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REAL AND MONETARY DETERMINANTS OF REAL EXCHANGE RATE BEHAVIOR: THEORY AND EVIDENCE FROM DEVELOPING COUNTRIES

Sebastian Edwards

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ABSTRACT

This paper develops a dynamic model of real exchange rate behavior in developing countries. A three goods economy (exportables, importables and nontradables) is considered. Residents of this country hold domestic and foreign assets, and there is a dual exchange rate regime. There is a government that consumes importables and nontradables. A distinction is made between equilibrium and disequilibrium movements of the RER. The determinants of real exchange rate misalignment are studied with emphasis placed on the role of devaluations and balance of payments crisis. The implications of the model are tested using data for 12 developing countries. The results obtained are generally favorable for the model. The issue of RER stationarity is also analyzed.

Sebastian Edwards
Department of Economics
University of California
Los Angeles
Los Angeles, CA 90024

1. Introduction

Recent discussions on macroeconomic policy in the developing and developed countries have emphasized the crucial role played by the real exchange rate (RER) in the adjustment process. There is a growing agreement that sustained real exchange rate misalignment will usually generate severe macroeconomic disequilibria, and that the correction of external imbalances (i.e., current account deficits) will generally require both demand management policies and a real exchange rate devaluation. Also, in recent policy evaluations of the performance of the less developed countries it has been argued that more "successful" developing countries owe much of their success to having been able to maintain the real exchange rate at its "appropriate" level.[1] It is not an overstatement to say that real exchange rate behavior occupies now a central role in policy evaluation and design.

In spite of the importance that real exchange rates have attained in recent policy discussions there have basically been no attempts to empirically analyze the forces behind real exchange rate behavior in the developing countries.[2] In many ways the issue of real exchange rate determination in the developing countries has remained in a murky state, with most of the discussion being carried on at an informal level. Moreover, in reviewing the literature on the subject it is surprising to find virtually no studies that formally attempt to explain the distinction between equilibrium and disequilibrium (i.e., misaligned) real exchange rates. The purpose of this paper is to develop a theory of real exchange rate behavior, and empirically test its main implications using data for a group of developing countries. In particular this research seeks to analyze the relative importance of monetary and real variables in the process of real exchange rate determination in both the short and long runs.

The paper is organized as follows: in Section 2 a dynamic model of real exchange rate determination for a small open economy with a dual nominal exchange rate system is developed. Section 3 provides a preliminary data analysis on real exchange rate behavior for a group of 12 developing countries. In Section 4 the main implications of the model developed in Section 2 are empirically tested using data for these 12 developing countries. Finally, Section 5 includes the conclusions.

2. The Model

In this section we develop a model of real exchange rate determination that allows for both real and nominal factors to play a role in the short run. In the long run, however, only real factors -- the "fundamentals" -- influence the equilibrium real exchange rate. The model attempts to capture in a simple way some of the most salient macroeconomic features of the developing economies, including the existence of exchange controls, trade barriers and a freely determined parallel market for foreign exchange for financial transactions.

The model considers a three goods -- exportables, importables, and nontradables -- small open economy. There is a dual nominal exchange rate system and a government sector. It is assumed that this country produces the exportable (X) and nontradable (N) goods and consumes the importable (M) and the nontradable. Nationals of this country hold both domestic money (M) and foreign money (F). Initially it is assumed that there are effective capital controls, so that there is no international capital mobility. However, it is assumed that the private sector has inherited a given stock of foreign money $\bar{F}$. The government consumes importables and nontradables, and uses both nondistortionary taxes and domestic credit creation to finance its expenditures. It is assumed that the government, as the private sector, cannot borrow from abroad. Also, it is assumed that there is no domestic public debt. Later, the assumption of no capital mobility is relaxed; it is assumed that the government is not subject to capital controls, and that there are some capital flows in and out of the country.

The dual nominal exchange rate system is characterized by a fixed nominal exchange rate for commercial transactions (E) and a freely floating nominal exchange rate (δ) for financial transactions. This latter rate takes whatever level is required to achieve asset market equilibrium. This assumption of a dual exchange rate system is made as a way of capturing the fact that in most developing countries there is a parallel market (many times a "grey" or "black" market) for financial transactions. It is assumed that there is a tariff on imports (τ) and that, in the tradition of international trade theory, its proceeds are handed back to the public in a nondistortionary way. It is assumed that the price of exportables in terms of foreign currency is fixed and equal to unity $1(P^*_X=1)$. Finally, it is assumed that there is perfect foresight.

The model is given by equations (1) through (16) below:

<u>Portfolio Decisions</u>

$$A = M + \delta F \tag{1}$$

$$a = m + \rho F, \quad \text{where} \tag{2}$$

$$a = A/E; \; m = M/E; \; \rho = \delta/E$$

$$m = \sigma(\dot{\delta}/\delta)\rho F; \qquad \sigma' < 0 \tag{3}$$

$$\dot{F} = 0 \tag{4}$$

Demand Side

$$P_M = EP_M^* + \tau; \quad e_X = E/P_N; \quad e_M = P_M/P_N; \quad e_M^* = (P_M^*E)/P_N \tag{5}$$

$$C_M = C_M(e_M, a); \quad \frac{\partial C_M}{\partial e_M} < 0, \quad \frac{\partial C_M}{\partial a} > 0 \tag{6}$$

$$C_N = C_N(e_M, a); \quad \frac{\partial C_N}{\partial e_M} > 0, \quad \frac{\partial C_N}{\partial a} > 0 \tag{7}$$

Supply Side

$$Q_X = Q_X(e_X); \quad \frac{\partial Q_X}{\partial e_X} > 0 \tag{8}$$

$$Q_N = Q_N(e_X); \quad \frac{\partial Q_N}{\partial e_X} < 0 \tag{9}$$

Government Sector

$$G = P_N G_N + EP_M^* G_M \tag{10}$$

$$\frac{EP_M^* G_M}{G} = \lambda \tag{11}$$

$$G = t + \dot{D} \tag{12}$$

External Sector

$$CA = Q_X(e_X) - P_M^* C_M(e_M, a) - P_M^* G_M \tag{13}$$

$$\dot{R} = CA \tag{14}$$

$$\dot{M} = \dot{D} + E\dot{R} \tag{15}$$

$$e = \alpha e_M^* + (1-\alpha)e_X = \frac{E[\alpha P_M^* + (1-\alpha)P_X^*]}{P_N} \tag{16}$$

Equation (1) defines total assets (A) in domestic currency as the sum of domestic money (M) plus foreign money (F) times the free market nominal exchange rate. Equation (2) defines real assets in terms of the exportable good, where E is the (fixed) commercial rate and $\rho = \delta/E$ is the spread between the free (δ) and the commercial (E) nominal exchange rates. Equation (3) is the portfolio composition equation and establishes that the desired ratio of real domestic money to real foreign money is a negative function of the expected rate of depreciation of the free rate δ. Since perfect foresight is assumed, in (3) expected depreciation has been replaced by the actual rate of depreciation. Equation (4) establishes that there is no capital mobility and that no commercial transactions are subject to the financial rate δ. It is assumed, however, that this economy has inherited a positive stock of foreign money, so that $F_0 > 0$.

Equations (5) through (9) summarize the demand and supply sides. e_M and e_X are the (domestic) relative prices of importables and exportables with respect to nontradables. Notice that e_M includes the tariff on imports. e_M^*, on the other hand, is defined as the relative price of importables to nontradables that excludes the tariff. Naturally, e_M is the relevant price for consumption and production decisions. Demand for nontradable and importable goods depend on the relative price of importables and on the level of real assets; supply functions, on the other hand, depend on the price of exportables relative to nontradables. Equations (10) and (11) summarize the government sector, where G_M and G_N are consumption of M and N respectively. It is convenient to express real government consumption in terms of exportables as:

$$g = g_M + g_N \tag{10'}$$

where $g = G/E$, and $g_N = G_N P_N/E$. Equation (11) defines the ratio of government consumption on importable goods as λ. Equation (12) is the government budget constraint and says that government consumption has to be financed via nondistortionary taxes (t) and domestic credit creation ($\dot{D}$). Notice, however, that under fixed nominal commercial rates a positive rate of growth of domestic credit ($\dot{D} > 0$) is not sustainable. Stationary equilibrium, then, is achieved when $G = t$ and $\dot{D} = 0$. If, however, a crawling peg is assumed for the commercial rate (i.e., ($\dot{E}/E) > 0$)), it is possible to have a positive $\dot{D}$ consistent with the rate of the crawl.

Equations (13) through (16) summarize the external sector. Equation (13) defines the current account in foreign currency as the difference between output of exportables Q_X and total (private plus public sector) consumption of importables. Equation (14) establishes that in this model, with no capital mobility and a freely determined financial rate, the balance of payments ($\dot{R}$) is identical to the current account, where R is the stock of international reserves held by the central bank expressed in foreign currency. It is assumed that initially there is a positive stock of international reserves (R_0). Equation (15) provides the link between changes in international reserves, changes in domestic credit and changes in the domestic stock of money. Finally, the model is closed with equation (16) which is the definition of the real exchange rate as the relative price of tradables to nontradables. Notice that this definition of the RER excludes the tariff on imports. This is done because most empirical measures of RER exclude import tariff or taxes. Naturally, for the theoretical discussion it would be trivial to compute all the results for an alternative definition of RER that included τ.[3]

Long run sustainable equilibrium is attained when the nontradable goods market and the external sector (current account and balance of payments) are simultaneously in equilibrium. Due to the assumption of tight exchange controls, the external sector long run sustainable equilibrium implies that the current account is in equilibrium in every period. In the short and even medium run, however, there can be departures from $CA = 0$. This, of course, will result in the accumulation or decumulation of international reserves. A steady state is attained when the following four conditions hold simultaneously: (1) the nontradables market clears; (2) the external sector is in equilibrium $\dot{R} = 0 = CA = \dot{m}$; (3) fiscal policy is sustainable $G = t$; and (4) portfolio equilibrium holds. The real exchange rate prevailing under these steady state conditions is the long run equilibrium real exchange rate $(\tilde{e}_{LR})$.

The nontradables good market clears when:

$$C_N(e_M, a) + G_N = Q_N(e_X). \tag{17}$$

Notice that $G_N = e_X g_N$, where g_N is real government consumption of N in terms of exportable goods. From (17) it is possible to express the equilibrium price of nontradables as a function of a, g_N, P^*_M and τ.

$$P_N = v(a, g_N, P^*_M, \tau) \quad \text{where} \quad \frac{\partial v}{\partial a} > 0,\ \frac{\partial v}{\partial g_N} > 0,\ \frac{\partial v}{\partial P^*_M} > 0,\ \frac{\partial v}{\partial \tau} > 0. \tag{18}$$

Notice that since the real value of total assets (a) is an endogenous variable we have to investigate how changes in g_N, P^*_M and τ affect real wealth (a) before solving for P_N.

Since the nominal exchange rate for commercial transactions is fixed, $(\dot{\delta}/\delta)$ in the portfolio equilibrium condition (3) can be substituted by the rate of change of the spread $(\dot{\rho}/\rho)$. Thus, we can write $m/\rho F = \sigma(\dot{\rho}/\rho)$. Inverting this equation and solving for $\dot{\rho}$ we obtain:

$$\dot{\rho} = \rho L(\frac{m}{\rho F}); \qquad L'(\cdot) < 0 \tag{19}$$

In Figure 1, the $\dot{\rho} = 0$ schedule has been drawn; it is positively sloped because in order for the public to hold larger amounts of m we need a higher ρ. The higher the spread the lower the expectations of further increases of the free rate, and thus, the higher the amount of (real) domestic money the public is willing to hold.

From equations (10), (12), (13), (14), and (15), the following expression for $\dot{m}$ can be derived:

$$\dot{m} = Q_X(e) - C_M(e,a) + g_N - t/E \tag{20}$$

Equilibrium of the external sector requires that $\dot{m} = 0$ (see Figure 1). Under the steady sta requirement that government expenditures are fully financed with taxes, the $\dot{R} = 0$ schedule will coincide with the $\dot{m} = 0$ schedule. The intuition for the negative slope of $\dot{m} = 0$ is related to the effects of wealth changes on the current account and on relative prices. An increase in m results in a higher (a) and in a current account deficit; in order to regain equilibrium real asset (a) should go down via a decline in ρ.

In Figure 1 the intersection of the $\dot{\rho} = 0$ and the $\dot{m} = \dot{R} = 0$ schedules determines the steady state level of real balances m_o and the steady state parallel market premium ρ_o. It is easy to show that this system is characterized by saddle path equilibrium. ss is the saddle path, and the arrows denote the dynamic forces at work in this system.[4]

After the steady state values of ρ and m are determined, equation (18) can be used to find, for the corresponding (exogenous) values of g_N, P^*_M and τ, the long run equilibrium price of nontradables. Equation (16) can then be used to find the long run equilibrium real exchange rate:

$$\tilde{e}_{LR} = v(m_o+\rho_o F_0, g_{N_o}, \tau_0, P^*_{M_o}) \tag{21}$$

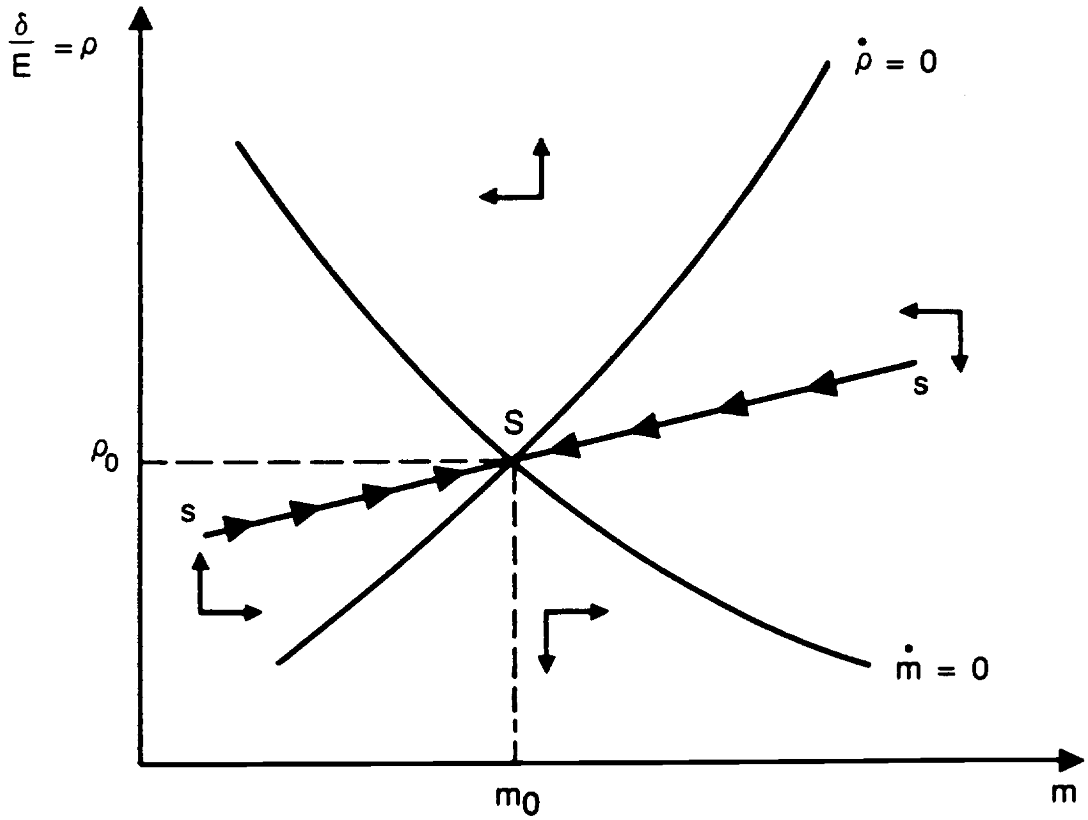


Figure 1

As can be seen from equation (21) the long run equilibrium real exchange rate is a function of real variables only -- the so-called <u>fundamentals</u>. Whenever there are changes in these variables, there will be changes in the <u>equilibrium</u> RER. In the short run, however, changes in monetary variables, such as D, $\dot{D}$ and E, will also affect the RER. In the rest of this section we analyze: (a) how changes in fundamentals affect the long run equilibrium RER, and (b) how monetary disturbances affect the short run RER.

2.1 <u>Real Disturbances and the Equilibrium Real Exchange Rate</u>

<u>A Tariff Increase</u>

Consider an (unanticipated) increase in import tariffs. In this case the $\dot{\rho} = 0$ schedule will not be affected; the $\dot{m} = 0$ schedule, however, will shift. The parallel movement of this schedule is given by:

$$dm\Big|_{\dot{m}=0} = - \frac{\{B(\frac{\partial v}{\partial \tau}) + \frac{P^*_M}{P_N}(\frac{\partial C_M}{\partial e_M})\}\, d\tau}{B\,\frac{\partial v}{\partial a} + P^*_M(\frac{C_M}{\partial a})} \lessgtr 0 \tag{22}$$

where

$$B = \left\{\left(\frac{\partial Q_X}{\partial e_X}\right)\frac{E}{P_N^2} - \frac{P^*_M}{P_N}\left(\frac{\partial C_M}{\partial e_M}\right)\frac{P_M}{P_N}\right\} > 0.$$

The sign of equation (22) is undetermined because $(\partial v/\partial \tau) > 0$ and $(\partial C_M/\partial e_M) < 0$. This implies that as a consequence of the (unanticipated) tariff increase the equilibrium real exchange rate can either appreciate or depreciate. This result is consistent with previous static analysis of Edwards and van Wijnbergen (1987). The most plausible outcome, however, corresponds to the situation where the direct effect of e_M on demand is stronger than the effect of the tariff on P_N. In what follows it will be assumed that the numerator in equation (22) is positive. In this case the $\dot{m} = 0$ schedule will shift to the right, and the new steady state equilibrium will be characterized by higher ρ and m (Figure 2), and a higher equilibrium price of nontradables. This is both because in this case a higher τ results in substitution in demand away from importables and into nontradables, and because the increase in m and ρ generate a higher value of real assets (a) and thus an additional increase in the demand for N. The dynamics of the adjustment process are also depicted in Figure 2; on impact the system jumps to R, and then proceeds on the new saddle path to the new steady state T. During the adjustment there is a current account surplus and international reserves are accumulated.

The effect of a hike in import tariffs on the long run equilibrium real exchange rate e_{LR} is given by:

$$d\bar{e}_{LR} = -(\frac{e}{P_N}) \{(\frac{\partial v}{\partial a}) [\frac{\partial m}{\partial \tau} + \frac{\partial \rho}{\partial \tau}] + \frac{\partial v}{\partial \tau}\} d\tau < 0 \tag{23}$$

Under the assumption that schedule $\dot{m} = 0$ shifts to the right $(\partial m/\partial \tau) > 0$ and $(\partial \rho/\partial \tau) > 0$, and higher import tariffs will result in a long run equilibrium real appreciation. The dynamic path followed by e can be easily traced from Figure 2.

A Terms of Trade Disturbance

Consider now the effect of a worsening in the international terms of trade generated by an increase in the international price of importables P^*_M. As before the $\dot{\rho} = 0$ schedule is not affected; the $\dot{m} = 0$ schedule, however, will shift. Its parallel movement will be given by:

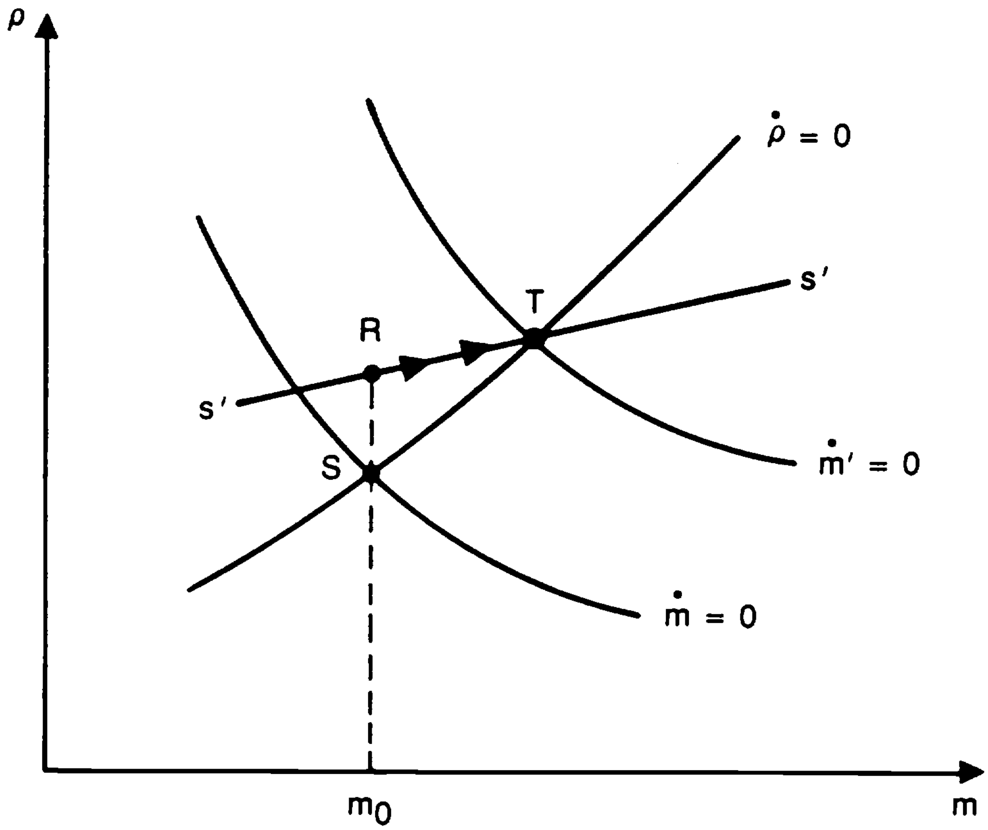


Figure 2

$$dm\Big|_{\dot{m}=0} = - \frac{(B \frac{\partial v}{\partial P^*_M} + \eta + 1)}{B \frac{\partial v}{\partial a} + P^*_M(\frac{\partial C_M}{\partial a})} dP^*_M \tag{24}$$

where $\eta = \left\{\frac{e_M}{C_M} \frac{\partial C_M}{\partial e_M}\right\}$ is the price elasticity of the demand for importables, and B is the same as in (22). Again it is not possible to know a priori whether $\dot{m} = 0$ shifts upward or downward. If the demand for importables is sufficiently elastic, and the numerator in equation (24) is positive, the $\dot{m} = 0$ schedule will shift up and the effects of this disturbance on the system -- including on the equilibrium real exchange rate -- will be qualitatively the same as in the tariffs case discussed above.

The effects of changes in government consumption on the long run equilibrium real exchange rate can be analyzed in a similar way. It is easy to show, for example, that an increase in the ratio of government consumption of nontradables will result in an equilibrium long run real exchange rate appreciation.

Capital Flows

The model presented above assumes that capital controls fully isolate the country from capital movements. Although most developing countries have some kind of capital controls, the assumption of a complete absence of capital flows is not totally satisfactory. In fact, after the debt crisis a number of poor countries have had to transfer important amounts of capital to the international banks. These payments, of course, represent a reversal from the situation in the 1970s, when most developing nations experienced large capital inflows.

The simplest way to incorporate capital flows into the model is by assuming that they are restricted to the government, and by treating them as exogenous. This means that equations (12) and (14) have to be modified. In the government budget constraint (12) the domestic currency value of these (exogenous) capital flows has to be added to the sources of funds; the foreign currency value of these capital flows should also be added to the right hand side of equation (14). Now, the current account is not equal to the balance of payments any longer. The model is closed by adding an intertemporal budget constraint that establishes that the present value of net capital flows had to be equal to zero, or the initial stock of foreign debt. Denoting the exogenous capital flows by H and the discount factor (world interest rate) by r^*, this intertemporal budget constraint is written as follows:

$$\int_0^\infty He^{-r^*t}\,dt = 0.$$

In this case changes in the intertemporal distribution of H will have important effects on the dynamics of the real exchange rate. For instance, an (unanticipated) decrease in H, generated by the payment of foreign debt, will result in an equilibrium real depreciation on impact. This real depreciation will last for as long as the country makes the transfer to the rest of the world. Once this is completed a real appreciation will ensue.

2.3 Macroeconomic Policies, Real Exchange Rate Misalignment and Devaluations

We have seen how changes in fundamentals affect the long run equilibrium RER. We now turn to the effect of nominal disturbances on the actual RER and, thus, on the differential between actual and equilibrium real exchange rates. This will allow us to discuss misalignment issues.

Consider first a once-and-for-all unanticipated increase in the stock of domestic credit (D). On impact, this means that there will be a jump in the real stock of money, since $m = M/E = R + D/E$. This is illustrated in Figure 3 by the new real stock of domestic money m_1. Assuming that the initial stock of international reserves is "sufficiently" large, the system moves from S to Q on the stationary saddle path, with a higher stock of money m_1 and spread ρ_1 (see below for the case with low reserves). From equation (18) it is easy to see that at Q the <u>actual</u> real exchange rate has appreciated relative to its long run equilibrium value:

$$de = -\frac{e}{P_N}\{(\frac{\partial v}{\partial a})\ dm + (\frac{\partial v}{\partial a})\ Fd\rho\} < 0 \qquad (25)$$

The reason for this lower short run real exchange rate is that the demand for nontradables is a function of real assets and of e. At Q, the higher m and the higher ρ, imply a higher $a(= m + \rho F)$ and, consequently, an incipient excess demand for N, which requires a lower e to reestablish nontradable equilibrium.

Notice that at Q there is also a higher δ. In order to induce the public to (temporarily) hold the higher m relative to F, it is required for them to expect an appreciation of δ (i.e., $(\dot{\delta}/\delta) < 0$). This is exactly what will happen during the transition period.

The difference between the actual short run real exchange rate e and its long run equilibrium level is defined as <u>real exchange rate overvaluation</u>. In this case, however, the overvaluation will be short lived, since there will be forces moving the system back towards equilibrium. After the initial once-and-for-all increase in D the economy will adjust along the saddle path ss moving from Q to S, with reductions of m and ρ. Throughout the transition two things will happen: (1) the stock of international reserves will decline as the public gets rid of the excess domestic money; and (2) the real exchange rate will continuously depreciate -- via

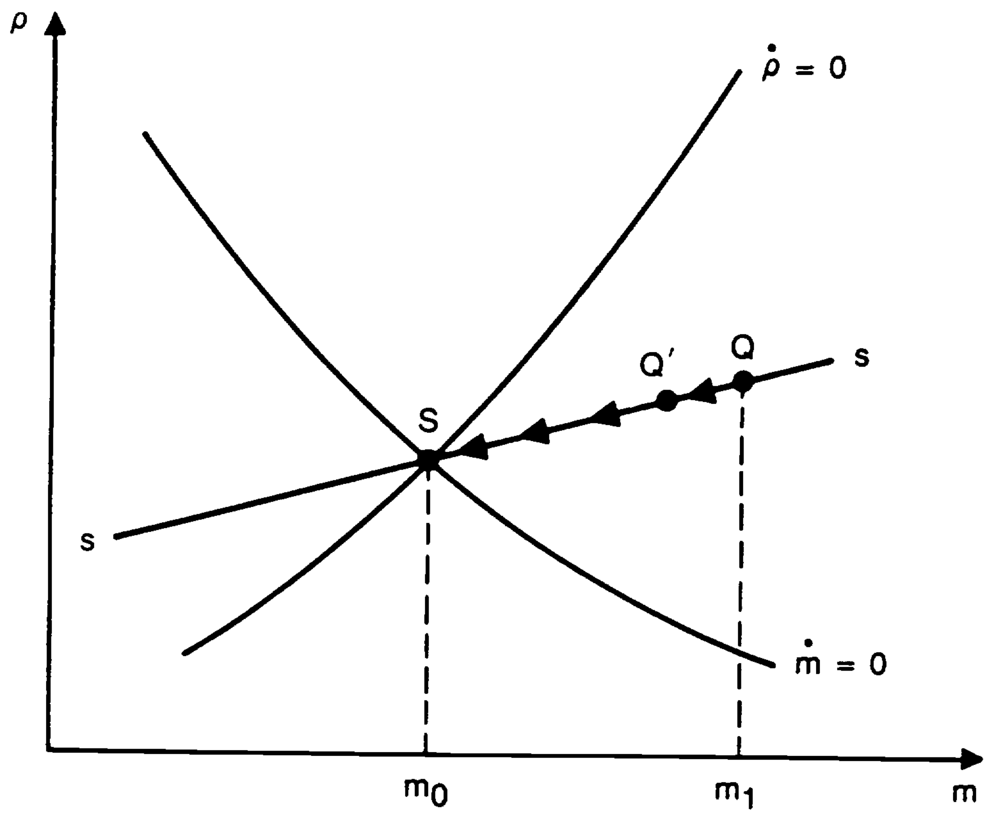


Figure 3

reductions in P_N -- moving back towards its long run sustainable level. However, throughout the adjustment the actual real exchange rate will still be overvalued. (i.e., throughout the transition the actual e will be below $\tilde{e}_{LR}$). Only once S is achieved has real exchange rate equilibrium been reestablished.

In the final equilibrium m, ρ and e are the same as before the increase in D: Monetary disturbances do not affect the long run equilibrium real exchange rate. There is, however, a new composition of domestic money with a higher level of D and a lower level of R.

The time taken to move back from Q to S in Figure 3 will depend on a number of variables including the magnitude of the original shock and the different elasticities involved. One possible way to accelerate the adjustment is by implementing an unanticipated discrete nominal devaluation of the commercial rate (E). As a result of the higher E the real stock of money (M/E) will jump down. Notice, however, that an important characteristic of discrete nominal devaluations is that if undertaken from a situation of equilibrium they will only have short run effects. If, on the other hand, they are engineered when the economy is out of equilibrium -- such as in point Q' in Figure 3 -- they can help speed up the adjustment process. For example, in our case, an unanticipated nominal devaluation of the commercial rate of the "right amount" implemented when the economy is at Q' in Figure 3, will result in a jump from Q' to S. The adjustment having been much faster than if the system was left to work its way back to S on its own. Moreover, with the discrete devaluation the total loss of reserves would have been reduced.

For the move from Q to S in Figure 3 to be a feasible adjustment path we have to assume that the initial stock of reserves is sufficiently high as to cover the loss of reserves that takes place during the transition. If, however, initial reserves are not high enough, the public will anticipate a balance of payments crisis that will include a discrete devaluation of the commercial rate.[5] In this case the adjustment is depicted in Figure 4. Now, at the time of the actual increase in D the public anticipates a future devaluation of E, and as a result there is a further jump in the free rate δ and thus in the spread ρ. On impact then, the system moves to point C in Figure 4. As before, at this point the real exchange rate suffers an appreciation relative to its long run equilibrium level (i.e., it becomes overvalued). The system then moves along the divergent path CG.

Throughout this adjustment path reserves are being lost, and the actual real exchange rate is still overvalued -- that is, it is below its long run sustainable level. The actual depreciation of the fixed rate E takes place when the Central Bank "runs out" of reserves -- or more precisely when reserves reach a predetermined lower threshold. In Figure 4 it is assumed that this happens when the system reaches point G. Exactly at this time E is devalued and the system jumps to point H; from there onwards the adjustment continues on the saddle path ss. At the time of the devaluation the real stock of money is abruptly reduced, since $m = M/E$. The nominal free rate δ, however, does not jump.[6] The spread $\rho = \delta/E$, on the other hand, does jump down. In terms of the diagram, the fact that δ does not jump when the anticipated devaluation of E actually takes place is captured by point H on the saddle path being along a ray from the origin that goes through G. In Figure 4 the magnitude of the devaluation of E is such that the new after-devaluation real stock of money m_2 is below the steady state level. This means that the final part of the adjustment will take place along the saddle path from H to S with some of the reserves previously lost being replenished. Notice that on H the real exchange rate has depreciated by more than what is required to achieve RER equilibrium.[7]

The initial level of international reserves plays an important role in determining the exact dynamic path followed by this economy. In terms of Figure 4, the initial level of reserves will determine the location of point G.

Up to now we have considered once-and-for-all increases in domestic credit D. It is easy, however, to analyze the case of a temporary increase in $\dot{D}$. Again, in this case, we find out that expansive domestic credit policies result in a real exchange rate appreciation (i.e., overvaluation) and, if the central bank doesn't hold "sufficient" reserves, in a speculative attack and devaluation crisis (see Edwards, forthcoming).

To summarize, the model developed in this section provides a unified dynamic framework for analyzing the behavior of the real exchange rate and the parallel market spread. Monetary and real factors will affect the real exchange rate in the short run. In the long run, however, real factors only -- the so-called fundamentals -- will affect the sustainable equilibrium real exchange rate. Under the most plausible conditions higher import tariffs will result in an equilibrium real appreciation. This will also be the case for increases in the consumption of nontradables by the government. An improvement in the terms of trade can result in either an equilibrium real depreciation or real appreciation. An increase in (exogenous) capital inflows will result in an equilibrium real appreciation. The model predicts that expansive (i.e., nonsustainable) macroeconomic policies will generally be associated with: (1) a loss in international reserves; (2) a current account deficit; (3) an increase in the spread between the free and the fixed nominal rates during the initial period; and (4) a real exchange rate overvaluation. The form in which the disequilibria is resolved will depend on the nature of the disturbances, the nominal exchange rate policy pursued, and the existing initial stock of international reserves. Although the assumption of perfect foresight introduces some limitations, the model is still able to capture some of the more important stylized facts related to macroeconomic policies in small open economies.

3. Real Exchange Rate Behavior in Selected Developing Countries: The Data

The construction of empirical measures of real exchange rates has, for some time, posed a nontrivial problem to applied researchers. In particular it is not easy to find exact empirical counterparts to P_N or P_T^*. The numerous discussions on how to appropriately measure the real exchange rate have, in fact, generated little agreement among practitioners. In this paper we follow a number of researchers and use the following proxy for the (bilateral) real exchange rate.[8]

$$RER = e = \frac{E\ WPI^{US}}{CPI} \tag{26}$$

where E is the nominal exchange rate between the domestic country and the U.S. dollar, WPI^{US} is the wholesale price index in the U.S. and is a proxy for the foreign price of tradables P_T^*, and where CPI is the domestic consumer price index and is considered as a proxy of the domestic price of nontradables.[9] As in the previous section an increase (decrease) in RER reflects a real depreciation (appreciation).

Table 1 contains summary statistics of RER for 12 developing countries used in the regression analysis reported in Section 4. The period included covers, for most cases, 1960-85. The index of RER was set equal to 100 for

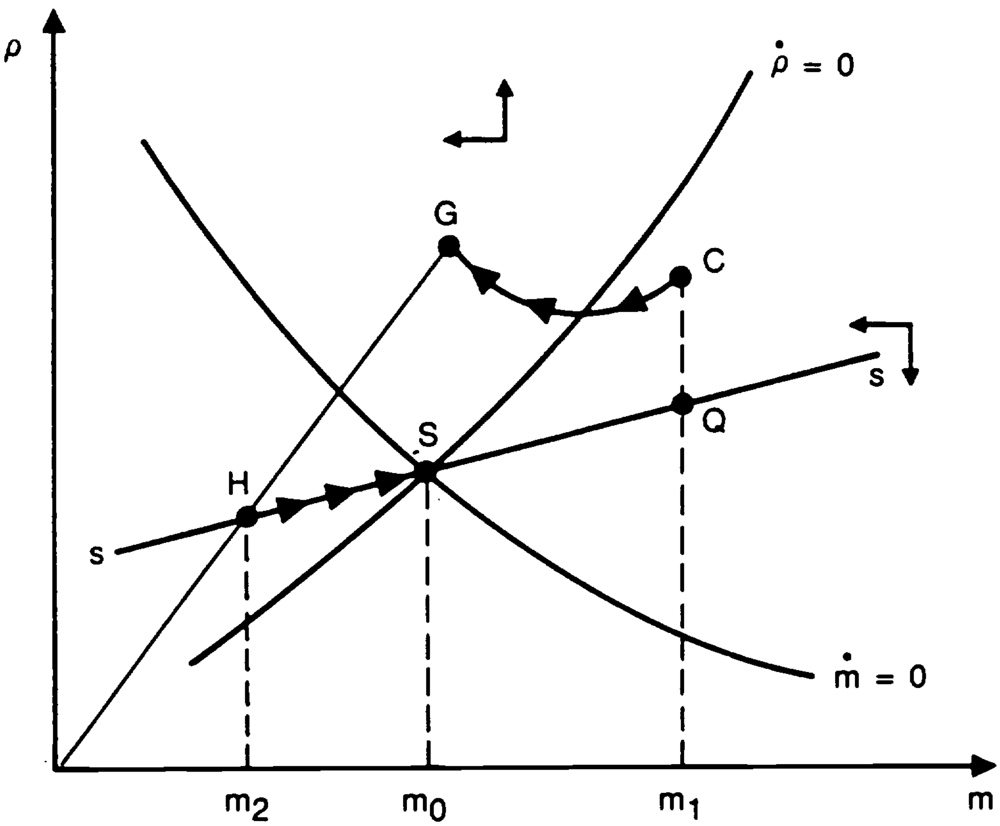


Figure 4

TABLE 1

Real Exchange Rates, 1965-1985:

Summary Statistics

1980 = 100

Country	Mean	Standard Deviation	Minimum	Maximum
Brazil	84.0	17.5	67.4	132.8
Colombia	102.2	12.2	76.0	126.4
El Salvador	107.8	11.6	77.6	129.3
Greece	108.4	6.7	95.0	128.6
India	87.1	12.6	63.2	109.8
Israel	93.4	12.2	71.8	112.5
Malaysia	96.2	5.2	85.7	105.3
Philippines	98.6	14.4	55.7	121.6
South Africa	107.5	5.5	99.2	119.7
Sri Lanka	54.4	31.7	28.8	107.7
Thailand	103.4	2.5	99.2	108.8
Yugoslavia	105.1	26.9	52.9	164.3

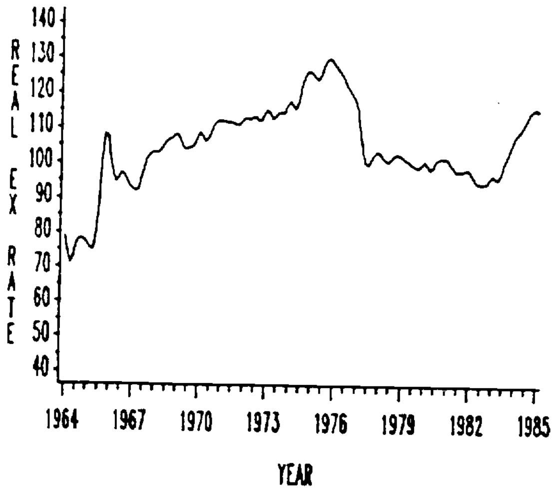
Source: These are bilateral real exchange rate indexes constructed from data obtained from the IFS.

1980. Figure 5 depicts the behavior of the real exchange rate index for these countries. As before, an increase in this index reflects a real depreciation while a reduction refers to a real appreciation. These figures portray a number of interesting properties of real exchange rate in these countries. First, in every country the RER has experienced significant movements in the 25 year period. Second, in some of these countries -- Sri Lanka being the best example -- there is an apparent structural break that, one can hypothesize, may have been generated by a structural change in one of the RER fundamentals. Third, it is difficult to establish a real exchange rate appreciation trend, as some observers have suggested (Wood, 1987). Fourth, with a few exceptions -- El Salvador being the most notable one -- in the last two years of the sample the majority of these countries have experienced a significant RER depreciation. This has basically been the consequence of deliberate nominal exchange rate policies pursued after the unleashing of the debt crisis in 1982.[10] Notice, however, that although the RER index has been fairly variable in all countries, the extent of variability has differed quite significantly across them.

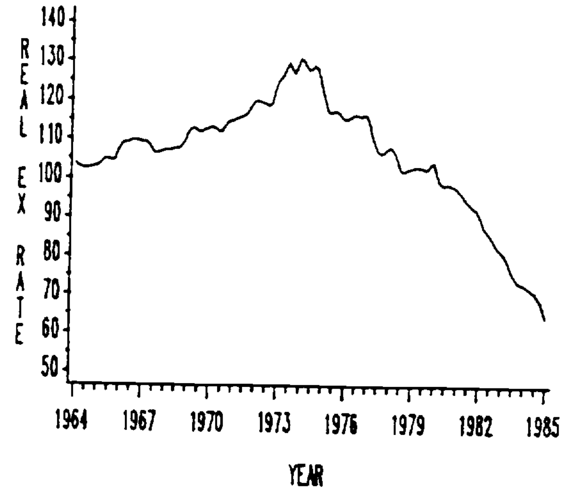
An important and difficult issue refers is whether these series are stationary.[11] If the series are nonstationary, standard regressions that try to explain the log of the RER would be meaningless; the standard errors of the parameters would be incorrect. Moreover, if the log of the RER is a random walk, the variance of forecasts into the future would be infinite; in a way, the system would not be anchored. In this paper the stationarity question was analyzed using two procedures. First the quarterly detrended time series were analyzed using the Box-Jenkins technique. In most cases the pattern of autocorrelation and partial autocorrelation functions suggested for most countries an ARMA(1,1). Second, the augmented Dickey-

REAL EXCHANGE RATE
(1980=100)

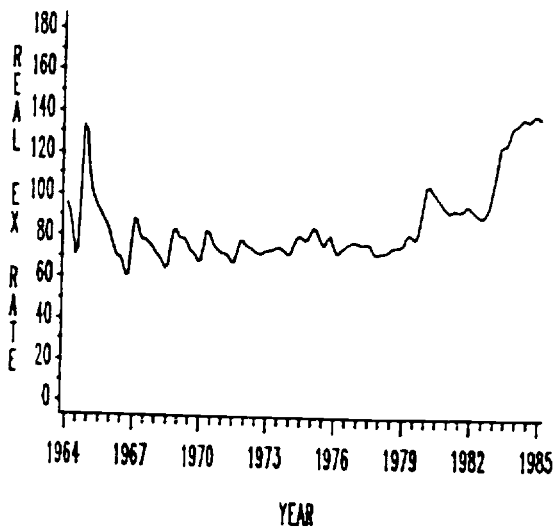
COUNTRY=COLOMBIA



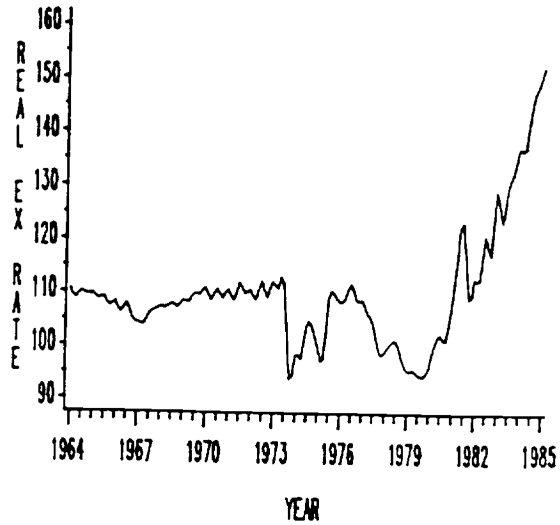
COUNTRY=EL SALVAD



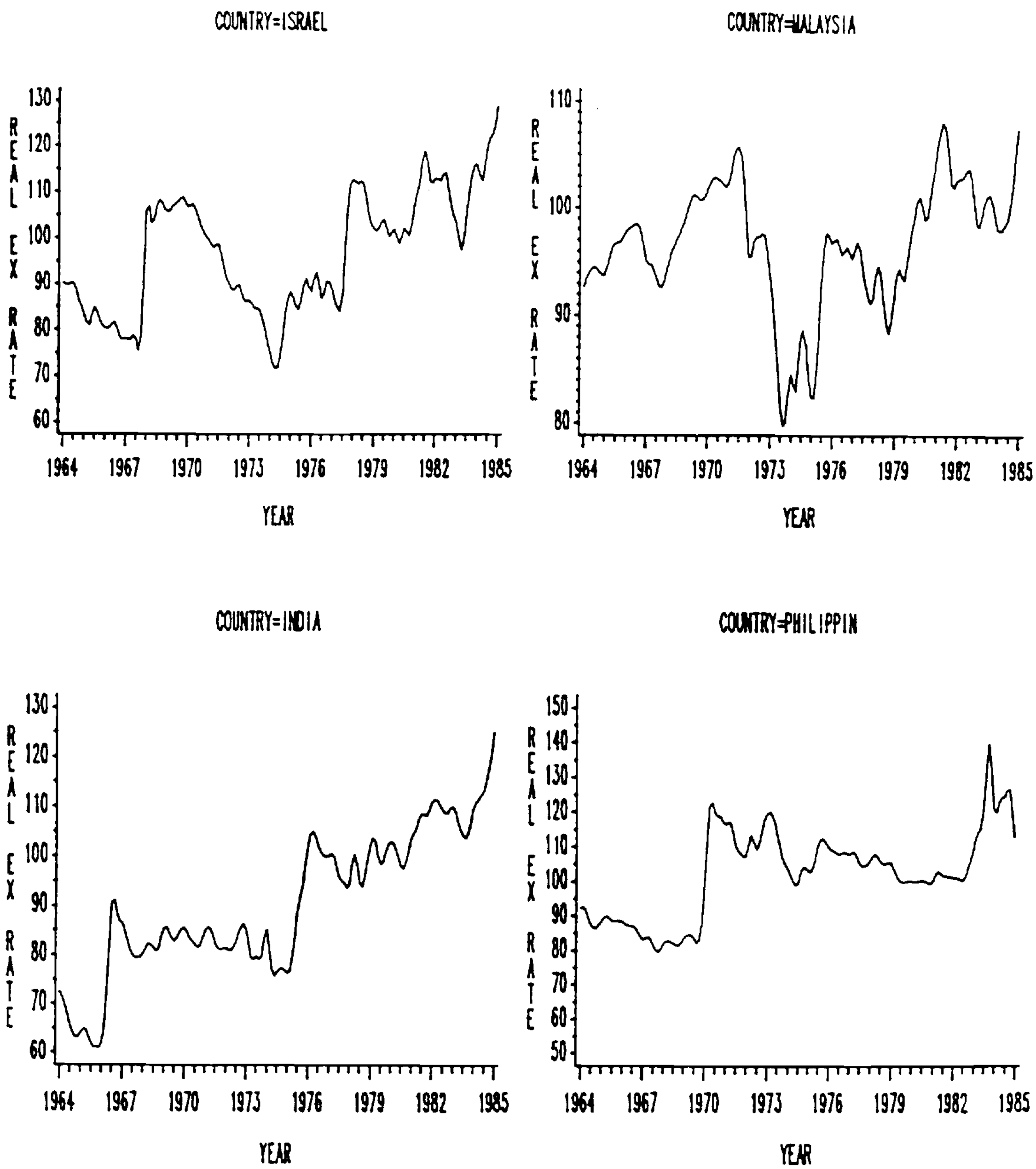
COUNTRY=BRAZIL



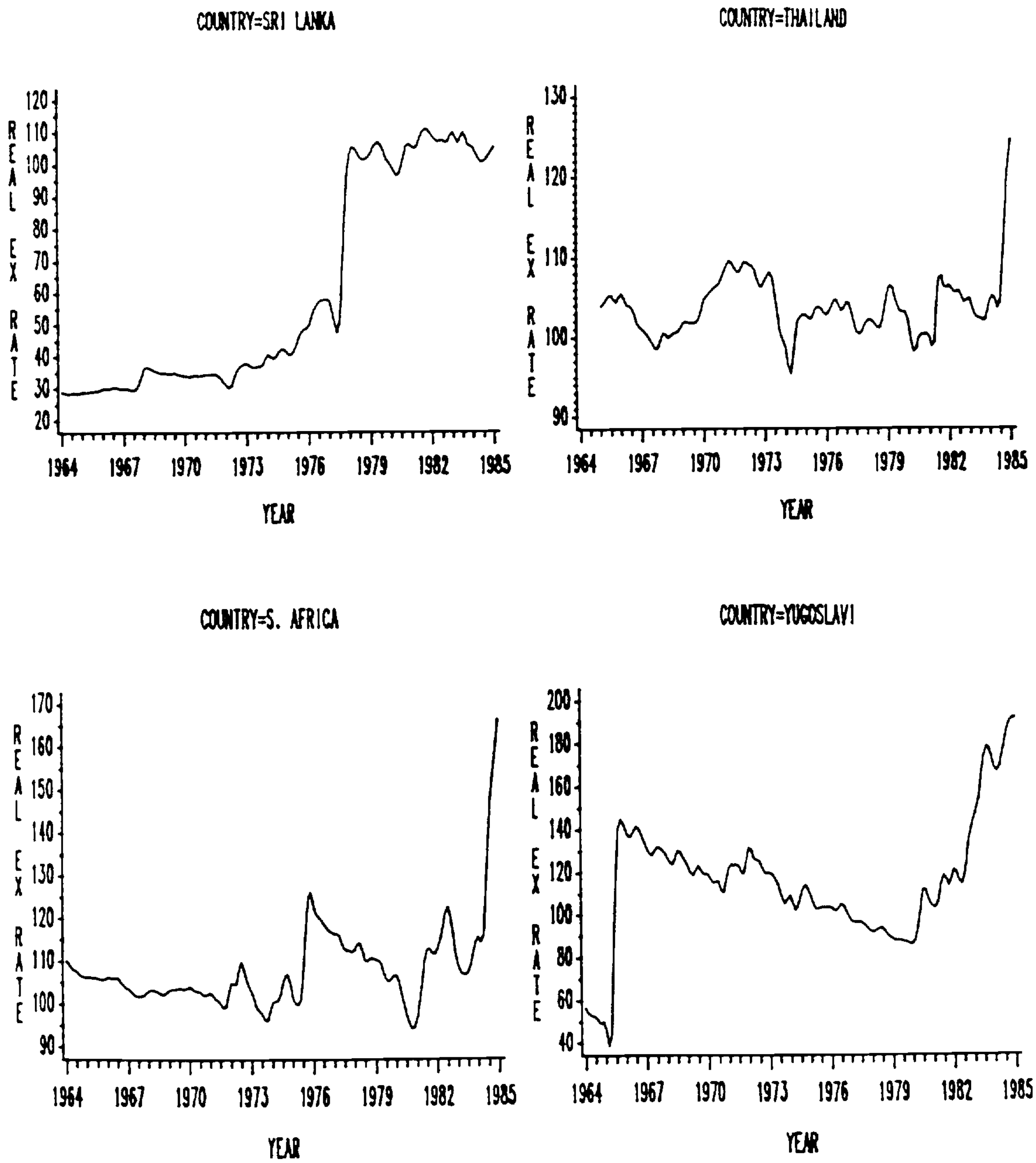
COUNTRY=GREECE



REAL EXCHANGE RATE
(1980=100)



REAL EXCHANGE RATE
(1980=100)



Fuller test for the presence of unit roots was also computed.

Table 2 contains the estimated coefficient of the ARMA(1,1) processes for the (detrended) log of the RER index. These computations were performed on quarterly data, and exclude Brazil due to the lack of long enough time series. As can be seen, in all cases the AR term was quite high and always significant. For most countries the MA term was negative and also significant. However, what is more important is that in 9 of the 11 cases -- the exceptions being El Salvador and Malaysia -- it is not possible to reject the hypothesis that these series indeed follow a stationary and invertible ARMA(1,1) process. Table 3, on the other hand, presents two computations for the augmented Dickey-Fuller τ-statistic. The first computations were performed using three lags for the differences of the log of the RER, while the second used 13 lags. These figures provide a somewhat different picture from that in Table 2. In fact, according to the augmented Dickey-Fuller test, with the exception of India and Sri Lanka, it is not possible to reject the null hypothesis of a unit root. The evidence, then, is inconclusive regarding the stationarity of these series. This is, of course, usually the case when the AR term is very near the unit circle. What is clear, however, is that the first differences of log RER are stationary.

4. Real and Monetary Determinants of Real Exchange Rates: The Empirical Evidence

In this section we use data for our 12 developing countries to test the most important implications of the model derived in Section 2. These implications were: First, in the short run real exchange rate movements will respond to both real and monetary disturbances. Second, in long run equilibrium real exchange rate movements will depend on real variables only. Third, inconsistently expansive macroeconomic policies will generate, in

TABLE 2

Estimates of ARMA(1,1) for log RER:

Quarterly Data 1965-1983

	AR	MA	Q(15)
Brazil	-	-	-
Colombia	0.980 (0.021)	-0.476 (0.100)	21.6
El Salvador	0.997 (0.104)	-0.428 (0.104)	38.7
Greece	0.871 (0.075)	0.338 (0.142)	21.7
India	0.737 (0.090)	-0.458 (0.114)	10.8
Israel	0.834 (0.073)	-0.115 (0.131)	11.3
Malaysia	0.946 (0.112)	-0.387 (0.112)	29.2
Philippines	0.874 (0.122)	-0.202 (0.122)	16.2
South Africa	0.894 (0.116)	-0.287 (0.116)	17.2
Sri Lanka	0.958 (0.040)	-0.557 (0.096)	8.7
Thailand	0.904 (0.054)	-0.238 (0.134)	17.0
Yugoslavia	0.332 (0.130)	-0.096 (-0.099)	4.2

Notes: The numbers in parentheses are approximate standard errors. Q(15) is the Box-Pierce statistic for autocorrelation check of the residuals. It is distributed χ^2 with 15 degrees of freedom. The critical value of the χ^2 distribution at 95% level of significance and 15 degrees of freedom is 25. Brazil was excluded due to the lack of long enough quarterly time series.

TABLE 3

Augmented Dickey-Fuller Tests for Stationarity:

log RER Levels, Quarterly Data 1965-1984

$$X_t = \alpha + \text{time} + \rho X_{t-1} + \sum_{i=1}^{K} \beta_i \Sigma(X_{t-i} - X_{t-i-1}) + \epsilon_t$$

	$\tau(\rho)$ K = 3	$\tau(\rho)$ K = 13
Colombia	-2.910	-2.034
El Salvador	-2.699	-1.710
Greece	-1.087	-1.068
India	-6.006	-4.458
Israel	-2.928	-2.207
Malaysia	-1.041	-1.148
Philippines	-2.833	-2.689
South Africa	-1.835	-0.320
Sri Lanka	-2.238	-3.627
Thailand	-1.220	-0.987
Yugoslavia	-1.167	-1.271

Notes: X_t denotes the log of the bilateral real exchange rate. The critical value at the 90% level is -3.15 for 100 observations. Brazil was excluded due to lack of long enough quarterly time series.

the short run, a situation of real exchange rate misalignment (i.e., an overvaluation). Fourth, nominal devaluations will only have a lasting effect on the equilibrium real exchange rate if they are undertaken from a situation of real exchange rate misalignment and if they are accompanied by "appropriate" macroeconomic policies. The model also predicts that there will be a negative relation between the parallel market spread and the actual (as opposed to equilibrium) real exchange rate. These two variables, of course, are endogenous. In addition, the model provides a list of (some of) the relevant real "fundamentals" that determine the behavior of the equilibrium RER (i.e., import tariffs, terms of trade, composition of government consumption, capital flows).

An Equation for the Dynamics of RERs

The following equation for the dynamics of RER behavior captures the basic points made by our theoretical analysis:

$$\Delta \log e_t = \theta(\log e^*_t - \log e_{t-1}) - \lambda(Z_t - Z^*_t) + \phi(\log E_t - \log E_{t-1}) - \psi[PMPR_t - PMPR_{t-1}] \quad (27)$$

where e is the actual real exchange rate; e^* is the equilibrium real exchange rate, in turn a function of the fundamentals; Z_t is an index of macroeconomic policies (i.e., the rate of growth of domestic credit); Z^*_{t-1} is the sustainable level of macroeconomic policies (i.e., rate of increase of demand for domestic money); E_t is the nominal exchange rate; PMPR is the spread in the parallel market for foreign exchange; θ, λ, ψ and ϕ are positive parameters that capture the most important dynamic aspects of the adjustment process.

Equation (27) establishes that the actual dynamics of real exchange rates respond to the four forces identified in Section 2. First, there will be an autonomous tendency for the actual real exchange rate to correct existing misalignments, given by the partial adjustment term $\theta(\log e^*_t - \log e_{t-1})$. With all other things given this self-correcting process tends to take place, under pegged nominal rates, through reductions in prices of nontradable goods or increases in "the" world price of tradables P^*_T. The speed at which this self-adjustment takes place is captured in equation (27) by parameter θ. The smaller is θ (i.e., the closer it is to zero), the slower will be the speed at which real exchange rate misalignments will be corrected. Theoretically, the value of θ will depend on the value of the different parameters in our model. In addition, a number of institutional factors, including the existence of wage indexation rules will influence its level.

The second determinant of real exchange rate movements is related to macropolicies and is given by $-\lambda[Z_t - Z^*_t]$. This term states that if the macroeconomic policies are unsustainable in the medium to longer run and are inconsistent with a pegged rate (i.e., $Z_t > Z^*_t$) there will be pressures towards a real appreciation: that is if $(Z_t - Z^*_t) > 0$, with other things given, $\Delta \log e < 0$. Notice that if macroeconomic disequilibrium and/or λ are large enough, these forces can easily dominate the self-correcting term, generating an increasing degree of overvaluation through time.

The third determinant of RER movements is related to changes in the nominal exchange rate (i.e., to nominal devaluations) and is given by term $\phi(\log E_t - \log E_{t-1})$. This term closely captures the implications from our model. A nominal devaluation will have a positive effect on the real exchange rate on <u>impact</u>, generating a short-run real depreciation; the actual magnitude of this real depreciation will depend on parameter ϕ.

The fourth element refers to the effect of changes in the parallel market premium on the real exchange rate. As shown in Section 2, increases in the parallel market spread will be related to a real exchange rate appreciation. Naturally, both e and PMPR are endogenous variables.

An important property of equation (27) is that, as in the model in Section 2, although nominal devaluations will have an effect on the real exchange rate in the <u>short run</u>, this effect will not necessarily last through time. In fact, as in the model, whether the nominal devaluation will have any impact over the medium to longer run will depend on the other two terms of equation (27), or, more precisely, on the initial conditions captured by (log e*-log e) and on the accompanying macropolicies, captured by $[Z_t - Z_t^*]$.

<u>The Equilibrium Real Exchange Rate</u>

According to the model of Section 2, the most important "fundamentals" in determining the behavior of equilibrium RERs are: (1) external terms of trade; (2) level and composition of government consumption; (3) import tariffs; (4) and capital flows. However, given the relative simplicity of that model some other possible real determinants of the equilibrium RER that were not explicitly derived from the model were also included in some of the equations estimated. For example, the variable technological progress was included in order to capture the possible role of the so-called Ricardo-Balassa effect on the equilibrium real exchange rate. According to this hypothesis countries experiencing a faster rate of technological progress will experience an equilibrium RER appreciation (Balassa (1964)).

For the purpose of estimating equation (27) the equilibrium real exchange rate was written in the following form:

$$\log e^*_t = \beta_0 + \beta_1 \log(TOT)_t + \beta_2 \log(NGCGDP)_t + \beta_3 \log(TARIFFS)_t$$
$$+ \beta_4 \log(TECHPRO)_t + \beta_5 (KAPFLO)_t + \beta_6 \log(OTHER)_t + u_t \qquad (28)$$

where the following notation has been used:

e*: equilibrium real exchange rate

TOT: external terms of trade, defined as (P^*_X/P^*_M)

NGCGDP: ratio of government consumption on nontradables to GDP.

TARIFFS: proxy for the level of import tariffs.

TECHPRO: measure of technological progress

KAPFLO: capital inflows; if negative it denotes capital outflows.

OTHER: other fundamentals, such as the investment/GDP ratio.

u: error term.

A problem faced in the implementation of this analysis refers to the unavailability of time series for some of the real exchange rate fundamentals in equation (28). In fact, the only fundamentals for which we have reliable data are the external terms of trade (TOT) and capital flows (KAPFLO). This means that in the estimation of the RER equation the other fundamentals either have to be excluded or, alternatively, proxies for them have to be found. In this investigation we followed the two approaches, estimating real exchange rate equations under alternative specifications that either omitted variables or used proxies for those which did not have data. The following proxies were used: technological progress was proxied by the rate of growth of real GDP. This type of proxy has been used in a number of empirical investigations dealing with the Ricardo-Balassa effect. With respect to import tariffs we computed implicit tariffs as the ratio of tariff revenues to imports. This proxy, however, has some limitations, since it is only available for a few years for each country, and it ignores the role of nontariff barriers. The ratio of government consumption on nontradables to GDP was replaced by the ratio of the government consumption to GDP (GCGDP). This is an admittedly limited proxy, since it is possible for GCGDP to increase with the share of nontradables on government expenditure actually going down. This means that the actual sign of GCGDP can be either positive or negative.

Macroeconomic Policies

In the RER dynamics equation (28) the term $-\lambda(Z_t - Z^*_t)$ measures the role of macroeconomic policies in real exchange rate behavior. According to our model, with other things given, if macroeconomic policies are "inconsistent" the RER will become overvalued. In the estimation the following components of $(Z_t - Z^*_t)$ were used:

(1) Excess supply for domestic credit (EXCRE) measured as the rate of growth of domestic credit minus the lagged rate of growth of real GDP:

$$EXCRE_t = (\text{dlog Domestic Credit}_t - \text{dlog GDP}_{t-1});$$

this assumes that the demand for domestic credit has a unitary elasticity with respect to real income.

(2) Also, we incorporated the ratio of fiscal deficit to lagged high powered money (DEH) as a measure of fiscal policies.

(3) Also, instead of our measure for the excess supply of domestic credit in a number of equations we included the rate of growth of domestic credit (DPDC).

Estimation

After replacing the equation for $\log e^*_t$ and the expressions for $(Z_t - Z^*_{t-1})$ into (27) we obtain an equation that could, in principle, be estimated using conventional methods. For example, when EXCRE is the only element of the macroeconomic policies vector $(Z_t - Z^*_t)$ the equation to be estimated is:

$$\Delta\log e_t = \gamma_1 \log(TOT)_t + \gamma_2 \log(GCGDP)_t$$
$$\gamma_3 \log(TARIFFS)_t + \gamma_5 (KAPFLO)_t + \gamma_6 \log(TECHPRO)_t$$
$$- \theta \log e_{t-1} - \lambda EXCRE_t + \phi NOMDEV_t$$
$$- \psi(PMPR_t - PMPR_{t-1}) + u_t \qquad (29)$$

where NOMDEV stands for nominal devaluation, and where the γ's are combinations of the β's and θ.

In our case the estimation of (29), or of its variants, is a task not completely free of problems. First, there are measurement errors. Starting with the dependent variable many of the variables involved are only proxies of the ideal correctly-measured variables. Second, for any particular country, the time series available for some of these variables are extremely short, making the country-by-country estimation of equation (29) all but impossible. For this reason pooled data procedures were used. Third a number of these variables -- most notably the parallel market premium -- are endogenous, making results obtained from OLS estimates suspicious. This last problem is compounded by the fact that since $\log e_{t-1}$ appears on the right hand side, the use of lagged endogenous variables as instruments is not completely appropriate. In evaluating the results reported above these problems should be kept in mind.

Results

Several versions of equation (29) were estimated using pooled data for the group of 12 countries of Section 3. These countries were chosen because of data availability. They were the only ones with long enough time series for all the relevant variables (except the proxies for import tariffs). Also throughout the period all of these countries had predetermined nominal exchange rate regimes -- either pegged or crawling. Moreover all of them, except El Salvador, experienced substantial nominal devaluations during the period under analysis. In some of the regressions the change in the parallel market spread ($\Delta PMPR_t$) was omitted since it is highly co-linear with the other RHS variables.[12]

The estimation was performed using instrumental variables on a fixed-effect procedure, with country specific dummy variables included in each regression.[13] Table 4 contains a summary of the results obtained from the estimation of a number of variants of equation (29). The results are quite satisfactory and provide support to the view that short-run movements in real exchange rates respond both to real and nominal variables.

In most of the regressions the measures of macroeconomic policy -- the excess supply of domestic credit (EXCRE), the fiscal deficit ratio (DEH) and the rate of growth of domestic credit (DPDC) -- are significantly negative. This indicates that, in accordance to the implications obtained from the model, as these policies become increasingly expansive -- higher deficits or increased excess supply for credit -- the real exchange rate will <u>appreciate</u>. Naturally, if we start from RER equilibrium and other things including the fundamentals remain constant, this appreciation will reflect a mounting disequilibrium. For the excess supply for credit (EXCRE) the estimated coefficients ranged from -0.147 to -0.075. Although these coefficients appear somewhat small, they do imply that inconsistent domestic credit policies maintained for periods of 3 to 4 years can generate very substantial disequilibria. Consider, for example, the case of equation (29.2) with a coefficient for EXCRE of -0.147; if domestic credit grows at a rate of 25% per year and real income at 5%, after three years there will be an accumulated real appreciation of 9.1%. In this sense, the estimates for the macro variables coefficients strongly support the view that inconsistent policies will result in growing pressures that will generate real exchange rate overvaluations.

The results in Table 4 show that real variables (the "fundamentals") have also influenced RER behavior in these countries. In all regressions the coefficients of the (log of the) terms of trade is negative, and significant at conventional levels in a number of them. Remember that according to our model the sign of the TOT coefficient was theoretically ambiguous. The results, however, give support to the popular view that suggests that improvements in the terms of trade -- an increase in log(TOT) -- will result in an equilibrium real appreciation (Edwards and van Wijnbergen 1987). The value of the coefficient is rather small; the reason is that this is the short run coefficient. The long run coefficient, of course, is much larger.

Due to the lack of data on the composition of government consumption, the ratio of government expenditures to GDP (log GCGDP) is the only real variable related to government behavior incorporated in the analysis. In most cases this coefficient was not significant, and in a number of equations it was positive. Notice that the coefficient of real growth turned out to be positive in all regressions and significant in a number of them. To the extent that growth is considered to be a measure of technological progress this result seems to contradict the Ricardo-Balassa hypothesis. The estimated coefficient of the proxy for tariffs was negative as suggested by the theory, although not significantly different from zero.

In all equations where it was included, the coefficient of the change in the parallel market spread was negative as suggested by the theory. It should be noticed that this variable may be capturing the effect of broadly defined exchange (i.e., trade and capital) controls. It is well known that as countries impose additional external restrictions the parallel market

TABLE 4

Real Exchange Rate Equations

(Instrumental Variables)

	Equations No.								
	29.1	29.2	29.3	29.4	29.5	29.6	29.7	29.8	29.9
$EXCRE_t$	-	-0.147 (-4.075)	-	-0.075 (-1.439)	-0.075 (-3.404)	-0.099 (-1.985)	-	-	-0.134 (-3.680)
$DPDC_t$	-0.132 (-3.462)	-	-0.052 (-0.898)	-	-	-	-0.116 (-2.987)	-0.175 (-5.660)	-
DEH_t	-	-	-	-	-0.019 (-2.016)	-	-0.016 (-2.148)	-	-0.015 (-1.759)
ΔNOM_t	0.665 (13.213)	0.689 (13.340)	0.431 (4.226)	0.467 (10.451)	0.634 (11.130)	0.516 (7.443)	0.678 (13.400)	0.561 (14.973)	0.702 (13.604)
$\Delta PMPR_t$	-	-	-0.525 (-3.056)	-0.486 (02.940)	-	-0.392 (-3.074)	-	-	-
$LTOT_t$	-0.052 (-2.100)	-0.056 (-2.234)	-0.042 (-1.247)	-0.044 (-1.378)	-0.003 (-0.840)	-0.018 (-0.503)	-0.057 (-2.276)	-0.019 (-0.873)	-0.062 (-2.310)
$Tariff_t$	-	-	-	-0.345 (-0.750)	-0.396 (-0.682)	-0.335 (-0.749)	-	-	-
$KAPFLO_{t-1}$	-	-	-	-	-	-	-	-0.163 (-1.376)	-0.040 (-0.820)
$LGCGDP_t$	0.021 (0.774)	0.027 (0.995)	0.006 (0.153)	0.009 (0.263)	-0.016 (-0.589)	-0.015 (-0.497)	0.025 (0.908)	-0.047 (-2.422)	0.029 (1.086)

(continued)

Table 4 (continued)

	29.1	29.2	29.3	29.4	29.5	29.6	29.7	29.8	29.9
$GROWTH_t$	0.146 (4.762)	0.150 (4.968)	0.633 (1.282)	0.702 (1.483)	0.090 (3.220)	0.085 (0.219)	0.146 (4.796)	-	0.148 (4.844)
$\log e_{t-1}$	-0.072 (-2.390)	-0.072 (-2.387)	-0.088 (-2.147)	-0.084 (-2.147)	-0.123 (-2.184)	-0.203 (-2.899)	-0.059 (-4.568)	-0.041 (-1.970)	-0.058 (-1.750)
N	225	225	225	120	120	120	225	225	225
R^2	0.524	0.529	0.396	0.422	0.678	0.663	0.532	0.591	0.540
χ^2	50.9	58.9	61.6	65.3	29.8	38.5	55.2	49.8	51.3

Notes: The numbers in parentheses are t-statistics. N is number of observations; χ^2 is the test for testing that all nonmonetary variables are jointly zero.

coverage and rate rapidly increase. Also, the coefficient of the capital flows variable had the negative sign predicted by the theoretical model when they were included as an explanatory variable. It turned out, however, that those coefficients were not significant at the conventional levels.

The estimated coefficients of nominal devaluation (NOMDEV) and lagged RERs provide the last two elements of analysis for the dynamics of RERs. The coefficient of NOMDEV is always significantly positive, ranging from 0.467 to 0.689. This indicates that even with all other things given, a nominal devaluation will be transferred in a less than one-to-one real devaluation in the first year. The size of this coefficient is, however, quite large, and provides evidence supporting the view that nominal devaluations can indeed be a quite powerful device to reestablish real exchange rate equilibrium. If, for instance, as in our prior example, the real exchange rate becomes overvalued by 9%, a nominal devaluation of approximately 15% will help regain equilibrium. Naturally for the nominal devaluation to have a lasting effect, it is necessary that the sources of the original disequilibrium -- the positive EXCRE and DEH -- are eliminated. If this is not the case, soon after the devaluation the RER will again become overvalued.

The coefficients of lagged RER are quite low in all regressions, but significantly different from zero. This is not surprising in light of the analysis of the time series properties of RERs discussed in Section 3. From an economic perspective these low values for the coefficients imply that in the absence of other intervention, actual real exchange rates converge very slowly towards their long run equilibrium level. This, indeed, supports the view that when there is a real exchange rate misalignment nominal devaluations, if properly implemented, can be a very powerful tool to help reestablish equilibrium.

The χ^2 tests reported at the bottom of Table 4 test the null hypothesis that all non-monetary variables are jointly zero. The critical value of the χ^2 distribution at the 95% level of significance is 7.38 for 2 degrees of freedom, 9.35 for 3 degrees of freedom and 11.1 for 4 degrees of freedom. As can be seen, all the χ^2 statistics are well above these critical values, indicating that the real factors as a group have indeed played an important role in determining RER behavior in these countries.

5. Summary, Conclusions and Extensions

The purpose of this paper has been to analyze RER behavior in developing countries. For this purpose the paper started with the presentation of a dynamic model of a small open economy with a dual exchange rate system. The model, although highly stylized, provided a number of important testable implications. The aim of the empirical part of the paper was to analyze whether, as the theoretical model suggests, real exchange rate movements have historically responded to both real and nominal disturbances. In order to carry out the analysis an equation for real exchange rate dynamics was postulated. This equation captures in a simple and yet powerful way the most important features of our theoretical analysis: (1) discrepancies between actual and equilibrium real exchange rates will tend to disappear slowly if left on their own; (2) nominal devaluations are neutral in the long run, but can be potentially helpful to speed up the restoration of real exchange rate equilibrium; (3) macroeconomic disequilibria affect the real exchange rate in the short run; (4) the long run equilibrium real exchange rate responds to changes in fundamentals. In addition the model provided us with a list of such fundamentals and the way in which they affect the equilibrium real exchange rate.

This dynamic equation was estimated using pooled data for a group of 12 countries. The estimation was done using a fixed effect procedure with country specific fixed terms. The results obtained provide broad support for the model of Section 2. In these countries real short run exchange rate movements have responded to both nominal and real disturbances. In particular expansive and inconsistent macroeconomic policies have inevitably generated forces towards real overvaluation.

The estimation also indicates that the autonomous forces that move the RER back to equilibrium operate fairly slowly, maintaining the country out of equilibrium for a long period of time. These results, in fact, indicate that if a country is indeed in disequilibrium, nominal devaluations can greatly help to speed up the real exchange rate realignment.

This analysis can be extended in several ways. One of the most interesting directions is related to estimating indexes of real exchange rate misalignment and, in turn, to use those indexes to investigate whether real exchange rate disequilibrium has indeed been associated to poorer economic performance. A possible -- and rather simple -- way of doing this is the following. First, from the estimation of equation (29) the coefficients of the long run equilibrium real exchange rate equation can be obtained. Second, using estimated equilibrium "sustainable" values of the fundamentals, estimated equilibrium RERs can be generated for each country. Third, RER exchange rate misalignment can then be defined as the difference between these estimated equilibrium RERs and actual RERs. Fourth, average indexes of RER misalignment can then be calculated for each country. Finally, these average indexes of misalignment can be used to estimate whether it has been the case that countries exhibiting larger misalignments have performed worse, with other things given, than those countries with the smaller degree of RER misalignment. This last step can be performed using cross country regression analysis. (For a preliminary analysis along these lines see Edwards 1988a.)

Footnotes

[1]On the role of real exchange rate misalignment see, for example, Dornbusch (1982) and Williamson (1985). On real exchange rates and economic performance see Harberger (1986), and Dervis and Petri (1987).

[2]The situation is not really better when it comes to the developed countries case. Here most recent empirical work has dealt with whether real exchange rates have a unit root, without significant efforts being devoted to analyzing the way in which RERs have responded to fundamentals. In the case of the developing nations the study by Khan (1986) is an exception.

[3]In Edwards (forthcoming) I discuss in detail the issues related to alternative definitions of the real exchange rate -- see also Edwards (1988a).

[4]The relevant expressions for determining the saddle path stability are:

$$\frac{\partial \dot{m}}{\partial m} = -\left\{\left[\left(\frac{\partial Q_X}{\partial e_X}\right)\frac{E}{P_N^2} - \left(\frac{P_M^*}{P_N}\right)\left(\frac{\partial C_M}{\partial e_M}\right)\left(\frac{P_M}{P_N}\right)\right]\frac{\partial v}{\partial a} + P_M^*\left(\frac{\partial C_M}{\partial a}\right)\right\} < 0,$$

and $\frac{\partial \dot{\rho}}{\partial \rho} = (L(\cdot) - L'\sigma) > 0.$

[5]On balance of payments crises and speculative attacks see, for example Krugman (1979), Obstfeld (1984), Flood and Garber (1984) and Calvo (1987). These papers, however, do not consider the case of a dual nominal exchange rate system.

[6]If the free rate were to jump there would be an "infinite" return to speculation. This is ruled out by the perfect foresight assumption. Economies with dual exchange rates are investigated by Dornbusch (1986a,b), Lizondo (1987a), Kiguel and Lizondo (1987) and Aizenman (1985).

[7]Instead of assuming an unanticipated increase in D, an alternative exercise would consist of a fully expected increase in D. In this case ρ will jump when the public anticipates the future increase of D. Then the system will move towards the northwest on a divergent path; the spread will continue to increase, and reserves will begin to go down even before the shock. At the time when D actually goes up we will observe the jump in m. The free rate δ, and the spread, however, will not jump at that time. The system will at that time move to the saddle path, and the more conventional adjustment will take place.

[8]See, for example, Harberger (1986), Diaz Alejandro (1986).

[9]An important limitation of this index is that it refers to a bilateral real exchange rate. On the attributes of this and other empirical measures of real exchange rates see Edwards (forthcoming).

[10]See, for example, Cline (1983), Edwards (1988b).

[11]Some recent papers on the more advanced economies have been concerned with whether the time series of RER indexes have a unit root. In many ways these discussions have been inserted in a new statistically oriented literature that inquires (once again) on whether Purchasing Power Parity holds (Kaminsky 1987; Huizinga 1986). In the case of our data set it is clear from a simple inspection of the diagrams that the simple version of PPP is a grossly inadequate representation of RER behavior. In fact, formal tests on the time series properties of these indexes -- Box-Pierce Q tests -- strongly reject the null hypothesis that the strong (or absolute) version of PPP holds.

[12]Moreover, as discussed below, the black market premium may very well be picking up the effects of exchange controls and capital market impediments.

[13]All the data except the black market premiums and the tariff proxies were obtained from the International Financial Statistics. Parallel market data come from Pick's Currency Yearbook and tariff proceeds from the IMF Government Finance Statistics. The following instruments were used: fiscal deficit; contemporaneous, lagged and twice lagged GDCDPP; NOMDEV; lagged NOMDEV; contemporaneous, lagged, twice and three times lagged log of nominal exchange rate; lagged e; terms of trade and lagged terms of trade; EXCRE, lagged EXCRE; contemporary and up to three lags unexpected money; contemporary and up to three lags unexpected credit growth; DPDC, lagged and twice lagged DPDC, and country specific dummies.

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