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Real Exchange Rate Targeting Under Capital Controls: Can Money Provide a Nominal Anchor?

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Abstract

This paper examines the issue of whether the money supply can serve as a nominal anchor for the domestic price level under real exchange rate targeting. When capital controls are perfect so that there is complete separation between official and unofficial markets for foreign exchange, the domestic inflation rate can be stabilized, but only at the expense of a widening gap between official and parallel market exchange rates. When cross-transactions between the two markets are permitted, the steady state of the model is identical to that of a model without capital controls and, hence, the money supply cannot serve as a nominal anchor for the price level in the long run. If capital controls are nevertheless maintained temporarily, and are known to be temporary, targeting the money supply fails to stabilize the rate of inflation even in the short run.

JEL Classification Numbers:
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Summary

When the nominal exchange rate is managed such as to offset the difference between domestic and foreign inflation, the authorities are effectively pursuing a target for the real exchange rate and forgoing the use of the exchange rate as a nominal anchor for the domestic price level. If the target value of the real exchange rate is not adjusted in response to real shocks under such a regime, such shocks may destabilize the domestic price level. In such a setting, it is natural to ask whether a financial aggregate, such as money, can effectively perform the role of nominal anchor for the economy and stabilize the price level.

One problem with adopting a money supply target in these circumstances is that high capital mobility may render the money supply uncontrollable. This paper thus investigates the possible stabilizing role of money in the presence of real exchange rate targeting and capital controls. It finds that if capital controls prove effective, holding the money supply constant without adjusting the real exchange rate target in response to a real shock, such as a change in the terms of trade, may indeed stabilize the price level, but will result in an ever-widening spread between the exchange rate in the official and the parallel markets. In such circumstances, capital controls are likely to break down and "leakages" are likely to emerge between the official and parallel exchange markets. In the presence of such leakages, the authorities would find it impossible to sustain both their real exchange rate and money supply targets for very long.

If they nevertheless attempted to do so for a short period of time, they would not succeed in stabilizing the price level. In response to a real shock, fixing the money supply would not prevent changes in the domestic inflation rate as long as private agents know that the controls on capital movements will eventually have to be abandoned. The analysis concludes, then, that the money supply cannot effectively replace the exchange rate as a nominal anchor when a country pursues an exchange rate policy designed to fix the real exchange rate.

I. Introduction

Active exchange rate management has become increasingly prevalent among developing countries in recent years. With a view toward the preservation of competitiveness, such countries have frequently adopted rules under which the nominal exchange rate is depreciated continuously to offset differences between domestic and foreign inflation rates. Because such rules, which effectively target the real exchange rate, establish a feedback from domestic inflation to the nominal exchange rate, countries adopting them sacrifice the role of the exchange rate as the nominal anchor for the price level. Since price level stability remains an important macroeconomic goal in such countries, the question naturally arises as to whether the role of nominal anchor can instead be provided by a policy-controlled financial aggregate, such as the money supply.

In an earlier paper (Montiel and Ostry (1991)), we investigated the effects of real shocks on price-level stability under real exchange rate targeting. We found that the stock of domestic credit could not replace the exchange rate in the role of nominal anchor under such a regime. While the money supply may represent a more obvious candidate for this role, our previous paper incorporated the assumption of perfect capital mobility, which prevented the authorities from treating the money supply as a policy variable. To examine the implications of money-supply targeting under a real exchange rate rule, we now consider the case in which capital controls are imposed, thereby rendering sterilization feasible, and ask whether fixing the money supply can stabilize the price level in response to shocks. The analysis leads naturally to a consideration of the case in which the effectiveness of capital controls is less than perfect, and we examine the implications of money-supply targeting in this case as well. We find that using money as a nominal anchor is problematic in both cases.

The paper is organized as follows: the next section presents an abbreviated description of our previous model modified for the presence of effective capital controls, and demonstrates the inflationary consequences of a real--specifically, a terms of trade--shock in the absence of money-supply targeting. The money supply is then fixed through a policy of active sterilization in Section III, and the macroeconomic implications of the terms of trade shock are reexamined under these circumstances. Section IV considers how the analysis is affected when capital controls are imperfect. Our findings regarding the role of money as a nominal anchor are summarized in a brief concluding section.

II. The Basic Model Under Capital Controls and No Leakages

We consider a small open economy in which competitive firms combine labor (available in fixed supply) and a sector-specific factor to produce home goods and exportables, using a standard concave technology. All prices are flexible, ensuring that full employment is continuously maintained.

The income generated from production of the two goods is received by consumers who use it to buy home goods and importables. Consumers have Cobb-Douglas utility, which implies that they allocate a constant fraction of their total expenditures to each of the two goods in every time period. The real value of aggregate consumption expenditures is assumed to depend upon the real value of factor income net of taxes, the real interest rate, and real financial wealth. Real factor income, which we denote by y, is the value of output of exportables and home goods, deflated by the consumer price index. As shown in Khan and Montiel (1987), under the assumption that the external trade surplus is zero in the initial steady state equilibrium, real factor income depends only on the terms of trade (the price of exports relative to imports), denoted by ρ, with $y'(\rho) > 0$.

Real household financial wealth consists of real money balances ($m = M/P$), plus the real value of foreign securities (vF_p/P), less the real value of loans extended to households by the banking system ($d_p = D_p/P$), where P is the domestic price level. To permit it to control the domestic money supply, the central bank in this economy refrains from engaging in foreign exchange transactions for financial purposes. We assume that, as a result of this policy, a parallel foreign exchange market emerges in which private individuals trade foreign exchange at the market-determined exchange rate, v. The central bank continues to operate an official exchange market, however, for all commercial transactions. Since trade in the official market is limited to commercial transactions, interest earnings on foreign securities are converted into domestic currency at the parallel market exchange rate.

To simplify the analysis, it is assumed that the foreign inflation rate is equal to the nominal interest rate on foreign securities and, therefore, that the foreign real interest rate is zero. This implies that inflows into the parallel market (in the form of interest earnings on the stock of foreign securities) are just sufficient to offset the rate at which the real value of the stock of foreign securities is eroded by foreign inflation and therefore, that the real stock of foreign securities (in terms of traded goods), denoted f_p, is constant when capital controls are perfect.

With regard to the composition of the household portfolio, we assume that uncovered interest rate parity holds continuously:

$$i = i^* + \hat{v}, \tag{1}$$

where i is the domestic cost of borrowing and i^* is the return on foreign securities. The demand for money depends on the nominal interest rate and on real income:

$$m = L[i^* + \hat{v};\ y(\rho)];\ L_1 < 0,\ L_2 > 0, \tag{2}$$

where subscripts denote partial derivatives with respect to the corresponding arguments. For the purposes of this section, we shall assume that monetary policy takes the form of holding the real stock of credit to the private sector (d_p) constant.

Under real exchange rate targeting, the authorities continuously adjust the commercial exchange rate, denoted by s, in order to keep the real exchange rate (the relative price of importables to home goods) constant at a base period level. Therefore, the rate of devaluation of the commercial exchange rate is adjusted according to the difference between the rate of inflation of home goods and the foreign-currency rate of inflation of importables, which we denote as π^*. 1/ Because the domestic price index is a weighted average of the domestic price of importables and home goods, under this rule the domestic rate of inflation, denoted by π, will be equal to the rate of inflation of home goods. Thus, the real exchange rate targeting rule can be expressed as:

$$\hat{s} = \pi - \pi^*. \tag{3}$$

We assume that the real exchange rate rule is implemented from an initial steady state characterized by a fixed nominal exchange rate (i.e., $\hat{s} = 0$) with no capital restrictions. The resulting equilibrium real exchange rate (see Khan and Montiel (1987)) represents the base period value for the application of the real exchange rate rule. From (3), therefore, domestic inflation will be equal to π^* in the initial equilibrium. The description of the financial sector is completed by using the Fisher equations, $r=i-\pi$ and $r^*=i^*-\pi^*$, together with equations (1) and (3), to write the following expression for the domestic real interest rate:

$$\begin{aligned} r &= i^* - \pi^* + \hat{b} \\ &= \hat{b}, \end{aligned} \tag{4}$$

where $b = v/s$ represents (one plus) the premium between the financial and commercial exchange rates, $\hat{b}$ is the proportional change of b, and we have used the assumption that $r^* = 0$.

An equilibrium for this economy requires first that the supply of nontraded goods, denoted y_n, equal the sum of demands for such goods from the private and public sectors, $c_n + g_n$ (internal balance). Denoting by θ the share of total private expenditure devoted to home goods, the internal balance condition may be written as:

$$y_n(\rho) = \theta c[y(\rho)-t,\ \hat{b},\ m+bf_p-d_p] + g_n, \tag{5}$$

where t represents the real value of taxes and where units are chosen so that the value of the real exchange rate is unity in the base period. 2/ In equation (5), ρ and f_p are exogenous variables, while g_n, t, and d_p are

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1/ In the absence of terms of trade shocks, π^* is the foreign currency rate of inflation of traded goods, which will be referred to in what follows simply as the foreign inflation rate.

2/ We have suppressed the real exchange rate as an argument from the supply of nontradables function since, under the real exchange rate rule, this relative price does not change.

policy-determined. The real money supply m, however, is an endogenous variable. Its behavior over time can be derived from the household budget constraint. This yields the following expression for the accumulation of real money balances:

$$\dot{m} = y(\rho)-t-c[y(\rho)-t,r^{*}+\hat{b},m+bf_p-d_p]+r^{*}(bf_p-d_p)-\hat{b}d_p-\pi m-b\dot{f}_p+\dot{d}_p. \tag{6}$$

Since $\dot{f}_p=0$ when $r^{*}=0$, and since monetary policy holds $\dot{d}_p=0$ in this section, we can rewrite equation (6) more simply as:

$$\dot{m} = y(\rho)-t-c[y(\rho)-t,\ \hat{b},\ m+bf_p-d_p]\ -\ \hat{b}d_p\ -\ \pi m. \tag{6'}$$

Using equation (3) and the definition of $\hat{b}$, the money market equilibrium condition (2) can be expressed as:

$$m = L[\hat{b}+\pi,\ y(\rho)]. \tag{2'}$$

Solving this expression for the domestic inflation rate π yields:

$$\pi = \pi(\hat{b},\ m;\ \rho),\ \pi_1 = -1 < 0;\ \pi_2 = 1/L_1 < 0;\ \pi_3 = -L_2y'/L_1 > 0. \tag{7}$$

Finally, equation (7) can be substituted into equations (5) and (6'), permitting us to express the model as a system of two differential equations in b and m. It can readily be shown, however, that the equilibrium defined by $\dot{m} = \dot{b} = 0$ is unstable (i.e., both roots of the system are positive). Since m and b are both "jumping" variables, therefore, the system will move instantaneously to the steady state position $\dot{m} = \dot{b} = 0$, which represents the unique perfect foresight solution. 1/

Imposing the conditions $\dot{m} = \hat{b} = 0$ in equations (5), (6'), and (7) yields a system of three equations in m, b, and π which can be used to determine the effects of real shocks on the equilibrium values of these variables. Since our primary interest in this section is in the inflation rate, it is convenient to rewrite the system as a two-equation system in π and b that can be analyzed graphically. To do so, note from (3) that $\hat{v} = \pi - \pi^{*}$ when $\dot{b} = 0$ (since $\dot{b} = \hat{v} - \hat{s}$). We can therefore rewrite the money market clearing condition (2) as:

$$m = L[\pi,\ y(\rho)]. \tag{2'}$$

Substituting this equation into equations (5) and (6') (with $\hat{b} = \dot{m} = 0$) yields the following two-equation system in π and b:

$$y_n(\rho) = \theta c\{y(\rho)-t,0,L[\pi,y(\rho)]+bf_p-d_p\} + g_n, \tag{8}$$

1/ The instability of the system defined by $\dot{m}=\hat{b}=0$ requires that the interest elasticity of money demand be less than one in absolute value. This assumption was also required in signing results in our previous paper (Montiel and Ostry (1991)) and is maintained throughout the present paper.

$$0 = y(\rho)-t-c\{y(\rho)-t,0,L[\pi,y(\rho)]+bf_p-d_p\}-\pi L[\pi,y(\rho)]. \tag{9}$$

The combinations of b and π that satisfy equations (8) and (9) are portrayed in Figure 1. The schedule labelled NN is the locus of combinations of b and π that clear the market for home goods (equation (8)). The slope of the NN schedule is:

$$d\pi/db|_{NN} = -f_p/L_1 > 0, \tag{10}$$

where a subscripted number denotes a partial derivative, so that L_1 is the partial derivative of money demand with respect to its first argument (namely, the interest rate), which is negative. The intuition underlying equation (10) is that a rise in b raises the real value of the private sector's financial wealth, and creates an incipient excess demand for home goods. To restore market clearing, a rise in the inflation rate, which reduces real wealth by lowering real money balances, is required.

The schedule labelled SS is the locus of combinations of b and π that maintain the rate of growth of real money balances equal to zero (equation (9)). Its slope is given by:

$$d\pi/db|_{SS} = -c_3f_p/[m(1-\epsilon)+c_3L_1), \tag{11}$$

where ϵ is the absolute value of the interest elasticity of money demand, which is taken to be less than unity in the initial steady state. The numerator of equation (11) is negative since a rise in b raises wealth, increasing consumption expenditures ($c_3>0$) and reducing monetary accumulation. The denominator, however, may be positive or negative since the first term, $m(1-\epsilon)$, is positive but the second term, c_3L_1, is negative. The sign of the denominator is ambiguous because an increase in inflation has an ambiguous effect on the accumulation of real money balances, $\dot{m}$. On the one hand, an increase in π raises the inflation tax on the assumption that $\epsilon<1$, thereby reducing $\dot{m}$; on the other hand, higher inflation reduces real balances, and hence wealth, which causes consumption to decline and saving and $\dot{m}$ to rise. For sufficiently inelastic money demand, however, the effect of inflation on consumption will be dominated by the effect on the inflation tax. This is the assumption underlying the negative slope of the SS schedule in Figure 1. 1/

Consider now the effect of an improvement in the terms of trade, i.e., a rise in ρ. An improvement in the terms of trade raises the productivity of labor in the exportables sector and causes labor to shift from home goods

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1/ Our comparative statics result with respect to inflation do not, however, depend on the assumption that the SS schedule is negatively sloped. If the slope of SS is positive, then the result requires only that SS be steeper than NN, which is assured by previous assumptions.

production to export production. 1/ In addition, the rise in ρ raises real income and hence the demand for home goods. For both reasons, an incipient excess demand for nontradables develops, the elimination of which requires a reduction in real wealth and hence in private spending on all goods, including nontradables. This is brought about by the adverse real-balance effect of a rise in inflation. Thus, the NN schedule in Figure 1 shifts vertically upwards to N'N', with the magnitude of the displacement given by:

$$d\pi/d\rho|_{NN} = [y_n' - \theta y'(c_1+c_3L_2)]/(\theta c_3L_1) > 0. \tag{12}$$

Turning to the SS schedule, a rise in ρ raises real factor income y, which by itself would tend to raise the rate of money accumulation. However, it also raises real consumption spending, both directly through the marginal propensity to consume, and indirectly by increasing real wealth (through a positive real balance effect). In addition, the positive effect of an improvement in the terms of trade on money demand increases the inflation tax πL, thereby reducing $\dot{m}$. Figure 1 is drawn on the assumption that the marginal saving propensity, $[1-c_1-(c_3+\pi^*)L_2]$, is positive, i.e., that the increase in real income associated with the terms of trade improvement raises income net of inflation tax by more than it raises consumption. 2/ In this case, the SS schedule shifts up to a position such as S'S' in Figure 1, by a magnitude which is given by:

$$d\pi/d\rho|_{SS} = y'[1-c_1-(c_3+\pi^*)L_2]/[m(1-\epsilon)+c_3L_1] > 0. \tag{13}$$

As can be seen, the shifts in both curves contribute to a rise in the inflation rate although they have opposite effects on the parallel market premium. Solving for the effects of the terms of trade shock on inflation gives:

$$d\pi/d\rho = [-y_n'c_3f_p+\theta y'c_1c_3f_p(1-\pi^*L_2)]/[m(1-\epsilon)f_p\theta c_3]. \tag{14}$$

The denominator of this expression is positive under our maintained assumption that $\epsilon<1$. A sufficient condition for the numerator to be positive is that $\pi^*L_2<1$, i.e., that the increase in real income net of inflation tax associated with the improvement in the terms of trade is positive, a condition which is likely to be satisfied in practice. 3/ We conclude that an improvement in the terms of trade raises the steady-state

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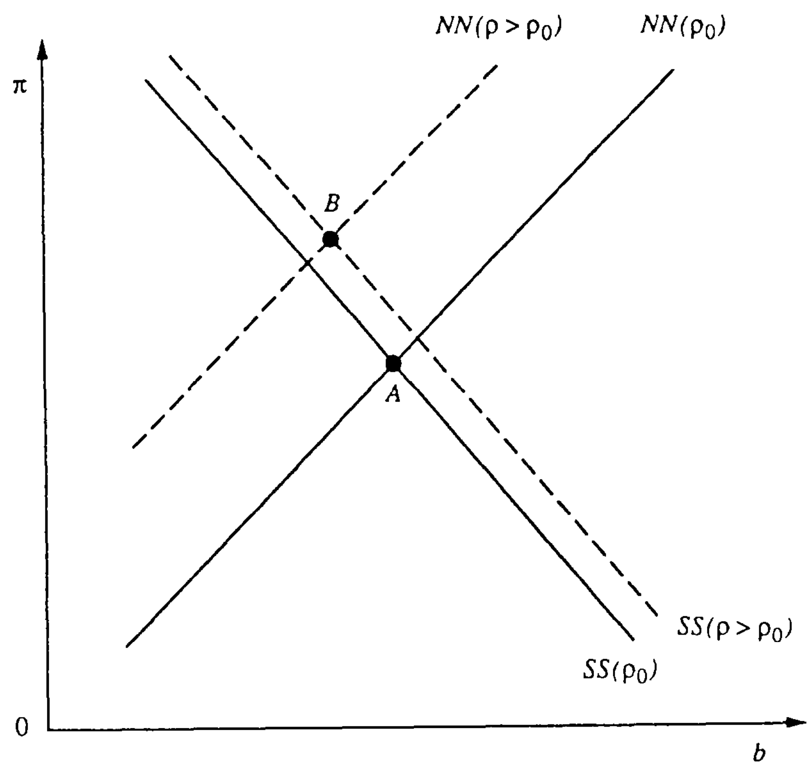
1/ The fact that $y_n' < 0$ can be rigorously shown by substituting into the output supply function the equilibrium real wage as a function of the terms of trade: See Khan and Montiel (1987).

2/ Again, our comparative statics results do not depend on this assumption.

3/ Notice that this condition is equivalent to the requirement that the product of the share of seignorage in real income and the income elasticity of money demand be less than unity, something that would be easily satisfied for any plausible values of the parameters.

Figure 1
Macroeconomic Equilibrium Under Capital Controls



Data: ρ_0 is the initial terms of trade defined as the price of exports relative to imports.

inflation rate under real exchange rate targeting and no capital mobility.1/ This is shown by the movement from Point A to Point B in Figure 1. The premium, b, will certainly decline for sufficiently inelastic money demand, but may increase otherwise.

III. Can a Money Supply Rule Stabilize Prices?

Suppose now that the authorities, anticipating the inflationary effects of a shock under real exchange rate targeting, attempt to stabilize the inflation rate (i.e., set $\pi = \pi^*$) by pursuing a monetary target. Under this regime, the nominal money supply continues to grow at the world rate of inflation π^*. This rule therefore implies:

$$\dot{m} = (\pi^* - \pi)m. \tag{15}$$

Of course, holding the nominal money supply on this path requires abandoning the assumption that the real stock of credit d_p is constant, since credit policy must now be geared to sterilizing the effects of the balance of payments on the money supply. Returning to the system consisting of equations (5), (6), and (7), the new monetary policy regime implies replacing $\dot{m}$ by $(\pi^*-\pi)m$ in equation (6), with d_p now an endogenous variable. Thus, equation (6') is replaced by:

$$\dot{d}_p = \pi^* m - \{y(\rho)-t-c[y(\rho)-t,\ \hat{b},\ m+bf_p-d_p]\} + \hat{b}d_p. \tag{16}$$

The new system consists of equations (5), (16), (7), and (15). To solve this system, it is convenient to define a variable $w=bf_p-d_p$, which represents households' nonmonetary financial wealth. Since $\dot{w} = \dot{b}f_p-\dot{d}_p$, we can now rewrite (16) as:

$$\dot{w} = y(\rho)-t-c[y(\rho)-t,\ \hat{b},\ m+w] + \hat{b}w. \tag{17}$$

Next, the nontraded-goods market equilibrium condition (5) can be solved for $\hat{b}$, yielding:

$$\hat{b} = b(m+w,\ \rho),\quad b_1 = -c_3/c_2 > 0,\quad b_2 = (y_n'-\theta c_1 y')/(\theta c_2) > 0. \tag{18}$$

Substituting this expression into equations (7) and (17), and the resulting version of (7) into (15), produces a two-equation system in m and w given by:

$$\dot{m} = \{\pi^* - \pi[b(m+w,\rho),\ m,\ \rho]\}m, \tag{15'}$$

$$\dot{w} = y(\rho)-t-c[y(\rho)-t,\ b(m+w,\rho),\ m+w] - \pi^* m + b(m+w,\rho)w. \tag{17'}$$

1/ By contrast, under a fixed exchange-rate regime, this shock would lead to a real exchange-rate appreciation in the model, with no change in the steady-state rate of inflation (see Khan and Montiel (1987)).

It can be readily shown that the roots of this system are positive. Since m and w are both "jumping" variables, this implies that the unique perfect foresight path is given by the solution of (15′) and (17′) with $\dot{m} = \dot{w} = 0$.

The immediate implication of this result is that the money-supply targeting rule considered in this section stabilizes the domestic inflation rate at the world rate π^* even in the face of a terms of trade shock. This follows from (15′) with $\dot{m} = 0$, since $\pi = \pi^*$ regardless of the value of ρ. Thus, when capital controls are perfect, a money supply rule can indeed stabilize the domestic inflation rate under a real exchange rate target. Notice, however, that (15′) and (17′) also imply that in response to a change in ρ, m and w will in general undergo discrete changes. Since the rate of growth of the nominal money supply is fixed by the rule (16), a discrete change in m can come about either through a jump in the domestic price level or through a once-for-all change in the stock of credit d_p to accommodate the impact of the terms of trade shock on the real demand for money. Thus, a jump in the price level can also be avoided under this rule if credit policy is accommodative.

To determine which way the stock of credit will have to move in order to stabilize the domestic price level on impact, equations (15′) and (17′), with $\dot{m} = \dot{w} = 0$, can be solved for the effects of the terms of trade improvement on the equilibrium values of m and w. In our case, it proves convenient to solve for m and m+w instead. The result is:

$$dm/d\rho = -mc_3[y'(1-wL_2/L_1)-y_n'/\theta]/(c_2\Delta) > 0, \tag{19a}$$

$$d(m+w)/d\rho = -m[y'(1-L_2\pi^*)-y_n'/\theta+(w-L_1\pi^*)(y_n'-\theta c_1y')/(\theta c_2)]/(\Delta L_1) < 0, \tag{19b}$$

where $\Delta = -mc_3(\pi^*-w/L_1)/c_2 > 0$ is the determinant of the system (15′) and (17′). Thus, the favorable terms of trade shock results in an increase in the real demand for money, the accommodation of which requires a once-for-all expansion of credit to prevent a discrete fall in the domestic price level. At the same time, the free exchange rate must undergo a discrete appreciation. This follows from the result in equation (19b) that real wealth falls. Since $m+w=m+bf_p-d_p$, and since credit-financed changes in m leave $m-d_p$ unchanged, the exogeneity of f_p under perfect capital controls implies that m+w can fall only through a reduction in the premium b.

In addition to the finding that monetary targeting can indeed stabilize the domestic inflation rate, the second key result of this section is that this initial change in the premium is not the end of the story. In fact, the premium will continue to change over time, even while m and w remain at their stationary values. To see this, notice from equation (17) that the increase in ρ and decline in m+w will tend to move the rate of increase in the premium--which effectively represents movements in the domestic real interest rate--in opposite directions. The favorable terms of trade shock tends to induce an excess demand for nontraded goods, requiring an increase in the domestic real interest rate (i.e., in b) to restore equilibrium in that market, while the reduction in household wealth m+w induces an excess supply of nontraded goods, requiring a fall in $\hat{b}$ to restore equilibrium. The net effect can be derived by using (19b) in (18), which yields:

$$d\hat{b}/d\rho = [y'(1-L_2\pi^*)-y_n'/\theta]/(L_1\pi^*-w) < 0. \tag{20}$$

Thus, the exchange rate (or equivalently the premium) in the parallel market undergoes a discrete initial drop and then appreciates continuously at a constant rate. The permanent rate of appreciation represents a reduction in the domestic real interest rate required to maintain equilibrium in the market for nontraded goods in the face of the reduction in the demand for such goods caused by the decline in real household wealth.

Under real exchange rate targeting, then, the only way that a permanent wedge between the domestic and foreign real interest rates can emerge is with an ever-widening gap between the commercial and financial exchange rates (i.e., $\hat{b} \neq 0$). 1/ While this may be sustainable in the short run, it is unlikely to be so in the long run, when an ever-widening gap between the two exchange rates would create unbounded incentives to engage in cross-transactions between official and unofficial markets. We now examine whether monetary targeting can effectively stabilize the price level when capital controls are less than perfect.

IV. The Model with Leakages

The results of the previous section suggest that our model should explicitly incorporate the effects of incentives to engage in cross-transactions that arise when a substantial gap begins to emerge between the financial and commercial exchange rates. In this section, we incorporate such "leakages" between markets in the simplest way possible. We make the conventional assumption that when the financial exchange rate v is depreciated (appreciated) relative to the commercial rate s, i.e., $b > 1$ ($b < 1$), arbitrage flows are created between these two markets. 2/ Thus, inflows into the parallel market will be an increasing function k(.) of the premium b-1:

$$\dot{F}_p = k(b-1) + i^*F_p, \quad k(0) = 0, \; k'(0) > 0, \tag{21}$$

where the second term in (21) represents interest earnings on holdings of foreign securities (which we have already assumed to be exchanged through

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1/ In this case, $\hat{b}$ must be negative, implying an appreciation of the financial exchange rate relative to the (fixed) commercial exchange rate. Notice also that, since $w = bf_p-d_p$ is constant and f_p is exogenous, the fact that $\hat{b} < 0$ implies that $\hat{d}_p < 0$. This perpetual credit contraction, resulting from the need to sterilize permanently the current account surplus induced by the favorable terms of trade shock, is in effect what causes the continual pressure on the financial exchange rate to appreciate.

2/ See, for example, Guidotti (1988) and Bhandari and Vegh (1990).

the parallel market). Using the definition of the real value of foreign securities f_p we can rewrite equation (21) as: 1/

$$\dot{f}_p = k(b-1). \tag{21'}$$

Thus, given the properties of the k(.) function, it is clear that when b=1 so that there is no premium, inflows into the parallel market in the form of interest earnings are just sufficient to offset the erosion in the real value of foreign securities due to foreign inflation, as in the last section. When $b > 1$, however, households are able to direct foreign exchange into the free market, implying that $\dot{f}_p$ is positive. Increases in b further increase inflows into this market. Conversely, when $b < 1$, $\dot{f}_p$ is negative as individuals find it profitable to sell in the official market foreign exchange acquired in the unofficial market. Although inflows are negative in this case, they become less negative as b rises towards 1, so that k(.) is still an increasing function as stated in equation (21).

Consider now the regime of Section II in which the authorities keep the real stock of credit d_p constant. The internal balance condition continues to be given by equation (5), which can be solved for $\hat{b}$ as a function of b, f_p, and m:

$$\hat{b} = \Phi(b,\ f_p,\ m),\ \Phi_1 = -f_p c_3/c_2 > 0;\ \Phi_2 = -c_3/c_2 > 0;\ \Phi_3 = -c_3/c_2 > 0. \tag{22}$$

A rise in b, f_p, or m raises real private holdings of financial wealth and creates an excess demand for home goods, the elimination of which requires a rise in the domestic real interest rate, and hence in $\hat{b}$.

Substituting equation (22) and the definition of $\hat{v}$ into the money market equilibrium condition (equation (2)) and solving for π gives:

$$\pi = \omega(b,\ f_p,\ m),\ \ \omega_1 = f_p c_3/c_2 < 0;\ \omega_2 = c_3/c_2 < 0;\ \omega_3 = c_3/c_2 + 1/L_1 < 0. \tag{23}$$

A rise in b or f_p raises the domestic interest rate, thereby lowering money demand and creating excess supply in the money market. Equally, a rise in m creates an excess supply of real balances. In all three cases, therefore, a fall in the inflation rate π is required to restore money market equilibrium. Substituting equations (21), (22), and (23) into the private sector's budget constraint and setting $\dot{d}_p = 0$ gives the following expression for $\dot{m}$:

$$\dot{m} = y(\rho) - t - c[y(\rho) - t, \Phi(b, f_p, m), m + bf_p - d_p] - \omega(b, f_p, m)m - \Phi(b, f_p, m)d_p - bk(b-1) \tag{24}$$

$$= \Psi(b, f_p, m),\ \Psi_1 = -k' - Rf_p c_3/c_2;\ \Psi_2 = -Rc_3/c_2;\ \Psi_3 = -Rc_3/c_2 - (1-\epsilon)m/L_1,$$

1/ Recall the assumption $i^* = \pi^*$.

where $R = (m-d_p)$ represents the central bank's holdings of foreign exchange reserves which are assumed to be positive. 1/ Under the assumption that ϵ (the absolute value of the interest elasticity of money demand) is less than unity, Ψ_1 is ambiguous in sign (since $k'>0$), but Ψ_2 and Ψ_3 are both positive. 2/ Equations (21'), (22), and (24) form a three-equation dynamic system in b, f_p, and m. The trace of the matrix associated with this dynamic system is equal to $\Phi_1 + \Psi_3$, which is positive, implying that not all the roots of the system can be negative. The determinant of the matrix associated with the dynamic system is equal to $-m(1-\epsilon)k'c_3/(c_2L_1)$, which is negative, implying that the number of negative roots must be odd. From these two facts, it follows that the matrix associated with the dynamic system possesses exactly one negative and two positive roots. Recalling that the system possesses a single predetermined variable (f_p), it follows that the equilibrium defined by $\dot{f}_p = \dot{b} = \dot{m} = 0$ is a saddlepoint.

Rather than solve for the dynamics of the system, which are not of immediate interest, we proceed directly to analyze the effects of a terms of trade shock on the long-run equilibrium, focusing particularly as before on the effects on the steady state rate of inflation. Since in the steady state, the real stock of foreign securities must be constant (i.e., $\dot{f}_p = 0$), it is clear from equation (21') that the premium must also reach a constant value, i.e., b = 1. Having established that b is constant (i.e., $\hat{b} = 0$), the internal balance condition (equation (5)) now determines the level of private wealth, $m+bf_p-d_p$. With b and f_p reaching constant values (equation (21')) and with monetary policy holding d_p constant, it is clear that internal balance requires m to be constant. Therefore, the private sector budget constraint (equation (6)) may be written as in Section II above with $\dot{m}=\dot{b}=\dot{f}_p=\dot{d}_p=0$. It follows that the steady state of the system is formally identical to the one analyzed in Section II (given specifically by equations (8) and (9) above). Because b and f_p enter the steady-state model only multiplicatively, the solutions for bf_p and π will be identical in this section with those in Section II. The only difference between the models is that, rather than determining π and b as in Section II, the system now determines the steady-state values of π and f_p. In particular, under the domestic credit rule $\dot{d}_p = 0$, the steady-state response of the rate of inflation to a terms of trade shock is the same in the model with leakages as in the model without.

The analysis of this section thus indicates first that the incorporation of leakages into the basic model of capital controls implies that, rather than adjusting instantaneously to terms of trade or other shocks, the economy moves gradually towards a steady state equilibrium, with its position at any instant being driven by the value of the system's only predetermined variable, f_p. In the steady state, the only differences between the models with or without leakages concerns the values of b and f_p.

1/ If the central bank extends credit to the government, $m-d_p$ is reserves plus credit to the government; in either case, $m-d_p$ is positive.

2/ As mentioned previously, all results are evaluated around an initial steady state with b=1.

In the model of Section II, f_p is exogenous while b is endogenous, and vice-versa in the model with leakages. Since b and f_p only enter the system as a product, it is clear that the value of bf_p must be the same in both cases. Equally, it is clear that the values of all other endogenous variables, and specifically the inflation rate, to which the economy ultimately converges in the steady state, are the same in the models with or without leakages. Therefore, as in Section II, an improvement in the terms of trade is inflationary under real exchange rate targeting in the model with leakages, with the long-run effect on π being given by the expression in equation (14). With this result in hand, we now proceed to address the issue of whether a monetary policy rule can contain this inflationary impact once the possibility of leakages is taken into account.

V. <u>The Effect of a Monetary Rule in the Model with Leakages</u>

To analyze the consequences of monetary targeting in the presence of leakages, we again assume that the authorities adopt the money supply rule (15). To derive the required rate of credit expansion, substitute (15) in (6) as before and solve for d_p without, however, setting $f_p = 0$ in this case. The resulting credit policy is given by:

$$\dot{d}_p = \pi^* m - \{y(\rho)-t-c[y(\rho)-t,\ \hat{b},\ m+bf_p-d_p]\} + \hat{b}d_p + b\dot{f}_p, \tag{25}$$

which differs from (16) only by the inclusion of the term $b\dot{f}_p$, representing the credit expansion required to offset the monetary consequences of leakages into the unofficial foreign exchange market.

The resulting model consists of the nontraded goods market clearing condition (5), the money market equilibrium equation (7), equation (15) describing the evolution of the real money supply, the leakage function (21′), and the credit rule (25). Proceeding as in Section III by making use of the variable $w = bf_p - d_p$, and noting that now $\dot{w} = \dot{b}f_p + b\dot{f}_p - \dot{d}_p$, we can again substitute into the credit rule, in this case, equation (25). It is immediately clear, however, that the resulting version of (25) is identical to equation (17′). Thus, the system that emerges in this section is identical to that of Section III, with the addition of the leakage function (21′).

The introduction of leakages, however, turns out to have radical implications for the model of Section III. The interpretation of the system is exactly as before except that corresponding to the new leakage function (21′), the variable f_p now becomes predetermined, rather than exogenous. Since the system is forward-looking, the solution implies working backward from a steady-state configuration. Consider, then, the steady-state version of the model. For the system to reach a steady state, the predetermined variable f_p must satisfy $\dot{f}_p = 0$. From (21′), this requires $b = 1$, i.e., the premium must disappear in the steady state, and f_p becomes an endogenous variable. Recall, however, from Section III that in the steady state the model determines values for both w and b. By examining equations (15′) and (17′), moreover, it is easy to verify that f_p does not appear in the model's steady-state equations. The condition $\dot{f}_p = 0$, with f_p made endogenous, therefore in effect introduces an additional restriction on the model ($b = 1$, so $\dot{b} = 0$), without introducing an additional endogenous variable (since f_p does not appear in the model). It is not surprising, therefore, that this model does not possess a steady state solution. There is no perfect-foresight path consistent with monetary targeting in the model with leakages.

The economics underlying this result are straightforward. In brief, the presence of leakages implies that in the long run the economy effectively exhibits perfect capital mobility. Changes in the stock of credit will not, therefore, affect the real money supply. Instead, since the system determines an equilibrium value of the stock of real nonmonetary assets w, changes in d_p will simply be offset by corresponding changes in f_p, just as in our previous model, and monetary policy will be powerless to alter the economy's steady-state inflation rate. The only steady-state solution of the system, therefore, is that of the previous section, with $\pi > \pi^*$ in response to a permanent improvement in the terms of trade. Money supply targeting cannot provide an alternative nominal anchor in this case, simply because monetary policy cannot control the money supply in the long run in the presence of leakages.

Suppose, however, that, in full awareness of this result, the authorities nevertheless respond to a terms of trade shock by <u>temporarily</u> supplementing their real exchange rate target with capital controls and a money supply target, intending to abandon such controls at some future date. Could such a policy, while it is in place, succeed in stabilizing the domestic inflation rate at the world rate π^*?

This question is addressed in Figure 2. Setting $\dot{m} = 0$ in equation (15') and $\dot{w} = 0$ in (17') yields the dotted loci labeled with the corresponding conditions in Figure 2. Along the $\dot{m} = 0$ locus, the domestic rate of inflation π equals the world rate π^*, so that with the target growth rate of the domestic money supply set equal to π^*, the real money supply is unchanged. Along the $\dot{w} = 0$ locus, real household nonmonetary financial wealth is unchanged. 1/ The relative slopes of these loci follow from:

$$dm/dw|_{\dot{w}=0}=(-wc_3/c_2)/(\pi^*+wc_3/c_2) < dm/dw|_{\dot{m}=0}=(-c_3/c_2)/(c_3/c_2+1/L_1) < 0. \quad (26)$$

A favorable terms of trade shock in a context of real exchange rate and monetary targeting causes the $\dot{w} = 0$ locus to shift to the left. 2/ The $\dot{m} = 0$ locus may shift in either direction, but in any case will intersect the new $\dot{w} = 0$ locus (labeled $\dot{w}' = 0$) to the northwest of point B, so that the intersection of the two loci corresponds to a lower value of w and higher

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1/ We assume that the $\dot{w} = 0$ locus is negatively sloped, which will be the case if the world rate of inflation is small. Our results do not depend on this assumption, however.

2/ The magnitude of the shift is given by $dw/d\rho|_{\dot{w}=0}=[y'(1-wc_1/c_2)-y_n'/\theta(1-w/c_2)]/(wc_3/c_2)<0$.

value of m, say at point C. This follows from equations (19a) and (19b) in Section III, and corresponds to the perfect foresight equilibrium in the absence of leakages between markets.

In the presence of leakages, however, the point C no longer represents an equilibrium. To study the economy's dynamics in this case, consider the family of loci in Figure 2 corresponding to constant values of real private wealth m+w, which for convenience we will call a (i.e., a=m+w). Each member of this family has a slope of -1, and one such member, denoted DE, is indicated in Figure 2. Another such locus, corresponding to a higher value of a, passes through the initial equilibrium at A, while yet a third, with the lowest value of a, passes through C. The relationship between the value of a at C and its initial value at A is derived in equation (19b). It is also possible to show that, once capital controls are abandoned, the long-run equilibrium value of a, which we refer to as a^*, will settle somewhere between its value at C and at A--i.e., the long-run free capital mobility equilibrium must be along a locus such as DE. 1/

To see how the economy gets from A to its long-run position along DE in the presence of leakages, notice that, along a perfect foresight path, neither the premium b nor the aggregate price level can be expected to move discontinuously, since this would create arbitrage opportunities among assets or across time. The implication of this is that household wealth cannot jump at the instant that capital controls are abandoned--i.e., the perfect foresight path must move the economy on to the locus DD at that instant. 2/ On impact, then, the economy must move into a region in the m-w plane from which it can reach DD at the appropriate instant. Notice that both m and w can jump to the perfect foresight path, as in Section III. Because the nominal values of the stocks of money, foreign assets, and credit are all predetermined, these jumps must come about through changes in the premium b and in the aggregate price level. From such an initial point, the dynamics of the system must obey the directional arrows indicated in Figure 2, which are derived with reference to the $\dot{m}' = 0$ and $\dot{w}' = 0$ loci, since these govern the system's dynamics until capital controls are abandoned.

To see where the economy moves on impact, consider first the locus of all points that can be reached from A by a jump in the price level, with b unchanged at its initial value of unity. This locus is labeled b=1 in Figure 2. It has a negative slope (because an increase in the price level reduces both m and d_p, and the latter increases w) which is greater than unity in absolute value. To reach points to the left of this locus b has to

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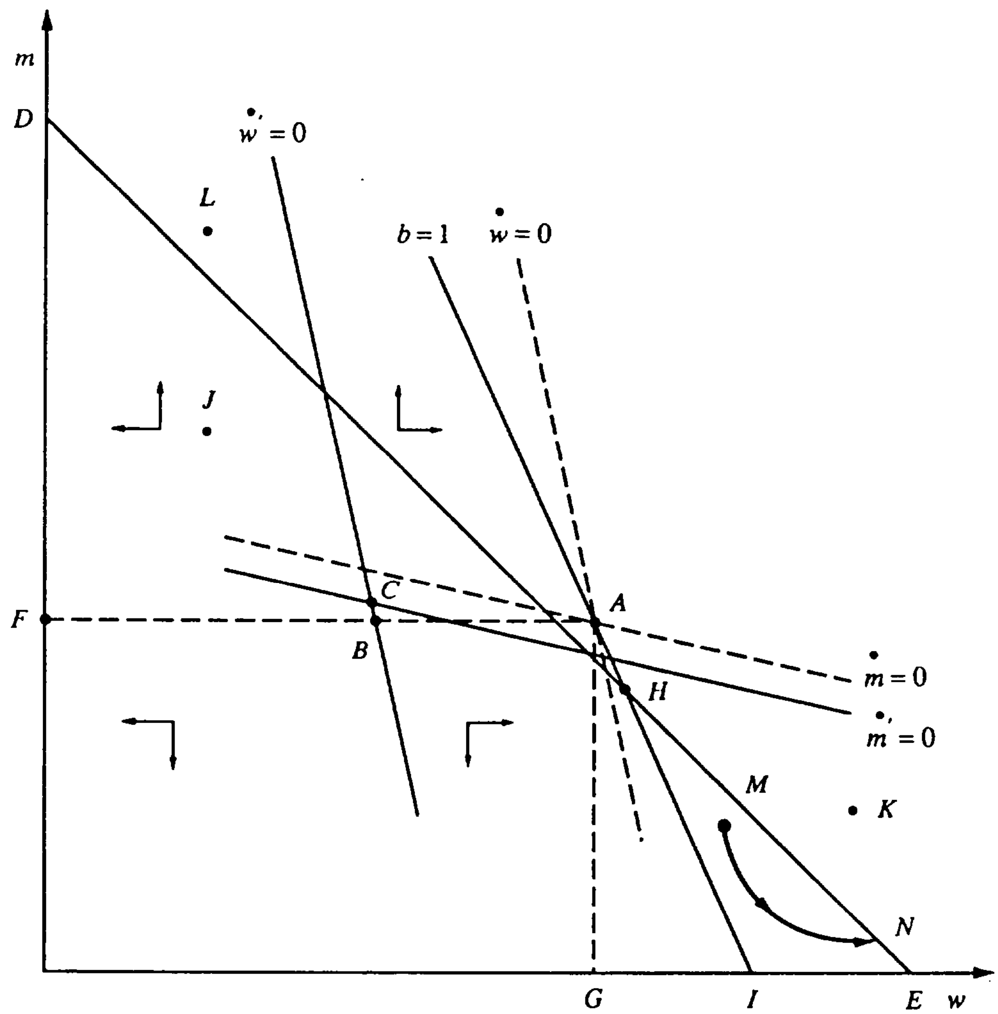
1/ This can be shown as follows. Totally differentiating equation (5) under the assumption of perfect capital mobility so that b=1 (and therefore $\dot{b}$=0), we have that $d(m+w)/d\rho = (y_n' - \theta c_1 y')/\theta c_3 < 0$. Comparing this to the result in (19b) shows that the reduction in m+w is smaller under perfect capital mobility than under perfect capital controls.

2/ Since m+w cannot jump at the moment that controls are abandoned, equation (5) implies that b also cannot change discontinuously.

Figure 2
Dynamics Under Temporary Capital Controls



fall, while to reach points to the right b has to rise. Points that are simultaneously below the b=1 and DE loci, such as J, cannot be on a perfect foresight path, because such points are characterized by b < 1 and m+w < a^*. The latter implies, from equation (18), that $\dot{b} < 0$, so b is unable to reach its final value of unity when controls are abandoned without undergoing a discrete upward jump, an event which we have previously ruled out. Similarly, points simultaneously above both loci, such as K, have b > 1 and m+w > a^* so $\dot{b} > 0$, and the same problem arises (except that a discrete drop is required in this case). Finally, it can be shown that the locus DE cannot be reached from points above DE and $\dot{m}' = 0$, but below b=1, such as L. 1/ It follows that on impact the economy must jump to a position below $\dot{m}' = 0$, and between the loci b = 1 and DE, to a point such as M in Figure 2. From M, the economy must follow a path such as the one indicated in the figure, reaching a point such as N on the locus DE at the instant capital controls are abandoned.

The relevant observation about this path for present purposes is that along MN the real money supply is continuously falling. Since, from equation (15'), this implies that $\pi > \pi^*$ along MN, it follows that targeting the growth rate of the money supply at its pre-shock level succeeds neither in stabilizing the price level--which jumps on impact--nor the rate of inflation, which remains above the world rate even as the domestic money supply is targeted to grow at the world inflation rate π^* by continuous sterilization with capital controls. Moreover, it can also be shown (see Montiel and Ostry (1991)), that the steady-state domestic inflation rate remains above the world rate when capital controls are eventually abandoned. It follows, then, that in the presence of leakages, targeting the money supply fails to stabilize the rate of inflation over all time horizons.

1/ Above the $\dot{m}' = 0$ locus, the directional arrows in Figure 2 imply that m is increasing, which from (15') implies that $\pi < \pi^*$. As shown in Montiel and Ostry (1991), we know that when capital controls are ultimately abandoned, say at time T, the rate of inflation $\pi(T)$ will be above the world rate π^*, which implies that above $\dot{m}' = 0$, $\pi < \pi(T)$. Summing equations (15') and (17') gives an expression for $\dot{a}$ which is decreasing in π (under our maintained assumption that money demand is interest-inelastic). Since real wealth is constant in the absence of capital controls, it follows $\dot{a}(\pi) = 0$ for $\pi = \pi(T)$ and, since $\dot{a}(\pi)$ is a decreasing function, it follows that for values of $\pi < \pi(T)$ (such as at point L in Figure 2), $\dot{a} > 0$. To sum up the argument thus far, $\dot{a}$ must be positive for all points in the indicated region, that is above $\dot{m}' = 0$ and DE but below b = 1. However, in order to reach DE from a position in the indicated region, a has to be falling, so $\dot{a} < 0$. We conclude therefore that it is not possible to reach the locus DE, along which the equilibrium at time T must lie, from a position in the indicated region.

VI. Conclusion

This paper has examined whether the money supply can serve as a nominal anchor for the price level under real exchange rate targeting, when the nominal exchange rate cannot serve this purpose. It was argued that, when capital controls are perfect, so that the government can permanently segment official and unofficial markets for foreign exchange, the inflation rate can indeed be stabilized in the face of exogenous shocks when the authorities follow an appropriately chosen money-supply rule. However, we also showed that the stabilization of the inflation rate carried with it the implication that in the long-run equilibrium, an ever-widening gap between the official and unofficial exchange rates would emerge. Since this growing gap between the two exchange rates would ultimately create unbounded incentives to engage in cross-transactions between official and unofficial markets, we argued that the effectiveness of capital controls could not ultimately be sustained.

The paper went on to examine whether monetary targeting could effectively stabilize the inflation rate when these incentives for cross-transactions create leakages between official and unofficial markets for foreign exchange. Our finding once again was that using money as a nominal anchor for the price level is problematic. Although the model with cross-transactions did not possess the difficulty that the gap between official and unofficial exchange rates grew continuously in the steady state, and hence avoided some of the problems that were inherent in the model with perfect capital controls, our conclusion was nonetheless that a money-supply rule could not prevent the emergence of inflation when the economy was subjected to a permanent terms of trade shock. The reason was simply that, in the presence of leakages, the long-run behavior of the economy must be identical to that of an economy without any capital controls, i.e., with perfect capital mobility. Since, under perfect capital mobility, changes in the stock of credit cannot affect the real money supply, so too in the model with leakages, the money supply becomes endogenous and hence cannot be used as a nominal anchor for the domestic price level. In addition, however, the paper showed that if capital controls are used temporarily to target the rate of growth of the money supply, a monetary rule would still fail to stabilize the rate of inflation even in the short run. To conclude, then, this paper finds little support for the view that a money-supply rule can stabilize the inflation rate when the authorities target the real exchange rate.

References

Adams, Charles and Daniel Gros, "The Consequences of Real Exchange Rate Rules for Inflation: Some Illustrative Examples," IMF Staff Papers 33 (September 1986), pp. 439-476.

Bhandari, Jagdeep S. and Carlos A. Vegh, "Dual Exchange Markets Under Incomplete Separation," IMF Staff Papers 37 (March 1990), pp. 146-167.

Guidotti, Pablo E., "Insulation Properties Under Dual Exchange Rates," Canadian Journal of Economics 21 (November 1988), pp. 799-813.

Khan, Mohsin S. and Peter J. Montiel, "Real Exchange Rate Dynamics in a Small Primary-Exporting Country," IMF Staff Papers 34 (December 1987), pp. 681-710.

Lizondo, J. Saul, "Real Exchange Rate Targets, Nominal Exchange Rate Policies, and Inflation," unpublished, University of Tucuman, 1989.

Montiel, Peter J. and Jonathan D. Ostry, "Macroeconomic Implications of Real Exchange Rate Targeting in Developing Countries," IMF Staff Papers, forthcoming, 1991.