adverse effects of a stabilization policy on output and employment would be correspondingly larger.

The model developed in this paper is "monetary" in the sense that it emphasizes the role of monetary disequilibria in explaining movements in output, prices, the parallel market exchange rate, and changes in net foreign assets. However, in contrast to the "standard" monetary approach to the balance of payments, foreign reserves do not move instantaneously to adjust supply and demand, consequently creating disequilibrium in the official market for foreign exchange. Excess demand at the official exchange rate spills over to the parallel market, which therefore plays a crucial role in the determination of macroeconomic equilibrium.

An early study emphasizing the role of monetary factors in the determination of the parallel market exchange rate was done by Blejer (1978a). Blejer's assumption that foreign exchange is demanded in the parallel market only for capital transactions would seem to be too constraining for most developing countries, which employ quantitative restrictions on imports as an instrument of control. 1/ More recently, Olgun (1984) developed and estimated a short-run macroeconomic model for Turkey that explicitly considers the impact of fluctuations in parallel market exchange rates on output, prices, and portfolio decisions in the private sector. Olgun's model, however, is based on restrictive assumptions--he assumes, in particular, that the money stock is demand-determined. Moreover, his model is not sufficiently detailed to analyze the impact of fiscal and credit policies on the economy.

The remainder of the paper is organized as follows. Section 2 discusses the specification of the model. Section 3 presents econometric estimates of the behavioral equations, and section 4 analyzes the simulation results based on alternative policy scenarios. The policy shocks considered are those most often discussed in stabilization programs: changes in domestic credit, changes in government spending, and devaluation of the official exchange rate. Section 5 offers some concluding remarks and draws policy implications

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1/ Moreover, Blejer uses ordinary least squares to estimate the parallel exchange rate equation derived from his model, so that his estimates may be subject to simultaneous equation bias.

for macroeconomic management in developing countries with a large parallel currency market. Data sources and definitions are given in Appendix I, and the solution procedure of the model is presented in Appendix II.

II. A Macroeconomic Model with a Parallel Currency Market

This section describes a macroeconomic model for a small open economy with a sizable parallel market for foreign exchange. In many respects, the model can be seen as an extension of the monetary framework developed by Khan and Knight (1981), which provides an essential reference for the analysis of stabilization policies in developing countries.

Consider a small open economy producing both traded and non-traded goods. The exchange rate system consists of a dual rate regime in which an official pegged nominal exchange rate coexists with an illegal or quasi-illegal parallel market for foreign exchange. Commercial transactions are settled partly in the official market at the exchange rate e, which is set by the monetary authorities and is treated as a policy instrument. The remainder of commercial transactions and all capital transactions are settled in the parallel market at the free exchange rate b, which is determined by the interactions between supply and demand for foreign exchange.

Only two financial assets are available, domestic money and foreign money, both being non-interest-bearing assets. Desired holdings of domestic and foreign currencies depend on both transactions motives and portfolio considerations. Markets for government securities do not exist, so that public budget deficits are financed either by borrowing abroad or by the domestic banking system.

1. The inflation process

The price level, P, is defined as a geometric average of the price of nontraded goods, P^N, and the price of traded goods, P^T:

$$P_t = (P_t^T)^{\delta}(P_t^N)^{1-\delta}, \qquad 0 < \delta < 1 \tag{1}$$

with δ measuring the share of traded goods in total expenditure. Taking log-differences of equation (1) yields

$$\Delta \log P_t = \delta \Delta \log P_t^T + (1 - \delta)\Delta \log P_t^N, \tag{1'}$$

with Δ denoting the first-difference operator.

Since the economy considered is "small", the world price of traded goods, Q, is exogenously given and its rate of change in domestic currency is determined by the world rate of inflation, $\Delta \log Q_t$, and a weighted average of the rate of change of the official exchange rate, $\Delta \log e_t$, and the rate of change of the parallel rate, $\Delta \log b_t$:

$$\Delta \log P_t^T = \varphi \Delta \log e_t + (1 - \varphi) \Delta \log b_t + \Delta \log Q_t, \quad 0 \leq \varphi \leq 1 \qquad (2)$$

where φ, assumed constant in the short run, denotes the proportion of trade carried through official channels. 1/ The rationale for considering a weighted average of both exchange rates to determine the domestic price of tradable goods is that trade takes place at <u>both</u> the official exchange rate (through official channels) and the parallel market rate (through smuggling). However, in most countries where foreign exchange rationing by the banking system is prevalent, the officially fixed exchange rate is not relevant for the determination of <u>market</u> prices of traded goods. It only measures the rents captured by those (usually the government and a small group of importers) to whom foreign exchange is made available at the official rate. This suggests that the weight attached to the parallel market rate in equation (2) above should be significantly greater than the share of smuggling in total trade, and that econometric estimates of φ should be close to zero and not statistically significant. As shown below, the latter implication is indeed supported by the empirical results.

Since an excess supply of money implies an excess demand for both traded and nontraded goods, by assuming that the excess demand for nontraded goods varies with excess demand throughout the economy, one can postulate the following equation for the rate of change of the prices of nontraded goods:

$$\Delta \log P_t^N = \phi_1 \pi_{t+1/t} + \phi_2 [\log m_{t-1} - \log m_t^d], \qquad (3)$$

$$0 \leq \phi_1 \leq 1, \ \phi_2 > 0$$

where $m \equiv M/P$ denotes the real money stock (M denoting the nominal stock of money), m^d the demand for real cash balances (explained below), and $\pi_{t+1/t} \equiv \Delta \log P^a_{t+1/t}$ the expectation of the rate of inflation for period $t+1$ formed at period t. The coefficient ϕ_1

1/ In the medium and long run, φ is likely to depend on the spread between the official and parallel exchange rates, the degree of restrictions on trade and capital movements, as well as the degree of law enforcement at the borders.

measures the degree to which the prices of non tradable goods move with the expected future level of domestic inflation, and ϕ denotes the elasticity of non traded goods prices to the excess supply of real money balances. 1/ Firms adjust the price of non tradable goods with respect to the price of all goods sold and exchanged in the economy. Accordingly, expected general inflation rather than the expected percentage change in the price index for home goods appears on the right-hand side of equation (3).

Substituting equations (2) and (3) in (1') yields an expression for the rate of domestic inflation as a function of world inflation, changes in the official and parallel exchange rates, expected inflation, and the rate of ex ante disequilibrium in the money market:

$$\Delta \log P_t = \varphi\delta\Delta\log e_t + (1 - \varphi)\delta\Delta\log b_t + \delta\Delta\log Q_t + (1 - \delta)\phi_1\pi_{t+1/t} + (1 - \delta)\phi_2[\log m_{t-1} - \log m_t^d]. \qquad (4)$$

If all goods are traded, i.e. $\delta = 1$, then the last two terms in equation (4) vanish, so that the domestic rate of inflation is pegged to the world rate at a composite exchange rate. Also, in the long run, the money market is in equilibrium and expected and actual rates of price increase are equal, so that domestic prices grow at the same rate as the rate of change in prices of traded goods (expressed in domestic currency, at a composite exchange rate) only if $\delta/[1 - (1 - \delta)\phi_1] = 1$, i.e. only if $\phi_1 = 1$.

2. The parallel market for foreign exchange

The parallel market exchange rate is determined by the interactions between the supply of and the demand for foreign currency in that market. The flow supply of foreign currency in the parallel market results from the overinvoicing of imports and underinvoicing of exports, the degree of which is assumed to depend on the level of the spread between the official and parallel exchange rates. Formally, the

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1/ Monetary disequilibrium in equation (3) is measured in terms of the deviation of the beginning-of-period actual stock of real balances from demand, a quantity that can be viewed as the "flow" supply of real balances. This concept ignores however the role that domestic credit expansion during the period plays in closing the real balance gap. An alternative measure which incorporates this last element is discussed by Blejer (1977) and Sundararajan (1986).

flow supply function can be written as: 1/

$$\Delta \log C_t^s = c_0 + c_1 \log(b_t/e_t). \qquad c_1 > 0 \qquad (5)$$

The demand for foreign currency in the parallel market has two components: a flow component and a portfolio component. The first component, the demand for foreign currency as a medium of exchange for current account transactions, arises because the monetary authorities cannot satisfy total demand (for legal and illegal transactions) at the official exchange rate. Such demand, denoted $\Delta \log C_{ft}^d$, is positively correlated with overall economic activity (measured by the level of real income) and the deviation of domestic prices from foreign prices (valued at the parallel exchange rate), as well as negatively related with the level of the premium:

$$\Delta \log C_{ft}^d = h_0 + h_1 \log y_t + h_2 \log(P_t/b_t Q_t) - h_3 \log((b_t/e_t), \qquad (6)$$

where $h_i > 0$, $i = 1, 2, 3$.

The stock or portfolio component of foreign currency demand in the parallel market is, as stressed in the currency substitution literature (see Calvo and Rodriguez, 1977, and Ramirez-Rojás, 1985), positively related to the return derived by holding this asset and negatively related to the return derived from holding alternative assets. The return from holding foreign currency as an asset is a function of the difference between the expected rate of depreciation of the domestic currency in the parallel market, $\Delta \log b_{t/t-1}^a$, and the expected world inflation rate, $\Delta \log Q_{t/t-1}^a$, expectations being formed at period $t-1$ for period t. The expected real rate of return on domestic money--that is, the opportunity cost of holding foreign currency--is equal to minus the expected domestic inflation rate, $\pi_{t/t-1}$, expectations being also formed at $t-1$ for period t. The stock demand for foreign currency in the parallel market, denoted by $\log C_{st}^d$, can therefore be written in log-linear form as

$$\log C_{st}^d = \eta_0 + \eta_1 \log y_t + \eta_2 \rho_{t/t-1} + \eta_3 \pi_{t/t-1}, \qquad (6')$$

1/ The supply function (5) should in principle include a risk factor, given the illegal nature of parallel market activities. The exclusion of a risk coefficient can be rationalized by the assumption either that parallel market operations, although illegal, are tolerated by the authorities, or that the probability of being caught, although non-negligible, is small.

where $\rho_{t/t-1} \equiv \Delta \log b^{a}_{t/t-1} - \Delta \log Q^{a}_{t/t-1}$ and $\eta_i > 0$, $i = 1,..4$.

On the basis of (5), (6), and first differences of (6'), the flow equilibrium condition between supply and demand for foreign currency can be solved for the parallel market rate: 1/

$$\log b_t = \gamma_0 + \gamma_1 \log e_t + \gamma_2 \log y_t + \gamma_3 \log(P_t/Q_t) \qquad (7)$$

$$+ \gamma_4 \Delta \log y_t + \gamma_5 \Delta \rho_{t/t-1} + \gamma_6 \Delta \pi_{t/t-1},$$

where

$$\gamma_0 = c_0/(c_1 + h_2 + h_3),$$

$$\gamma_1 = (c_1 + h_3)/(c_1 + h_2 + h_3) \leq 1,$$

$$\gamma_2 = h_1/(c_1 + h_2 + h_3) > 0,$$

$$\gamma_3 = h_2/(c_1 + h_2 + h_3) > 0,$$

$$\gamma_k = \eta_{k-3}/(c_1 + h_2 + h_3) > 0, \qquad k = 4, \ldots 6.$$

Equation (7) indicates that the parallel market rate is positively related to the official exchange rate, real output, relative prices, and changes in the expected rates of return on foreign and domestic currencies. The coefficient of the official exchange rate variable will be higher, the higher the elasticity of supply of foreign exchange in the parallel market and the lower the elasticity of demand for foreign currency in that market. For given prices and expectations, a devaluation of the official rate reduces on impact the exchange rate differential and therefore the incentive to underinvoice exports, and overinvoice imports. The fall in (flow) supply pushes

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1/ The equilibrium condition in the parallel exchange market is expressed in terms of flows rather than stocks for estimation purposes, since reliable data on stocks of foreign currency held illegaly by domestic agents in developing countries do not exist. The asymmetric treatment between stocks and flows implies that in the sense of Foley (1975) and Buiter (1980), the model is neither a pure stock (beginning-of-period) model nor a pure flow (end-of-period) model. But insofar as continuous money stock equilibrium does not obtain and changes in the money supply in real terms reflect disequilibria elsewhere in the system, it is a flow model.

the parallel rate up and this in turn reduces demand, offsetting the initial effect on the free exchange rate. When $h_2 > 0$, the parallel rate depreciates by less than the official rate ($\gamma_1 \leq 1$) so that the exchange rate differential falls. When $h_2 = 0$, the parallel rate depreciates in the same proportion as the official exchange rate, and the spread remains constant. A statistical estimate of γ_1 close to one should therefore be associated with an estimate of γ_3 close to zero.

Finally, a higher level of economic activity, a rise in the level of domestic prices relative to foreign prices, or an increase in the rate of change of the expected rate of return on foreign currency holdings, will increase the unofficial demand for foreign currency and this will entail a depreciation of the parallel market exchange rate.

3. The money market and official reserves

Actual holdings of real money balances $m = M/P$ are assumed to adjust with a lag to the difference between (the logarithm of) desired holdings, m^d, in the current period and (the logarithm of) actual holdings at the end of the previous period. This partial adjustment mechanism can be described as

$$\Delta \log m_t = \nu[\log m_t^d - \log m_{t-1}], \qquad 0 < \nu < 1 \tag{8}$$

where ν denotes the speed of adjustment.

The demand for real balances is specified as a function of real output, the expected rate of inflation, and the difference between the expected rate of depreciation of the domestic currency in the parallel market and expected world inflation, expectations being formed for period t conditional on information available at $t-1$:

$$\log m_t^d = \alpha_0 + \alpha_1 \log y_t - \alpha_2 \pi_{t/t-1} - \alpha_3 \rho_{t/t-1}. \tag{9}$$

The expected inflation rate measures the opportunity cost of money holdings in terms of domestic real assets. As discussed above, foreign exchange is bought and sold in the unofficial market in part because the public desires to alter the composition of its money holdings. This implies that the expected rate of depreciation of the domestic currency in the parallel market, net of foreign inflation, influences the demand for money. The coefficient of the variable $\rho_{t/t-1}$ is expected to be negative. When expectations of a depreciation of the parallel exchange rate increase, for example, the expected return from holding foreign currency increases and agents

tend to substitute foreign money for domestic cash balances as the opportunity cost of holding domestic money rises. This leads to a reduction in the demand for domestic currency in real terms. 1/

From the money supply identity, changes in the stock of money--broadly defined to include currency in circulation, demand deposits, and savings and time deposits--are equal to the sum of changes in net foreign assets of the consolidated banking system, R, and changes in net domestic assets, L:

$$\Delta M_t = \Delta R_t + \Delta L_t. \tag{10}$$

This relationship can be log-linearized about the sample means and expressed in terms of the rate of change of variables in real terms as

$$\Delta \log m_t = k_1 + k_2 \Delta \log(R/P)_t + k_3 \Delta \log(L/P)_t, \tag{11}$$

where $k_2 = (\bar{R}/\bar{M})$ and $k_3 = (\bar{L}/\bar{M})$ are, respectively, ratios of the sample means of net foreign assets and net domestic assets to the money supply, lagged by one period.

Substituting equation (8) in (11) and rearranging terms yields an equation that expresses the "required" rate of change of net foreign assets in real terms as a function of monetary imbalances and the rate of change of the real stock of domestic assets:

$$\Delta \log(R/P)^r_t = k_1/k_2 + v/k_2[\log m^d_t - \log m_{t-1}] - k_3/k_2 \Delta \log(L/P)_t. \tag{12}$$

For a given rate of growth of domestic credit in real terms, equation (12) indicates that in a fixed exchange rate economy, changes in the stock of net foreign assets should occur as long as there is an ex ante disequilibrium between supply and demand in the money market, as emphasized in the monetary approach to the balance of payments (see Frenkel and Mussa, 1985, and Wilford, 1986). However, if foreign exchange controls are in place, equation (12) cannot be used to explain actual changes in foreign reserves. To do so, the mechanism by which exchange restrictions are enforced must first be specified. A sensible approach is to modify the model of import restrictions developed by Hemphill (1974), and used subsequently by Lipschitz (1984)

1/ In an end-of-period formulation of the model, portfolio considerations would imply adding-up restrictions on the parameters of equations (6) and (9).

and Sundararajan (1986). 1/ The authorities are assumed to choose the rate at which the banking system can allocate changes in the real stock of foreign exchange, $\Delta\log(R/P)^p$, so as to minimize the cost of deviations from the "required" rate of change, $\Delta\log(R/P)^r$, as well as the cost of deviations from a "targeted" rate of change of net reserves, $\Delta\log(R/P)^*$. A compromise between these potentially conflictive objectives is reached through a linear allocation scheme:

$$\Delta\log(R/P)^p_t = (1 - \omega)\Delta\log(R/P)^r_t + \omega\Delta\log(R/P)^*_t, \qquad (13)$$

where $0 \leq \omega \leq 1$. In the standard monetary model, reserves adjust fully to equilibrate current supply and demand in the official exchange market, so that $\omega = 0$. If, on the contrary, it is assumed that the authorities are only concerned about their reserve growth target, then $\omega = 1$. More generally, the above equation indicates that the higher the targeted value of the rate of change of net reserves is, the higher the allowed increase in reserves by the banking system. Similarly, a rise in the required rate of change of international reserves for balance of payments equilibrium translates into an increase proportional to $1 - \omega$ in the rate of change of net foreign assets held by the banking system. Therefore, in the general case where $0 < \omega < 1$, the assumed behavior of the authorities creates an ex ante disequilibrium in the official foreign exchange market. The coefficient ω can be conveniently regarded as an implicit measure of the degree of rationing, and will be referred to below as the trade-off parameter.

In the context of an annual model, changes in the actual rate of growth of international reserves can be assumed to adjust rapidly (within a year) to changes in the rate of growth of allocated external assets, so that $\Delta\log(R/P) = \Delta\log(R/P)^p$. The targeted rate of growth of net external reserves in real terms is assumed to depend linearly on the level of net foreign assets at t-1:

$$\Delta\log(R/P)^*_t = k_0 - \lambda\log(R/P)_{t-1}. \qquad \lambda > 0 \qquad (13')$$

Equation (13') indicates that the higher the real level of reserves at t-1 is, the lower the desired rate of increase for period t. Substituting (12) and (13') into (13) yields,

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1/ The approach outlined by these authors to model an import licensing scheme cannot be strictly applied in the framework used here, because it is based on an exportable/importable distinction rather than on a tradable/non tradable dichotomy. Nevertheless, the procedures are conceptually similar.

$$\Delta\log(R/P)_t = [(1-\omega)k_1/k_2 - \omega k_0] + (1-\omega)\nu/k_2[\log m_t^d - \log m_{t-1}]$$
$$- (1-\omega)k_3/k_2\Delta\log(L/P)_t - \omega\lambda\log(R/P)_{t-1}. \quad (14)$$

Since k_2 and k_3 are determined from the sample, and since the coefficient ν can be estimated separately (see below), a simple test of the foreign exchange rationing scheme outlined above can be implemented by recovering the parameter ω from the regression coefficients in equation (14). The higher this estimate is, the higher the emphasis the authorities put on their reserve target. Conversely, the lower this estimate is, the lower the degree of rationing, or the higher the degree of adjustment between current supply and demand in the official market for foreign exchange.

4. Real output

The growth rate of real output is assumed to depend on the deviation of actual output from normal capacity level (treated as exogenous), on the excess stock of real money balances, and on the budget deficit:

$$\Delta\log y_t = \delta_1 - \delta_2\log(y_{t-1}/\bar{y}_{t-1}) + \delta_3[\log m_{t-1} - \log m_t^d] + \delta_4\log(G_t/T_t) \quad (15)$$

with G denoting nominal government expenditure and T, nominal fiscal revenues. The first term on the right-hand side of equation (15) --the so-called output gap--represents the extent to which producers adjust output to changes in their desired supply. This term implies that when actual output is low relative to normal production capacity, $\bar{y}$, its growth rate tends to rise. The second term captures the spill over effects of monetary disequilibrium on output. An excess supply of money induces output effects in the short run as agents, in their attempt to adjust money balances to equilibrium level, change their spending and their holdings of financial assets. 1/ The third term reflects the effects of fiscal policy on activity. Budget deficits are assumed to have a positive effect on output behavior. 2/ In the long run, output is equal to its capacity level, the money market is in equilibrium and government spending equals fiscal revenues so that the steady state growth rate of output is equal to δ_1.

1/ Clements and Johnson (1979) have shown that under certain circumstances the use of the excess cash balances term in (15) is equivalent to using unanticipated changes in the money stock.

2/ More precisely, real output is assumed to depend on the difference between the actual and desired levels of government expenditure, the latter being a function of tax revenues.

5. Government sector

Nominal government expenditure, G, is assumed exogenous. Nominal government revenues, T, are specified as a log-linear function of nominal income:

$$\log T_t = \beta_0 + \beta_1[\log y_t + \log P_t]. \qquad \beta_1 > 0 \tag{16}$$

Finally, since money is the only domestic financial asset, the government budget deficit cannot be financed by the public. Rather, it is financed by external borrowing and by domestic borrowing from the central bank. The change in net domestic assets of the banking system is therefore equal to changes in the stock of credit to the private sector, ΔL^p--assumed exogenous--plus changes in net credit to the government, which are determined by the budget deficit net of foreign financing (consisting of loans and grants), ΔF^g:

$$\Delta L_t = \Delta L_t^p + (G_t - T_t + \Delta F_t^g). \tag{17}$$

The complete structural model is shown in summary form in Table 2; the variables are defined in Table 3.

III. Estimation Results

Estimation of a macroeconomic model such as the one described above for developing countries raises several difficult statistical problems, mostly stemming from inadequacies in, and the lack of comparability of, the data. Consistent series for long periods on aggregate data are available for only a few economies. A sensible way to proceed is therefore to consider pooled cross-sectional and time-series data for a selected group of countries. Specifically, a sample consisting of annual data covering the period 1974-86 for eight developing countries is used (see Appendix I for more details), and a fixed-effect estimation procedure is applied to the pooled sample. 1/

Before estimation results are discussed, however, two issues must be examined: the treatment of expectations and the cross-equation restrictions imposed by the money demand function. Consider first the procedure used to estimate the (unobservable) expectational variables of the model (current and one-period-ahead domestic rate of inflation, current real rate of return on the foreign currency). Expectations

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1/ For a detailed discussion of the fixed-procedure approach to estimation of pooled time series-cross sections, see Kmenta (1986, pp. 616-635).

Table 2. Equations of the Model

Money demand

$$\log m_t^d = \alpha_0 + \alpha_1 \log y_t - \alpha_2 \pi_{t/t-1} - \alpha_3 \rho_{t/t-1}.$$

Real output

$$\Delta \log y_t = \delta_1 - \delta_2 \log(y_{t-1}/\bar{y}_{t-1}) + \delta_3[\log m_{t-1} - \log m_t^d] + \delta_4 \Delta \log(G_t/T_t).$$

Inflation rate

$$\Delta \log P_t = \varphi\delta\Delta \log e_t + (1 - \varphi)\delta\Delta \log b_t + \delta\Delta \log Q_t + (1 - \delta)\phi_1 \pi_{t+1/t} + (1 - \delta)\phi_2[\log m_{t-1} - \log m_t^d].$$

Net foreign assets

$$\Delta \log(R/P)_t = [(1-\omega)k_1/k_2 - \omega k_0] + (1-\omega)\nu/k_2[\log m_t^d - \log m_{t-1}] - (1-\omega)k_3/k_2 \Delta \log(L/P)_t - \omega\lambda \log(R/P)_{t-1}.$$

Parallel market exchange rate

$$\log b_t = \gamma_0 + \gamma_1 \log e_t + \gamma_2 \log y_t + \gamma_3 \log(P_t/Q_t) + \gamma_4 \Delta \log y_t + \gamma_5 \Delta \rho_{t/t-1} + \gamma_6 \Delta \pi_{t/t-1}.$$

Government revenues

$$\log T_t = \beta_0 + \beta_1[\log y_t + \log P_t].$$

Money supply

$$M_t = L_t + R_t.$$

Domestic credit

$$L_t = L_{t-1} + \Delta L_t^p + G_t - T_t - \Delta F_t^g.$$

Real money balances

$$m_t \equiv M_t/P_t.$$

Table 3. Definition of Variables

Δ	First-difference operator
b	Parallel market exchange rate
$\Delta \log b^{a}_{t/t-1}$	Expected rate of depreciation of the parallel market exchange rate, formed at period $t-1$ for period t
e	Official exchange rate (exogenous)
ΔF^{g}	Foreign financing (including loans and grants) of the budget deficit (exogenous)
G	Nominal government expenditure (exogenous)
L	Domestic credit of the consolidated banking system
L^{p}	Domestic credit to the private sector (exogenous)
M	Nominal money stock
$m \equiv M/P$	Real money balances
P	Domestic cost of living index
P_{N}	Price index of non tradable goods
P_{T}	Domestic price of tradable goods
$\pi_{t/t-1}$	Expected rate of inflation, formed at period $t-1$ for period t ; $\pi_{t/t-1} \equiv \Delta \log P^{a}_{t/t-1}$
$\pi_{t+1/t}$	Expected rate of inflation, formed at period t for period $t+1$; $\pi_{t+1/t} \equiv \Delta \log P^{a}_{t+1/t}$
Q	World price of tradable goods (exogenous)
$\Delta \log Q^{a}_{t/t-1}$	Expected rate of world inflation, formed at period $t-1$ for period t
R	Net foreign assets, consolidated banking system
$\rho_{t/t-1}$	Expected rate of return on the foreign currency, formed at $t-1$ for t; $\rho_{t/t-1} \equiv \Delta \log b^{a}_{t/t-1} - \Delta \log Q^{a}_{t/t-1}$
T	Fiscal revenues
y	Real domestic output
$\bar{y}$	Capacity level of real domestic output (exogenous)

are assumed "rational" or--more appropriately and perhaps less controversially--"consistent" with the underlying model. To implement this assumption empirically, one approach consists in estimating unrestricted reduced-form equations for the relevant expectational variables, and using the predicted values as proxies for expectations. 1/ Here, however, since the model does not incorporate "surprise" terms, the alternative errors-in-variables procedure proposed by McCallum (1976) and generalized by Wickens (1982) can be used. By the assumption of rational expectations, expected values are equal to actual values plus a stochastic error term. Substituting for expectational variables in a regression equation implies therefore that the composite disturbance term is correlated (even asymptotically) with a regressor, so that ordinary least squares are inconsistent. Consistent estimates are obtained by an appropriate instrumental variable method. 2/ For the model described above, estimation was performed according to an instrumental variable method on a fixed-effect procedure, with country-specific dummy variables and time trends included in each behavioral equation. Instruments used are the constant term, country-specific time trends, an index of industrial output in industrialized countries, and all exogenous variables, as well as one lagged value of all endogenous variables.

The second econometric issue relates to the fact that the same demand for money function appears in the output, price, and net foreign assets equations. To ensure that cross-equation restrictions on the parameters of the money demand equation are satisfied, a two-step procedure is used here. Substituting (9) in (8) yields the following estimating equation:

$$\log m_t = \alpha_0 \nu + \alpha_1 \nu \log y_t - \alpha_2 \nu \pi_{t/t-1} - \alpha_3 \nu \rho_{t/t-1} + (1 - \nu) \log m_{t-1}. \quad (18)$$

1/ Such a procedure (known as the "substitution" method) has been widely used in econometric applications of the rational expectations hypothesis; see Barro (1979), Blejer and Fernandez (1980) or Leiderman (1984). Pagan (1984) provides a critical evaluation of its properties.

2/ The difficulty with this method is that in the price equation --where the one-period-ahead expected rate of inflation appears--, replacing expectations by actuals implies that the disturbance term will follow a moving average process of order one. Ignoring this property of the error process--as is done here--may result in biased standard errors and invalid inference, although parameter estimates will still be consistent. This should be kept in mind when the results are evaluated. For a further discussion of this procedure and its limitations, see Wickens (1986) and Pesaran (1988, pp. 190-95).

The variable $\log m_t^d$ is then replaced by $(1/\hat{\nu})[\log m_t^c - (1 - \hat{\nu})\log m_{t-1}]$ in the other equations of the system, where $\log m_t^c$ denotes the predicted value of $\log m_t$ obtained from the estimating equation (18), and $\hat{\nu}$, the estimate of the speed of adjustment from the same equation. Because of the endogeneity of real output, equation (18) must also be estimated by an instrumental variables procedure to ensure consistency of the estimates.

Given the estimated value of ν and the sample estimates of k_2 and k_3, the net foreign assets equation can be estimated subject to the constraint that the sum of the coefficients of $\hat{\nu}/k_2(\log m_t^d - \log m_{t-1})$ and $k_3/k_2\Delta\log(L/P)_t$ is equal to zero. This constraint is imposed by simply using the difference between these two expressions as a regressor. The estimated coefficient is therefore equal to $1 - \omega$, from which an estimate of the trade-off parameter can be derived.

Table 4 presents parameter estimates for the behavioral equations of the model. 1/ Coefficients in brackets are t-ratios. $\bar{R}^2$ denotes the coefficient of determination adjusted for degrees of freedom, $\hat{\sigma}$ the estimated standard error of the regression, *SSR* the sum of squared residuals, and DW the Durbin-Watson statistic. For convenience, country dummies and country-specific time trends are not reported.

Overall, the estimation results look quite satisfactory. All variables have the expected a priori sign, except the rate of change of output in the parallel rate equation. 2/ The estimate of the short-run income elasticity of money demand is not significantly different from unity whereas the long-run elasticity is roughly 1.7, a result consistent with those obtained in several econometric studies on the demand for money in developing countries. Parameters measuring currency substitution effects are both highly significant, with a fairly large difference between the own- and cross-elasticity. In the output equation, changes in real activity show a limited response to

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1/ The restriction on the coefficients of $\Delta\log e$, $\Delta\log b$ and $\Delta\log Q$ in the price equation was not imposed because preliminary testing indicated that it was strongly rejected by the data. Also, in the net foreign assets equation, the variable $\log(R/P)_{t-1}$ is replaced by $(R/P)_{t-1}$, because R is negative for some countries for a number of periods.

2/ The variable was also not significantly different from zero, and was consequently dropped from the equation.

monetary disequilibria, while the ratio of government expenditure to fiscal revenue--although positive--is barely significant at the 10 percent level. The lagged value of the output gap seems on the contrary to have a large impact on the current rate of growth of real output.

In the inflation rate equation, the rate of change in the official exchange rate is small and not significant whereas the rate of depreciation of the parallel exchange rate is well defined statistically, although relatively small. This suggests that, as noted earlier, prices of imports and their near substitutes tend to reflect the marginal cost of foreign exchange in the parallel market. Besides, the estimate of the parameter ϕ_1 is $0.527/(1 - 0.421) \cong 0.91$, implying that the estimated price equation exhibits reasonable long-run properties.

The rate of change of net foreign assets in real terms shows significant response to the variable measuring the difference between excess real balances and fluctuations in the rate of growth of the real stock of domestic credit. The coefficient of the lagged value of foreign reserves is small and barely different from zero at a 5 percent tolerance level. The estimate of the trade-off parameter, ω is given by $1 - 0.714 \cong 0.28$. This coefficient is relatively small, however, implying that the monetary authorities have apparently put more emphasis during the period considered on equilibrating supply and demand of foreign exchange than on targeting a given rate of growth of net international reserves.

The parallel exchange rate equation displays interesting properties. The coefficient of the level of real output is positive and significantly different from zero. Changes in expected rates of return on domestic and foreign currencies are also statistically significant variables, reflecting the importance of portfolio considerations in the determination of the parallel market demand for foreign exchange. The coefficient of the official exchange rate is not statistically different from unity while at the same time the coefficient of the relative prices variable is relatively small. This implies that the direct impact of a devaluation will be a proportional depreciation of the parallel exchange rate, a key feature of the simulation result discussed below. Finally, tax revenues seem highly elastic to nominal income for the group of countries considered.

The estimation results provide broad support for the specification of the model. 1/ However, it is difficult to infer from the data strong evidence in favor of a key assumption of the model,

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1/ The goodness of fit of the model as a whole is discussed in Appendix II.

Table 4. Parameter Estimates of the Model 1/
(Two-step, instrumental variable procedure)

$$\log m_t = \underset{(-5.907)}{-18.785} + \underset{(5.569)}{1.173}\ \log y_t - \underset{(-1.992)}{0.229}\ \pi_{t/t-1}$$

$$- \underset{(-1.599)}{0.073}\ \rho_{t/t-1} + \underset{(3.574)}{0.297}\ \log m_{t-1}$$

$\bar{R}^2 = 0.999$ $\quad \hat{\sigma} = 0.050$ $\quad SSR = 0.151$ $\quad DW = 1.993$

$$\Delta \log y_t = \underset{(4.823)}{0.012} - \underset{(-4.567)}{0.449}\ \log(y_{t-1}/\bar{y}_{t-1})$$

$$+ \underset{(2.596)}{0.087}\ [\log m_{t-1} - \log m_t^d] + \underset{(1.643)}{0.054}\ \log(G_t/T_t)$$

$\bar{R}^2 = 0.563$ $\quad \hat{\sigma} = 0.026$ $\quad SSR = 0.041$ $\quad DW = 2.046$

$$\Delta \log P_t = \underset{(0.276)}{0.189} + \underset{(0.181)}{0.014}\ \Delta \log e_t + \underset{(1.830)}{0.132}\ \Delta \log b_t$$

$$+ \underset{(1.726)}{0.421}\ \Delta \log Q_t + \underset{(3.397)}{0.527}\ \pi_{t+1/t} + \underset{(2.349)}{0.172}\ [\log m_{t-1} - \log m_t^d]$$

$\bar{R}^2 = 0.853$ $\quad \hat{\sigma} = 0.051$ $\quad SSR = 0.147$ $\quad DW = 1.887$

$$\Delta \log(R/P)_t = \underset{(-0.009)}{-0.003} + \underset{(1.738)}{0.714}\ [\hat{\nu}/k_2(\log m_t^d - \log m_{t-1})$$

$$- k_3/k_2 \Delta \log(L/P)_t] - \underset{(-1.837)}{0.004}\ (R/P)_{t-1}$$

$\bar{R}^2 = 0.531$ $\quad \hat{\sigma} = 0.416$ $\quad SSR = 47.9$ $\quad DW = 1.605$

$$\log b_t = \underset{(5.546)}{0.245} + \underset{(14.567)}{1.021}\ \log e_t + \underset{(5.257)}{0.026}\ \log y_t + \underset{(1.927)}{0.019}\ \log(P_t/Q_t)$$

$$+ \underset{(3.287)}{0.194}\ \Delta \rho_{t/t-1} + \underset{(2.923)}{0.258}\ \Delta \pi_{t/t-1}$$

$\bar{R}^2 = 0.995$ $\quad \hat{\sigma} = 0.092$ $\quad SSR = 1.153$ $\quad DW = 1.722$

$$\log T_t = \underset{(0.083)}{0.197} + \underset{(12.198)}{1.214}\ [\log y_t + \log P_t]$$

$\bar{R}^2 = 0.998$ $\quad \hat{\sigma} = 0.068$ $\quad SSR = 0.298$ $\quad DW = 1.873$

1/ t-ratios in parentheses. Country-specific dummies and time trends not reported.

namely, the hypothesis that monetary authorities allow foreign reserves to adjust only by a fraction of the amount necessary to equilibrate supply and demand in the official market for foreign exchange. On the contrary, the estimate of the trade-off parameter ω suggests a fairly flexible reserve policy. This in turn runs contrary to the widely held view that official foreign exchange rationing is a major factor explaining the existence of a parallel currency market. At this stage, however, it is not clear how robust this result is. In particular, the relatively low estimate of ω may be the consequence of an improper specification of the rationing scheme, or it may be a feature of the particular sample of countries considered and/or the estimation period. Nevertheless, the fact that the estimate of ω is not negligible may be taken as evidence of partial foreign exchange rationing, implying that the econometric results do not invalidate the use of the model for policy analysis. Future research will need to focus on this particular aspect of the model.

IV. Policy Experiments

We now consider the impact of various policy shocks on the economy, using the point estimates of the parameters presented in the previous section. Model solutions are derived under the assumption of rational, or consistent, expectations, implying that expectations coincide with actual model forecasts. The procedure and the computer program used are described in Appendix II. 1/ A baseline case is first obtained, and deviations of the path of the economy from it in response to changes in policy variables are analyzed. All shocks are assumed fully anticipated. 2/ In what follows, graphic results for six endogenous variables are presented: real output, the domestic price level, nominal domestic credit, real money balances, the stock

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1/ In principle, the simulations discussed here are not immune to the Lucas (1976) critique, according to which a policy change sufficiently atypical to amount to a change in "policy regime" could well induce behavioral responses by private sector agents that would shift the parameters of the model's equations. However, since the analysis in this paper focuses on policy changes that lie within the range of policy variations observed during the model's estimation period, the Lucas critique may not be especially relevant.

2/ The experiments were also carried out with unexpected shocks. The major difference with the results reported below is that real effects are higher--and price effects lower--in the short run; qualitatively, however, the results are basically identical to those discussed in the text. The analysis of fully anticipated policies also serves to illustrate the proposition that imposing rational expectations in a macroeconomic model is not sufficient to obtain the neutrality property of new classical economics.

of net foreign assets, and the parallel exchange rate.

1. Changes in domestic credit

Consider first a temporary--one period only--, fully anticipated increase of 10 percent from the base value of net credit to the private sector. Chart 1 depicts the time path of major macroeconomic variables following the credit expansion. To permit a better understanding of the transmission process of monetary shocks in this model, the case where the authorities allow net foreign assets to adjust fully to equilibrate supply and demand in the official exchange market--that is, the case where $\omega = 0$--will also be analyzed and will be referred to as the "full-reserve-adjustment" economy.

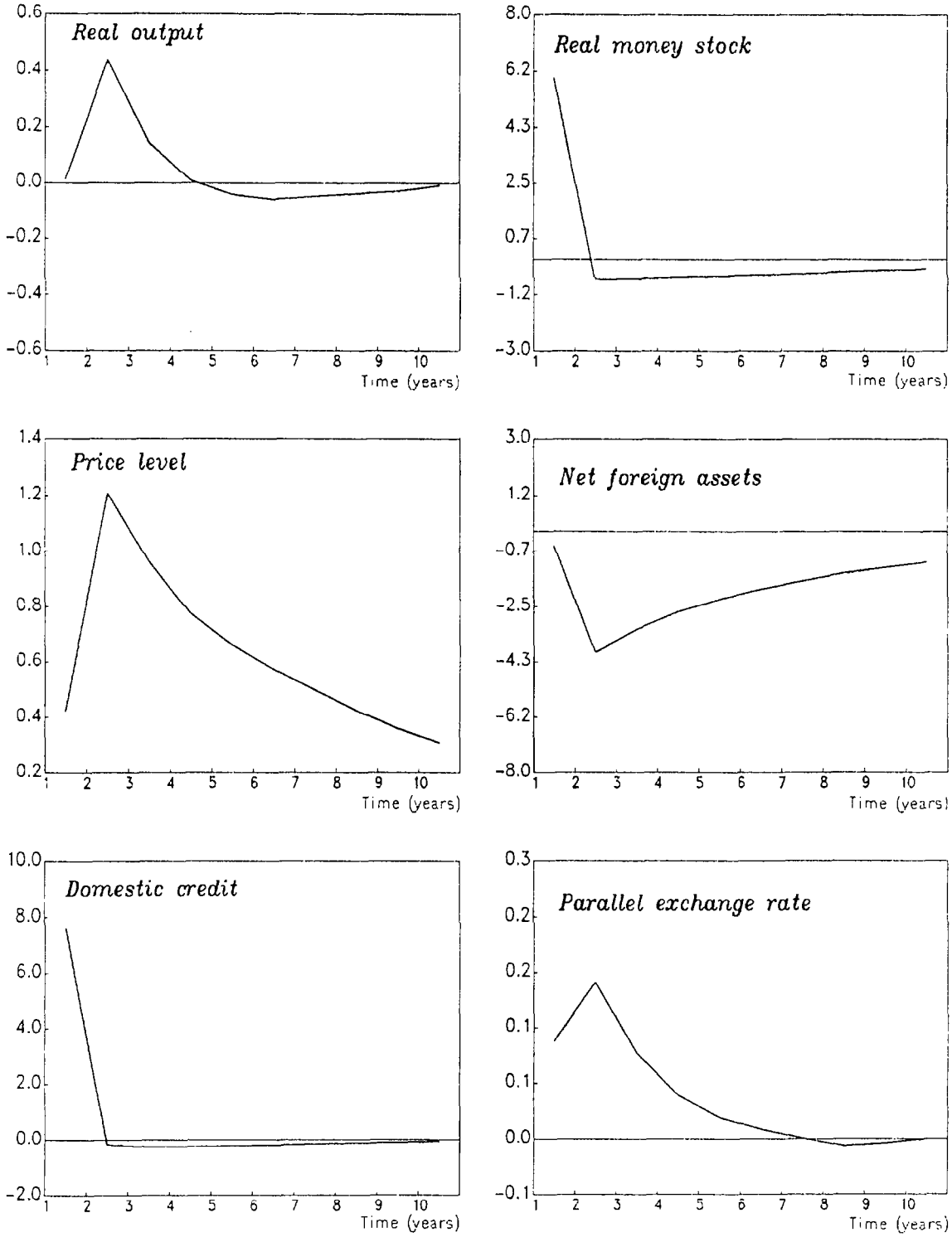
The rise in the stock of domestic credit provides an initial monetary stimulus and creates excess real balances in the system, which, after one year--as a result of the one-period lag built into the system--stimulate output (by 0.4 percent), raise prices (by 1.2 percent) and entail a fall (by nearly 4 percent) in the rate of growth of the real stock of net foreign assets. The domestic price level rises on impact by more than it otherwise would under a backward-looking expectational scheme, since by the assumption of rationality agents foresee correctly the future impact of monetary disequilibria on the inflation rate. Through its impact on output and prices, the excess supply of real balances also translates into a depreciation of the parallel exchange rate. In addition to the effects of output and changes in relative prices, the behavior of the parallel exchange rate also depends on changes in the expected rates of return of domestic and foreign currencies. Indeed, since expectations are consistent, agents anticipate correctly the effect of the future depreciation on the relative rates of return of domestic and foreign currencies. The rise in the expected rate of depreciation of the parallel exchange rate and the expected rate of domestic inflation exert a positive impact on the actual rate of change of the free rate. After its initial depreciation, the parallel exchange rate appreciates, exerting a downward effect on prices. Over time, all variables return gradually to their baseline levels, with output and domestic prices decreasing, and the real money stock increasing.

A general implication of the above results is that output and price effects associated with an increase in domestic credit are higher and last longer than in an economy where official reserves are free to adjust. This is because in the model discussed here, the rate of growth of net reserves in real terms falls by less than the amount necessary to preserve equilibrium in the official exchange market, so that the offsetting effect on the money supply coming through the balance of payments is lower than what would obtain if the authorities allowed net foreign assets to move freely to equilibrate supply and demand in that market. Since the rise in the rate of growth of output and in the domestic inflation rate relative to world inflation raises

CHART 1

TEMPORARY INCREASE IN PRIVATE SECTOR CREDIT OF 10 PERCENT

(Percentage deviations from baseline)



the demand for foreign currency in the parallel market, the free exchange rate is also higher than it would otherwise be in a full-reserve-adjustment economy. 1/

2. Changes in government spending

Consider next the effects of a fully anticipated temporary increase of 10 percent in nominal government spending, with net foreign borrowing by the public sector held constant (Chart 2).

The rise in public expenditure, by increasing the initial budget deficit, has an immediate direct effect on output. This raises money demand in the current year and reduces real excess balances, offsetting in part the direct positive impact of higher government spending. Overall, output rises by 0.5 percent in the first year. This pushes the parallel exchange rate up which, in turn, exerts a fairly small upward effect on prices. Through the government budget constraint, total credit expands and this in turn has an immediate negative impact on the nominal stock of net foreign assets, which falls by 1 percent. As the nominal stock of money expands, real excess balances grow, and this provides an expansionary effect which, after a year, translates mainly into higher prices and a fall in net foreign assets. Over time, the fall in net reserves reduces money supply, reversing the initial expansionary effect. Overall, the simulation results are qualitatively similar to those obtained in the case of an expansion of private domestic credit. There are, however, significant differences in both the first-year effects and in the time path of major variables, which display here a longer adjustment process.

The transmission of monetary disequilibria resulting from expansionary monetary and fiscal policies to the parallel exchange market can be summarized as follows. Excess cash balances have a positive effect on real activity and the inflation rate, as well as a negative effect on net reserves in the short run. The parallel market exchange rate depreciates for two reasons. First, the increase in output and domestic prices stimulates the demand for foreign goods through both legal and illegal channels, implying a rise in the transactions demand for foreign currency and therefore a depreciation

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1/ In the extreme case of complete rationing at the official rate--that is, with no adjustment at all in net reserves--an increase in the rate of domestic credit creation would result in even higher domestic prices and higher output, and therefore in a more depreciated parallel market rate. As a consequence of the rise in the exchange rate differential, a smaller proportion of export proceeds would be surrendered at the official rate, making the crisis even worse.

of the parallel rate, since the increase in demand cannot be fully accommodated in the official market for foreign exchange. Second, the increase in the (actual and expected) domestic inflation rate is equivalent to a fall in the rate of return on domestic money, and this stimulates the portfolio component of the demand for foreign currency in the parallel market.

Moreover, partial rationing of the demand for foreign exchange in the official market implies longer persistence effects of policy shocks on output and prices, and this in turn implies a more prolonged impact on the parallel rate. The higher the degree of rationing in the official foreign currency market is, the lower the offsetting effect on the money supply coming through the balance of payments will be, and the higher the rate of depreciation of the parallel exchange rate generated by an expansionary credit or fiscal policy.

3. Devaluation of the official exchange rate

Finally, consider the impact of a once-for-all fully anticipated 10 percent devaluation of the official exchange rate (Chart 3). By assumption, devaluation profits (i.e., valuation effects owing to exchange rate changes) are retained by the monetary authorities.

The immediate impact of the devaluation is a rise of 1.2 percent in the domestic inflation rate and a proportional depreciation of the parallel exchange rate. The inflationary impact of the devaluation is reinforced by the evolution of the parallel rate and by agents' anticipations of the future inflationary effects. Although the upward jump in the expected inflation rate and in the expected rate of depreciation of the parallel exchange rate reduces the demand for domestic currency, the real money stock falls because of higher domestic prices, and this implies (with a one-year lag) a contraction in real excess balances. As a consequence, output and prices fall while net foreign assets rise, thereby reversing the initial effects. Overall, a devaluation has a positive effect in the short run on the inflation rate and the parallel exchange rate, as well as a negative impact on real output, via the real balances effect. 1/ In the long run, domestic prices rise by 1 percent, and the parallel exchange rate depreciates by 10 percent. Since by assumption devaluation profits are not monetized, a return of the real money stock to its baseline value implies an increase of nearly 1.6 percent in the long-run stock of net foreign assets. Real output also returns gradually to its baseline level. The parallel market premium--defined as the ratio of

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1/ The last result has some interesting implications for the debate on whether or not devaluations in developing countries are "contractionary" (see Lizondo and Montiel, 1989). A detailed discussion of these issues is outside the scope of this paper.

CHART 2

TEMPORARY INCREASE IN GOVERNMENT SPENDING OF 10 PERCENT

(Percentage deviations from baseline)

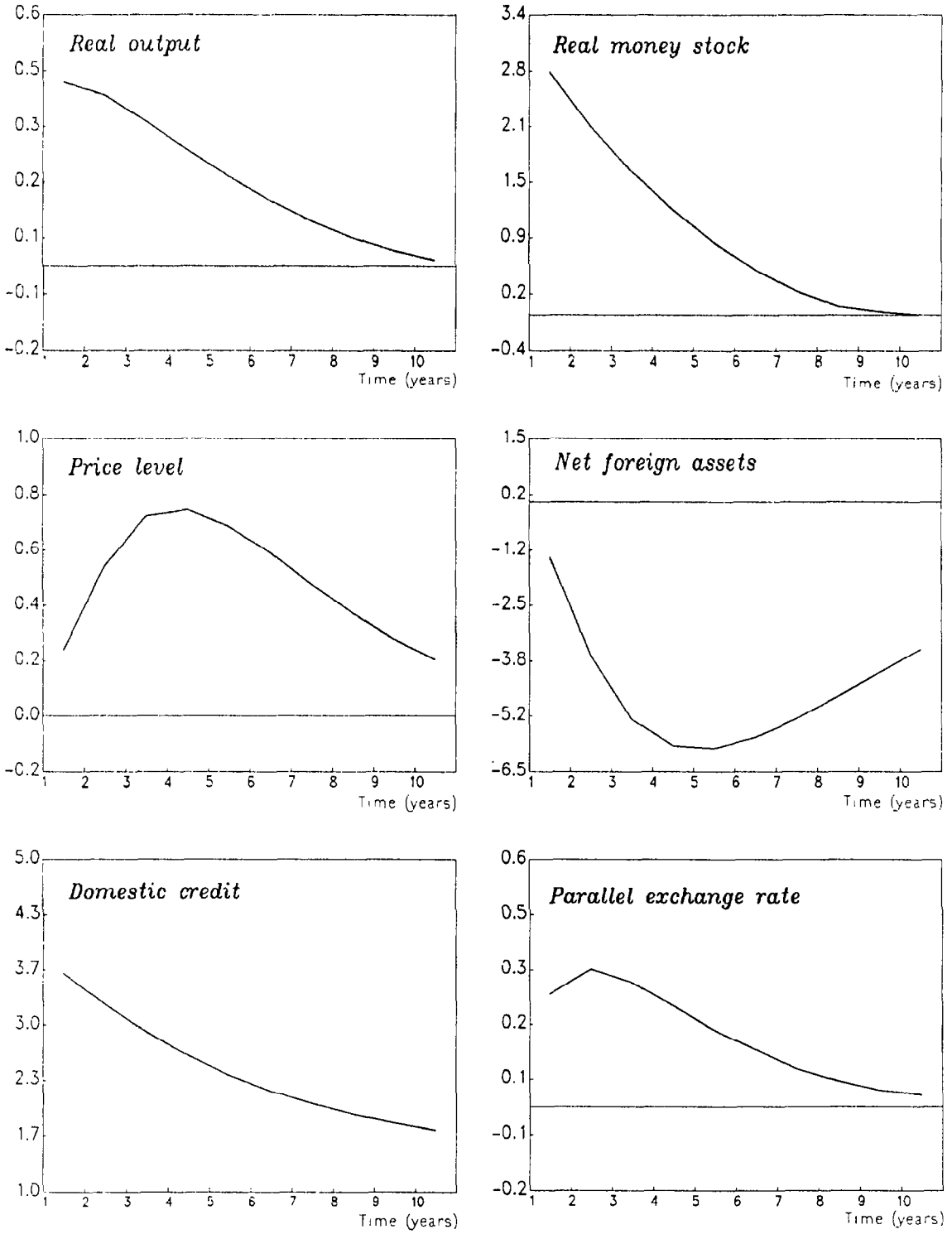
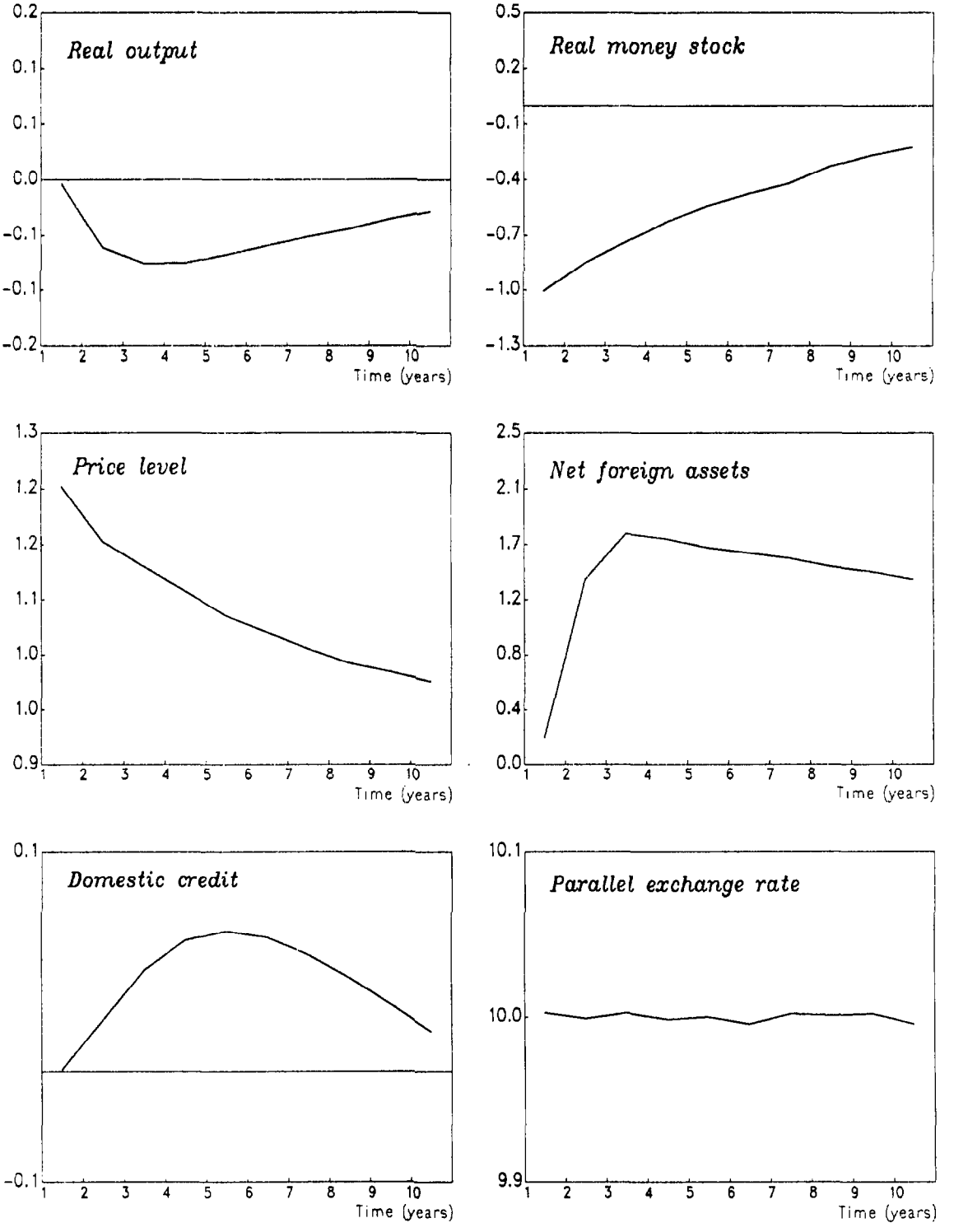


CHART 3

DEVALUATION OF THE OFFICIAL EXCHANGE RATE OF 10 PERCENT

(Percentage deviations from baseline)



the parallel rate to the official exchange rate minus one--falls on impact and returns rapidly to its baseline value. The magnitude of the fall in the premium is however relatively small, though, as a result of the immediate upward effect of the official exchange rate devaluation on the parallel rate. This result is consistent with the analytical prediction obtained with the perfect-foresight, currency-substitution models of the determination of the premium developed by Lizondo (1987), and Kharas and Pinto (1989).

How do the above results compare with available "stylized facts"? There is scant empirical evidence on the way in which dual markets, with legal and illegal segments, react to policy shocks. Two of the few studies available are Edwards's (1989) analysis of 18 devaluation experiences that took place between 1962 and 1982 in Latin America, and Kamin's (1988) study of the behavior of parallel exchange rates across 40 devaluation episodes in a larger group of developing countries. Edwards's results show first that in the presence of a freely determined parallel market rate, expansive domestic credit policies have usually been reflected in a depreciation of the free rate, an increase in the domestic rate of inflation, and a fall in international reserves. Second, in most instances, a large nominal devaluation of the official rate tends, on impact, to reduce the spread between the freely determined parallel rate and the predetermined official rate. In the medium term, however, the premium seems largely unaffected by the parity change. Similarly, Kamin's study shows that the parallel exchange rate rises in most cases following an official devaluation. In the quarter during which the devaluation is effected, the premium declines unambiguously, but it seems to widen again in subsequent periods.

Although it is difficult to discern unidirectional causality effects in the studies mentioned above, the simulation exercises reported in this paper seem to corroborate to some extent the empirical regularities discussed by Edwards and Kamin. These experiments provide evidence of the crucial role played by monetary disequilibria in the transmission process of policy shocks and the behavior of major macroeconomic variables. More generally, they illustrate the importance of taking into account the role of parallel currency markets in the discussion of alternative stabilization packages in developing countries.

V. Summary, Conclusions, and Extensions

The purpose of this paper has been to develop, estimate, and simulate a macroeconomic model for a developing country with a sizable parallel market for foreign exchange. Following early work by Khan and Knight (1981, 1985), the model has stressed the role of monetary factors in the determination of output, prices, net foreign assets, and the parallel market exchange rate.

Using a pooled time series-cross section data set, the model has been estimated by a consistent two-step procedure for a group of eight developing countries. The parameter estimates have been used to analyze the effects of alternative policy measures on the economy under the assumption of consistent forward-looking expectations, namely, a rise in domestic credit to the private sector, an increase in nominal government spending, and a devaluation of the official exchange rate. The simulation results have highlighted the important role played by parallel exchange markets in the transmission process.

The key policy implications of the model can be summarized as follows. First, expansionary fiscal and credit policies are--in addition to their well-known effects on output, prices, and net foreign assets--associated with a more depreciated parallel exchange rate (through changes in both the transactions and portfolio components of the unofficial demand for foreign currency), while displaying a more persistent pattern. This is because partial rationing in the official market for foreign exchange prevents the balance of payments from playing fully its offsetting role on the money supply. The rise in the parallel rate plays a crucial role in the elimination of excess money balances and the restoration of macroeconomic equilibrium. In addition, as a consequence of this rise, the inflationary impact is larger, and the output effect is smaller, than they would be in an economy without foreign exchange rationing.

The second major implication of the model relates to exchange rate policy. An official devaluation has no long-run effect on the premium, because the parallel exchange rate depreciates proportionately. A devaluation, unless supplemented by adequate fiscal and monetary policies, is virtually powerless as an instrument to control the spread. This conclusion may have far-reaching implications for the design of stabilization programs in developing countries in which the parallel market for foreign exchange plays an important role.

Finally, although the framework developed in this paper provides many insights, there are several areas in which further work is both necessary and desirable. First, the estimation results do not provide strong support regarding the existence of policy-induced disequilibria between supply and demand in the official foreign exchange market, as postulated in the rationing scheme outlined in the paper. This is indeed a feature of the results that clearly deserves considerable attention. Second, the treatment of the demand functions for domestic and foreign currencies may be improved by taking into account cross-equation restrictions in estimation. This can be achieved by using a full information maximum likelihood procedure, which would also allow explicit account of the nonlinear cross-equation constraints implied by the domestic money demand function. Third, although the sample of countries considered can be regarded as

reasonably representative, estimation using a larger group of developing economies may provide more reliable estimates and more general results than those obtained here, particularly with respect to the rationing process in the official foreign exchange market. Finally, supply-side effects of stabilization policies could be integrated in the model by specifying the determinants of capacity output. However, although these changes might improve the structure of the model, it is arguable whether they would affect substantially the two major policy implications described above.

APPENDIX I

Data Sources and Definitions

Annual data for the period 1974-86 were collected from the Fund's International Financial Statistics (*IFS*) tapes, except data on parallel market exchange rates, which were collected from the World Currency Yearbook. Due to data limitations, only eight countries are considered: Ecuador, India, Korea, Malaysia, Morroco, Pakistan, Singapore, and Uruguay. The sample thus includes low- and middle-income developing countries, manufacturing- and primary-exporters, as well as service and remittance countries, and one heavily indebted country. This diversity makes the sample reasonably representative of developing countries in general.

The official exchange rate, e, is the end-of-period domestic currency/U.S. dollar rate (*IFS* line ae). Real output, y, is measured by GDP at constant 1985 prices (*IFS* line 99b.p). Capacity output, $\bar{y}$, is derived as the predicted value of a regression of y on country dummies and country-specific time trends. The price level, P, is the consumer price index (*IFS* line 64). Nominal money supply, M, is measured as M_2 (*IFS* line 35L). Net foreign assets of the banking system, R, is line 31n in *IFS*. Total government spending in nominal terms, G, is defined as the sum of government expenditure (*IFS* line 82) plus lending minus repayments (*IFS* line 83). Total external financing, ΔF^g, is measured as foreign borrowing (*IFS* line 85a) plus grants received (*IFS* line 81z). Net domestic financing is defined as the difference between flow credit to the government (*IFS* line 84a) minus the change in government's deposits in the banking system (*IFS* line 87). Total credit to the private sector, L^p, is derived from the monetary identity, by subtracting from the money stock net foreign assets and domestic financing of the budget deficit. The world inflation rate, $\Delta \log Q$, is approximated by the rate of growth of consumer prices in the industrial countries. Finally, the data used for the parallel market rate, *b*, are those reported in the World Currency Yearbook (*WCY*, formerly Pick's Currency Yearbook), various issues. *WCY* provides end-of-month quotations, and reasonable efforts have been made to ensure that the quotations are consistently reported. *WCY* data have been used by most researchers in the field, although some authors have used data obtained directly from local authorities (see for example Canto, 1985).

APPENDIX II

Solution Procedure for the Model

The model is solved by a computer algorithm that forces the expectations entering the model's equations to be equal to the model's forecasts. 1/ For example, given information for $t-1$, assumed available to all agents, the algorithm first solves the model for t, $t+1, \ldots$ $t+N$, given an initial set of (guessed) values for the expected endogenous variables. After checking for equality between expectations and the solved forecasts, the initial expectations set is gradually altered until convergence is obtained. Terminal conditions take the form of "no-change" assumptions, whereby expectations beyond $t+N$ are assumed equal to solution values for period $t+N$. The uniqueness of the solution path is checked by numerical sensitivity analysis of the model, that is, by the evaluation of the early parts of the solution for successive values of N, until the solution values stabilize. For the results reported in this paper, the terminal date is set to 20, assuming the period of interest for the forecast is 10.

The above procedure can also be used to evaluate the goodness of fit of the model as a whole in a consistent fashion. To do this requires the use of projected--rather than actual--values for exogenous variables. Specifically, the information set available to agents is defined to include lagged values (up to $t-1$) of endogenous and exogenous variables. From period t up to the terminal date (set to 20 periods ahead), future values of exogenous variables are calculated by a simple first-order autoregressive process, the autoregressive coefficient being set to the average value observed during the three- year period preceding the current year of forecast. The solution values for period t--and period t only--are used as the model predictions. The procedure is then repeated for $t+1$, $t+2$, etc., until the last period of the sample. The important difference between the above procedure and a standard ex post simulation procedure for an econometric model is that in a forward-looking framework, agents are assumed to make forecasts of exogenous variables. Although in general the results may be sensitive to the particular forecasting procedure considered, those reported here were fairly insensitive to the specific choice of the number of

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1/ The program was developed by the Liverpool Research Group in Macroeconomics and is based on a solution technique similar to the procedure described by Fair and Taylor (1983) and Fair (1984). The method is a special case in a general class of iterative algorithms for models which incorporate consistent forward-looking expectations discussed by Fisher and Hughes Hallet (1988). For a general discussion of alternative solution procedures for rational expectations models, see Blanchard (1985).

periods used to calculate the average autoregressive coefficient, as long as this number was greater than one.

In any case, the comparison between the projected and actual values provides a measure of the in-sample predictive performance of the model. The results for the major endogenous variables proved quite satisfactory, except for net international reserves. The root mean square error was 0.057 for real output, 0.082 for the domestic price level, 0.078 for the parallel market exchange rate, 0.436 for the level of net foreign assets, and 0.146 for the real money stock.

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