International Finance Discussion Papers

Number 331

August 1988

# REAL INTEREST RATES DURING THE DISINFLATION PROCESS IN DEVELOPING COUNTRIES

by

Steven B. Kamin and David F. Spigelman

## ABSTRACT

This paper addresses a phenomenon often noted in association with programs aimed at stabilizing high rates of inflation: a rise in the *ex post* real interest rate following implementation of the disinflation strategy. Such increases have been observed in connection with the stopping of European hyperinflations in the 1920s, as well as during the more recent experiences of disinflation in Argentina and Israel. To better understand this behavior, we develop a very general model of interest rate determination in a small open economy with two goods -- traded and non-traded-- and three assets -- money, domestic bonds, and foreign bonds. We show that in partial portfolio equilibrium, a reduction in the fiscal deficit leads to a fall in inflation exceeding the decline in nominal interest rates, so the real interest rate rises; this effect derives from the increase in money demand resulting from the disinflation. In partial goods-market equilibrium, however, a reduction in the fiscal deficit reduces goods demands and lowers the real interest rate. In consequence, the general equilibrium response of the real interest rate to a disinflation program based on fiscal contraction is shown to be indeterminate.

The framework described above is used to examine the response of real interest rates to Argentina's disinflation in 1985. We show that the reduction in the fiscal deficit, as well as the government's shift away from money-financing, should have increased real interest rates substantially. However, the imposition of the Austral Plan appears to have exerted an independent effect in reducing interest rates, so that the impact of the program on the real rate of interest was largely neutralized.

Real Interest Rates During the Disinflation Process
In Developing Countries

Steven B. Kamin and David F. Spigelman*

## I. Introduction.

In this paper we address a phenomenon often noted in association with programs aimed at stabilizing high rates of inflation: a rise in the ex post real interest rate following implementation of the disinflation strategy. This has been observed in connection with the stopping of European hyperinflations in the 1920s, and has also been cited in the more recent experiences of disinflation in Argentina and Israel in 1985. (See Dornbusch and Fischer, 1985, and Blejer and Liviatan, 1987.) The coincidence of high real interest rates and disinflation is especially problematic in that these reductions in inflation were achieved in large part through fiscal contraction. It was the hope of the architects of the more recent stabilization programs that fiscal contraction would reduce the "crowding out" effect of government fiscal deficits and hence encourage private capital formation. In fact, real interest rates in Argentina, for example, averaged roughly 22 percent on an annual basis during the first two years following implementation of the Austral Plan. Such interest rates must exceed rates of return on all but the most lucrative investment projects, and hence constitute a significant disincentive to capital formation in Argentina. Accordingly, the response of real interest rates to disinflation has important implications for the long-term success of stabilization programs.

To better understand the movements of interest rates during programs of disinflation, we developed the very general model of interest rate determination that is presented in Sections II and III. The model focuses on (steady-state) interest rate determination in a small open

---

*The authors are staff economists in the International Finance Division. This paper represents the views of the authors and should not be interpreted as reflecting those of the Board of Governors of the Federal Reserve System or other members of its staff. We are indebted to Dale Henderson for his extensive assistance, and would also like to thank Neil Ericsson, Joseph Gagnon, Michael Gavin, David Howard, Ross Levine, Ralph Tryon, and Timothy Wilson for their helpful comments and suggestions. Eugene Vega and Michael Occhiolini provided capable research assistance.

economy with two goods -- traded and non-traded -- and three assets -- money, domestic bonds, and foreign bonds. It extends the two-asset (domestic and foreign currencies) model of Calvo and Rodriguez (1977) to three assets, so the interest rate may be solved for in addition to the rate of exchange rate depreciation. Domestic and foreign assets are assumed to be imperfectly substitutable in domestic agents' portfolios, so that uncovered interest parity need not hold.

We show that in partial portfolio equilibrium, a reduction in the fiscal deficit and the attendent rate of money and bond growth reduces exchange rate depreciation and price inflation by the same proportion. The domestic bond interest rate falls as well, but not by the same extent as price growth. Hence, the fiscal contraction and disinflation will be associated with a rise in real interest rates. This is the open economy analogue of the 'Tobin effect', which describes the inverse movement of real interest rates and inflation in the closed economy context.

In general equilibrium, however, the response of the real interest rate to fiscal contraction is indeterminate. The reduction in government spending will dampen aggregate demand, leading to a decline in the price level, nominal income, and hence the demand for money. Depending upon the strength of this effect, the fall in money demand could exert sufficient downward pressure on the real interest rate to reverse the rise in the real rate induced by the portfolio effects described above. In this instance, a fiscal contraction would be followed by a fall in real interest rates.

In Section IV, the path of real interest rates during Argentina's attempt at disinflation in the mid-1980s is examined in light of the theoretical model developed in the preceeding pages. Many analysts have commented casually on the rise in real interest rates following implementation of the Austral Plan in June, 1985. To our surprise, we found little hard statistical evidence of a rise in <u>ex post</u> real interest rates from before to after the announcement of the program. It is not clear whether this reflects the stability of <u>ex ante</u> real rates, or a discrepancy between the movement of <u>ex ante</u> and <u>ex post</u> rates; either outcome would be broadly consistent with our theoretical model.

To address this problem more closely, we estimated a reduced-form equation for the interest rate implied by our theoretical model. We show that in Argentina during this period, nominal interest rates moved less than proportionately to movements in the rate of domestic asset creation (and inflation), so that the Austral Plan should have increased real interest rates substantially; this effect should have been reinforced by the government's reduced reliance on money financing following implementation of the program. However, the imposition of the Austral Plan appears to have exerted an independent effect in reducing nominal rates of interest, so that the impact of the program on the real rate of interest was largely neutralized.

## II. A Model of Interest Rate Determination

Section II.a describes the portfolio sector of the model. The assets are assumed to be imperfectly substitutable in domestic agents' portfolios (foreigners are assumed to hold no domestic assets), so that uncovered interest parity need not hold. In fact, variations in the rate of exchange rate depreciation, as well as in the transactions needs of domestic agents, will systematically alter the rate-of-return differential between domestic and foreign bonds. The link between the interest rate and real wealth in portfolio equilibrium is derived, and the response of this relationship to changes in government monetary policy are explored.

In Section II.b, the goods market is described, and the partial equilibrium relationship in the goods market between the interest rate, rate of inflation, and stock of real wealth is derived. In Section II.c, the two relationships between the interest rate and real wealth are combined to describe the determination of the interest rate in general equilibrium.

### II.a. Portfolio sector

Much of the initial structure of the portfolio sector closely follows Tobin's (1969) model of portfolio demands in the closed economy context. Tobin analysed the behavior of asset demands for money, bonds, and physical capital in response to changes in asset supplies and price inflation. Holdings of physical capital represent a hedge against inflation in this setting. In the context of small, open, developing economies, however, foreign assets probably represent the more important inflation hedge. Accordingly, agents in our model hold three nominal assets: 1) money (M), 2) domestic bonds (B), and 3) interest-bearing foreign assets (F, in dollar terms). Holdings of these assets are subject to a nominal wealth contraint:

$$W = M + B + E \times F \qquad (1)$$

E represents the exchange rate in domestic currency per dollar. M and B are determined exogenously by the central bank, or alternatively, are pre-determined by the public sector's borrowing needs. F is predetermined, at any instant, by the prior history of the current account. Both the interest rate and the exchange rate are determined endogenously in the asset markets.

Agents formulate demands for assets as a share in total wealth ($S^M$, $S^B$, $S^F$) depending upon the real rates of return accruing to these assets ($r_M$, $r_B$, $r_F$) and their transactions needs, which are represented by the ratio of nominal income to wealth (yP/W). (P represents the domestic price level, and y represents real GDP, which is assumed to be fixed at the full employment rate).

$$S^M(r_M, r_B, r_F, yP/W) = M/W \qquad (2)$$
$$S^B(r_M, r_B, r_F, yP/W) = B/W \qquad (3)$$
$$S^F(r_M, r_B, r_F, yP/W) = E \times F/W \qquad (4)$$

We assume these assets to be gross substitutes, and that it is differentials in rates of return, not their levels, which influence asset demands. Therefore, equal increases in all three rates of return will leave asset demands unchanged:

$$\partial S^i/\partial r_M + \partial S^i/\partial r_B + \partial S^i/\partial r_F = 0 \qquad i = M,B,F \qquad (5)$$

The domestic price level P is an aggregate of traded and non-traded goods prices:

$$P = P_T^{\phi} P_N^{(1-\phi)} = (E \times P_T^*)^{\phi} P_N^{(1-\phi)} \tag{6}$$

$\phi$ - share of traded goods in spending
$P_T^*$- dollar price of traded goods, fixed at unity
$P_N$ - non-traded goods price

Define $\pi = \hat{P}$ to be the rate of inflation and $i^*$ the exogenous interest rate earned by the foreign asset, while a superscripted e denotes expectations. Then real rates of return are defined:

money: $$r_M = -\pi^e = -\hat{P}^e = -\phi\hat{E}^e - (1 - \phi)\hat{P}_N^e \tag{7}$$

bonds: $$r_B = i - \pi^e = i - \phi\hat{E}^e - (1 - \phi)\hat{P}_N^e \tag{8}$$

foreign assets: $$r_F = i^* + \hat{E}^e - \pi^e = i^* + \grave{E}^e - \phi\grave{E}^e - (1-\phi)\dot{P}_N^e \tag{9}$$

$$= i^* + (1 - \phi)(\hat{E}^e - \hat{P}_N^e)$$

Examination of asset demand equations (2), (3), and (4) will show that the portfolio sector is homogenous of degree 0 in all nominal levels M, B, $P_N$, E, and therefore W and P. That is, an equiproportionate rise in all of these terms will leave real wealth, asset demands, and rates of return unchanged. In order to examine the system's steady-state behavior, we assume the central bank issues money and bonds in constant proportion to each other in order to finance the government's fiscal deficit, so that money and bonds represent shares $\mu$ and $1-\mu$ of total nominal domestic assets A ($A = M + B = \mu A + (1-\mu)A$); $\mu$ is chosen by the government, but is constant for any steady state. Accordingly, the growth rate of A, denoted $\kappa$, will in steady state determine and be equal to the growth rate of non-traded goods prices, the rate of exchange rate depreciation, and the overall inflation rate $\pi$.[1] We therefore simplify

---

1. By equating the rates of inflation and exchange rate depreciation, we implicitly rule out models of real interest rate movements based on divergences between $\hat{E}$ and $\pi$. In these models, the nominal interest rate (Footnote continues on next page)

our definition of real asset returns:

$$r_M = -\pi = -\kappa \tag{10}$$

$$r_B = i - \pi = i - \kappa \tag{11}$$

$$r_F = i^* + \hat{E} - \pi = i^* + \kappa - \kappa = i^* \tag{12}$$

Under the assumption of perfect foresight, the expectational superscript e is dropped as well. Note that the real rate of return on foreign assets is invariant with respect to government fiscal policy.

Applying Walras' Law, we eliminate the equation for equilibrium in the market for foreign assets. For simplicity, we also represent asset demands in terms of i and $\kappa$ rather than the real rates of return included above; $i^*$ is considered fixed, and hence dropped from the system shown below. Finally, we define real wealth $\omega = W/P$ and the share of domestic assets in wealth $\delta = A/W$; note that $M/W = \mu A/W = \mu\delta$ and $B/W = (1-\mu)A/W = (1-\mu)\delta$.

$$S^M(\overset{-}{i}, \overset{-}{\kappa}, \overset{+}{y/\omega}) = \mu\delta \tag{13}$$

$$S^B(\overset{+}{i}, \overset{-}{\kappa}, \overset{-}{y/\omega}) = (1-\mu)\delta \tag{14}$$

The signs above the arguments in the asset demand functions represent the partial derivative responses to changes in those arguments, and are derived as follows:

$$\begin{aligned} \partial S^j/\partial i &= (\partial S^j/\partial r_M)(dr_M/di) + (\partial S^j/\partial r_B)(dr_B/di) + (\partial S^j/\partial r_F)(dr_F/di) \\ &= \partial S^j/\partial r_B \end{aligned} \tag{15}$$

---

(Footnote continued from previous page)

is often equated to the foreign interest rate, adjusted for exchange rate depreciation, so that changes in the real exchange rate lead to changes in real interest rates. (See Fernandez, 1985, and Hanson and de Melo, 1985.)

$$\partial S^j/\partial\kappa = (\partial S^j/\partial r_M)(dr_M/d\kappa) + (\partial S^j/\partial r_B)(dr_B/d\kappa) + (\partial S^j/\partial r_F)(dr_F/d\kappa)$$

$$= -(\partial S^j/\partial r_M + \partial S^j/\partial r_B) < 0 \qquad (16)$$

$$j = M, B$$

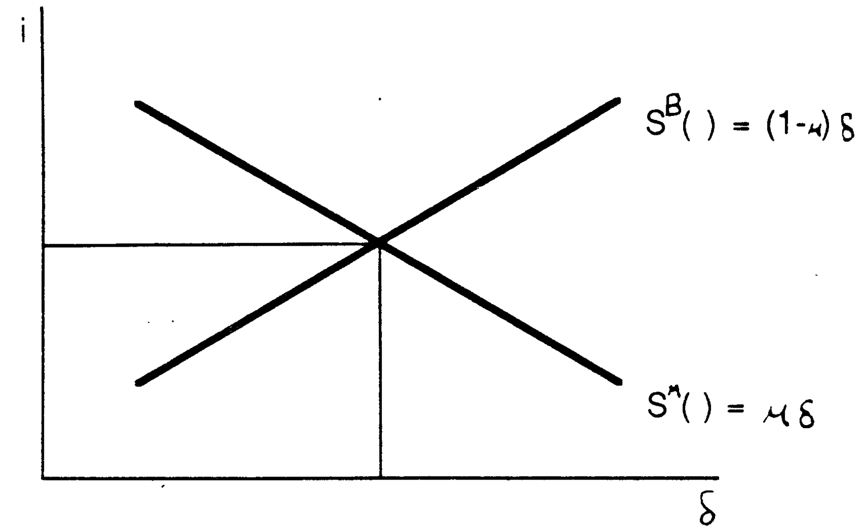
It is assumed that increases in transactions needs increase the demand for money and reduce the demands for both domestic and foreign bonds as shares of wealth:

$$\partial S^M/\partial(y/\omega) > 0 \qquad \partial S^B/\partial(y/\omega) < 0 \qquad \partial S^F/\partial(y/\omega) < 0 \qquad (17)$$

Portfolio Equilibrium:

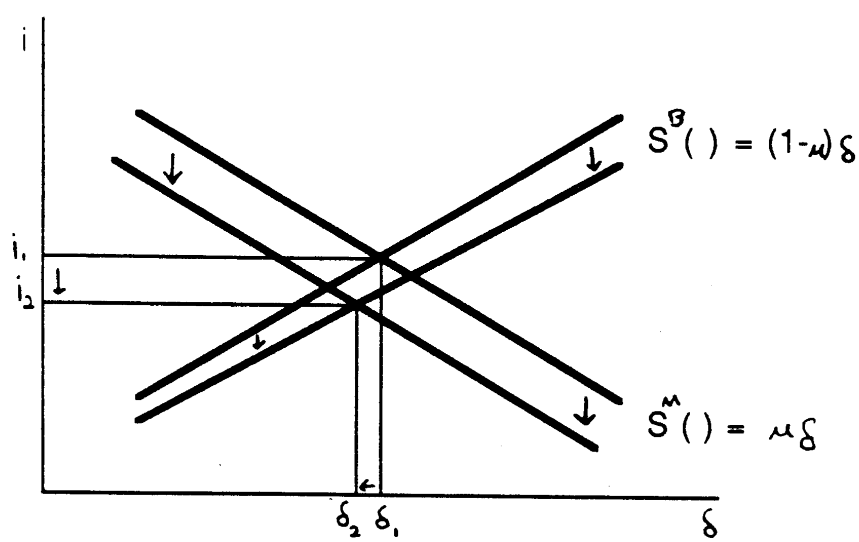
Equations (13) and (14) represent two equations in three unknowns: the interest rate i, real wealth $\omega$, and the share of domestic assets in total wealth $\delta$. The magnitudes of these variables are determined by government policy variables $\kappa$, the rate of domestic asset creation, and $\mu$, the share of money in domestic assets. The figure below depicts the two equilibrium relationships between i and $\delta$, holding the third endogenous variable $\omega$ constant, as well as $\kappa$ and $\mu$. The $S^M(\ ) = \mu\delta$ curve represents the locus of combinations of i and $\delta$ in which the money market is in equilibrium; the $S^B(\ ) = (1-\mu)\delta$ curve represents the locus of points in which the demand for bonds equals their supply. Increases in $\delta$ raise the share of wealth held as money and require decreases in the interest rate to induce agents to hold additional money balances; hence, the $S^M$ curve slopes downwards. Increases in $\delta$ also raise the share of bonds in wealth, requiring a rise in the interest rate to promote additional bond demands; the $S^B$ curve therefore slopes upwards. The intersection of the two curves represents portfolio equilibrium.

FIGURE 1




We now derive the portfolio equilibrium relationship between the interest rate and the (also endogenous) stock of real wealth $\omega$. An increase in $\omega = W/P$ represents a decrease in nominal income yP relative to W, since y is fixed, and this reduces the demand for money relative to the demand for bonds. The $S^M$ curve shifts down, since the interest rate must fall to raise the demand for money back to its original level; the $S^B$ schedule shifts down as well, since a fall in the interest rate is needed to reverse the increase in bond demand. The interest rate therefore falls, as shown in Figure 2 below:

FIGURE 2



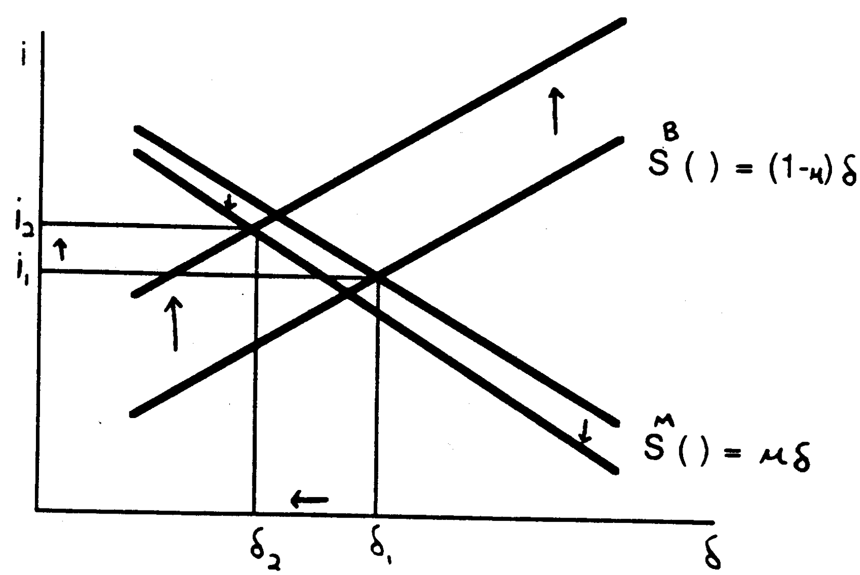
We can also derive this result by differentiating equations (13) and (14), solving out changes in $\delta$, and deriving the relationship between i and $\omega$:

$$di/d\omega = (1/\omega)(y/\omega)\left( \frac{[(\partial S^B/\partial(Y/\omega))(\partial S^M/\partial i) - (\partial S^M/\partial(Y/\omega))(\partial S^B/\partial i)]}{[\mu \partial S^B/\partial i \; - \; (1-\mu)\partial S^M/\partial i]} \right) < 0 \tag{18}$$

This relationship between the interest rate and real wealth, represented as the Portfolio Equilibrium curve in Figure 4, below, is analogous to the LM curve in the conventional two-asset -- money and bonds -- model of the macroeconomy.

Turning to the response of the Portfolio Equilibrium curve to a change in $\kappa$, the rate of domestic asset creation (as well as the rates of inflation and exchange rate depreciation in steady-state), we note this is equivilent to analysing the behavior of interest rates in partial portfolio equilibrium, that is, when real wealth $\omega$ is held constant. As indicated in Figure 3, below, an increase in $\kappa$ lowers the $S^M$ curve, for at every level of $\delta$ it reduces the demand for money and hence reduces the interest rate. Conversely, an increase in $\kappa$ reduces the attractiveness of bonds relative to foreign assets, lowers bond demands, and requires an increase in interest rates to restore bond market equilibrium; therefore, the $S^B$ curve shifts upwards.

FIGURE 3



The response of the interest rate to an increase in $\kappa$ is ambiguous. If in response to an increase in $\kappa$, the $S^B$ curve shifts farther left than the $S^M$ curve, as above, the interest rate will rise. Intuitively, this reflects the case where bonds are closer substitutes for foreign assets than is money, so that the interest rate rises to restore bond demands in the face of flight from domestic bonds to foreign assets. Conversely, if it is assumed that money represents a closer substitute for foreign assets than do bonds, then the $S^M$ curve shifts farther left than the $S^B$ curve, and interest rates fall.

This may also be seen by solving for $di/d\kappa$ explicitly:

$$di/d\kappa = \frac{(\partial S^B/\partial\kappa)/(1-\mu) - (\partial S^M/\partial\kappa)/\mu}{(\partial S^M/\partial i)/\mu - (\partial S^B/\partial i)/(1-\mu)} \qquad (19)$$

The denominator of $di/d\kappa$ is negative, while the sign of the numerator depends upon the absolute magnitudes of $(\partial S^M/\partial\kappa)/\mu$ and $(\partial S^B/\partial\kappa)/(1-\mu)$, the responses of money and bond demands to changes in $\kappa$. If the response of bond demands to $\kappa$ exceeds that of the demand for money in absolute value, $di/d\kappa > 0$. In practice, this is likely since domestic bonds probably represent closer substitutes with foreign assets than does money, so the presumption that $di/d\kappa$ is positive will be maintained for the remainder of the paper.

Ambiguities concerning its sign notwithstanding, $di/d\kappa$ unambiguously must be less than unity. Examining Figure 3 above, note that i can rise by the same extent as $\kappa$ only if (1) the $S^M$ curve is vertical, (2) the $S^M$ curve does not shift left, and (3) the $S^B$ curve shifts upward by the extent of the rise in $\kappa$. This can only occur if $S^M$ is completely unresponsive to changes in either i or $\kappa$, and if $S^B$ is equally responsive to i and $\kappa$. However, $\partial S^M/\partial i$ and $\partial S^M/\partial\kappa$ are, by assumption, non-zero, so the first two conditions do not hold. Moreover, by implication of equations (15) and (16), the "own-elasticity" exceeds the absolute magnitude of the "cross-elasticity" of the demand for bonds; therefore, the $S^B$ curve cannot rise as much as the increase in $\kappa$, so the third condition does not hold. Hence, in response to an increase in $\kappa$, the interest rate must rise by a lesser extent.

These considerations may also be examined in the expression for $di/d\kappa$ presented above. Note that even if $\partial S^M/\partial i$ and $\partial S^M/\partial \kappa$ are both zero,

$$di/d\kappa = -(\partial S^B/\partial \kappa)/(\partial S^B/\partial i) \quad (20)$$

$$= (\partial S^B/\partial r_M + \partial S^B/\partial r_B)/(\partial S^B/\partial r_B) < 1,$$

since $\partial S^B/\partial r_M < 0$. If, as is maintained throughout, $\partial S^M/\partial i < 0$ and $\partial S^M/\partial \kappa < 0$, $di/d\kappa$ becomes smaller yet.

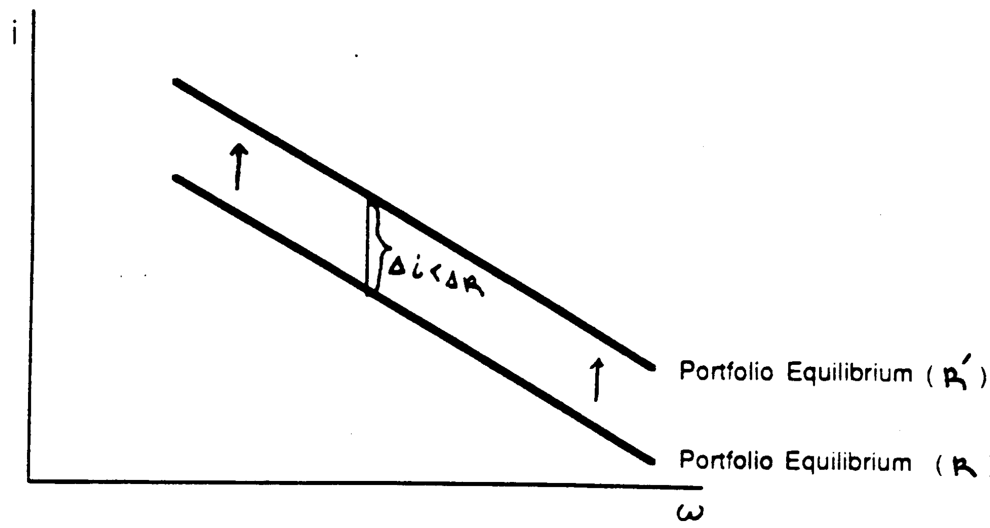
Intuitively, an increase in $\kappa$ lowers the rate of return to domestic assets relative to foreign. This, in turn, creates a notional flight from domestic to foreign bonds which raises the domestic interest rate i. The interest rate cannot, however, rise by the same extent as $\kappa$. If it did, bonds would remain equally attractive relative to foreign assets and become more attractive relative to money; an excess demand for bonds would develop until the interest rate fell to a lower level. Hence, interest rates move less than proportionately to $\kappa$ in portfolio equilibrium. Unless there are offsetting changes in real wealth $\omega$, inflation and the real interest rate will move inversely to each other. This is an open economy version of the 'Tobin effect'. In Tobin's closed economy portfolio model (1969), a fall in the rate of price inflation would reduce the nominal rate of return to physical capital; this would induce a less than proportionate decrease in the bond interest rate for the same reasons outlined above.[2]

Figure 4, below, demonstrates how an increase in $\kappa$ elicits a smaller rise in the Portfolio Equilibrium curve. In the next section, the relationship between the interest rate and real wealth in goods market equilibrium will be derived.

---

2. One of the few general models of interest rate determination oriented specifically toward developing countries was developed by Edwards and Khan (1985). In their analysis, the determination of the interest rate represents a weighted average of open and closed economy processes, the former being based on the uncovered interest parity condition and the latter on the long-run real interest rate and inflation, combined with the dynamics of money supply and demand in the short run. Their model predicts that the more closed the economy, the smaller will be the response of the nominal interest rate to changes in exchange rate depreciation.

FIGURE 4




II.b. The goods market

There are two sectors in the economy: a traded and a non-traded goods sector. The non-traded goods sector is presumed to be in equilibrium at all times. Between steady states, the traded goods sector may be out of equilibrium, in which case a non-zero current account will generate inflows or outflows of foreign assets. In steady state, however, the supply of traded goods is equated to their demand. Total real output y is presumed to be fixed, but is composed of both tradables and non-tradables production according to a Cobb-Douglas production possibility curve:

$$y = q_T^{\phi} q_N^{(1-\phi)} \tag{21}$$

$q_T$ - real tradable goods production
$q_N$ - real non-tradable goods production

While total output y is fixed, tradables and non-tradables production shift in response to changes in relative prices. The condition for equilibrium in the non-traded goods sector is expressed:

$$c_N(\overset{+}{\omega},\overset{+}{e},\overset{-}{i},\overset{+}{\kappa}) + g = q_N(\overset{-}{e}) \qquad (22)$$

$c_N$ - real consumption of non-tradables
$g$ - real government spending upon non-tradables
$q_N$ - real production of non-tradables
$e$ - real exchange rate = $E/P_N$

The condition for traded goods equilibrium is more simply expressed, since it is assumed for simplicity that the government spends only on non-traded goods:

$$c_T(\overset{+}{\omega},\overset{-}{e},\overset{-}{i},\overset{+}{\kappa}) = q_T(\overset{+}{e}) \qquad (23)$$

$c_T$ - real consumption of tradables
$q_T$ - real production of non-tradables

The government is assumed to raise no taxes, so its fiscal deficit is exactly equal to its expenditures: nominal government spending on non-tradables $P_N \times g$ plus interest payments on its outstanding debt $iB$. If the government were to have access to sources of foreign financing, such as commercial banks, then it could determine the level of government spending $g$ and the extent of domestic deficit financing (which equals the rate of domestic asset creation) $\kappa$ independently of each other. Thus both $g$ and $\kappa$ would represent exogenous government policy variables.

In an economy such as present-day Argentina, government access to additional foreign financing is not available, so the government is constrained to finance its expenditures through domestic money and bond creation alone. In such a situation, the rate of domestic asset creation $\kappa$ and real government spending $g$ are no longer independent of each other, but are linked through the following equation:

$$\kappa = dA/A = (gP_N + iB)/A = gP_N/A + i\beta \qquad (24)$$

For simplicity, we define $\beta = B/A = 1-\mu$, the ratio of bonds to domestic assets. In this exercise, we consider the rate of domestic asset creation $\kappa$ to be the government policy variable. Accordingly, we solve for endogenous real government spending:

$$g = A/P_N(\kappa - i\beta) \tag{25}$$

We derive the expression for $A/P_N$:

$$A/P_N = (A/W)(W/P)(P/P_N) = \delta\omega(P_N^{(1-\phi)}E^{\phi})/P_N = \delta\omega P_N^{-\phi}E^{\phi} = \delta\omega e^{\phi} \tag{26}$$

Substituting into equation (23), we derive government spending on non-tradables as a function of all four endogenous variables $\delta, \omega, e$, and $i$:

$$g = \delta\omega e^{\phi}(\kappa - i\beta) \tag{27}$$

The condition for non-traded goods equilibrium is now expressed:

$$c_N(\omega, e, i, \kappa) + \delta\omega e^{\phi}(\kappa - i\beta) = q_N(e) \tag{28}$$

Goods market equilibrium:

A number of assumptions are introduced to simplify the interpretation of the results. First, we assume that i and $\kappa$ affect consumption equally, but with opposite signs ($\partial c_N/\partial i = -\partial c_N/\partial \kappa = \partial c_N/\partial r$, and $\partial c_T/\partial i = -\partial c_T/\partial \kappa = \partial c_T/\partial r$). This is equivalent to assuming that the real rate of return on domestic bonds alone determines consumption decisions. Since the real rate of return on foreign assets is constant, and real returns on money and bonds are positively correlated, we would expect the rate of return on domestic bonds to be well correlated with that on the total portfolio. This assumption should therefore not prejudice our results.

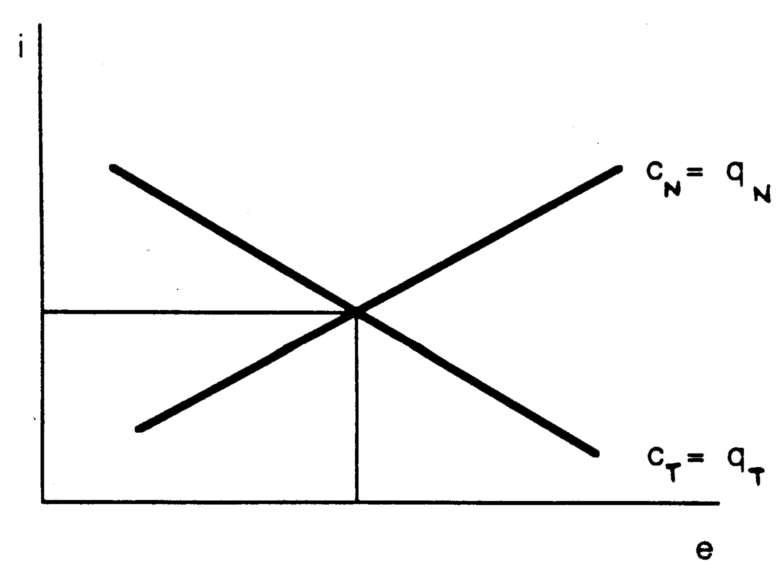
Second, we assume that the semi-elasticities of consumption with respect to the real interest rate are equal in both sectors ($[\partial c_N/\partial r]/c_N = [\partial c_T/\partial r]/c_T$). Finally, we assume that the elasticity of consumption with respect to wealth is also the same in both sectors ($\eta_{c_T,\omega} = \eta_{c_N,\omega} = \eta_{c,\omega}$). ($\eta_{a,b}$ defines the elasticity of a with respect to b).

The relationship between i, $\kappa$, and $\omega$ in the goods market is derived under two different assumptions. First, we assume the government has access to foreign financing, so that $\kappa$ and g are exogenous and independent of each other. Second, we assume the government must finance its deficit through domestic asset creation alone, so that real government spending becomes a function of the rate of domestic asset creation.

i. Access to foreign financing

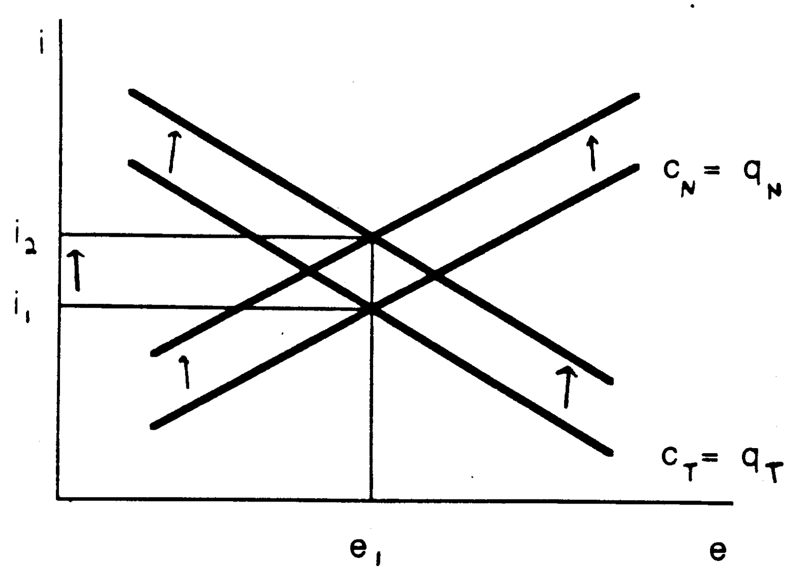
Equilibrium in the goods market requires that supply equal demand in both the traded and non-traded goods markets. The figure below illustrates the determination of goods-market equilibrium levels of the interest rate i and the real exchange rate e, given values for the third relevant endogenous variable, real wealth $\omega$, as well as for government policy variables $\kappa$ and g. The $c_N$-$q_N$ curve represents equilibrium in the non-traded goods market; it slopes upwards because as the real exchange rate e rises, consumption demand for non-traded goods rises while supply falls, so the interest rate, for a fixed inflation rate, must rise to choke off the additional demand. A rise in e boosts the supply of tradables relative to demand, so the interest rate falls along the $c_T$-$q_T$ curve to boost tradable goods consumption and maintain traded goods equilibrium.

FIGURE 5



We now solve for the locus of $(i,\omega)$ combinations consistent with equilibrium in both the traded and non-traded goods markets. As indicated in the graph below, an increase in real wealth $\omega$ leaves the real exchange rate unchanged, since it does not change relative demands for traded versus non-traded goods. The effect of the wealth increase is to raise consumption demands in both sectors. Since supplies are unchanged by the shock, the interest rate must rise to increase the real interest rate enough to lower consumption to its original level.

FIGURE 6



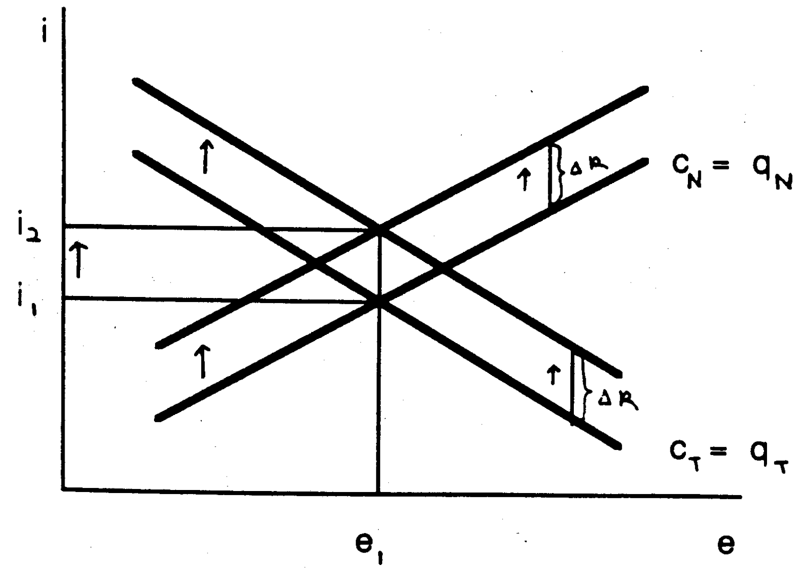

Differentiating equations (22) and (23) and solving out changes in the real exchange rate e, the magnitude of the response of the interest rate to changes in real wealth is derived:

$$di/d\omega = -(1/\omega)(\eta_{c,\omega})/((\partial c/\partial r)/c) > 0 \qquad (29)$$

The positive relationship between i and $\omega$ in the goods market is depicted as the Goods Market Equilibrium (G.M.E.) curve in Figure 8 on page 17.

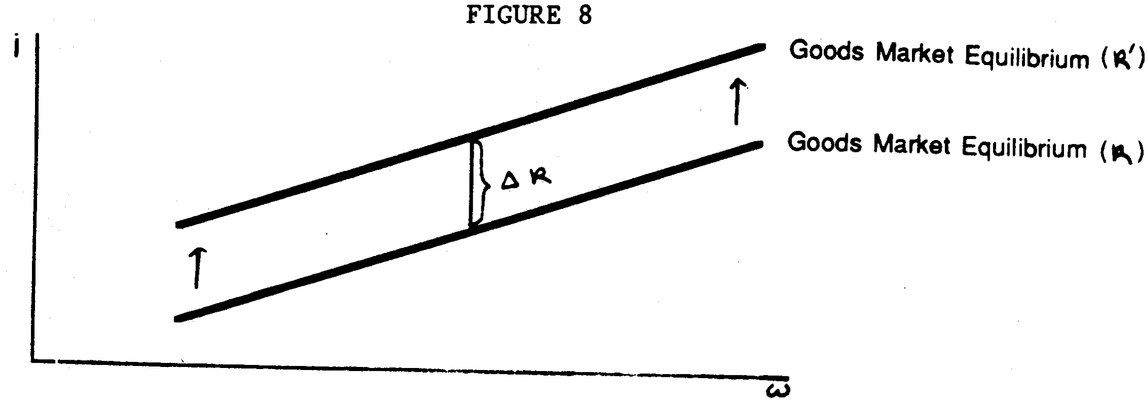
Next, we analyse the response of the G.M.E. curve to a change in the rate of domestic asset creation or inflation. Figure 7 demonstrates that a rise in the inflation rate $\kappa$ elicits an increase in the interest rate i of the exact same magnitude, while the real exchange rate e is unchanged. By rising the exact amount as $\kappa$, the nominal interest rate change leaves the real interest rate and hence consumption demands unchanged; therefore, there is no impetus for the real exchange rate to change either.

FIGURE 7




The response of the G.M.E. curve to the change in $\kappa$ is shown below. Note that a rise in real government spending g would also raise the G.M.E. curve, as it would create an excess demand which would have to be resolved, in part, through higher real interest rates which would lower consumption. In this case the real exchange rate would appreciate as well, for the demand for non-traded goods would rise relative to the demand for tradeables.[3]

FIGURE 8




3. See Alessandro (1983) for a more detailed discussion of the link between fiscal deficits and the exchange rate.

ii. Access to domestic financing only

When the government can finance deficits through domestic money and bond creation alone, real government spending and domestic asset creation cease to be independent. As above, we assume the government chooses the rate of domestic asset creation $\kappa$, so that real government spending g is determined as a residual. The two equations for market-clearing in the goods market are now (23) and (28). Since the latter equation for non-traded goods market equilibrium now includes the additional endogenous variable $\delta$, the share of domestic assets in wealth, a clear graphical presentation would be difficult. Instead, we solve differentiated versions of these equations for the algebraic relationship between i, $\kappa$, and $\omega$:

$$di = d\kappa \times (1 + [(1-\beta)\delta\omega e^{\phi} + g/\kappa \times \eta_{\delta,\kappa}]\psi_1) \qquad (30)$$

$$+ \hat{\omega} \times ([c_N \eta_{c,\omega} + g(1 + \eta_{\delta,\omega})]\psi_1 + c_T \eta_{c,\omega} \times \psi_2)$$

where:

$$\psi_1 = \frac{(q_T \eta_{q_T,e} - c_T \eta_{c_T,e})}{(\partial c_T/\partial r)(q_N \eta_{q_N,e} - c_N \eta_{c_N,e} - \phi g) - (\partial c_N/\partial r - \beta\delta\omega e^{\phi})(q_T \eta_{q_T,e} - c_T \eta_{c_T,e})} > 0$$

$$\psi_2 = \frac{(q_N \eta_{q_N,e} - c_N \eta_{c_N,e} - \phi g)}{(\partial c_T/\partial r)(q_N \eta_{q_N,e} - c_N \eta_{c_N,e} - \phi g) - (\partial c_N/\partial r - \beta\delta\omega e^{\phi})(q_T \eta_{q_T,e} - c_T \eta_{c_T,e})} > 0$$

$$\eta_{\delta,\kappa} = (\kappa/\delta)\left(\frac{[\partial S^M/\partial\kappa \times \partial S^B/\partial i - \partial S^B/\partial\kappa \times \partial S^M/\partial i]}{[\mu\partial S^B/\partial i - \beta\partial S^M/\partial i]}\right) < 0$$

$$\eta_{\delta,\omega} = (y/\omega\delta)\left(\frac{[\partial S^B/\partial(y/\omega) \times \partial S^M/\partial i - \partial S^M/\partial(y/\omega) \times \partial S^B/\partial i]}{[\mu\partial S^B/\partial i - \beta\partial S^M/\partial i]}\right) < 0$$

Note that $\eta_{\delta,\kappa}$ and $\eta_{\delta,\omega}$ are derived from the portfolio equilibrium conditions (13) and (14); since $\delta$ appears in equation (28), the non-traded goods equilibrium condition, some aspects of portfolio behavior must be brought into the equation in order to explain its movement. Both elasticities are negative. A rise in $\kappa$ raises the attractiveness of foreign assets relative to domestic assets, while an increase in $\omega$ reduces nominal income relative to wealth and hence reduces the transactions demand for money.

Neither $di/d\omega$ nor $di/d\kappa$ are unambiguously signed. Turning first to the relationship between interest rates and real wealth, we note that for $abs[\eta_{\delta,\omega}] < 1$, $di/d\omega > 0$ unambiguously. An increase in real wealth raises consumption, which must be offset by a decrease in consumption caused by a higher interest rate. The possibility of an increase in wealth reducing interest rates stems from the wealth increase's role in reducing $\delta$, the share of domestic assets in wealth, which in turn reduces real government spending $g = \delta\omega e^{\phi}(\kappa - i\beta)$. Intuitively, the increase in real wealth (or more relevantly, the reduction in the price level relative to nominal wealth) reduces the demand for money and causes prices to rise until the money market is re-equilibrated; this price rise, however, reduces the real value of government spending and causes the interest rate to decline. Hence, the larger the absolute value of $\eta_{\delta,\omega}$, the response of $\delta$ to $\omega$, the greater the chance that $di/\omega < 0$.

In fact, it can be shown that if the elasticity of money demand with respect to income is less than or equal to unity, $\eta_{\delta,\omega}$ will most likely be less than one in absolute value as well. Hence, the relation between i and $\omega$ in goods market equilibrium, when domestic financing alone is available, is assumed to be positive; as in the case where external financing is available, the G.M.E. curve slopes upward.

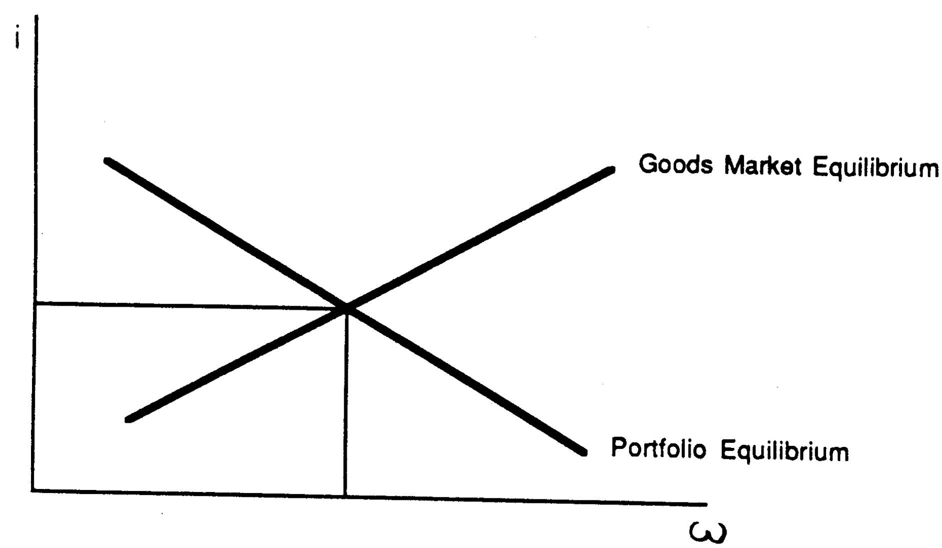
We now examine the response of the G.M.E. curve to changes in $\kappa$ when only domestic financing is available. The magnitude of $di/d\kappa$ in this instance hinges upon how effectively the government can use the inflation tax to finance its spending. If we hold money demand, price level, and government spending effects constant, equation (30) indicates $di/d\kappa$ to be unity. The interest rate must rise by exactly the same extent as the inflation rate to keep the real interest rate constant. This is exactly as in the above section, when government spending and asset creation were independent. The endogeneity of real government spending, however, will lead to additional influences on the rate of interest. First, the increase in $\kappa$, domestic asset creation, raises real government spending. This effect is captured by the $(1 - \beta)\delta\omega e^{\phi}$ term, and will lead to an increase in the interest rate exceeding the rise in $\kappa$. On the other hand, a rise in $\kappa$ lowers $\delta$ and, as discussed in reference to wealth changes, depresses real government spending and interest rates through this channel. In other words, the increase in inflation could reduce money demand and drive up the price level sufficiently to reduce the real value of the fiscal deficit, notwithstanding increases in the nominal deficit.

In this latter case, the government is on the "wrong" side of the seignorage curve, so that increases in domestic asset creation actually lower real government spending; $di/d\kappa$ will be less than one, and conceivably less than zero. This situation has been associated with economies experiencing hyperinflation, but is not regarded as typical of economies with more normal rates of inflation. We view the most likely context, therefore, as that in which the government can raise real spending through its exploitation of seignorage, so that $di/d\kappa > 1$ in goods market equilibrium.

II.c. <u>Interest rate determination in general equilibrium</u>

As the graph below indicates, the conditions for equilibrium in both the goods and the financial markets mutually determine the interest rate, as well as the level of real wealth, in the economy.

FIGURE 9



As noted in the preceeding section, the goods market equilibrium (G.M.E.) curve slopes upward regardless of whether or not the government has access to foreign financing. Both its slope and the magnitude of its response to different shocks, however, depend upon the government's access to external financing, or equivalently, the degree of independence of $\kappa$ and g.

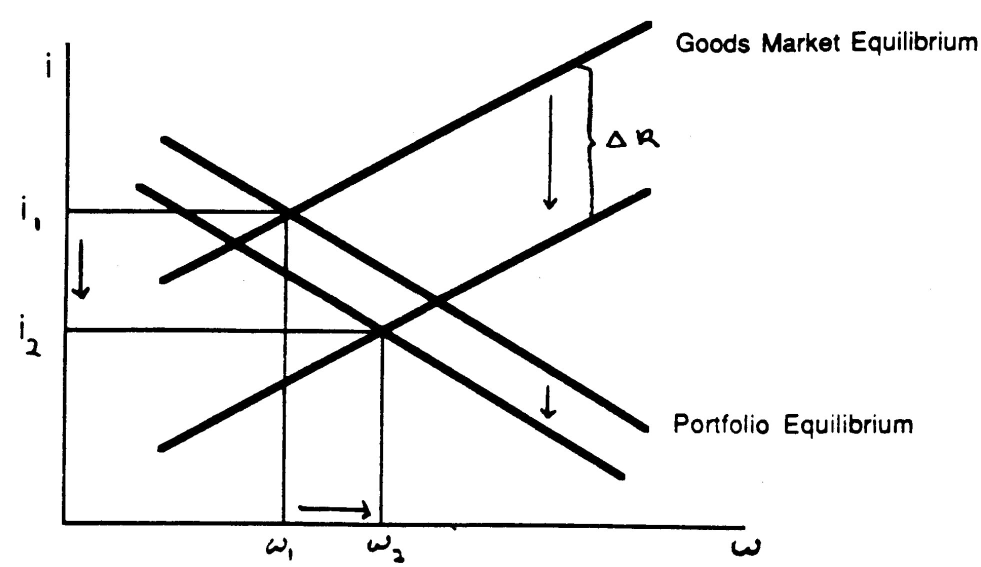
## III. Real Interest Rate Responses to Stabilization Policies

In the first part of this section, we consider the impact of a number of different stabilization policies in an environment where external financing is available and g and $\kappa$ are exogenous and independent of each other. In the second part of the section, we consider the impact of a fiscal deficit reduction-cum-disinflation program when only domestic financing is available so that real government spending depends upon the rate of domestic asset creation.

IV.a. Stabilization when external financing is available

Reduction in $\kappa$ only As the graph below indicates, when real government spending remains the same but domestic asset creation is reduced (presumably to be replaced by increased foreign financing), the Portfolio Equilibrium (P.E.) curve falls by less than $\kappa$ while the G.M.E. curve falls by the same extent as $\kappa$. The resulting equilibrium interest rate must fall by less than $\kappa$, so the real interest rate rises unambiguously.

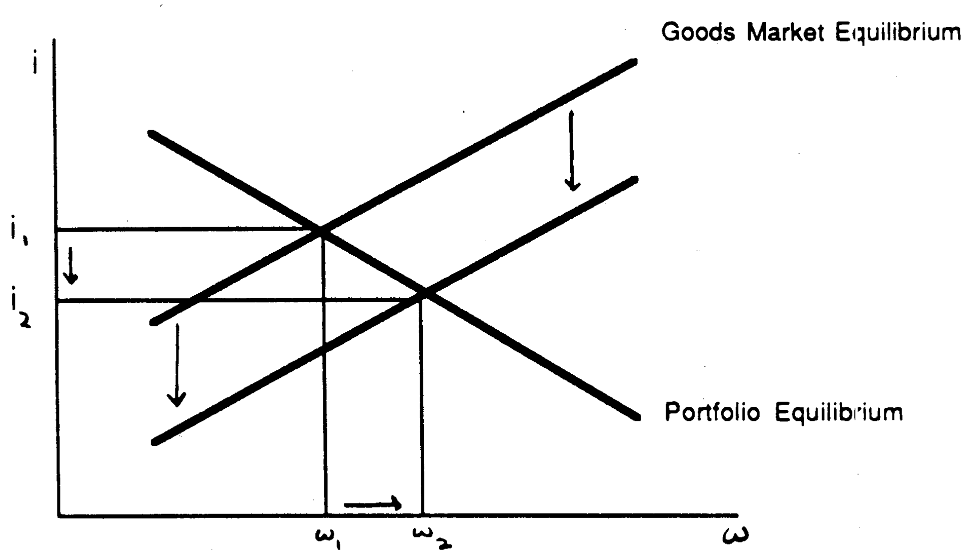
FIGURE 10



We have discussed, in Section II.a, how in partial portfolio equilibrium, when the G.M.E. curve may be construed to be fixed and vertical, this rise in real interest rates is exactly the 'Tobin Effect'. A rise in real interest rates would also result if the P.E. curve was fixed, albeit downward sloping, while the G.M.E. curve shifted down by the change in $\kappa$. This outcome has been referred to as the 'Mundell effect', and the fixity of the P.E. curve in this instance derives from a two-asset specification in which the rate of inflation does not affect the demand for money relative to bonds. (See Mundell, 1971)

Reduction in $g$ only In this case, real government spending is reduced but domestic asset creation remains unchanged; in essence, foreign deficit financing alone is reduced. The P.E. curve remains unchanged, while the G.M.E. curve falls. The nominal interest rate falls while the inflation rate $\kappa$ is unchanged, so the real interest rate falls as well.[4]

FIGURE 11

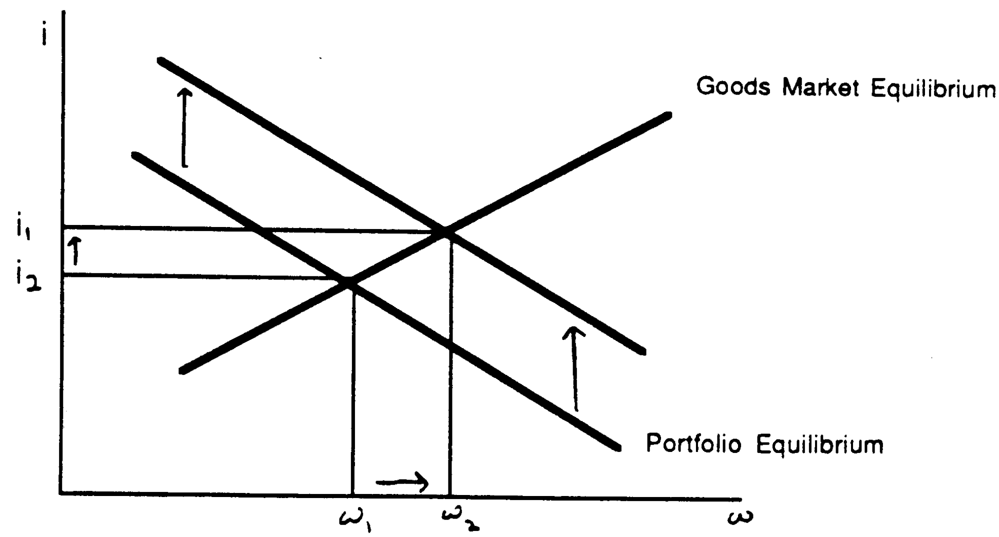



Reduction in $\mu$ (increase in $\beta$) Inflation stabilization programs have in the past been accompanied by government commitments to finance future

4. Boyer (1978) derives a similar result using a model with static exchange rate expectations.

deficits through bond issue rather than monetary emission. Using the portfolio equilibrium conditions (13) and (14), it is easy to show that in response to a drop in the supply of money relative to bonds, the interest rate must rise in order to lower money demand and increase the demand for bonds. As the graph below shows, if the rate of aggregate domestic asset creation $\kappa$ is left unchanged, both the nominal and the real interest rate will rise.

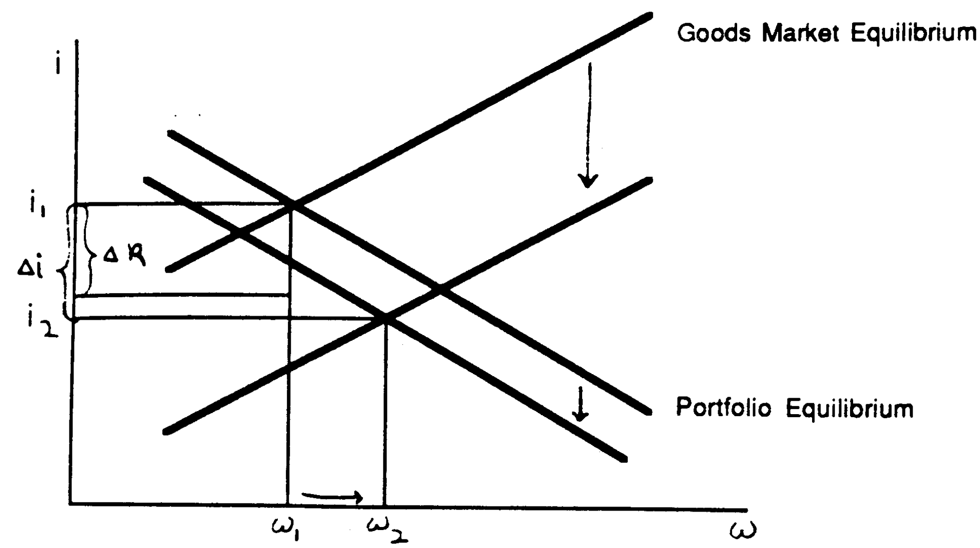
FIGURE 12




III.b. <u>Stabilization when domestic financing alone is available</u>

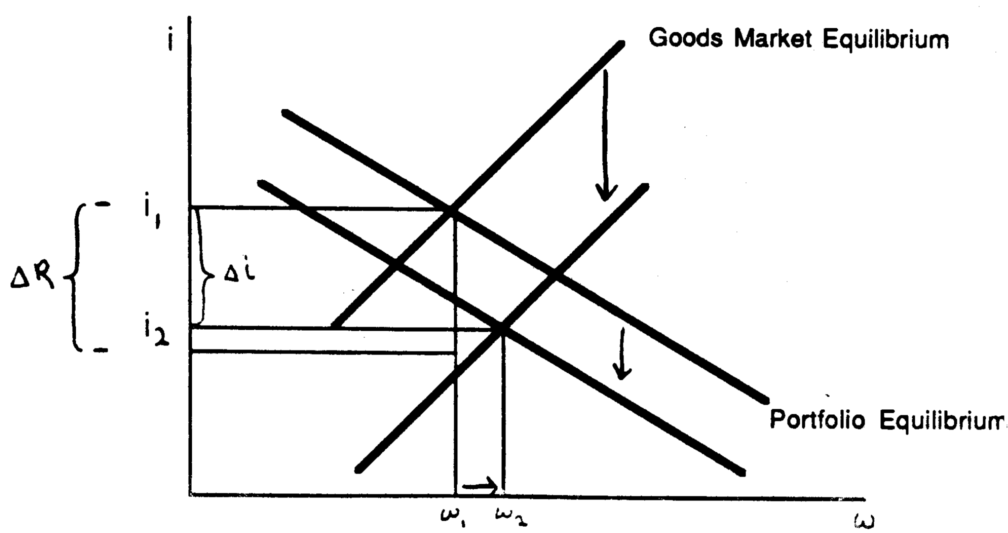
We now examine the initial motivation for this model, the effects of a reduction in the nominal fiscal deficit associated with a reduction in the rate of domestic bond and money creation -- that is, a fall in both $\kappa$ and g. This has the effect, given reasonable assumptions, of lowering both equilibrium curves. The goods market equilibrium (G.M.E.) curve drops by an amount greater than the drop in $\kappa$, while the portfolio equilibrium (P.E.) curve drops by an amount less than $\kappa$'s fall. The resultant fall in i relative to $\kappa$ is indeterminate. If the change in the nominal deficit strongly reduces real government spending, and if consumption is highly insensitive to the real interest rate, the real interest rate will fall following the fiscal contraction; this will occur because a strong reduction in the interest rate will be needed to increase consumption to offset the drop in government spending. This possibility is illustrated below.

FIGURE 13




Conversely, if portfolio effects are very strong, real government spending is relatively unaffected, and consumption is highly sensitive to the interest rate, neither the goods market nor the financial market will put strong downward pressure on the interest rate, and the real interest rate will rise following stabilization. As in the case where $\kappa$ and g were independent and exogenous, the rise results from a combination of the 'Tobin' and 'Mundell' effects.

FIGURE 14



Note that because total output is fixed while real government spending falls, private spending must increase. The proximate cause of this rise in consumption is an increase in real wealth which more than offsets the contractionary impact of the rise in real interest rates. Hence, in this simple model no crowding out occurs in response to the increase in real interest rates. However, a more complex model might incorporate private investment spending which moves inversely with the real rate of interest but is unaffected by real wealth. In this context, private investment would fall while private consumption spending rose in response to the disinflation policy considered here.

The potential for a rise in the real interest rate following fiscal contraction may seem counter-intuitive, but only in the context of a reduction in a purely bond-financed deficit. In the example portrayed above, the government finances its deficit with both bonds and money in constant proportions -- when the fiscal deficit contracts, not only does bond creation drop, but money creation falls as well. Hence, the share of bonds and money in the agents' portfolios remains unchanged. If the government were to reduce bond creation more than it reduced money creation, the interest rate would drop still further, and it would be less likely that the real rate would rise; that is, the government could increase $\mu$ (reduce $\beta$) to offset those forces operating through portfolio decisions to raise the real interest rate.

Most governments implementing fiscal stabilizations, however, have historically relied most heavily upon money-creation in financing their deficits prior to stabilization, so this option may not be open to them. In fact, many stabilizations have been accompanied by a verbal commitment to bond-financing rather than money-financing of future deficits. This was the case in Argentina in 1985, and as noted in the next section, the ratio of central bank claims on the government to privately held government debt fell following implementation of the Austral Plan. As various scholars have pointed out, a one-time increase in the money supply to offset the real interest rate rise could potentially injure the credibility of the stabilization program. These considerations further support the possibility of real interest rate increases after fiscal contraction.

Finally, recall that if the government is on the wrong side of the seignorage curve, decreases in the nominal government deficit will actually raise real spending, so that the G.E.M. curve falls by less than the drop in $\kappa$; this guarantees that the real interest rate rises following disinflation. This is consistent with the finding of real interest rate increases following stabilizations of hyperinflations; in these economies, the government may well have lost the ability to raise more real tax revenues through inflation, and reductions in the fiscal deficit, by raising real spending, could have by themselves created a crowding out effect on real interest rates. Countries implementing fiscal contractions in the context of more moderate inflations would be more likely to lower the real interest rate following stabilization.

## IV. Interest Rate Movements during Argentina's Disinflation

### IV.a. General Evidence on Interest Rate Movements

Argentina implemented a stabilization program known as the Austral Plan in mid-June 1985. Among its features were a planned reduction in the fiscal deficit through various tax increases, a temporary wage freeze on most workers' salaries as well as price guidelines as to how firms could pass on increases in costs in their output prices, and a temporary fixing of the nominal exchange rate relative to the dollar. (However, a "parallel" exchange rate for dollars was determined freely on an unofficial, but officially tolerated, market for currency.) In addition, a significant component of the Austral Plan was a promise not to finance the government's fiscal deficit through money creation. In other words, the fiscal deficit was to be entirely financed through either foreign borrowing or new bond issues.

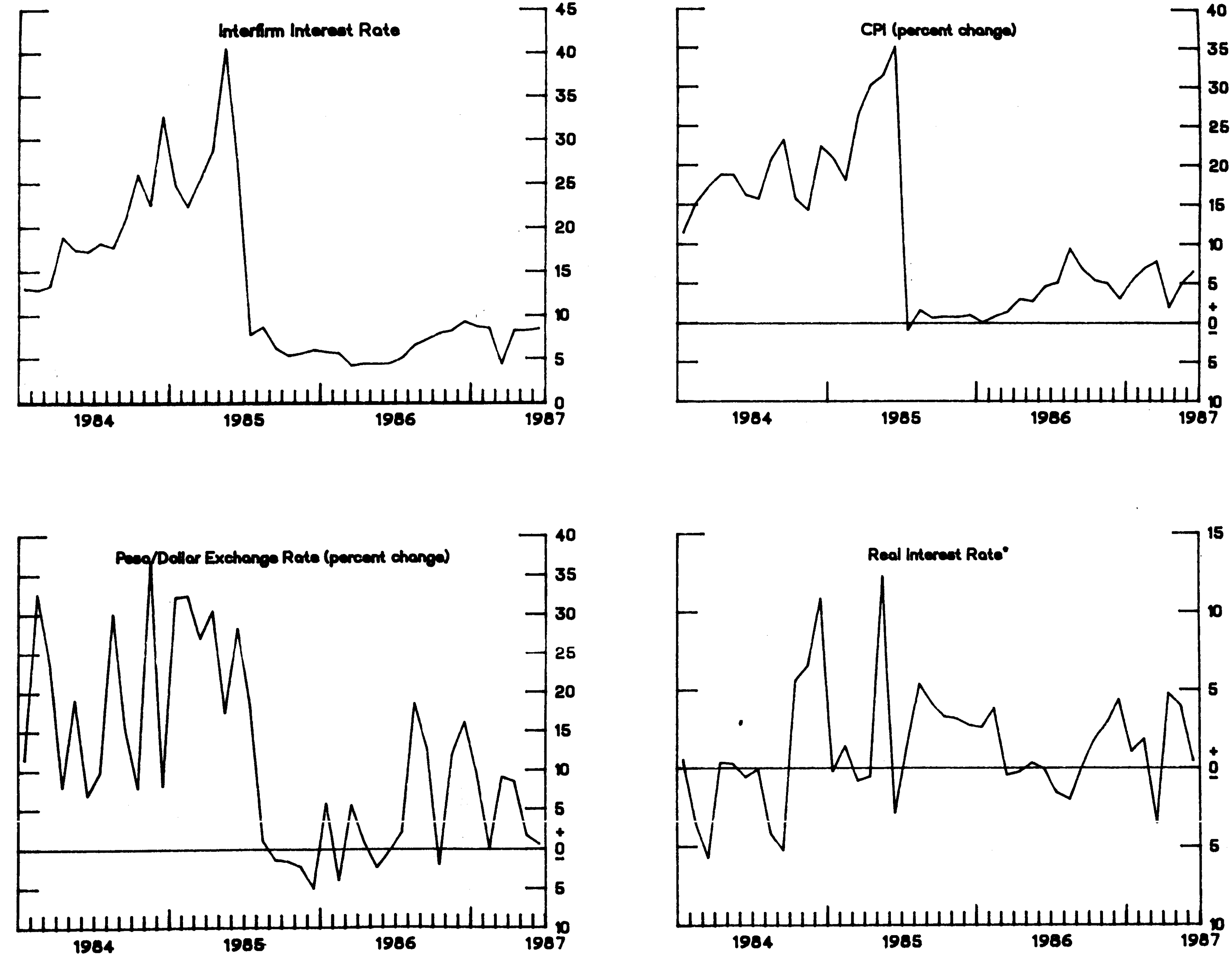
During the months following implementation of the program, the authorities succeeded in substantially reducing the size of the fiscal deficit and, at least initially, restrained monetary growth to that resulting from capital inflows from abroad. (See Howard, 1987) As the graphs on the following pages demonstrate, the nominal interest rate (in this case the rate that firms charged each other for seven day loans--the interfirm rate), the rate of change of the consumer price index (CPI), and depreciation of the parallel market peso (after the Austral Plan, the Argentine unit of currency was called the austral) all dropped dramatically following the inception of the plan. However, movements in real interest rates are less easily interpreted.

The real interest rate, defined as $r = ((1 + i)/(1 + \pi) - 1) \times 100$, is extremely variable before the implementation of the Austral Plan. Immediately following June 1985, the real interest rate appears to stabilize for a time, after which its fluctuations increase, albeit with somewhat less magnitude than in the period prior to the implementation of the Austral Plan. The table below shows the means and sample variances of the real interest rate before and after the implementation of the Austral Plan for two time horizons. The first set of calculations compares the year before to the year after June 1985, the month the program was announced. The second set uses longer sample periods to utilize all the data available.

Table 1: Argentina's Real Interest Rate

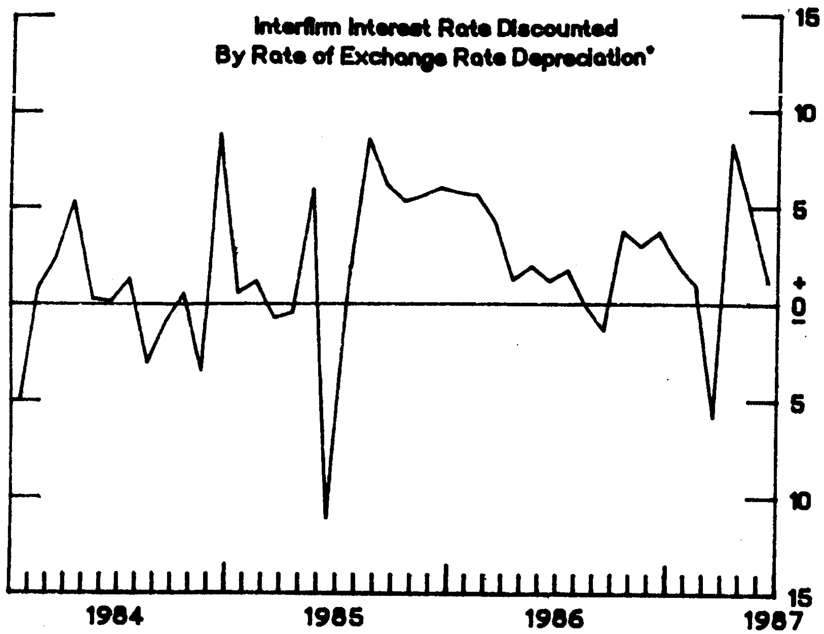
| | Mean | Median | Sample variance |
|---|---|---|---|
| 84:6 to 85:5 | 2.10 | -0.12 | 30.81 |
| 85:7 to 86:6 | 2.18 | 2.67 | 3.71 |
| | | | |
| 84:1 to 85:5 | 1.01 | -0.07 | 26.24 |
| 85:7 to 87:5 | 1.73 | 1.87 | 5.51 |

# ARGENTINA




*Real interest rate equals ((1+interfirm rate)/(1+CPI inflation rate)-1)*100

## ARGENTINA




*i.e., ((1+interfirm rate)/(1+Exchange rate depreciation)-1)*100

Mean interest rates did not rise substantially in the post-Austral Plan period, and the hypothesis that the means were the same cannot be rejected at the 95 percent confidence level. The large sample variances of the real interest rate over the different time periods tend to dwarf changes in the means.

The medians, in either of the time horizons, show greater tendencies to increase. It may be that observers of this period concentrated on the medians of the sample distribution to arrive at the conclusion that the real interest rate increased in Argentina following the implementation of the Austral Plan. It may also be true that there were large deviations between the ex ante and ex post real interest rates both before and after the Austral Plan, and that if we could observe the "true" ex ante real interest rate series, it would be smoother than the ex post rate. However, since we can't observe the ex ante real rate, it is impossible to conclude that the ex ante real interest rate increased from before to after the inception of the Austral Plan.[5]

In the theoretical development of the preceeding sections, we assumed the rate of inflation and the rate of exchange rate depreciation to be equated in the steady state. During the period in question, however, these two rates diverged substantially. Because of the importance of foreign exchange as an alternative asset, we found it useful to look at the interest rate discounted by the rate of exchange rate depreciation, defined as $((1 + i)/(1 + \hat{E}) - 1) \times 100$. This measure essentially compares financial investments in domestic bonds with foreign asset holdings. (Given that the rates shown below are on a monthly basis, we can safely presume that the foreign interest rate is essentially constant relative to the rate of exchange rate depreciation,

---

5. The perfect foresight assumption underlying our theoretical model precludes explanations of real interest rate movements based on divergences between actual and expected inflation. It has been suggested, however, that because the possibility of a breakdown in the Austral Plan was always present, inflation expectations may have consistently exceeded actual inflation following the plan's implementation, so that ex post real interest rates may have consistently overstated ex ante real rates. This is a variant of the familiar "peso problem", and would tend to undercut Blejer and Liviatan's (1987) argument that because the price freeze would have reduced short term inflation uncertainty, the ex ante and ex post rates of interest would have been similar.

and thus ignore it in the discussion here.) From the graph of this measure on the preceeding page, it is not immediately obvious whether the mean or the sample variance increases or decreases. The following table provides data on this version of the real interest rate.

Table 2: Argentina's Depreciation-Adjusted Interest Rate

| | Mean | Median | Sample variance |
|---|---|---|---|
| 84:6 to 85:5 | 0.81 | 0.33 | 12.02 |
| 85:7 to 86:6 | 4.36 | 5.45 | 6.22 |
| | | | |
| 84:1 to 85:5 | 0.79 | 0.54 | 11.82 |
| 85:7 to 87:5 | 3.18 | 3.70 | 10.77 |

As one can see, there is a much greater discrepancy between the "before" and "after" Austral Plan periods using this measure than using the conventional definition of the real interest rate. Moreover, a simple test of the hypothesis that the means are the same is rejected at the 95 percent confidence level. Hence, the <u>ex post</u> measure of the exchange rate depreciation-adjusted interest rate does appear to have risen during disinflation in Argentina.[6] Insofar as exchange rates rather than price levels may have been the focus of Argentine investors' concern during this period, this suggests (weakly) that the <u>ex ante</u> real interest rate may have risen as well. This evidence, however, is far from conclusive.

IV.b. <u>Econometric Evidence</u>

The ambiguity in the movement of real interest rates described above does not contradict the theoretical model presented in Sections II and III. According to that model, Argentina's shift away from money-financing its fiscal deficit should have, by itself, raised the real

---

6. The substantial risk premia implicit in the values for this measure during the post-Austral Plan periods are by no means unprecedented for Argentina or other South American countries in the 1970s and 1980s. Blejer (1982) documented the existence of this premium during Argentina's "tablita" period, but could not relate the size of the premium to other economic variables.

interest rate. However, the impact of the fiscal contraction and disinflation is theoretically indeterminate and could have tended to lower real rates. In this section, we estimate the historical relationship between interest rates, domestic asset creation, and the money/bonds ratio in order to decompose the change in real interest rates associated with the Austral Plan into that part attributable to the disinflation, that part attributable to the shift away from money-financing, and that part as yet unexplained.

<u>Nominal interest rate equation</u>:

Equation (31) is a log-linear representation of the portfolio equilibrium relationship described in Section II. Implications of the model for the signs and magnitudes of the coefficients are presented as well:

$$i = \alpha_0 + \alpha_1\kappa + \alpha_2\log(\omega) + \alpha_3\log(M/B) \qquad (31)$$

$$\alpha_0 > 0 \qquad 0 < \alpha_1 < 1 \qquad \alpha_2 < 0 \qquad \alpha_3 < 0$$

Equation (32) represents the goods market when domestic asset creation alone can be used to finance the fiscal deficit:

$$i = \beta_0 + \beta_1\kappa + \beta_2\log(\omega) \qquad (32)$$

$$\beta_0 > 0 \qquad \beta_1 > 1 \qquad \beta_2 > 0$$

The reduced form equation for i is derived:

$$i = a_0 + a_1\kappa + a_2\log(M/B) \qquad (33)$$

$$a_0 = \frac{\alpha_0\beta_2 - \alpha_2\beta_0}{\beta_2 - \alpha_2} > 0$$

$$a_1 = \frac{\alpha_1\beta_2 - \alpha_2\beta_1}{\beta_2 - \alpha_2}, \quad 0 < a_1 \gtrless 1$$

$$a_2 = \frac{\alpha_3\beta_2}{\beta_2 - \alpha_2} < 0$$

Table 3, below, presents the results of OLS estimation of this equation using monthly data. The Austral Plan was implemented roughly half-way through the estimation period, which runs from February 1984 through May 1987. Because the Plan represented a substantial break with past policies, or at least was promoted as such, the equation was estimated with dummy variables to proxy for any non-quantifiable effects of the program which were not included in the estimated equation.

Table 3: OLS Equations for the Nominal Interest Rate

(standard errors in parenthesis)

| Explanatory Variables: | Equations: (a) | (b) | (c) | (d) |
|---|---|---|---|---|
| Constant: | 2.5* | 17.3** | 13.8** | 12.22 |
| | (1.36) | (5.61) | (5.47) | (9.83) |
| $\kappa$ : | .96** | .54** | .33** | .37 |
| | (.07) | (.17) | (.17) | (.29) |
| log(M/B): | .47 | -12.18** | -9.19* | -8.06 |
| | (.14) | (5.56) | (5.09) | (7.92) |
| DUMMY : | | -10.17** | -8.86** | -7.50 |
| | | (3.76) | (3.41) | (7.92) |
| DUMMY $\times\kappa$: | | | | -0.06 |
| | | | | (.32) |
| $i_{-1}$ : | | | 0.31** | 0.32** |
| | | | (.10) | (.11) |
| Corrected $R^2$: | .82 | .85 | .88 | .87 |
| DW : | 1.70 | 1.83 | 2.34 | 2.35 |

* -- different from 0 at the 90% level of significance (2-sided test)

** -- different from 0 at the 95% level of significance (2-sided test)

Variable Definitions:

i: monthly average interest rate for 7-day interfirm loans

$\kappa$: monthly growth rate of gross claims (by the central banks and commercial banks) on the government

(M/B): ratio of gross central bank claims on government to gross commercial bank claims on government

DUMMY: dummy variable = 0 before June 1985, = 1 thereafter

The estimation results support equation (c) as the most appropriate reduced form relationship for the nominal interest rate. The intercept-dummy is significantly different from zero, and suggests that the Austral Plan had important effects upon the interest rate in addition to those described in the theoretical section of the paper.

The significance of the coefficient on the lagged interest rate indicates that while the response of the interest rate to shocks is rapid (the implied adjustment parameter is .69), it is not instantaneous. This may reflect the fact that the data on claims on government are end-of-period, so that agents only perceive shocks to $\kappa$ and log(M/B) in the following month. Lags between $\kappa$ and inflation, such as are documented below, may also contribute to the lagged adjustment of interest rates to monetary policy shocks. By dividing through by the adjustment parameter, we derive the steady-state interest rate equation:

$$i = 20.0 + .48\kappa - 13.3\log(M/B) - 12.8DUMMY \qquad (34)$$

As expected, the coefficent on the log of the money-to-bonds ratio is negative. Theoretically, the coefficient on the rate of domestic asset creation could have been greater or less than one; the estimated coefficient of .48 is lower than even the authors expected. It indicates that all else equal, if inflation and domestic asset creation move in proportion to each other, an increase in domestic asset creation of one percentage point will lead to a fall in the real interest rate of one half of a percentage point.

Domestic asset creation, inflation, and exchange rate depreciation:

The homogeneity of our theoretical model guarantees that domestic asset creation $\kappa$ will be equated to domestic price inflation $\pi$ and exchange rate depreciation $\hat{E}$. Notwithstanding the certainty that during the mid-1980s, Argentina was not in steady state, the regressions presented below confirm the correlations between the three growth rates over the sample period in question. In the exchange rate depreciation equation, the parallel exchange rate is used instead of the official rate. Because capital account transactions were controlled by the Argentine government during this period, most private financial transactions were conducted in the parallel exchange market. (Standard errors are in parentheses.)

$$\hat{E} = \underset{(2.14)}{.34} + \underset{(.15)}{1.02\kappa} \qquad R^2 = .54, \quad DW = 2.11 \qquad (35)$$

$$\pi = \underset{(1.07)}{.63} + \underset{(.12)}{.57\kappa} + \underset{(.12)}{.41\pi_{-1}} \qquad R^2 = .82, \; DW = 2.49 \quad (36)$$

In the exchange rate depreciation equation, the lagged endogenous variable did not enter in significantly; the parallel rate apparently moved quite rapidly in response to exogenous shocks. The inflation rate, however, does show some lagged adjustment to changes in $\kappa$; the steady-state equation is derived:

$$\pi = 1.07 + .97\kappa \qquad (37)$$

Decomposing the change in real interest rates:

In the 12 months prior to the implementation of the Austral Plan, the ex post real interest rate averaged 2.43 percent per month; it fell to 2.24 percent per month in the year following the program's announcement. [This very small drop in the real interest rate differs from the insignificant rise noted in Section IV.a above because it is measured as $i-\pi$ rather than $(1+i)/(1+\pi)$. The cruder formulation is employed to more easily attribute the change in the real interest rate to its different contributing factors. Note that this formulation of the real interest rate is only accurate for small values of i and $\pi$; for larger values, $r=(1+i)/(1+\pi)$ is more accurate.] To explain this change, we combine the coefficients in the steady-state nominal interest rate equation (34) with those in the steady-state inflation equation (37) to derive an equation for the real interest rate:

$$r = i - \pi = 18.93 - .49\kappa - 13.31\log(M/B) - 12.8DUMMY \qquad (38)$$

We can now express changes in the real interest rate as a function of changes in government policy variables. Let $X_0$ denote the average value of variable X in the 12 months preceeding the Austral Plan, and $X_1$ the average value in the year following. Then:

$$r_1 - r_0 = -.49(\kappa_1 - \kappa_0) - 13.3(\log(M/B)_1 - \log(M/B)_0) - 12.8 \quad (39)$$

Table 4 below summarizes the values of the key policy variables before and after the announcement of the Austral Plan and evaluates their contribution to changes in the real interest rate.

Table 4: Decomposition of Real Interest Rate Change

| | Pre-Austral Plan | Post-Austral Plan | Change | Coefficient×Change |
|---|---|---|---|---|
| $\kappa$: | 21.95 | 2.85 | -19.10 | +9.36 |
| log(M/B): | 0.38 | 0.23 | -0.15 | +2.00 |
| DUMMY: | 0 | 1 | 1 | -12.8 |
| Predicted r: | 3.12 | 1.67 | -1.44 | -1.44 |
| Actual r: | 2.43 | 2.24 | -0.19 | -0.19 |

As may be seen in the table, the predicted drop in the real interest rate is marginally higher than the actual over the period. The change in government policy variables -- $\kappa$ and M/B -- would, ceterus paribus, have raised the real interest rate by 11.36 percentage points per month. This would have resulted not only from the reduction in $\kappa$, but also the government's shift toward increased reliance on bond financing relative to money financing of its fiscal deficit.

The incipient rise in real interest rates, however, was offset by the influence of the as yet unidentified factors captured by the dummy variable. Identifying the forces underlying the dummy's importance will be an important priority for our future research. One possible explanation for the unexplained drop in the nominal interest rate may be the reduction in the variance of exchange rate depreciation and inflation associated with the drop in their levels. The variance of the parallel exchange rate's depreciation fell from 128.1 in the 12 months leading up to the Austral Plan to 40.7 in the following year, while the variance of inflation fell from 20.0 to 1.9 over the same period. This may have reduced uncertainty concerning the real rates of return associated with domestic assets, and by reducing the risk premium required to hold them, reduced their nominal rates of return.[7]

## VI. Conclusion

The salient results of our research are described in the introduction to the paper. A number of directions for additional research present themselves. First, it is not clear why the statistical data fail to confirm fully more impressionistic observations that the real interest rate rose in Argentina following implementation of the Austral Plan. A strong possibility is that actual inflation and exchange rate depreciation rates are poor proxies for expectations of those variables. Developing better measures of these expectations would be useful in the future.

Second, the paucity of exogenous instruments, as well as an appropriate measure of real wealth, prevented us from estimating the structural portfolio and goods market equilibrium equations. Such estimates would be quite valuable, and we would like to continue to attempt to find suitable data to perform the estimations. It would be especially interesting to confirm our hypothesis that it is the rate of exchange rate depreciation, rather than price inflation, that enters into portfolio demands and is the proximate determinant of changes in the nominal interest rate.

Third, the role of the interest rate equation's dummy variable in lowering the nominal interest rate and keeping the real interest rate essentially unchanged following the Austral Plan needs to be further explored. As suggested above, one explanation may be a decline in the risk premium following implementation of the program. The factors

---

7. The strong negative coefficient on the dummy variable also casts doubt on the hypothesis that, because of the "peso problem" discussed in footnote 5 above, the ex post real interest rate exceeded the ex ante rate following the Austral Plan. If this factor were operative, the nominal interest rate should, all else equal, have risen following the plan and the coefficient on the dummy variable should have been positive.

underlying the risk premium have not been studied in this paper; an analysis of them would enhance considerably the usefulness of the thoeretical model of interest rate determination we have developed. It would also be useful in understanding why Argentina has had chronically high real interest rates which date back to even before the Austral Program.

## REFERENCES

Blejer, Mario I., "Interest Rate Differentials and Exchange Risk: Recent Argentine Experience," IMF Staff Papers, vol.29, no.2, June 1982.

Blejer, Mario I. and Jose Gil Diaz, "Domestic and External Factors in the Determination of the Real Interest Rate: The Case of Uruguay," Economic Development and Cultural Change, vol.34, no.3, April 1986.

Blejer, Mario I. and Nissan Liviatan, "Fighting Hyperinflation: Stabilization Strategies in Israel and Argentina, 1985-86," IMF Staff Papers, vol.34, no.3, September 1987.

Boyer, Russel, "Financial Policies in an Open Economy," Economica, vol.45, no.177, February 1978.

Calvo, Guillermo, and Rodriguez, Carlos, "A Model of Exchange Rate Determination under Currency Substitution and Rational Expectations," Journal of Political Economy, vol. 85, no. 3, June 1977.

Dornbusch, Rudiger and Stanley Fischer, "Stopping Hyperinflations Past and Present," Weltwirtschaftliches Archiv, 4/1986.

Edwards, Sebastian and Mohsin S. Khan, "Interest Rate Determination in Developing Countries: A Conceptual Framework," IMF Staff Papers, vol.32, no.3, September 1985.

Fernandez, Roque B, "The Expectations Management Approach to Stabilization in Argentina during 1976-82," World Development, vol.13, no.8, September 1985.

Hanson, James and Jaime de Melo, "External Shocks, Financial Reforms, and Stabilization Attempts in Uruguay during 1974-83," World Development, vol.13, no.8, August 1985.

Howard, David H., "Exchange Rate Regimes and Macroeconomic Stabilization in a Developing Country," International Finance Discussion Papers no. 314, Board of Governors of the Federal Reserve System, Washington, 1987.

Mundell, Robert A., Monetary Theory - Inflation, Interest, and Growth in the World Economy, Goodyear Publishing Co., Pacific Palisades, Cal., 1971.

Penati, Alessandro, "Expansionary Fiscal Policy and the Exchange Rate," IMF Staff Papers, vol.30, no.3, September 1983.

Tobin, James, "A General Equilibrium Approach to Monetary Theory," JMCB Vol.1, no.1, February 1969.

# International Finance Discussion Papers

| IFDP NUMBER | TITLES | AUTHOR(s) |
|---|---|---|
| | **1988** | |
| 331 | Real Interest Rates During the Disinflation Process in Developing Countries | Steven B. Kamin<br>David F. Spigelman |
| 330 | International Comparisons of Labor Costs in Manufacturing | Peter Hooper<br>Kathryn A. Larin |
| 329 | Interactions Between Domestic and Foreign Investment | Guy V.G. Stevens<br>Robert E. Lipsey |
| 328 | The Timing of Consumer Arrivals in Edgeworth's Duopoly Model | Marc Dudey |
| 327 | Competition by Choice | Marc Dudey |
| 326 | The Determinants of the Growth of Multinational Banking Organizations: 1972-86 | Robert S. Dohner<br>Henry S. Terrell |
| 325 | Econometric Modeling of Consumers' Expenditure in Venezuela | Julia Campos<br>Neil R. Ericsson |
| 324 | Income and Price Elasticities of Foreign Trade Flows: Econometric Estimation and Analysis of the US Trade Deficit | Jaime Marquez |
| 323 | Money, Interest, and Capital in a Cash-in-Advance Economy | Wilbur John Coleman II |
| 322 | The Simultaneous Equations Model with Generalized Autoregressive Conditional Heteroskedasticity: The SEM-GARCH Model | Richard Harmon |
| 321 | Adjustment Costs and International Trade Dynamics | Joseph E. Gagnon |
| 320 | The Capital Flight "Problem" | David B. Gordon<br>Ross Levine |
| | **1987** | |
| 319 | Modeling Investment Income and Other Services in the U.S. International Transactions Accounts | William Helkie<br>Lois Stekler |

---

Please address requests for copies to International Finance Discussion Papers, Division of International Finance, Stop 24, Board of Governors of the Federal Reserve System, Washington, D.C. 20551.

## International Finance Discussion Papers

| IFDP NUMBER | TITLES | AUTHOR(s) |
|---|---|---|
| 318 | Improving the Forecast Accuracy of Provisional Data: An Application of the Kalman Filter to Retail Sales Estimates | B. Dianne Pauls |
| 317 | Monte Carlo Methodology and the Finite Sample Properties of Statistics for Testing Nested and Non-Nested Hypotheses | Neil R. Ericsson |
| 316 | The U.S. External Deficit: Its Causes and Persistence | Peter Hooper<br>Catherine L. Mann |
| 315 | Debt Conversions: Economic Issues for Heavily Indebted Developing Countries | Lewis S. Alexander |
| 314 | Exchange Rate Regimes and Macroeconomic Stabilization in a Developing Country | David H. Howard |
| 313 | Monetary Policy in Taiwan, China | Robert F. Emery |
| 312 | The Pricing of Forward Exchange Rates | Ross Levine |
| 311 | Realignment of the Yen-Dollar Exchange Rate: Aspects of the Adjustment Process in Japan | Bonnie E. Loopesko<br>Robert E. Johnson |
| 310 | The Effect of Multilateral Trade Clearinghouses on the Demand for International Reserves | Ellen E. Meade |
| 309 | Protection and Retaliation: Changing the Rules of the Game | Catherine L. Mann |
| 308 | International Duopoly with Tariffs | Eric O'N. Fisher<br>Charles A. Wilson |
| 307 | A Simple Simulation Model of International Bank Lending | Henry S. Terrell<br>Robert S. Dohner |
| 306 | A Reassessment of Measures of the Dollar's Effective Exchange Value | B. Dianne Pauls<br>William L. Helkie |
| 305 | Macroeconomic Instability of the Less Developed Country Economy when Bank Credit is Rationed | David F. Spigelman |
| 304 | The U.S. External Deficit in the 1980s: An Empirical Analysis | William L. Helkie<br>Peter Hooper |
| 303 | An Analogue Model of Phase-Averaging Procedures | Julia Campos<br>Neil R. Ericsson<br>David F. Hendry |