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Macroeconomic Implications of Real Exchange Rate Targeting in Developing Countries

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Abstract

This paper analyzes the macroeconomic effects of a variety of exogenous and policy-induced real disturbances when the authorities target the level of the real exchange rate. It first discusses the implications--particularly for inflation and the current account--of targeting the rate at an "overdepreciated" level. The paper then examines the dynamic response of both output and inflation to a number of shocks. Further applications of the model, particularly as regards fiscal explanations of inflation, high-inflation plateaus, and money-based stabilization programs, are also considered.

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I. Introduction

It is by now well accepted that the real exchange rate is an important endogenous variable that responds to both exogenous and policy-induced real disturbances. Not infrequently, however, it is also a variable that is implicitly or explicitly targeted by policymakers. For example, the acceleration of inflation in many developing countries has led to an increased use of nominal exchange rate depreciation as a means of preventing losses in international competitiveness. In many such cases, the nominal exchange rate is explicitly linked to inflation differentials in order to keep the real exchange rate from deviating too far from its targeted level. In this context, the policymakers undertake to make frequent adjustments to the nominal exchange rate (in some cases on a daily basis) in order to keep the real exchange rate close to its "equilibrium" level, typically taken to be the level in some base period. 1/

Previous analytical work has explored the relationship between the real exchange rate and its fundamental exogenous determinants under the assumption that the value of the equilibrium real exchange rate is determined by the requirement that the domestic market for nontradable goods be in continuous equilibrium (internal balance) and that the current account deficit be equal to the value of sustainable capital inflows (external balance). 2/ An important result that emerges from this line of research is that, depending on the values of a variety of elasticities and the type of exogenous disturbance under consideration, movements in the equilibrium real exchange rate may be substantial. 3/ A direct implication of this result is that policies to keep the real exchange rate constant in the face of exogenous real disturbances may prevent the establishment of macroeconomic equilibrium and hence be destabilizing.

Given the prevalence of real exchange rate targeting in developing countries, it is somewhat surprising that there has not been much analytical work on the macroeconomic effects of real exchange rate rules. 4/ Further, there has apparently not been any systematic analysis of the effects of exogenous and policy-induced shocks (such as fluctuations in world interest rates and the international terms of trade, changes in

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1/ Such rules are usually justified on the grounds that they help to keep the real effective exchange rate close to its purchasing power parity (PPP) level.

2/ Examples are Dornbusch (1974), Edwards (1989), Khan and Montiel (1987), and Ostry (1988).

3/ For an attempt to quantify the magnitude of the response of the equilibrium real exchange rate to a variety of disturbances using representative parameter values for the developing countries, see Khan and Ostry (1991).

4/ Exceptions are Dornbusch (1982), Adams and Gros (1986), and Lizondo (1989). The differences between these studies and the present one will become clear as we proceed.

government spending levels and in commercial policies) in economies in which the real exchange rate is targeted by the authorities. This is all the more surprising given the frequency with which the developing countries are subjected to such disturbances, as well as the prevalence of real exchange rate targeting in these countries.

This paper attempts to address some of the above issues in the context of a familiar dynamic model in which the authorities pursue an explicit target for the real exchange rate. 1/ Two versions of the model are considered. In the first, nominal wages and prices are completely flexible and accordingly, output does not deviate from its full employment level. In the second, a Phillips curve determines the rate of nominal wage adjustment in the short-run. Although the long-run properties of the two models are identical, the transition paths towards the steady state are not. Since an important issue in previous discussions of real exchange rate rules has been their effects on "macroeconomic stability" (defined broadly to include the stability of both prices and output), it seems reasonable to compare the adjustment to various shocks under alternative assumptions about the flexibility of the labor market, on which output responsiveness depends. 2/

The remainder of this paper proceeds as follows. Section II presents the basic model under a real exchange rate rule. The model is then used in Section III to study the effects of a number of exogenous and policy-induced shocks on the main endogenous variables of the system. Section IV re-examines these issues in the context of the model with short-run wage stickiness. Section V considers some further applications of the model, having to do with fiscal explanations of inflation, high-inflation plateaus, and money-based stabilization programs. The main conclusions of the paper are presented in Section VI.

II. The Basic Model with Flexible Wages

We begin by describing the "full employment" version of the type of model posited by Khan and Montiel (1987), in which there is instantaneous

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1/ In a recent paper, Lizondo (1989) also looks at the effects of a variety of different real exchange rate rules. However, the model utilized differs from the one developed below in terms of the number of assets in the model and the commodity structure. In addition, Lizondo (1989) does not consider the adjustment of the economy to various exogenous and policy-induced shocks, which is the main subject of this paper.

2/ Effects of real exchange rate rules on macroeconomic stability are discussed in Dornbusch (1982) and Adams and Gros (1986). The former focuses on output fluctuations, while the latter is concerned primarily with price movements.

adjustment of money wages. 1/ The Khan-Montiel model assumed a fixed exchange rate, whereas the present version assumes that the authorities use the nominal exchange rate in order to continuously maintain the real exchange rate constant at some predetermined level. For ease of comparison between the models with and without real exchange rate rules, we follow the basic outline of the model's description in the Khan-Montiel paper. 2/

1. Supply

We model a small open economy in which there are three goods: importables, exportables, and nontradables. A homogeneous factor (labor) is allocated competitively among the profit-maximizing producers of the three goods. A standard concave production technology is available in each sector. There is no investment and, accordingly, producers' optimization boils down to a static problem.

The sectoral demand for labor depends on the real product wage. In equilibrium, the sum of the sectoral demands for labor must equal the supply, which is assumed to be fixed. The equality of the demand for labor and the fixed supply of labor determines an equilibrium wage function. The wage here is expressed in terms of units of the importable good, which is taken to be numeraire throughout the analysis. Thus, if W is the money wage, and P_z is the domestic price of importables, then the wage in terms of the numeraire (hereafter referred to simply as the wage), w, is equal to W/P_z. Using this notation, the real product wage in the remaining two sectors may be written as w/ρ for the exportables sector, and ew for the nontradables sector, where ρ is the terms of trade defined as the relative price of exportables to importables, P_x/P_z, and e is the real exchange rate, defined as the relative price of importables to nontradables, P_z/P_n. 3/ Clearly, with sectoral labor demands depending on the real product wages, which in turn depend on the terms of trade and the real exchange rate, the equilibrium wage will also depend on these two relative prices:

(1) $w = w(\rho,e)$, $\partial w/\partial \rho > 0$, $\partial w/\partial e < 0$.

1/ The main features of the model draw on the standard two-good dependent economy model popularized by Dornbusch (1974), Rodriguez (1978), and Liviatan (1979). The modelling of asset accumulation is similar to that found in Calvo and Rodriguez (1977) and Khan and Lizondo (1987).

2/ The reader is referred to the Khan-Montiel paper for further discussion of the basic features of the model, which is kept to a minimum in what follows.

3/ This is the importables definition of the real exchange rate. The exportables definition, P_x/P_n, will of course behave in the same way as the importables definition as long as the terms of trade, ρ, remain constant. Complications arising when there are terms of trade changes will be analyzed where relevant.

The signs of the partial derivatives in equation (1) are explained as follows. An improvement in the terms of trade (a rise in ρ) depresses the real product wage in the exportables sector and hence raises the demand for labor in that sector. With the aggregate supply of labor fixed, a higher wage is necessary to reduce demand in the remaining sectors and restore market clearing. Similarly, a fall in e (a real appreciation) depresses the real product wage in the nontradables sector and therefore raises the demand for labor by that sector. Again, w must rise to maintain equality between aggregate labor demand and supply.

With labor as the only intersectorally mobile factor of production, the sectoral output supplies may also be written as functions of the terms of trade and the real exchange rate: 1/ With y_i denoting the output of sector i, and L_i employment of labor in sector i (i=x,z,n), we have:

$$(2a) \quad y_x = y_x\{L_x[w(\rho,e)/\rho]\}, \ \partial y_x/\partial\rho > 0, \ \partial y_x/\partial e > 0,$$

$$(2b) \quad y_z = y_z\{L_z[w(\rho,e)]\}, \ \partial y_z/\partial\rho < 0, \ \partial y_z/\partial e > 0,$$

$$(2c) \quad y_n = y_n\{L_n[w(\rho,e)e]\}, \ \partial y_n/\partial\rho < 0, \ \partial y_n/\partial e < 0,$$

where the signs of the partial derivatives follow from equation (1). Thus, an improvement in the terms of trade increases the supply of exportables but lowers the supply of the other two goods, and a real depreciation raises the supply of both tradable goods and lowers the supply of nontradables.

2. Demand

On the demand side, aggregate real consumption spending c is assumed to depend in standard fashion on real factor income y net of taxes paid to the government t_p, on the real interest rate r, and on the private sector's real financial wealth, all measured in terms of the consumption basket. 2/ Agents are assumed to allocate their aggregate spending in each period between the importable and the nontradable good according to a Cobb-Douglas utility function with weights $1-\theta$ and θ, respectively. 3/ Thus, using the definition of the real exchange rate and the fact that, with the Cobb-Douglas utility function, the price of the consumption basket is a geometric average of the prices of home goods and importables, P_n and P_z, we can write

$$(3a) \quad c_z = (1-\theta)e^{-\theta}c$$

1/ Any sector-specific factors are assumed to be fully employed.

2/ See, for example, Frenkel and Razin (1987a) and (1987b, chapter 4) for previous use of a similar consumption function in the context of an analysis of the Mundell-Flemming model.

3/ We assume that there is no domestic consumption of the exportable good, mainly for simplicity. None of our qualitative results is affected by this assumption.

(3b) $c_n = \theta e^{1-\theta} c$

where

(4) $c = c(y-t_p, r, e^{\theta} a_p), \quad 0 < c_1 < 1, \; c_2 < 0, \; 0 < c_3$

and where a_p is private wealth in terms of importables, so that $e^{\theta} a_p$ is real private wealth in terms of the consumption basket. Finally, using equations (2a)-(2c) and assuming that in the initial equilibrium the trade account of the balance of payments is in balance, it is straightforward to show that real factor income (which is equal to nominal output divided by the consumer price index) may be written as a function of the terms of trade alone: 1/

(5) $y = y(\rho), \quad y'(\rho) > 0,$

where the sign of the derivative follows from equations (1) and (2a)-(2c).

Real household financial wealth consists of real money balances $m = M/P$, where M is the nominal money stock and P the consumer price index, plus the real value of foreign securities $f_p = sF_p/P$, where s is the nominal exchange rate and F_p is the nominal value of foreign securities, minus the real value of the private sector's liabilities $d_p = D_p/P$ which are taken to consist of the real value of loans extended by the banking system. Thus,

(6) $e^{\theta} a_p = m + f_p - d_p.$

It is assumed that money pays no interest, that the nominal return on foreign assets is i^*, and that the domestic cost of borrowing is i. Under the assumptions that domestic and foreign securities are perfect substitutes and that expectations are characterized by perfect foresight, uncovered interest parity implies

(7) $i = i^* + E(\hat{s}) = i^* + \hat{s}$

where a circumflex above a variable denotes a proportional rate of change, so that $E(\hat{s})$ is the expected (equal to actual) rate of depreciation of the domestic currency.

The type of real exchange rate rule that the authorities are assumed to follow involves a continuous adjustment in the nominal exchange rate,

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1/ The assumption that changes in the real exchange rate do not affect the level of real factor income (or equivalently, that the trade account is balanced in the initial equilibrium) is not restrictive and is made mainly in order to simplify the algebra. In general, if there is an initial surplus on trade account, a rise in e raises y, and conversely, if there is an initial deficit, a real depreciation lowers y. See Khan and Montiel (1987, pp. 687-688) for the general case.

s, that keeps the real exchange rate, e, constant at the level that prevailed at the time the authorities begin following the rule. It is possible to think of the authorities following other rules, for example, adjusting the nominal rate of depreciation in proportion to the discrepancy between some target level of the real exchange rate and its actual level, or adjusting the rate of depreciation in accordance with some balance of payments or current account objective. 1/ However, we believe that the type of rule that is considered here is a useful benchmark that captures the main features of real exchange rate targeting in developing countries, in which frequent (almost continuous in some cases) adjustments in the nominal exchange rate are used to prevent the real exchange rate from deviating from its level in the base period.

Using the definition of the real exchange rate, e, and the assumption that the law of one price holds for tradable goods, the real exchange rate rule takes the form:

$$\hat{s} = \pi_n - \pi^*,$$

where π_n is the rate of inflation of home goods ($\pi_n = \hat{P}_n$) and π^* is the rate of inflation of the world price of the importable good (i.e., $\pi^* = \hat{P}_z^*$). Because the domestic price index is a weighted average of P_z and P_n, 2/ the domestic rate of inflation π will be equal to the rate of inflation of home goods, π_n, under the real exchange rate rule. Therefore, the rule could equally be written as

$$(8) \quad \hat{s} = \pi - \pi^*,$$

which involves only the domestic rate of inflation and the rate of inflation of world prices.

Substituting equation (8) into equation (7) yields a relationship between the domestic interest rate, the foreign interest rate and the inflation differential under a real exchange rate rule:

$$(7') \quad i = i^* + \pi - \pi^*.$$

Assuming that the demand for real money balances L depends in conventional fashion on the nominal interest rate and real income, we have, using equation (7'), that

$$(9) \quad m = L(i^* + \pi - \pi^*;\ y) \quad L_1 < 0, \quad L_2 > 0,$$

where L_1 and L_2 are the partial derivatives of real money demand with respect to i and y, respectively. Finally, defining the domestic interest rate r as the difference between the nominal interest rate i and the rate of domestic inflation π, and the foreign real interest rate r^* as the

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1/ These rules are considered in Lizondo (1989).
2/ Recall that exportables are not consumed domestically.

difference between i^* and π^*, and applying equation (7'), it is clear that domestic and foreign real interest rates will be equalized, i.e., $r = r^*$.

Private sector saving is the difference between disposable income and expenditure. Disposable income in turn is equal to the sum of factor income and income from asset holdings less tax payments to the government. Expressing all variables in terms of units of the numeraire, one obtains after some manipulation that the real value of private saving, denoted s_p, may be written as

$$(10)\quad s_p = e^{-\theta}\{y(\rho)-t_p-c[y(\rho)-t_p;r^*;e^{\theta}a_p]\} + (r^*+\pi)(a_p-e^{-\theta}L[r^*+\pi;y(\rho)] + e^{-\theta}(\pi^*-\pi)f_p.$$

Using equation (10), the change in the real value of private asset holdings, $\dot{a}_p$, will be given by:

$$(11)\quad \dot{a}_p = s_p + e^{-\theta}(\pi-\pi^*)f_p - \pi a_p = e^{-\theta}\{y(\rho)-t_p-c[y(\rho)-t_p;r^*;e^{\theta}a_p]\}+r^*a_p-(r^*+\pi)e^{-\theta}L[r^*+\pi;y(\rho)].$$

3. The public sector

The government in this model consumes the same two goods as the private sector. The real value of its consumption (in terms of the consumption basket) is denoted by g. It finances its expenditures by levying taxes (t_p), through the receipt of transfers from the central bank (t_b), and by borrowing (D_g). Like the private sector, the government also holds foreign securities (F_g) which provide it with interest income. 1/ Its net worth at any instant (in terms of the numeraire) is denoted by $a_g = (sF_g - D_g)/P_z$. At any point in time, the government's real budget surplus, s_g, will be given by

$$(12)\quad s_g = e^{-\theta}(t_p+t_b-g) + (r^*+\pi)a_g + e^{-\theta}(\pi^*-\pi)f_g = e^{-\theta}(t_p+t_b) + (r^*+\pi)a_g + e^{-\theta}(\pi^*-\pi)f_g - e^{-1}g_n - g_z,$$

where $f_g = sF_g/P$ denotes the real value of foreign securities, and g_n, g_z denote government consumption of nontradable and importable goods, respectively.

In addition to its instantaneous budget constraint (equation 12), the government's actions must satisfy the standard intertemporal constraint, which rules out Ponzi-type schemes. 2/ It is straightforward to show that the joint satisfaction of this intertemporal constraint and the analogous constraint for the rest of the world requires that $\dot{a}_g$ must converge to

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1/ If the government chose to borrow abroad, F_g would simply be negative.

2/ Technically, the requirement is that the government's net worth be nonnegative in the long-run.

zero. Since $\dot{a}_g = s_g + e^{-\theta}(\pi-\pi^*)f_g - \pi a_g$, this means that $s_g = \pi a_g - e^{-\theta}(\pi-\pi^*)f_g$ and therefore that one of the variables on the right hand side of equation (12) (t_p, g_n, or g_z) must eventually move into a residual role. 1/ Unless otherwise indicated, we will take this variable to be g_z, so that in the limit, the government's spending and taxation plans must satisfy

$$(12a) \quad g_z = e^{-\theta}(t_p+t_b) + r^*a_g - e^{-1}g_n$$

where the condition $s_g = \pi a_g - e^{-\theta}(\pi-\pi^*)f_g$ has been imposed on (12).

Turning now to the central bank, its balance sheet is given by

$$(13) \quad a_b = e^{-\theta}(f_b + d_p + d_g - m)$$

where a_b represents the central bank's real net worth, and f_b, d_p, d_g, and m represent, respectively, the real value of foreign securities F_b held by the central bank (sF_b/P), the real value of credit extended to the private sector (D_p/P), to the government (D_g/P), and the real money supply (M/P). The central bank's operating profits (s_b), in turn, are given by

$$(14) \quad s_b = e^{-\theta}[(r^*+\pi)(f_b + d_p + d_g) + (\pi^*-\pi)f_b - t_b].$$

Operating profits thus represent the difference between the real value of interest receipts, on the one hand, and transfers to the government, on the other. Finally, from the central bank's budget constraint

$$(15) \quad \dot{a}_b = s_b + e^{-\theta}(\pi-\pi^*)f_b - \pi a_b$$
$$= e^{-\theta}\{r^*(f_b + d_p + d_g) + \pi L[r^*+\pi, y(\rho)] - t_b\}.$$

4. External accounts

We complete the model by specifying the behavior of the current and capital accounts of the balance of payments. The former, denoted ca, is by definition equal to the rate of accumulation of net claims on the rest of world. If we let these claims be denoted by $F = F_p + F_g + F_b$, and use the definitions of the net worth of each of the three sectors, it is straightforward to show that

$$(16) \quad ca \equiv e^{-\theta}s\dot{F}/P = s_p + s_g + s_b.$$

Thus, the current account is equal to national saving (recall that there is no investment in the model). 2/

1/ See Khan and Montiel (1987), pp. 690-1.

2/ It is straightforward to show, using equations (10), (12), and (14), that the "saving" definition of the current account given in equation (16) is equivalent to the more usual definition in terms of income less absorption.

Turning to the capital account (denoted ka), using the balance of payments identity $ca + ka = e^{-\theta}s\dot{F}_b/P$, and substituting from the time-differentiated version of equation (13), we have

$$(17) \quad ka = e^{-\theta}s\dot{F}_b/P - ca$$
$$= e^{-\theta}[\dot{m} - (\dot{d}_p + \dot{d}_g - \dot{a}_b) + \pi^* f_b] - ca.$$

The first term on the right hand side of equation (17) simply restates the balance of payments as the excess of the (flow) demand for money ($\dot{m}$) over the change in the net domestic assets of the banking system ($\dot{d}_p+\dot{d}_g-\dot{a}_b$), as in the monetary approach to the balance of payments.

5. Equilibrium and solution of the model

The first condition that must be satisfied in any equilibrium is that of internal balance, which requires that the domestic markets for labor and nontradable goods clear continuously:

$$(18) \quad y_n\{L_n[w(\rho,e)e]\} = \theta e^{1-\theta}c[y(\rho)-t_p, r^*, e^{\theta}a_p] + g_n.$$

Equation (18) states that the supply of nontraded goods must equal the sum of demands from the private and public sectors. It may be noted that this equation also embodies the requirement of equilibrium in the labor market since supply is written as a function of the equilibrium wage.

In the fixed nominal exchange rate version of the model, equation (18) determines the real exchange rate e at each instant, conditional on the predetermined variable a_p. In the steady state, a_p must reach a constant value. Therefore, private wealth accumulation $\dot{a}_p$ must be equal to zero:

$$(11') \quad 0 = e^{-\theta}\{y(\rho)-t_p-c[y(\rho)-t_p; r^*; e^{\theta}a_p]\}+r^*a_p-(r^*+\pi)e^{-\theta}L[r^*+\pi; y(\rho)].$$

Equations (18) and (11') together thus determine the steady state values of e and a_p in the fixed exchange rate version of the model. Notice that, with e fixed in the steady state, equation (8) with $\hat{s} = 0$ implies that domestic inflation must be equal to world inflation. Assuming that the latter is zero, the steady-state domestic price level is stable ($\pi = 0$).

Suppose, for concreteness, that all central bank operating profits are transferred to the government in the fixed exchange rate steady state, i.e., $t_b = r^*(f_b + d_p + d_g)$. From equation (14), we then have $s_b = 0$. Since equation (12a) must also hold, it will be true that $s_g = 0$. With steady state national saving therefore equal to zero, the current account must necessarily be in balance in the fixed exchange rate steady state.

In order to analyze the determination of the equilibrium under a real exchange rate rule, we assume that the target level of the real exchange rate is initially set at the level corresponding to this fixed exchange rate steady state, given the values of the exogenous and policy variables,

including the values of t_b and g_z described above. In particular, then, the current account of the balance of payments is equal to zero and the domestic rate of inflation is also zero. The real exchange rate rule holds e constant at its original steady state value, but the nominal exchange rate s becomes an endogenous variable, as does the domestic price of importables, P_z. This means, in particular, that private real wealth a_p is no longer predetermined. Instead, it is an endogenous variable inversely related to the domestic price level, which itself must be proportional to P_z by the real exchange rate rule. Thus, equation (18) now determines a_p (through movements in the price level), for given values of e and the other exogenous variables. With a_p determined in this way, the condition, $\dot{a}_p = 0$, must hold continuously, not just in the steady state, in order to ensure continuous equilibrium in the market for nontraded goods. In response to any change in the exogenous variables, equation (18) requires that the level of a_p jump discretely to its new steady state value through an adjustment in the domestic price level. In contrast to the model with a fixed nominal exchange rate (and, therefore, an endogenously determined real exchange rate), there can be no dynamic adjustment of a_p during which the economy converges toward the new steady state. 1/ Since equation (11') must therefore hold continuously, changes in a_p induced by shocks must be offset by adjustments in the domestic inflation rate (π) which is the only other endogenous variable appearing in this equation.

The economics of the situation is straightforward. Shocks which give rise to changes in the domestic price level (and thus in a_p) will tend to alter measured private saving, s_p. This increase in saving in response to the initial discrete adjustment in a_p generates an incipient increase in real private wealth. This, in turn, would cause private consumption to increase over time, leading to excess demand for nontraded goods. In order to maintain equilibrium in the home goods market in the face of this incipient demand pressure, domestic prices must rise sufficiently rapidly to maintain a_p continuously at its new equilibrium level. As in Lizondo (1989), the inflation tax must be sufficiently high as to render the private sector willing to hold the stock of real wealth necessary to clear the market for nontraded goods, given the real exchange rate target and the values of the exogenous and policy variables.

The determination of equilibrium is illustrated in Figure 1. The level of the real exchange rate in the base period satisfies equations (18) and (11'), at an initial domestic inflation rate of zero. On the vertical axis, we plot the domestic rate of inflation, π, while on the

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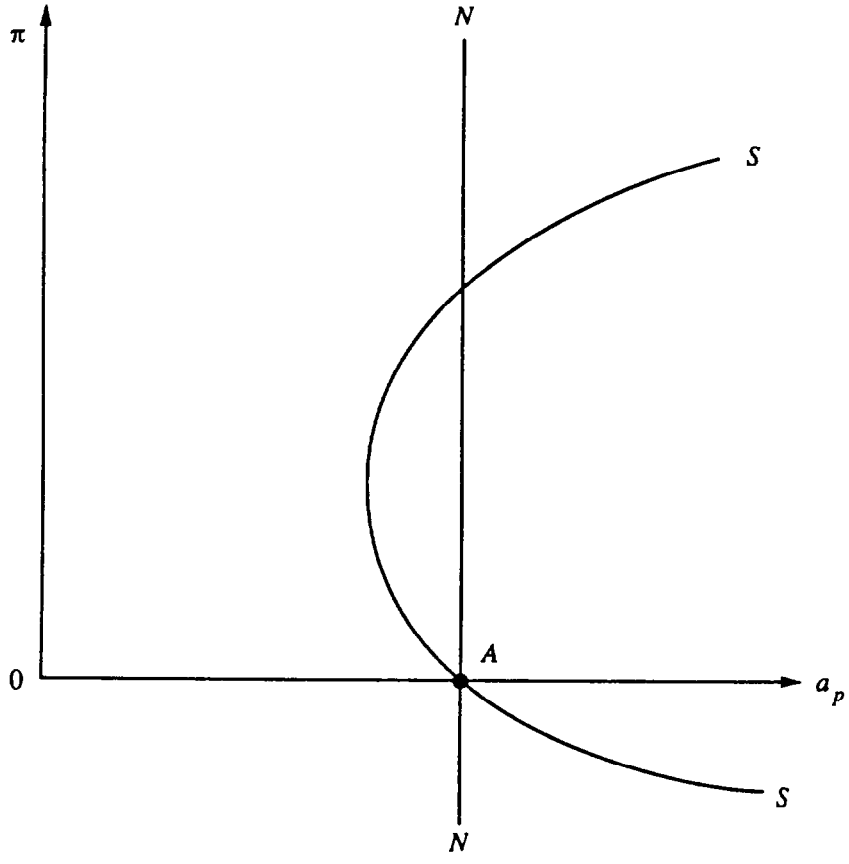
1/ For an analysis of this dynamic adjustment under fixed exchange rates, see Khan and Montiel (1987). In the context of that model, equation (11) rather than (11') gives the evolution of wealth accumulation out of steady state. See also Section IV of the present paper in which the presence of predetermined wages in the short-run (in combination with a real exchange rate rule) is shown to imply some dynamic adjustment in response to shocks.

Figure 1
Equilibrium under a Real Exchange Rate Rule



horizontal axis we plot the level of real domestic assets, a_p. 1/ Equation (18) is represented by the NN locus which shows that, given the real exchange rate target, there is only one level of real assets that will clear the market for home goods. The condition for zero real private wealth accumulation (equation 11') is labelled SS. Its slope is equal to

$$(19) \quad d\pi/da_p\big|_{SS} = (r^*-c_3)/[(r^*+\pi)L_1+L]. \text{ 2/}$$

The numerator of this expression is negative as long as the marginal propensity to consume out of wealth exceeds the world real interest rate, which we assume to be the case. 3/ The sign of the denominator depends on whether the interest elasticity of money demand is greater or less than unity. In what follows, we make the conventional assumption (which would be valid, for example, in any semilog specification) that money demand is interest inelastic at low levels of inflation, but as inflation rises the elasticity eventually rises above unity. This implies that the SS locus has the "C" shape portrayed in Figure 1. As is usual with this sort of money demand function, there are two possible equilibria, corresponding to the two intersection points of the SS curve with the NN line. We assume that the government, upon announcing the real exchange rate target, remains at the low-inflation equilibrium, denoted by point A in Figure 1, that corresponds to a position of long-run equilibrium for the fixed exchange rate version of the model.

The question of interest, of course, is how the economy will respond to shocks under the new policy regime. To begin with, we can ask how the equilibrium will be affected if the authorities decide on a real exchange rate target that is overdepreciated relative to the initial long-run level, which we denote e^*. That is, what are the effects of choosing the target $\bar{e} > e^*$? It is straightforward to verify, from equation (11'), that an increase in e, at a given value of π (in this case, $\pi = 0$), leads to an incipient tendency to dissave on the part of the private sector. To restore saving to its initial level, a_p has to fall. Thus, the SS curve shifts to the left in Figure 2 according to

$$(20) \quad da_p/d\bar{e}\big|_{SS} = -\theta a_p < 0.$$

The new equilibrium value of a_p, however, will be that which clears the nontraded goods market. Since a real exchange rate depreciation creates an excess demand for nontraded goods, the domestic price level must rise, and a_p must consequently fall. The locus NN thus shifts to the left in

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1/ Recall that under the real exchange rate rule, it will always be the case that $\pi = \pi_n$.

2/ Throughout the analysis, we choose units such that, in the initial steady state, all prices (including e) are equal to unity.

3/ As pointed out by Khan and Montiel (1987), this assumption is not very restrictive, and would hold, for example, in a life-cycle model in which households had finite horizons (see Flavin, 1985).

Figure 2. The change in the equilibrium value of a_p, and thus the magnitude of the shift, is given by

$$(21) \quad da_p/d\bar{e}\big|_{NN} = -\theta a_p - (1-\theta)c/c_3 + [\partial y_n/\partial e]/\theta c_3 < 0.$$

Although both curves shift to the left, it is straightforward to verify that the NN line shifts by more than the SS curve and, therefore, that at the original (zero) rate of inflation, real private wealth would be increasing ($a_p > 0$). 1/ This puts upward pressure on domestic prices, implying that the new point of equilibrium (B in Figure 2) must involve a higher inflation rate. Thus, the choice of a real exchange rate target that is higher than the one dictated by the long-run equilibrium of the fixed exchange rate version of the model, leads to an increase in the domestic rate of inflation. This increase is permanent and is sustained by a permanent inflow of reserves, the counterpart of which is a surplus in the external current account. Given our assumption of perfect capital mobility, it is not possible for the authorities to prevent inflation from rising by sterilizing the increase in foreign exchange reserves.

It should be noted also that choosing a real exchange rate target that avoids an increase in domestic inflation relative to the fixed exchange rate case (i.e., setting $\bar{e}$ at the level e^*), is no easy matter. In particular, detailed knowledge of the entire economic structure (i.e., the values of all the parameters and exogenous variables in the model) is required. It follows that if such knowledge is unavailable and if, in setting a target level for the real exchange rate, one wishes to err on the side of an overdepreciated rather than an insufficiently depreciated target (say, because of external balance considerations), then real exchange rate targeting will be inherently inflationary.

A final point to be made before turning to the comparative statics exercises is illustrated in Figure 3. There, it is seen that some targets for the real exchange rate are not feasible in the sense that no equilibrium exists for choices of $\bar{e}$ that are sufficiently above e^*. In terms of the Figure, since the NN schedule shifts by more than the SS schedule as the real exchange rate target is raised, it follows that for a sufficiently depreciated target, the two curves will no longer intersect and no equilibrium will exist. 2/ The intuition of this type of situation is clear. While successively higher levels of $\bar{e}$ require successively lower levels of a_p to eliminate excess demand for nontradables, substitution away from domestic money and into foreign currency-

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1/ That the NN schedule shifts by more than the SS schedule can be seen from the fact that the first term in equations (20) and (21) are identical but the last two terms in equation (21) are each strictly negative.

2/ Because the extent of the horizontal shifts in the NN and SS loci do not depend on the initial level of inflation, the argument provided in the previous footnote is sufficient to establish that, for sufficiently depreciated real exchange rate targets, the two loci will not intersect, and hence, no equilibrium will exist.

Figure 2

Effect of Choosing an Overdepreciated Real Exchange Rate Target

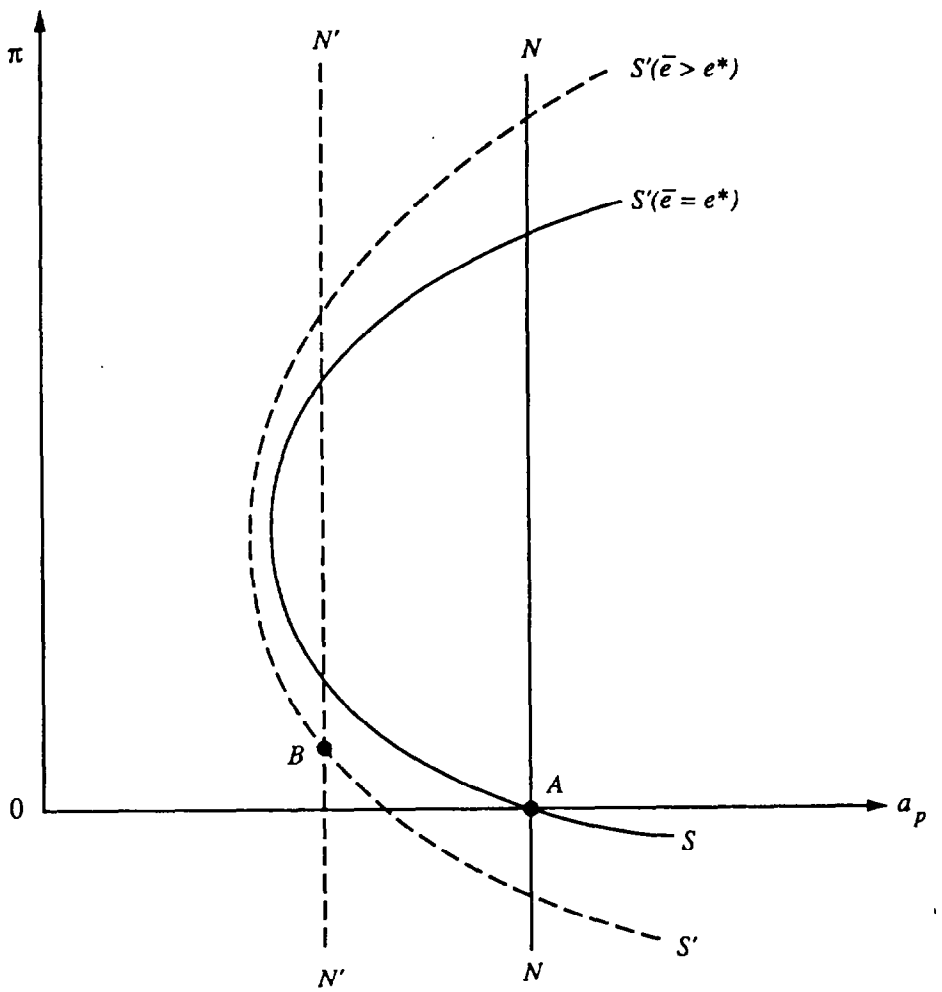
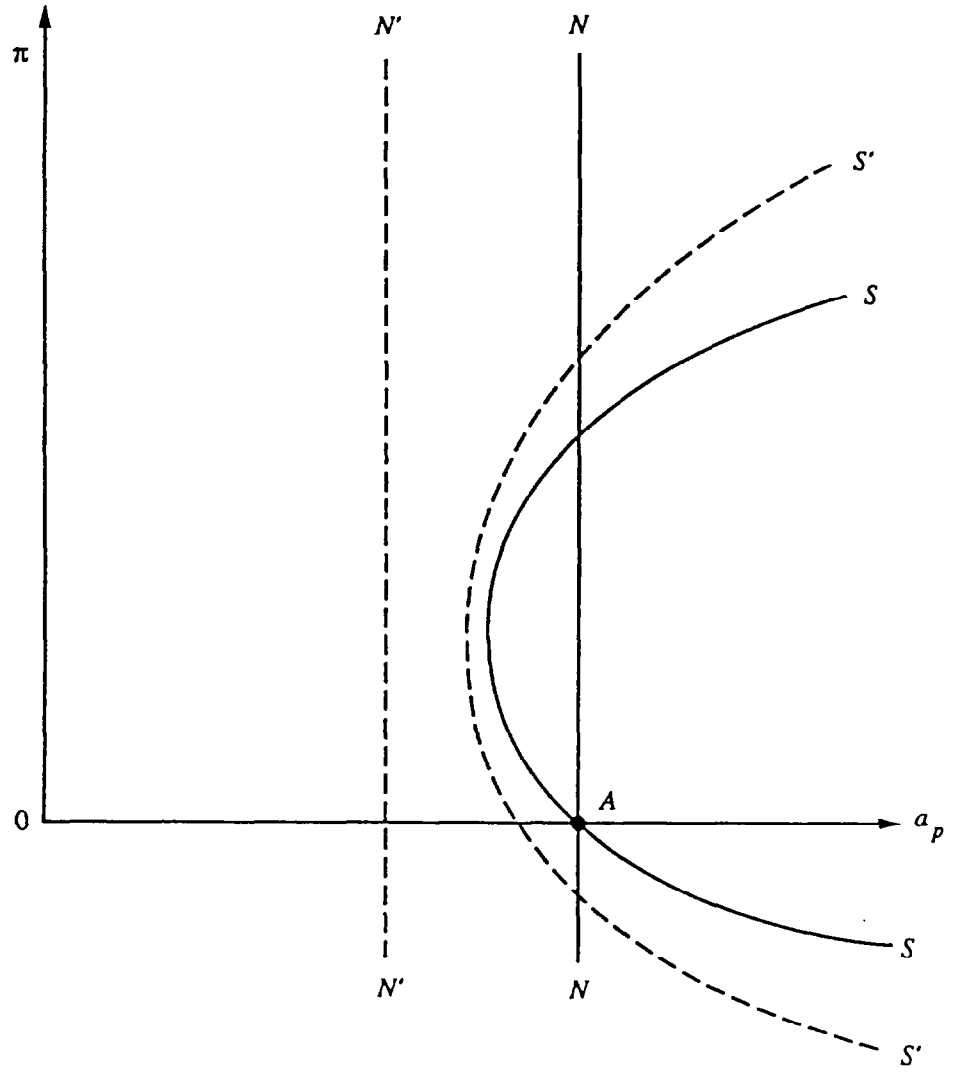


Figure 3

Effect on Equilibrium of Excessively Depreciated Real Exchange Rate Targets



denominated assets at high rates of inflation implies that there is no level of inflation that is sufficiently high to generate a large enough inflation tax such that equation (11') can be satisfied. In such a situation, some other policy will need to be altered if such a depreciated real exchange rate target is to be maintained, and the economy is to achieve a steady state equilibrium.

III. Effects of Shocks in the Presence of Real Exchange Rate Rules

In this Section, we consider the effects on the two endogenous variables of the system--the level of inflation and the level of private real wealth--of a variety of real shocks of the type that are frequently experienced by developing countries. The specific shocks that are considered are: a change in the terms of trade; changes in fiscal policies; changes in commercial policies; and fluctuations in the level of world real interest rates. Given the prevalence of real exchange rate targeting among the developing countries, and the propensity of these countries to experience these type of disturbances, the analysis in this section should prove useful in providing an understanding of macroeconomic adjustment to exogenous and policy-induced disturbances in economies operating with real exchange rate rules.

1. Fluctuations in the terms of trade

Consider first the effects of a rise in ρ, that is an improvement in the terms of trade. 1/ From equation (10), we know that, for a given rate of inflation π, an increase in ρ raises saving because it leads to a rise in real factor income, not all of which is consumed. The stabilization of real private wealth therefore requires a rise in a_p, which reduces saving by increasing consumption. This is shown by the rightward shift of the SS curve in Figure 4, the magnitude of which is given by

$$(22) \quad da_p/d\rho\big|_{SS} = y'[1-c_1-(r^*+\pi)L_2]/(c_3-r^*) > 0. \text{ 2/}$$

1/ As mentioned previously, there is reason to believe that the effects of targeting the importables or the exportables real exchange rate will differ when there are shocks to the terms of trade. In the first part of this subsection, we assume that the authorities target e (the importables real exchange rate). Before concluding this subsection, however, we briefly consider the consequences of targeting the exportables real exchange rate, $e\rho$. Finally, it should be recalled that when ρ is constant (as in the remainder of this section except for the subsection dealing with tariffs), it makes no difference which definition of the real exchange rate the authorities choose to target. Accordingly, in those subsections, we only consider the effects of targeting the importables real exchange rate, e.

2/ In signing equation (22), we assume that the marginal propensity to save remains positive even after allowing for the loss of interest income caused by the instantaneous portfolio shift into money that is induced by an increase in household income (see Khan and Montiel, 1987, p. 690).

In order to determine the new equilibrium value of a_p, we turn to the condition for equilibrium in the market for nontraded goods. From equation (1), we know that an increase in ρ will raise the real product wage in the home goods sector, and thereby cause a reduction in the supply of nontradable goods (equation 2c). In addition, from equation (5), we know that the rise in ρ raises real factor income, which increases the demand for home goods. Thus, both the supply and the demand effects lead to an incipient excess demand in the home goods market, which requires (given that e is fixed by equation 8) a reduction in a_p to restore market clearing. 1/ The magnitude of the reduction in a_p, and hence the extent of the leftward shift of the NN schedule in Figure 4, are given by

$$(23) \quad da_p/d\rho\big|_{NN} = [\partial y_n/\partial\rho - y'\theta c_1]/\theta c_3 < 0.$$

It is clear from Figure 4 that, at the original level of inflation, real private wealth would be increasing. The fact that $\dot{a}_p$ is incipiently positive generates excess demand pressures in the home goods market, thereby putting upward pressure on domestic prices. Equilibrium is therefore only reestablished once inflation and, hence, the inflation tax, have increased to a level that is sufficient to induce the private sector to hold the new equilibrium value of a_p (which is determined in the home goods market, given the new value of ρ).

The new equilibrium is given by point B in Figure 4, where a_p is lower and π higher than at point A. Totally differentiating equations (11') and (18), the magnitude of the increase in inflation is given by

$$(24) \quad d\pi/d\rho = \{y'[1-c_1-(r^*+\pi)L_2]-(c_3-r^*)(\partial y_n/\partial\rho - y'\theta c_1)/\theta c_3]\}/[(r^*+\pi)L_1+L] > 0.$$

This equation shows that inflation rises for two reasons. First, as previously indicated, the rise in ρ directly contributes to an increase in saving which, from equation (11'), requires π to rise in order to stabilize real wealth. The magnitude of this direct effect is given by the first term in equation (24), $y'[1-c_1-(r^*+\pi)L_2]$. In addition, the fall in a_p that is necessary to clear the home goods market also increases saving, and hence requires an increase in inflation to keep $\dot{a}_p$ from rising above zero. The magnitude of this indirect effect is given by the second term in equation (24), namely $-[(c_3-r^*)(\partial y_n/\partial\rho - y'\theta c_1)/\theta c_3]$.

Finally, as alluded to previously, the effects of an improvement in the terms of trade under real exchange rate targeting depend on which definition of the real exchange rate is chosen as the target. Formally, if the authorities decide to target the exportables real exchange rate $e_x = e\rho$, the effects of a rise in ρ will be a combination of those that were analyzed so far in this subsection, together with a reduction in the real exchange rate e. From Figure 2, we know that the qualitative effects of the a reduction in e are to lower inflation and raise the level of real wealth, and hence are opposite to the effects of a rise in ρ (which tends to raise π and lower a_p). In fact, the apparent ambiguity can be

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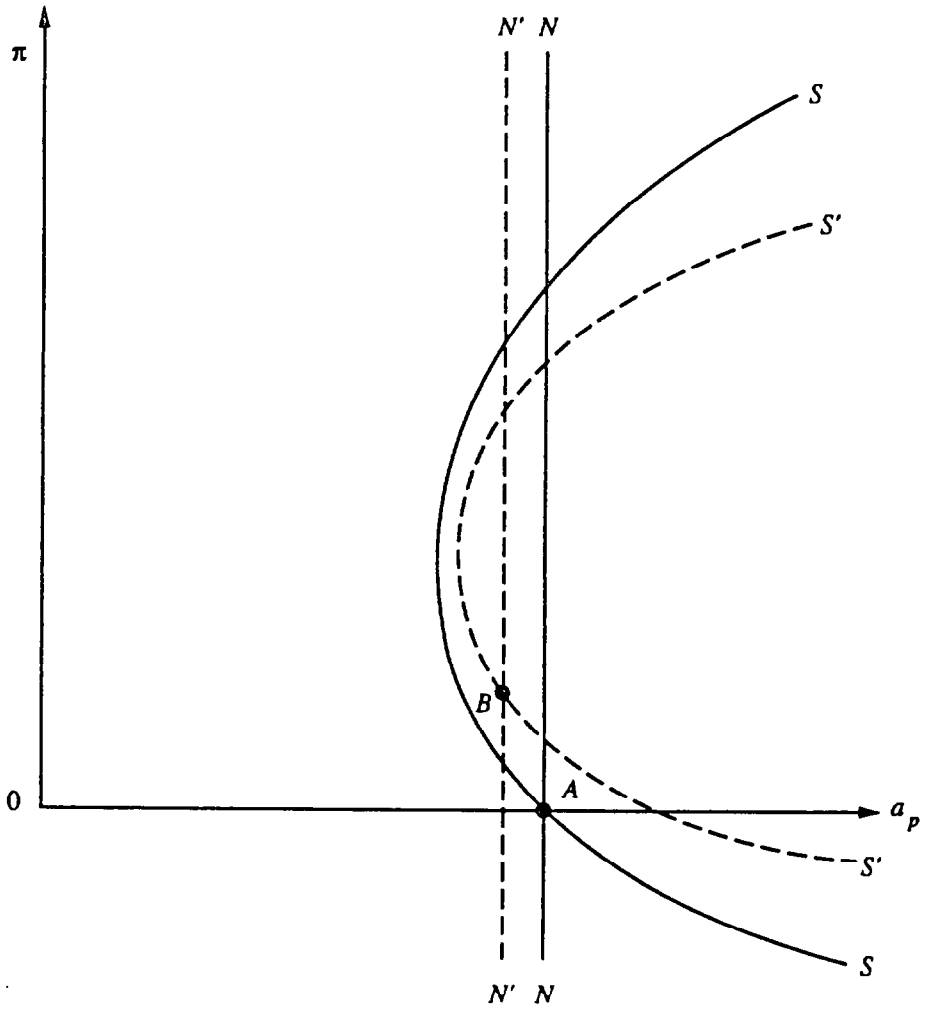
1/ The reduction in a_p is brought about by a discrete rise in the nominal exchange rate, s.

Figure 4

An Improvement in the Terms of Trade



established analytically, so that in the presence of a target for the exportables real exchange rate, it is not possible to determine in advance whether a change in the terms of trade will be inflationary or deflationary, and whether it will lead to a rise or a fall in real private sector wealth. This underscores the potential importance of specifying which definition of the real exchange rate is actually to be targeted when an economy is subject to shocks that affect its terms of trade.

2. A change in the composition of government spending

Consider now the effects of an increase in government spending on nontradable goods that is financed by a reduction in spending on importables, i.e., a shift in the composition of government spending. Because the government's budget constraint is satisfied without any change in taxes, the compositional shift does not directly affect private sector saving decisions and, hence, the SS curve does not shift in response to the policy change.

Clearly, however, the rise in g_n creates an incipient excess demand for nontraded goods, the elimination of which requires a fall in a_p. The magnitude of this fall, and hence the shift of the NN schedule (see Figure 5), are given by

$$(25) \quad da_p/dg_n\big|_{NN} = -(\theta c_3)^{-1} < 0.$$

At a constant inflation rate, this fall in a_p would increase private sector saving. In order to stabilize real wealth, inflation must therefore rise. The magnitude of the rise (which is indicated by the move along the SS schedule from point A to point B in Figure 5) is given by

$$(26) \quad d\pi/dg_n = [(c_3-r^*)/\theta c_3]/[(r^*+\pi)L_1+L] > 0.$$

3. Changes in the tariff on imports

Changes in trade taxes are a frequent component of economic policy-making in developing countries. As is well known, the effects of changes in import tariffs or export taxes may be decomposed into an income effect and a substitution effect. When both are present, the effects of trade taxes are very similar to those of shocks to the international terms of trade. As these were investigated in subsection III.1, it seems reasonable to concentrate here on the pure substitution effects associated with trade taxes. This is done by assuming that the government redistributes the proceeds from the trade tax in a lump sum fashion and also that there are no initial distortions. Under these circumstances, changes in the tariff, or equivalently in the tax on exports, do not alter the level of real disposable income received by the private sector. Finally, in terms of the notation we have presented thus far, it is necessary to reinterpret the variables ρ and e, as the internal terms of

trade and real exchange rate, i.e., relative prices which are inclusive of the ad valorem tax rates on imports or exports. 1/

Since the level of real disposable income received by the private sector, $y(\rho) - t_p$, is unaffected by the tariff change, it is clear from equation (11') that for a given level of inflation, private sector saving is unchanged. Thus, the SS curve does not shift in Figure 6. However, the imposition of the tariff reduces the real product wage in the nontradables sector, $w(\rho,e)e$, and thereby leads to an expansion of output in that sector. In order to maintain market clearing, the level of real private wealth must jump upwards. The magnitude of this increase, and hence the extent of the rightward shift of the NN schedule in Figure 6, are given by

$$(27) \quad da_p/d(\text{tariff})\big|_{NN} = -(\partial y_n/\partial\rho)/\theta c_3 > 0.$$

Given the rise in a_p that is necessary to clear the home goods market, it is clear that at the initial inflation rate associated with point A in Figure 6, there is a decrease in private sector saving. In order to stabilize private sector wealth, the new equilibrium (given by point B) requires a lower level of inflation, where the magnitude of the change is given by

$$(28) \quad d\pi/d(\text{tariff}) = \{(c_3-r^*)[(\partial y_n/\partial\rho)/(\theta c_3)]\}/[(r^*+\pi)L_1+L] < 0.$$

In this subsection, as in the one dealing with terms of trade shocks, we have assumed that the measure of the real exchange rate targeted by the authorities, e, is the consumption or importables measure. However, one could either think of the government targeting $e = e^*(1+t)$, where t is the ad valorem tariff rate and e^* is the exchange rate-adjusted world price of importables relative to the domestic price of nontraded goods, or e^* itself. 2/ As in the terms of trade case, when the government targets e^*, it is straightforward to see that the effects are a combination of the ones identified here, together with a change in the real exchange rate target, i.e., a rise in e. Recall that a rise in e raises π and lowers a_p, i.e., has opposite effects on the model's endogenous variables to those of the tariff change. However, by using equations (20), (21), and (30), it may be shown that these indirect effects, coming from the change in the real exchange rate target, actually

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1/ Since Lerner symmetry holds here, we will consider only the effects of changes in the tariff on imports. Also, since the shock in question affects the internal terms of trade, it will be necessary to consider its effects in the presence of alternative definitions of the real exchange rate. In the first part of this subsection, we consider the effects of the tariff in the presence of a target for the importables real exchange rate, while in the second part, we consider the case of a target for the exportables real exchange rate.

2/ Notice that targeting e^* is equivalent to targeting the exportables real exchange rate, $e\rho$, where ρ is the internal terms of trade.

Figure 5

A Shift in the Composition of Government Spending towards Home Goods

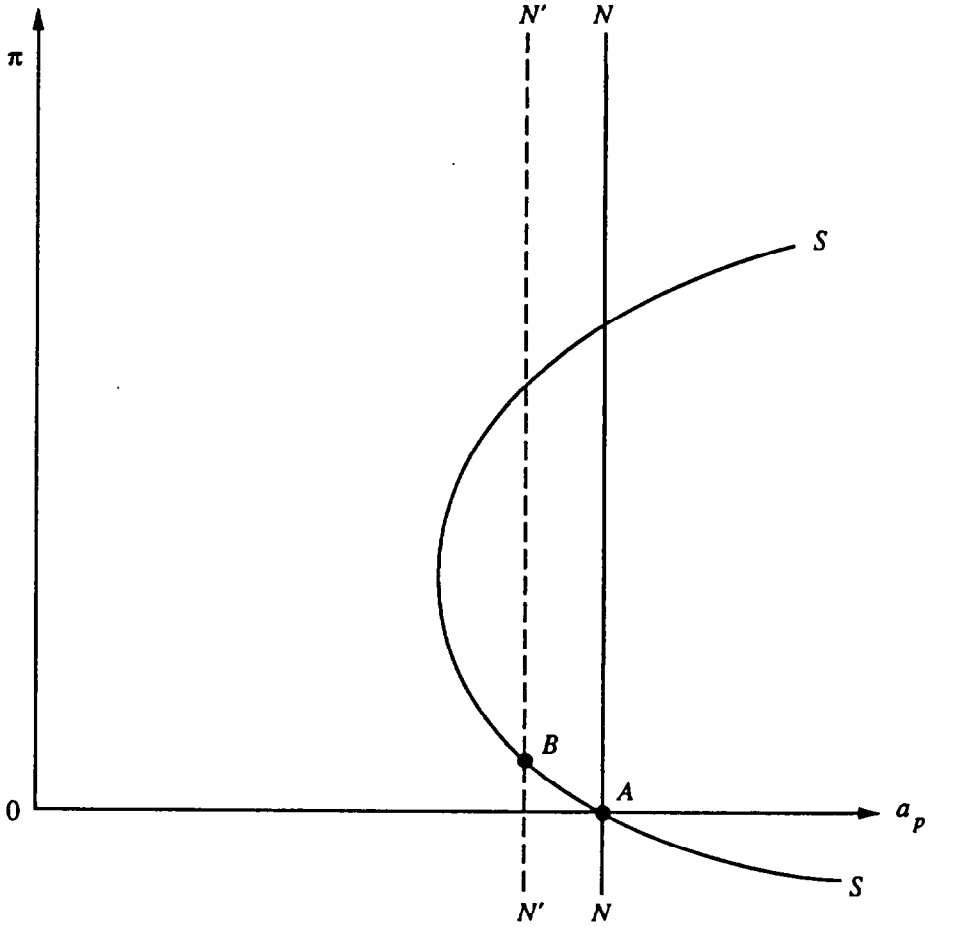
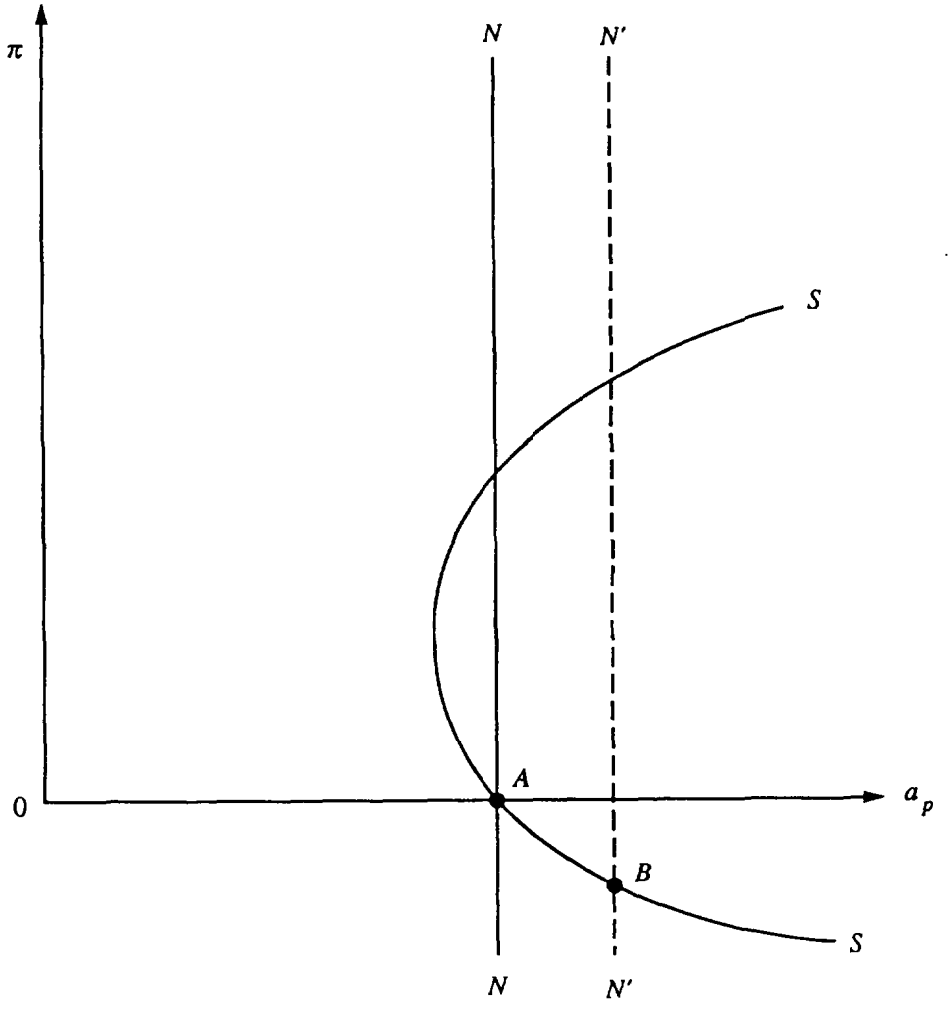


Figure 6
An Increase in the Tariff on Imports



outweigh the direct effects of the tariff change discussed in this subsection. Therefore, when the authorities target the real exchange rate e^* rather than e, the new equilibrium following the imposition of a tariff will involve higher inflation and a lower steady state level of real private sector wealth. Since this is opposite to what was obtained in the case when the authorities targeted e, it is clear once again that the choice of which measure of the real exchange rate is to be targeted is of considerable importance when the economy is faced with shocks that affect the internal terms of trade.

4. Changes in world real interest rates

The final exercise to be considered in this section concerns the effects of fluctuations in world real interest rates. As previously mentioned, under a real exchange rate rule of the type given in equation (8), the interest parity condition (equation 7') implies that domestic and world real interest rates will continuously be equalized, i.e., at every instant $r = r^*$. Thus, fluctuations in r^* will be immediately transmitted to the domestic economy.

At a given inflation rate, an increase in the world real interest rate exerts three distinct impacts on domestic saving. First, given the form of the consumption function, a rise in r^* depresses the real value of current consumption which tends to raise saving, where the magnitude of this effect is given by the partial derivative, c_2, of the consumption function. Second, there is an increase in real interest income in proportion to the existing holdings of interest bearing assets, $a_p - L$ (which we assume to be positive). This rise in real income also tends to raise saving. Finally, real money balances, which constitute the base for the inflation tax, will fall. The reduction in this tax base (for a given level of the rate) raises the private sector's available resources and thereby contributes to an increase in saving, with the magnitude of this effect being proportional to the change in real balances with respect to the interest rate, L_1. Thus, these three effects on saving at a given level of π cause the private sector's wealth accumulation to become incipiently positive and therefore require a rise in a_p in order to return $\dot{a}_p$ to zero. Thus, the magnitude of the shift in the SS curve in Figure 7 is given by

$$(29) \quad da_p/dr^*|_{SS} = [-c_2 + (a_p - L) - L_1(r^* + \pi)]/(c_3 - r^*) > 0,$$

where the three effects on saving described above correspond to the three terms in the numerator of equation (29).

As before, the change in a_p resulting from the shock to world interest rates is determined by the equilibrium condition in the market for home goods. Clearly, changes in r^* only affect the demand side of the nontraded goods sector, there being no investment effects on the supply side. With the rise in r^* depressing aggregate consumption, part of which falls on nontraded goods, it is clear that a rise in a_p (and therefore a fall in the domestic price level) is required to return consumption of

home goods to its previous level, to match the fixed supply. The magnitude of the rise in private sector wealth, and hence the magnitude of the shift of the NN schedule in Figure 7, are given by

$$(30) \quad da_p/dr^*|_{NN} = -c_2/c_3 > 0.$$

From equations (29) and (30), it is clear that, at a given inflation rate, the overall effect on the level of saving resulting from a rise in r^* depends on two conflicting forces. The direct effect of the rise in r^* is to raise saving (equation 29). According to this direct effect, therefore, the stabilization of private sector wealth requires an increase in the inflation tax, and hence in the rate of inflation. On the other hand, the indirect effect arises because the rise in r^* requires an increase in a_p to clear the home goods market. This rise in a_p tends to depress saving, and calls for a decline in inflation to ensure that $\dot{a}_p$ is zero (equation 30). However, inspection of the two equations reveals that the direct effect must always dominate (under the maintained assumption of an inelastic demand for money) so that a rise in r^* must always induce an increase in inflation as long as the economy is operating in the inelastic portion of its money demand schedule:

$$(31) \quad d\pi/dr^* = [(a_p-L) - L_1(r^*+\pi) - r^*c_2/c_3]/[(r^*+\pi)L_1+L] > 0.$$

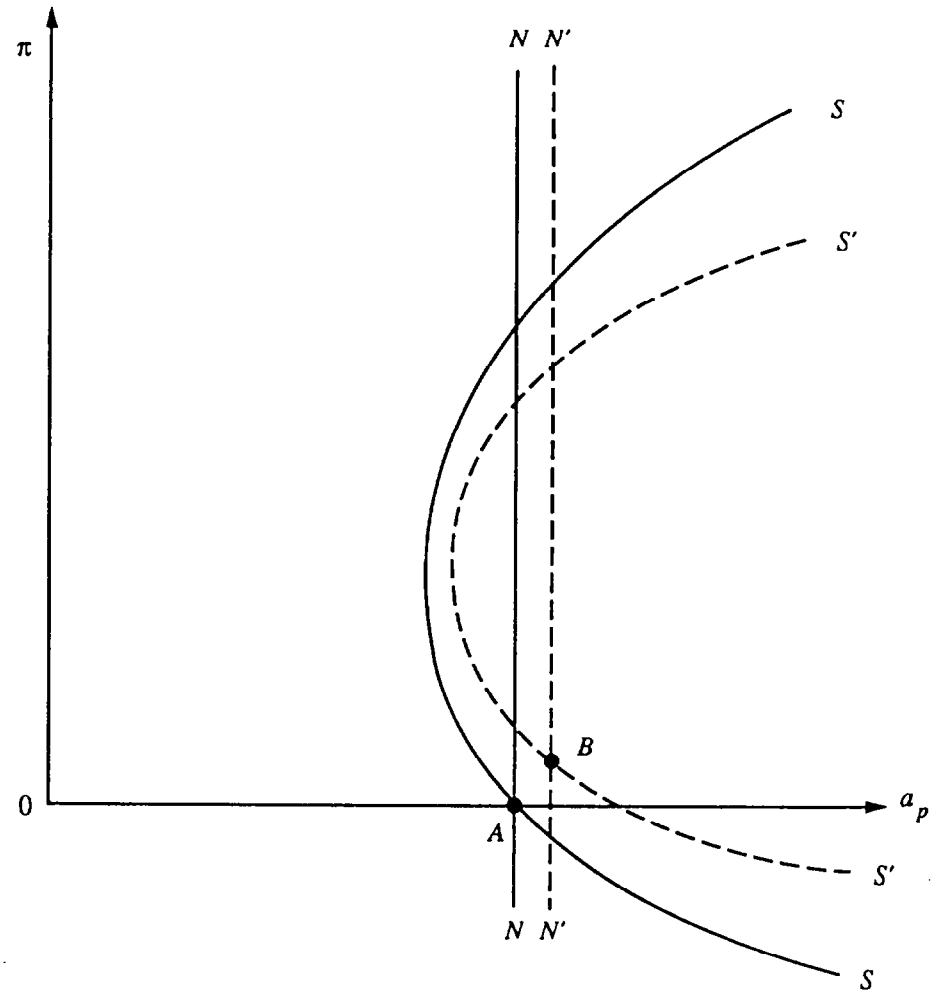
This is illustrated in Figure 7 where, at the new equilibrium (point B), both a_p and π are higher than initially (point A), that is, prior to the rise in world interest rates.

IV. Effect of Shocks in the Model with Sticky Wages

The previous section has investigated the effects of a variety of real disturbances, both exogenous and policy-induced, in a model with fully flexible nominal wages and prices. A notable feature of the model was that the economy adjusted immediately to shocks, with wages, the level of real private sector wealth, as well as the rate of inflation all adjusting instantaneously to their new, long-run, equilibrium values, and full employment prevailing continuously. Yet, both from a theoretical and practical standpoint, it is often just as important to understand the likely behavior of all of these variables--especially that of the level of real economic activity--along the transition from one steady state to another.

The main purpose of this section is to analyze the dynamic path followed by an economy that shares all the main features of the one described in Section III--particularly in terms of its overall structure and adherence to a real exchange rate target--except for the fact that in the labor market a Phillips curve is assumed to determine the rate of nominal wage adjustment in the short-run. This simple modification of the basic model is sufficient to analyze deviations of real output from its full employment level, as well as to generate interesting dynamic paths for the other main variables of interest (particularly real wages and real wealth accumulation, and hence external current balances) in response to

Figure 7
A Rise in World Real Interest Rates



various disturbances. In the remainder of this section, we briefly outline the modifications to the model that are necessary when the nominal wage is a predetermined variable. We then discuss how, in response to some of the shocks considered in Section III, the main endogenous variables will evolve towards their new steady state values.

We begin with the labor market. It is assumed that the nominal wage, W, while fully flexible in the long-run, is a predetermined variable in the short-run, whose rate of change is given by the following simple Phillips curve adjustment rule:

$$(1') \quad \hat{W} = G[L_X(W/P_X) + L_n(W/P_n) - \bar{L}] + \pi, \quad G(0) = 0, \; G'(0) > 0,$$

where $\bar{L}$ is the fixed supply of labor, and where we have assumed, purely in order to economize on notation, that the importable good is supplied entirely from abroad. Equation (1') states that the rate of change of nominal wages is equal to the rate of expected (equals actual) price inflation plus some positive function of the extent of demand pressure in the labor market. By using the definition of the real wage $w = W/P_Z$ and the real exchange rate rule (equation 8), it is straightforward to show that equation (1') is equivalent to

$$(1'') \quad \hat{w} = G[L_X(W/P_X) + L_n(W/P_n) - \bar{L}] = G[L_X(w/\rho) + L_n(ew) - \bar{L}] = g(w,\rho,e).$$

Thus, equation (1") determines the evolution of the real wage out of steady state (as a function of the level of the real wage, the terms of trade and the real exchange rate target) while equation (1) determines the equilibrium value of w in the steady state (where excess demand for labor is equal to zero), as a function of ρ and e.

Consider now the condition for market clearing in the home goods sector. Recall that in the flexible-wage version of the model the nontradables market clearing condition (equation (18)) determined the level of real wealth a_p through movements in the nominal exchange rate, or equivalently, in the domestic price level. The story is almost the same here, except that now, with the nominal wage W predetermined, movements in the nominal exchange rate simultaneously determine both the real wage w and the level of real wealth a_p, in the short-run. Any shock that affects equilibrium in the home goods sector will therefore bring about some change in the nominal exchange rate, s, which in turn will cause the level of the real wage and the level of real private wealth to jump. Thus, in the long run, equation (1) will determine the level of the real wage and the nontradables market clearing condition (equation (18)) will determine the level of real wealth; in the short run, both the level of the real wage and the level of real wealth will be determined in the nontradables market via changes in the domestic price level.

Some of these considerations are illustrated in Figure 8. On the vertical axis, we plot the level of real private wealth a_p, while on the horizontal axis, we plot the real wage, w. The line labelled ww depicts equation (1") with $\hat{w} = 0$. It intersects the horizontal axis at the

initial steady state level of the real wage, given by equation (1). To the left of the ww line, real wages are rising, and conversely to the right of ww, real wages are falling (equation 1"). The locus labelled HH passing through point A represents those combinations of w and a_p that are consistent with zero excess demand for home goods (equation 18). A rise in w reduces supply of nontraded goods (by raising the real product wage in that sector), the elimination of which requires a fall in a_p to reduce demand in line with the reduction in supply. Thus, the HH schedule must have a negative slope: 1/

$$(32) \quad da_p/dw = [(\partial y_n/\partial w)(1-\theta c_1)-\theta c_1(\partial y_x/\partial w)]/\theta c_3 < 0.$$

At point A, the intersection of the HH and ww loci determine the initial levels of a_p and w, consistent with simultaneous equilibrium in the market for home goods and labor. 2/ Since $a_p=(sF_p+M-D_p)/P_z$ and $w=W/P_z$, it can be shown that changes in s (or equivalently in P_z) will induce a_p and w to move along a locus given by $a_p=F_p+(M-D_p)w/W$ which passes through A. If F_p and $(M-D_p)$ are both positive, this locus has a positive slope and positive intercept. It is depicted by KK in Figure 8.

Figure 8 is useful for analyzing both the transitional dynamics and long-run response of the economy to various shocks. To take an example, suppose that the economy is initially in the steady state equilibrium given by point A in Figure 8, and is hit by some shock which disturbs equilibrium in the home goods sector, thereby causing the nontradables equilibrium locus to shift to a position such as H'H'. 3/ For concreteness, suppose further that the shock is to some variable other than the terms of trade or the real exchange rate target, so that in the new steady state, the real wage will be equal to its initial steady state value (i.e., the ww locus does not shift). At the instant the shock occurs, the domestic price level must adjust to maintain market clearing in the home goods sector. With real exchange rate targeting, this will induce a proportional change in s, so the new equilibrium must lie along the locus KK. Since it must also be on H'H', the economy moves to point B, where KK intersects H'H'. To obtain the dynamics from point B toward the long-run equilibrium given by point C, recall that because the level of w at B is below its steady state level, w will be rising (from equation 1"). Since the nontraded goods market must clear continuously, the economy moves southeastward along H'H' from B to C, with rising w and falling a_p. The level of real output will move in the opposite direction as the real wage, since employment is assumed to be demand-determined and,

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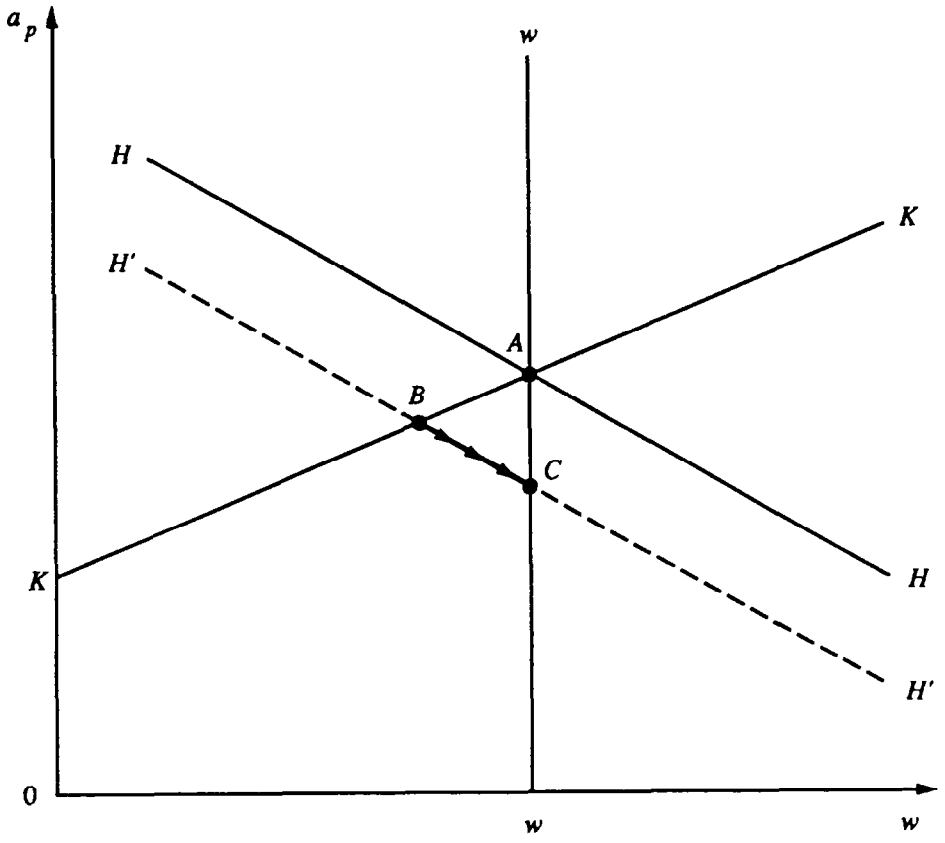
1/ In addition, a rise in w reduces the level of real factor income, y, which indirectly depresses the private sector's demand for nontradables. It is assumed that the direct supply effect of a rise in w dominates the indirect demand effect, so that a rise in w at a given level of a_p results in excess demand for home goods.

2/ The position of the locus NN in Section III is determined by the intersection of the ww and HH loci in (a_p,w) space.

3/ Any of the shocks considered in Section III would fit this description.

Figure 8

Equilibrium with Short-run Nominal Wage Rigidity



in the presence of a real exchange rate rule and a sticky nominal wage, the product wage in all sectors will vary inversely with the domestic price level.

Thus far, we have described the short-run, intermediate-dynamics, and long-run behavior of three of the endogenous variables of the model (w, a_p, and real output), but have not described the behavior of the inflation rate, π. As in the flexible-wage version of the model, the steady-state value of π is determined by the condition that private sector wealth remain constant in real terms, i.e., $\dot{a}_p = 0$ (equation 11'). Outside of the steady state, the behavior of π is determined by the values assumed at each instant by the other two variables in the system, w and a_p. Specifically, combining equations (1"), (11), and (32), it is possible to solve for the inflation rate π conditional on values of the two predetermined variables w and a_p:

$$(33) \quad \pi = \pi(w, a_p), \quad \pi_1 < 0, \ \pi_2 < 0,$$

where

$$\pi_1 = \{(\partial y/\partial w)[1-c_1-(r^*+\pi)L_2]-w(\partial g/\partial w)[(\partial y_n/\partial w)(1-\theta c_1)-\theta c_1(\partial y_x/\partial w)]/(\theta c_3)\}/$$

$$[L+(r^*+\pi)L_1] < 0,$$

$$\pi_2 = -(c_3-r^*)/[L+(r^*+\pi)L_1] < 0.$$

Thus, given the values of w and a_p determined in the home goods market, equation (33) determines the value of the inflation rate, π, at any instant.

Having outlined the overall workings of the model, it is now possible to discuss the response of the economy to some of the shocks considered in Section III. Rather than go through all the details of each of the shocks considered in the previous section, we confine the discussion here to the effects of a terms of trade shock and of a shift in the composition of government spending. As already seen, a terms of trade shock leads to a shift in the level of the real wage in the long-run, whereas the fiscal policy change leaves the real wage unaffected. Thus, considering these two shocks is sufficient to illustrate the main differences between the model of this section and the flexible-wage model of Section III.

Consider first the effect of a compositional shift in government spending towards nontraded goods. As mentioned previously, the initial equilibrium lies along the locus KK in Figure 8. The initial level of the real wage (determined by the position of the ww line) is assumed to satisfy the condition $g(w) = 0$, i.e., the initial equilibrium is a steady state with zero excess demand for labor. The initial level of real wealth is determined by the nontraded goods market equilibrium condition (equation 18) and is shown as point A in the Figure, where the HH schedule intersects the ww locus.

The vertical shift of the HH schedule caused by the compositional shift in government spending is given by the expression derived previously in equation (25). Given that the steady-state level of w is unaffected by this type of shock (from equation 1), the expression in equation (25) also gives the long-run change in a_p. The short-run change in a_p is however less than the long-run change since the former must lie along the locus KK (at its intersection with the H'H' locus). This short-run equilibrium point is B in Figure 8. It is also possible to solve for the short-run change in the nominal exchange rate (or, equivalently, the domestic price level 1/) from A to B:

$$(34) \quad ds/dg_n = [-(\partial y_n/\partial w)(1-\theta c_1)+\theta c_1(\partial y_x/\partial w)+\theta c_3 a_p]^{-1} > 0.$$

Thus, a rise in g_n creates excess demand for home goods. In order to restore market clearing, supply of nontradables must rise and/or private demand must fall. A rise in s, which reduces both the real wage and the level of private sector wealth, leads to an increase in the supply of, and a reduction in the private sector's demand for, nontraded goods, thereby restoring equilibrium to that market. Notice that the product wage falls in the exportables sector as well, stimulating an increase in output in that sector. Since production of both types of goods increases, this shock is expansionary in the short run.

At point B in Figure 8, the real wage is below its steady state value, which continues to be given by the ww line. 2/ Thus, the dynamics of adjustment are as in Figure 8--i.e., the real wage rises and both real wealth and real output fall as the economy moves along H'H' from B to C.

Finally, although not shown in the Figure, it is clear from equation (33) that, since w and a_p both fall on impact (that is at point B), the rate of inflation must rise above its initial level at point A. We also know from equation (26) that in the new steady state (point C), the inflation rate is higher than at point A. Whether the inflation rate initially over- or undershoots its new long-run value is ambiguous; in any case, however, its level at any point is fully determined by the level of w and a_p according to equation (33).

Next, consider the effect of an improvement in the terms of trade (a rise in ρ), which is illustrated in Figure 9. Once again, the initial equilibrium is at point A, where the ww line intersects the HH locus along the initial locus labelled KK. On impact, the improvement in the terms of trade creates excess demand for home goods, which causes the HH locus to shift to the left, intersecting the locus KK at B. The vertical shift in the schedule is given by

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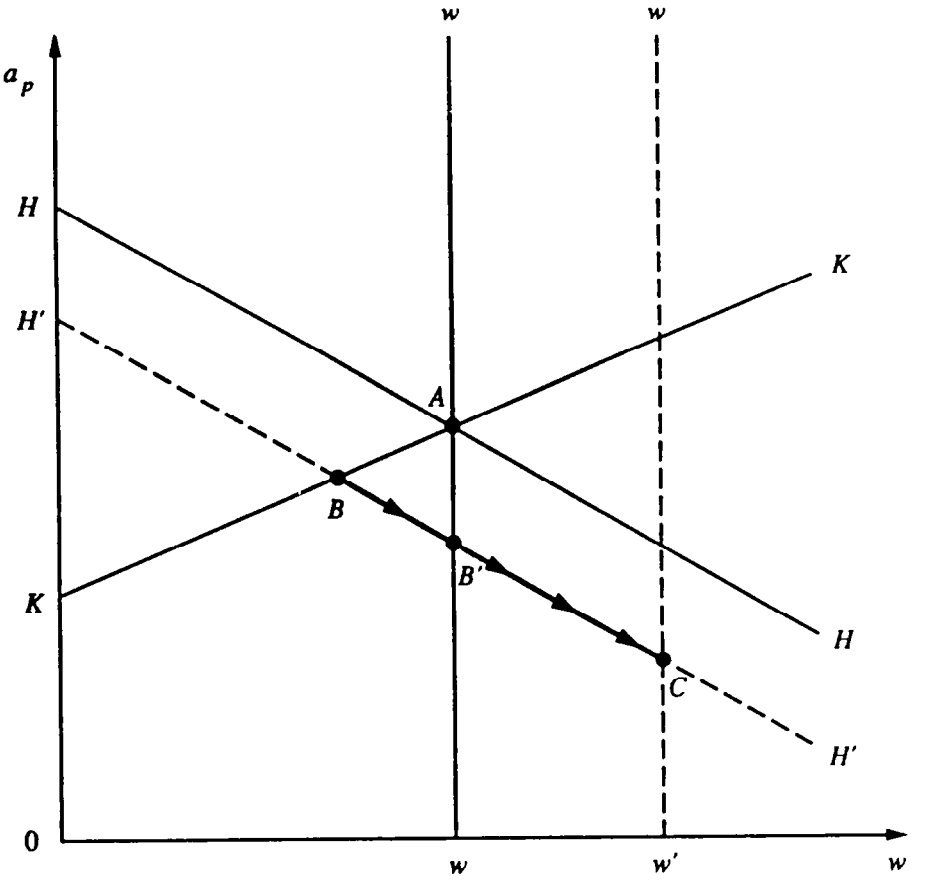
1/ As in Section III, it is assumed that units are chosen so as to make all prices (including wages) equal to unity in the initial equilibrium.

2/ From Section III.3, we know that the steady state value of w is unaffected by this type of disturbance.

Figure 9

An Improvement in the Terms of Trade in the Rigid-wage Model



$$(35)\quad da_p/d\rho\big|_{HH} = -\{c_1[\partial(\rho y_x)/\partial\rho]\}/c_3 < 0.$$

The reduction in w and a_p at B (relative to A) is brought about by a rise in the nominal exchange rate (or equivalently, the domestic price level), the magnitude of which is given by

$$(36)\quad ds/d\rho = \theta c_1 \partial y_x/\partial w[(\partial y_n/\partial w)(1-\theta c_1)-\theta c_1(\partial y_x/\partial w)-\theta c_3 a_p]^{-1} > 0.$$

As before, the shock is expansionary on impact. From point B, the economy will once again move to the southeast along H'H', with the dynamics of real output behaving as before. However, unlike the previous case, this movement now continues beyond the point B' in Figure 9, since the long-run equilibrium real wage must rise (equation 1). The final long-run equilibrium is at point C, with a higher real wage and lower level of real wealth than before the shock. In "Dutch disease" fashion, long-run equilibrium output rises in the exportables sector, but contracts in the nontraded sector. Finally, the inflation rate rises on impact and is higher in the new steady state than in the initial one, but it may initially either over- or undershoot its new steady state level.

V. Some Applications

In this section, we illustrate the relevance of the model by applying the results derived above to three important macroeconomic issues: the fiscal view of inflation; the "plateau" character of high inflation experience; and money-based stabilization.

1. Fiscal explanation of inflation

The view that sustained high levels of inflation in many developing countries has been the result of excessive budget deficits is a venerable one, and developments in macroeconomic analysis since Sargent and Wallace (1981) have strengthened this view. The current state of thinking is summarized in Fischer and Easterly (1990):

> "Milton Friedman's famous statement that inflation is always and everywhere a monetary phenomenon is correct. However, governments do not print money at a rapid rate out of a clear blue sky. They generally print money to cover their budget deficit. Rapid money growth is conceivable without an underlying fiscal imbalance, but it is unlikely. Thus, rapid inflation is almost always a fiscal phenomenon." (p. 138)

The analysis in the previous sections purported to explain equilibrium inflation rates, but it did so without explicit mention of the fiscal deficit. What, then, does this analysis have to say about the fiscal view of inflation?

The answer to this question has three parts:

a. High levels of inflation can be sustained without large budget deficits, or even with a balanced budget.

b. Even where high levels of inflation are accompanied by large budget deficits, the budget deficits may result from high inflation, rather than vice-versa.

c. Nevertheless, expansionary fiscal policy would indeed increase the sustainable level of inflation in this model.

It is easy to see how high inflation can occur without large budget deficits in this model. Suppose the target real exchange rate is one at which the current account is initially balanced, and suppose the economy experiences a favorable terms of trade shock. As shown in Section III.1, the resulting incipient excess demand for nontraded goods will cause the domestic price level to jump, causing a fall in real household wealth, a_p, which induces households to save, and thus gives rise to a current account surplus. This reserve inflow must be monetized by the central bank, since perfect capital mobility rules out the possibility of sterilization. As the money supply increases, sustaining equilibrium in the market for nontraded goods requires that prices continue to rise, keeping the real value of private wealth, a_p, at its new equilibrium level. With the real exchange rate unchanged, the price increase is sustainable, since the money supply continues to be fueled by a permanent increase in the current account surplus.

Notice that all of this occurs with unchanged fiscal policy. Thus, the government budget remains in balance--inflation, at a possibly high level, coexists with no budget deficit. Nonetheless, there is an increase in the inflation tax, which is the counterpart of the household "saving" required to keep the real money supply constant. With t_b unchanged, equation (15) shows that $\dot{a}_b = \pi L$, so this inflation tax accrues to the central bank (not the government). The bank receives this tax in the course of its foreign exchange operations, and devotes it to the accumulation of foreign exchange reserves.

While this general policy stance is sustainable indefinitely, it is not necessarily rational. If it persisted with its original fiscal policy permanently, the public sector in this economy (in the form of the central bank) would acquire claims on the rest of the world that would not ultimately be repaid. 1/ One way to avoid this would be for the central bank to transfer the inflation tax to the government, which would then spend it on imports (g_z). If this were done, the fiscal deficit would increase by the amount of the inflation tax, and the current account surplus would disappear. The rate of inflation, however, is unaffected by this policy. If this were done at the moment the terms of trade shock materialized, an observer would see an increase in the fiscal deficit

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1/ That is, the present value of public sector claims on the rest of the world would converge to a positive number.

financed by an expansion of central bank credit to the government, together with an increase in the rate of inflation. In this case, though, inflation is not caused by an increase in the fiscal deficit. Rather, the deficit and the increase in inflation are both caused by a terms of trade shock in the context of real exchange rate targeting. Moreover, the inflation rate may not be reduced by a fiscal adjustment. It would not be, for example, if that adjustment took the form of returning g_z to its initial level. The only effect of such a measure would be to alter the disposition of the inflation tax--instead of being used by the government to purchase goods abroad, it would be used to amass claims on foreigners.

Finally, none of this suggests that expansionary fiscal policy does not cause inflation. An increase in government spending on nontraded goods (g_n) would be consistent with the fiscal explanation of inflation. As shown in Section III.2, with an increase in g_n, the domestic price level would jump on impact, a_p would fall, and an increase in the desire to save on the part of households would give rise to an incipient current account surplus. Whether the surplus materializes or not depends on the response of g_z, but in any event the result is a higher rate of inflation accompanying an expansionary fiscal policy that also results in an increased fiscal deficit.

2. The "plateau" character of high inflation

A number of developing countries have suffered through prolonged periods of high, but fairly stable inflation. A common feature of such episodes is that the inflation rate tends to remain at a high and stable level for some time and then move rather quickly to a new (usually higher), but again stable, level. This "plateau" character of high-inflation episodes has been noted by several observers (see, for example, Liviatan and Piterman, 1986).

Competing explanations have been proposed for this phenomenon. Most familiar is the "fiscal view," which essentially maintains that, for a variety of possible exogenous reasons, the government is confronted with the need to raise additional revenue, which it chooses to collect in the form of an inflation tax. An alternative "balance of payments" view suggests that changes in the underlying inflation rate arise from balance of payments crises, which induce exchange rate depreciation. These in turn raise the rate of inflation through increasing expectations of inflation, which are then accomodated by the monetary authorities, or through the wage indexation mechanism. The latter arises if the frequency of indexation increases due to inflationary expectations associated with a devaluation. With more frequent wage adjustments, a higher rate of inflation is required to maintain an equilibrium real wage (Liviatan, 1986).

The analysis of real exchange rate targeting presented in Sections III and IV sheds light on several aspects of this issue. First, it demonstrates that changes in a stable, but high, inflation rate can arise from either fiscal or external shocks, so the issue is an empirical, not

an analytical one. Second, the model demonstrates that external shocks can move the economy to a higher inflation rate without the need to posit what seems to be a tenuous direct link between devaluation and expectations of permanently higher inflation. 1/ Third, external shocks can move the economy to a higher inflation plateau even in the absence of periodic backward wage indexation or of accomodative credit policy. This can happen in two ways. First, some adverse external shocks, such as increases in world real interest rates, can directly move the economy to a higher inflation equilibrium in the absence of a change in the target real exchange rate. Even a favorable external shock, such as a positive movement in the terms of trade, can have this effect. Second, external shocks can produce an equilibrium with a higher, stable, rate of inflation if, in response to such shocks, the authorities alter the real exchange rate target in a way that leads to overdepreciation. Thus, for example, while an adverse terms of trade shock would tend to lower the equilibrium inflation rate, a response in the form of a depreciation of the target real exchange rate could easily overshoot, resulting in a new, higher-inflation plateau. There is evidence, in fact, that the upward ratcheting of the inflation rate immediately preceding the "heterodox" stabilization programs adopted by Argentina, Brazil, and Israel in the mid-eighties was prompted by exchange rate adjustments in response to adverse external shocks, followed by a period of real exchange rate targeting. 2/

3. Money-based stabilization programs

As a final application of the model, we examine the likely outcome of "money-based" stabilizations--i.e., stabilization programs based on using a financial aggregate as a nominal anchor, while relying on a real exchange rate target to maintain competitiveness. Suppose, in particular, that the economy to be stabilized finds itself in one of the high-inflation steady-state equilibria described in previous sections, and suppose that the proceeds of the inflation tax are transferred to the government by the central bank, which also maintains the real supply of credit constant to both the private and public sectors ($\hat{d}_p = \hat{d}_g = 0$). Thus, high inflation is accompanied by rapid credit expansion and a substantial fiscal deficit.

Consider now the effects of a stabilization program along the following lines: The fiscal deficit is removed by curtailing government spending (we shall assume that this takes the form of reduced public sector imports), thereby removing the perceived fiscal roots of inflation. This is supplemented by the use of credit as a nominal anchor. To take an extreme case, suppose that a target of zero inflation is adopted, so that the stock of credit is frozen. To maintain external competitiveness, however, the nominal exchange rate is devalued initially such as to

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1/ In the fixed-exchange rate version of the model, for example, such expectations would in fact be incorrect.

2/ See Montiel (1989).

achieve a substantial real exchange rate depreciation, and the authorities commit themselves to not allowing the real exchange rate to get out of line in the event of "slippages" in the rate of inflation--i.e., a policy of active nominal exchange rate management is adopted designed to keep the real exchange rate at the target level.

What would be the outcome of such a program? As described, the analysis in previous sections suggests that the rate of inflation will in fact increase, although the credit targets are strictly adhered to and the fiscal deficit is eliminated. The reason for this is that the stock of credit cannot provide a nominal anchor to this economy. The price level is determined by the stock of nominal wealth, and credit policy can only alter the composition of private portfolios, without affecting household net worth. The credit freeze cannot provide a nominal anchor because domestic price increases are being driven by private wealth accumulation, a process over which changes in the rate of growth of domestic credit have no effect. In spite of the credit freeze, the domestic money supply grows continuously, financed by external inflows in the form of the current account surplus.

Inflation increases in this case because the depreciation in the target real exchange rate increases the current account surplus which, as indicated in Subsection V.1, must be monetized. The rate of growth of the money supply increases despite the credit freeze component of the program, through both the current and capital accounts of the balance of payments. From equation (15), it can be shown that the increase in the central bank's net worth ($\dot{a}_b$) will equal the inflation tax (πL), and from (17), it then follows that the credit freeze (which implies that $\dot{d}_p + \dot{d}_g = -\pi(d_p + d_g)$) simply gives rise to a capital inflow equal to $\pi(d_p + d_g)$. If the rate of growth of credit had instead been positive, the capital inflow (and thus the overall balance of payments surplus) would have been commensurately smaller, with no effect on the inflation outcome.

VI. Conclusions

This paper has developed a model that is suitable for analyzing the macroeconomic implications of real exchange rate targeting in developing countries. The analysis has concentrated on the following issues: (a) How does the choice of a real exchange rate target affect the nature of macroeconomic equilibrium?; (b) Are all real exchange rate targets sustainable, in the sense that, once adopted, the economy converges to a new steady state without having to change some other exogenous variable in the system?; and (c), How do economies in which the real exchange rate is a target of macroeconomic policy adjust to the type of external and internal disturbances to which developing countries are frequently subjected?

A main result of the paper was that choosing an overdepreciated exchange rate (with a view, say, to achieving some external balance objective) would lead to a rise in the economy's inflation rate. This rate would, however, be sustainable, in the sense that in the absence of

other exogenous or policy-induced disturbances, the economy would remain at that rate indefinitely. It was shown, however, that the pursuit of successively higher (that is, more depreciated) real exchange rate targets would increase the likelihood that no steady-state equilibrium would exist. These results were thought to be of more than theoretical interest because choosing a target for the real exchange rate that avoided increasing the rate of inflation would involve detailed knowledge of a variety of structural relationships in the economy, something most policymakers would find difficult to obtain.

It was also shown that, when the authorities pursued a real exchange rate target, a variety of real shocks would have inflationary implications, a result that is quite different from what would obtain in the absence of the real exchange rate rule. For example, in the fixed exchange rate version of the model with an endogenous real exchange rate, terms of trade shocks, a shift in the composition of government spending, or commercial policy changes, would have no effect on the economy's steady state inflation rate. This was shown not to be the case when the real exchange rate is itself a target of policy. In particular, an improvement in the terms of trade and a compositional shift in government spending towards home goods are inflationary under a real exchange rate rule, while the inflationary effects of increases in import tariffs may be positive or negative, depending on which definition of the real exchange rate is actually targeted by the authorities. These results underscore the very different responses to macroeconomic shocks in economies with real exchange rate targeting, relative to those in which the real exchange rate is left to adjust freely in the face of various disturbances.

The far-reaching macroeconomic implications of targeting the real exchange rate were illustrated through three more general policy applications. We showed that inflation need not be the result of excessive fiscal deficits, and that even where a high rate of inflation is accompanied by a large deficit, both phenomena may result from an overdepreciated real exchange rate target, either because the target was chosen inappropriately to begin with, or was chosen correctly initially but rendered inconsistent with stable prices by subsequent events. Also, it was shown that successive plateaus of high inflation, a puzzling and controversial phenomenon observed in several developing countries, may arise due to the incidence of external shocks in the presence of real exchange rate targeting. Finally, stabilization of high inflation using domestic credit as a nominal anchor, while relying on a real exchange rate target to maintain external competitiveness, may prove to be a precarious undertaking. Depending on how the target real exchange rate is set, the rate of inflation may not only fail to decline, but may actually increase as a consequence of the program.

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