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# The Behavior of Real Interest Rates in Exchange-Rate-Based Stabilization Programs

*Pierre-Richard Agénor**


## Abstract

This paper examines the behavior of real interest rates at the inception of exchange-rate-based stabilization programs. The analysis is based on an optimizing model of a small open economy facing imperfect world capital markets. A reduction in the devaluation rate is shown to have a positive impact on real interest rates. By contrast, a program characterized by an initial reduction in the devaluation rate and a perceived future increase in government spending has an ambiguous effect—which depends in particular on the degree of credibility of the fiscal policy stance.


## 1. Introduction

The behavior of real interest rates in exchange-rate-based stabilization programs has been the subject of much interest in recent discussions related to macroeconomic adjustment in developing countries. The evidence summarized in Figures 1 and 2 suggests that while real interest rates declined at the inception of the Southern Cone "Tablita" experiments of the late 1970s, they rose sharply in the heterodox programs implemented in the 1980s in Argentina, Brazil, Israel, and Mexico (Végh, 1992). In addition, while real interest rates showed a tendency to increase gradually over time in the early stabilization experiments, no discernible pattern seems to have emerged in the more recent programs.[1]

Few analytical models have been proposed to account for the divergence in the behavior of real interest rates across the exchange-rate-based disinflation programs of the 1970s and 1980s. In particular, models aimed at explaining the boom–recession cycles that have often accompanied these programs have been unable to provide a convincing rationale. In the model developed by Rodríguez (1982), for instance, an unanticipated, permanent reduction in the devaluation rate leads to an immediate fall in real interest rates, because price expectations are predetermined at any moment in time.[2] Similarly, in the perfect-foresight framework developed by Calvo and Végh (1993), an imperfectly credible exchange-rate-based stabilization—modeled as an initial reduction in the devaluation rate coupled with an increase of the same magnitude at a well-defined date in the future—leads to an initial fall in domestic real interest rates. There is, however, no initial movement in real interest rates under full credibility, because in this case their model possesses no transitional dynamics. In an extension of their analysis, Calvo and Végh suggest that the use of money as an additional nominal anchor—resulting from the imposition of capital controls and/or the adoption of a credit target—in the exchange-rate-based programs implemented in the 1980s may explain the existence of initially high real interest rates. If, for instance, capital controls are in place, the money stock becomes predetermined; the initial increase in domestic money demand associated with a reduction in the devaluation

* Agénor: Research Department, International Monetary Fund; Economic Development Institute, World Bank; and Georgetown University. I am grateful to Joshua Aizenman, José De Gregorio, Jorge Roldos, and Carlos Végh for discussions and comments. The views expressed in this paper do not necessarily represent those of the Bank or the Fund.

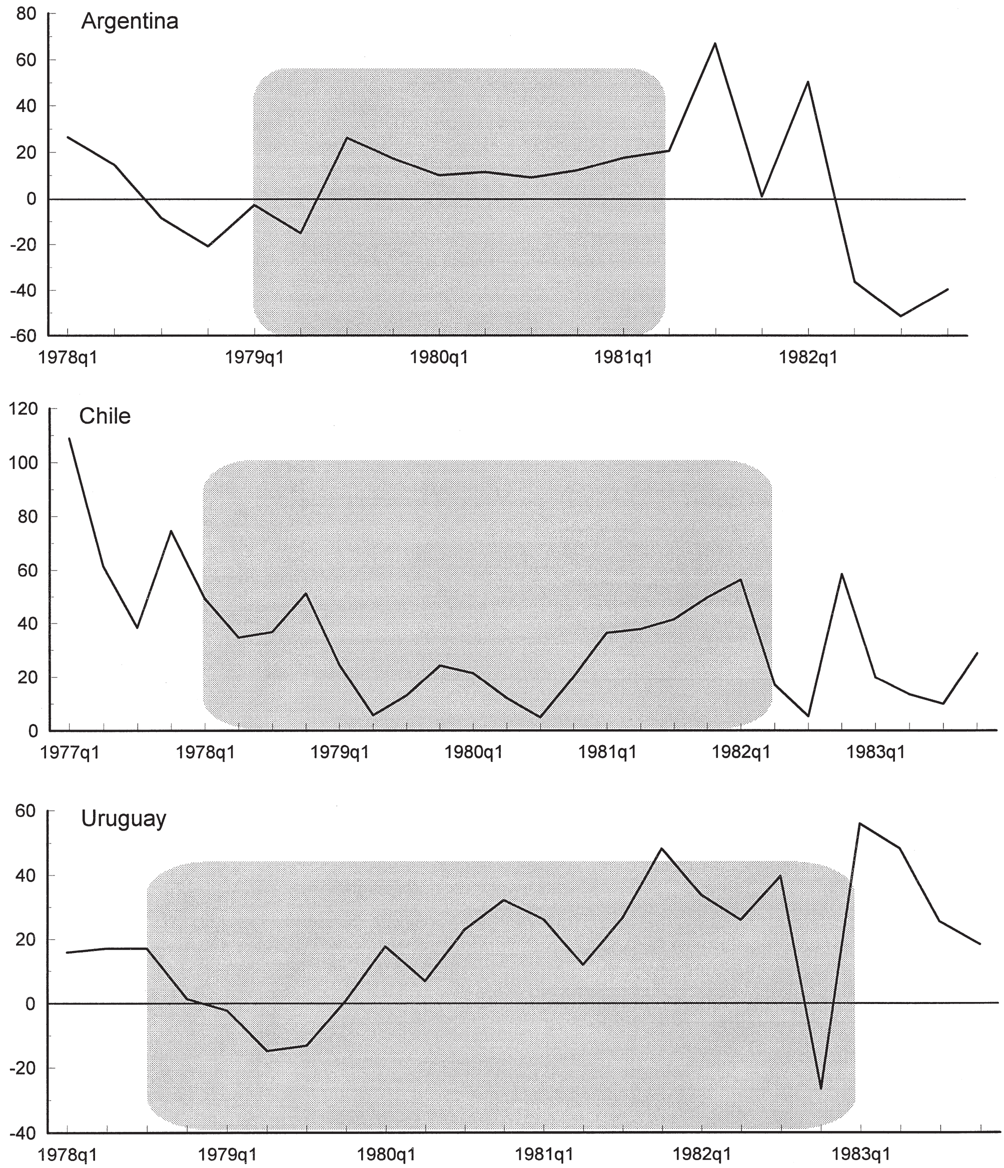


*Figure 1. Real Interest Rates in the Tablita Experiments (real lending rates, in percent per year)*

and inflation rates must be in this case by an upward adjustment in domestic interest rates. This line of argument seems to be particularly relevant for the Israeli program of 1985. The restrictive credit policy adopted by the authorities at the inception of the program is widely believed to have been the major factor behind the sharp increase in real interest rates observed in that country.[3] However, there does not appear to be much evidence suggesting that credit policy and/or the intensity of capital controls were altered significantly at the inception of the programs implemented in the 1980s in Latin America, compared with the experiments of the 1970s. Thus, the puzzle would seem to persist.

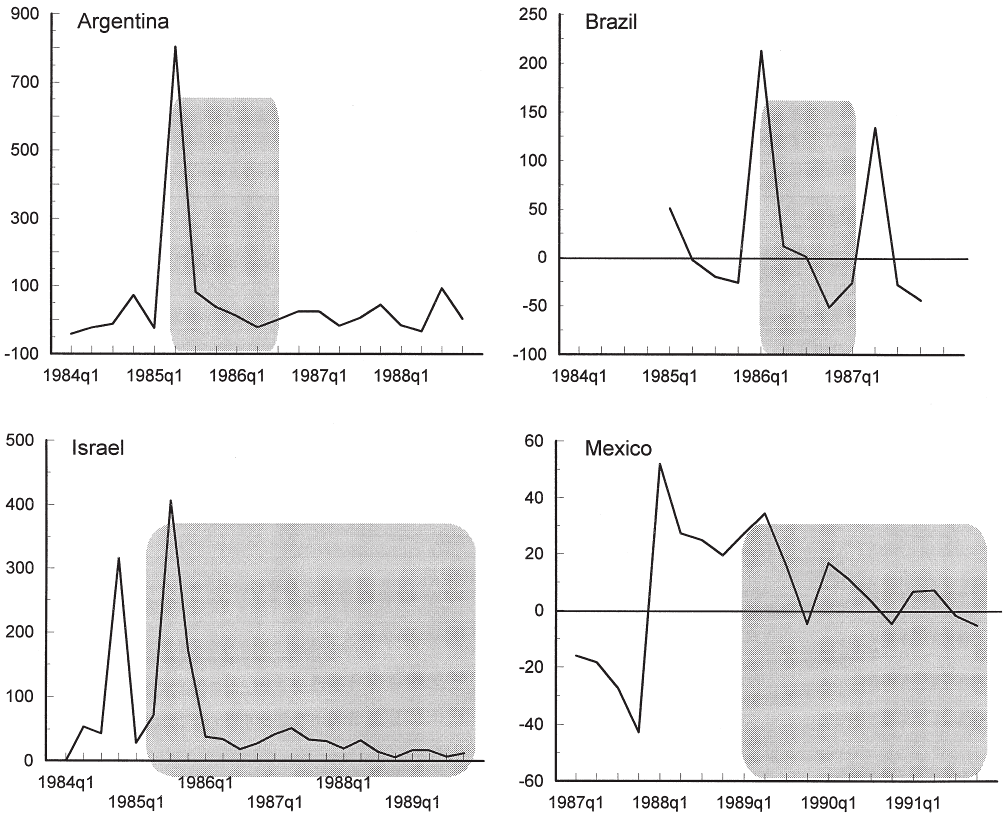


*Figure 2. Real Interest Rates in Heterodox Experiments (real lending rates, in percent per year)*

Two issues that bear considerable importance for explaining the behavior of real interest rates in exchange-rate-based stabilization programs have received only limited attention in existing studies. The first relates to the fiscal implications of a reduction in the devaluation rate. Such a measure may lead to a deterioration of the financial position of the public sector, through the loss of seignorage and the increase in the real cost of servicing fixed-rate debt issued when nominal interest rates were high (Velasco, 1993). Eventually, the government must correct the fiscal deficit thus created via changes in its policy instruments, such as the rate of growth of domestic credit, transfers to private agents, income taxes, or public expenditure. In a forward-looking world, expectations about the nature of the instruments that the policymakers are likely to use will have immediate effects on the behavior of real interest rates.[4] The second issue relates to the observation that in actual exchange-rate-based programs, the exchange rate adjustment is typically only one element of an overall stabilization package comprising trade, financial, and fiscal reforms designed to reduce inflation, raise revenue, and improve the balance of payments. Indeed, in almost all of the programs of the 1970s and 1980s, fiscal and other policy measures figured prominently with the initial exchange rate adjustment (see for instance Agénor and Montiel, 1996). In many cases, these measures were either implemented at the inception of the program (in conjunction with the exchange rate adjustment) or were announced as likely to take place in the near future.

This paper dwells on the last observation. Its purpose is to examine the mechanisms through which expectations about future fiscal policy changes may affect the behavior of real interest rates at the inception of an exchange-rate based stabilization program, and thus account for the diverging pattern observed in the past two decades in Latin America. While many economists have emphasized the lack of credibility of exchange rate policy *per se*, the analysis developed here focuses on the credibility of the fiscal component of a stabilization program consisting not only of an initial exchange rate adjustment, but also a future cut in public spending. Section 2 develops an optimizing model of a small open economy facing imperfect world capital markets. Section 3 examines the short-run interest rate dynamics associated with permanent and temporary reductions in the rate of devaluation of the nominal exchange rate. Section 4 then introduces fiscal considerations, by focusing on a program in which the devaluation rate is permanently reduced, but private agents expect government spending to increase in the future. Section 5 summarizes the implications of the analysis and discusses some possible extensions.

## 2. The Analytical Framework

Consider a small open economy in which there are three types of agents: a representative household, the government, and the central bank. Domestic production is fixed during the time frame of the analysis, and purchasing power parity holds continuously. The exchange rate is depreciated at a constant, predetermined rate by the central bank, whose stock of foreign assets adjusts to equilibrate supply and demand for foreign exchange. The household is endowed with perfect foresight and holds three categories of assets: domestic money, foreign bonds, and domestic government bonds. Domestic money is not held abroad and bears no interest. Domestic and foreign bonds are imperfect substitutes as a result of capital market imperfections. The domestic interest rate adjusts to maintain equilibrium in the money market. The government consumes goods and services, collects lump-sum taxes, and pays interest on its domestic debt.

*Households*

The representative household's discounted lifetime utility is given as[5]

$$\int_0^\infty \left\{ \ln m + \frac{c^{1-\eta}}{1-\eta} \right\} e^{-\rho t} dt, \quad \rho > 0 \tag{1}$$

where $\rho > 0$ denotes the constant rate of time preference, $c$ consumption, and $m$ real money balances. The parameter $\eta$ is positive and different from unity. For simplicity, the instantaneous utility function is assumed to be additively separable in consumption and real money balances.

Real financial wealth of the representative household $a$ is defined as

$$a = m + b + b^*, \tag{2}$$

where $b$ is the stock of domestic government bonds and $b^*$ the foreign-currency value of the stock of foreign bonds.

The flow budget constraint is given by

$$\dot{a} = y + ib - c - \tau + (i^* - \theta)b^* - (m + b)\varepsilon, \tag{3}$$

where $y$ denotes domestic output (assumed exogenous), $\tau$ the real value of lump-sum taxes, $i$ the domestic nominal interest rate, and $\varepsilon \equiv \dot{E}/E$ the predetermined rate of depreciation of the exchange rate. The term $-(m + b)\varepsilon$ accounts for capital losses on the stocks of money and domestic bonds resulting from inflation. As a result of capital market imperfections, the total rate of return on foreign bonds $i^* - \theta$ consists of a risk-free component $i^*$ and a household-specific component, $\theta$. This component can be interpreted as a risk discount (or premium, if $b^* < 0$), and is assumed to be positively related to the household's holdings of foreign assets. $\theta$ is also assumed to be a convex function of $b^*$. Thus, $\theta_{b^*}$ and $\theta_{b^*b^*}$ are both positive. Thus, the effective interest rate faced by the representative household on world capital markets falls the more it lends, and rises the more it borrows.[6]

Using (2), equation (3) can be written as

$$\dot{a} = ra + y - c - \tau + \left(i^* + \varepsilon - \theta\right)b^* - im, \tag{4}$$

where $r = i - \varepsilon$ denotes the domestic real interest rate.

Households treat $y$, $\varepsilon$, $i$, $i^*$, and $\tau$ as given, internalize the effect of their portfolio decisions on $\theta$, and maximize (1) subject to (4) by choosing a sequence $\{c, m, b, b^*\}_{t=0}^{\infty}$. Let $\sigma = 1/\eta$ be the intertemporal elasticity of substitution. The required optimality conditions are given by

$$m = c^{1/\sigma}/i, \tag{5}$$

$$i = \left(i^* + \varepsilon\right) - b^*\theta_{b^*}, \tag{6}$$

$$\dot{c}/c = \sigma\left(r - \rho\right), \tag{7}$$

together with the transversality condition $\lim_{t\to\infty}(e^{-\rho t}a) = 0$.

Equations (5) and (7) are familiar results in the class of representative-agent models used here. Equation (5) is the money demand function, and is derived by equating the marginal rate of substitution between consumption and real money balances to the opportunity cost of holding money, the domestic nominal interest rate. It relates money demand positively to the level of transactions—as measured by consumption expenditure—and negatively to the nominal interest rate. Equation (7) shows that total consumption rises or falls depending on whether the domestic real interest rate exceeds or falls below the rate of time preference.

Equation (6), by contrast, differs from standard results. Essentially, it equates the rates of return on domestic and foreign interest-bearing assets under imperfect capital markets. To understand its derivation, suppose that agents are net debtors ($b^* < 0$) and consider first the case in which households face no risk premium on world capital markets ($\theta = 0$). In that case, clearly, optimality requires $i = i^* + \varepsilon$. Suppose, for instance, that $i > i^* + \varepsilon$; agents would borrow unlimited amounts of funds on world capital markets—reaping a net profit by buying government bonds. This would, of course, bid up the price of government bonds and lower the rate of return on these assets up to the point where it is equal to the marginal cost of borrowing measured in domestic-currency terms, $i^* + \varepsilon$. On the contrary, with $i < i^* + \varepsilon$, households would hold no domestic bonds in their portfolios. An equilibrium with a positive level of domestic bonds in equilibrium therefore requires that the parity condition $i = i^* + \varepsilon$ holds continuously.

Suppose now, as assumed above, that $\theta$ rises with the household's level of foreign debt, so that the cost of borrowing on world capital markets increases with a marginal increase in borrowing. Equilibrium (with a positive level of domestic assets) requires, as before, that the rate of return on domestic bonds and the marginal cost of foreign borrowing be equalized. However, the marginal rate of borrowing is no longer equal to $i^* + \varepsilon$ but is now given by $i^* + \varepsilon - \theta$ plus the increase in interest payments on the existing stock of foreign debt induced by the marginal increase in the risk premium, itself resulting from the marginal increase in borrowing on world capital markets, $-b^*\theta_{b^*}$.[7] A similar reasoning shows that (6) must also hold if households are net creditors ($b^* > 0$), with the term on the left-hand side of that equation measuring now the marginal rate of return on foreign assets.

Taking a linear approximation to $\theta$ implies that (6) can be written as

$$b^* = \left(i^* + \varepsilon - i\right)/\gamma = \left(i^* - r\right)/\gamma, \tag{8}$$

where $\gamma = 2\theta_{b^*} > 0$. Equation (8) indicates that holdings of foreign bonds depend positively on the difference between the safe rate of return on foreign assets—calculated as the sum of the risk-free interest rate and the devaluation rate—and the domestic interest rate. When $\gamma \to 0$, (8) yields the uncovered interest parity condition $i = i^* + \varepsilon$. In such a case domestic and foreign interest-bearing assets are perfect substitutes.[8]

*Central Bank and Government*

There are no commercial banks in the economy, and the central bank lends only to the government. The money stock is therefore equal to

$$m = d + R^*, \tag{9}$$

where $d$ is the real stock of domestic credit allocated by the central bank to the government, and $R^*$ net official holdings of foreign assets, measured in foreign currency terms. Changes in the real credit stock are given by

$$\dot{d} = \left(\mu - \varepsilon\right)d, \tag{10}$$

where $\mu$ denotes the rate of growth of the nominal credit stock.

The central bank receives interest on its holdings of foreign assets.[9] Profits of the central bank, given by $(i^* + \varepsilon)R^*$ (where $\varepsilon R^*$ measures real capital gains on reserves), are transferred to the government.

In addition to these resources, the government levies lump-sum taxes on the representative household. It also consumes goods and services and pays interest on its domestic debt. It finances its budget deficit by borrowing from the central bank or issuing bonds. The flow budget constraint of the government can be written as

$$\dot{d} + \dot{b} + \varepsilon m = g + rb - i^*R^* - \tau, \tag{11}$$

where $g$ denotes government spending, assumed exogenous. This equation states that government spending plus net interest payments on the domestic debt, minus lump-sum taxes and interest income on reserves, must be financed by revenue from the inflation tax ($\varepsilon m$), issuance of bonds, or an increase in domestic credit.

*Money Market Equilibrium*

To close the model requires specifying the equilibrium condition of the money market. From equation (5), with $m$ given, the market-clearing domestic interest rate can be written as

$$i = i\left(\overset{+}{c}, \overset{-}{m}\right), \tag{12}$$

which shows that the nominal interest rate depends positively on consumption expenditure and negatively on the real money stock.

Combining equations (4), (9), (10), and (11) yields the consolidated budget constraint of the economy

$$\dot{R}^* + \dot{b}^* = i^*\left(R^* + b^*\right) - \theta b^* + y - c - g, \tag{13}$$

which determines the behavior over time of the total stock of foreign assets.

## 3. Dynamic Form and Steady State

Equations (7), (8), (9), (10), (12), and (13) describe the evolution of the economy along any perfect-foresight equilibrium path. Suppose that the central bank sets the rate of growth of nominal credit so as to keep the real stock of credit constant ($\mu = \varepsilon$), and that the government foregoes the issuance of bonds to finance its deficit—varying instead lump-sum taxes to balance the budget. The credit rule is thus such that $\dot{d} = 0$. Setting for simplicity the constant levels of domestic bonds and credit to zero, equation (11) yields

$$\tau = g + rb - \left(i^* + \varepsilon\right)R^*. \tag{14}$$

Because now, from equation (2), $a = R^* + b^*$, the set of equations driving the behavior of the economy can be written in summary form as

$$b^* = \left[i^* + \varepsilon - i\left(c,\ R^*\right)\right]\gamma, \tag{15}$$

$$\dot{c}/c = \sigma\left[i\left(c,\ R^*\right) + \varepsilon - \rho\right], \tag{16}$$

$$\dot{R}^* + \dot{b}^* = i^*\left(R^* + b^*\right) - \theta b^* + y - c - g. \tag{17}$$

These equations represent a first-order differential equation system in three endogenous variables, $c$, $b^*$, and $R^*$. Consumption is a jump variable, but the economy's stock of assets (which is equivalent to the household's net worth, in the case considered here) $F = R^* + b^*$ cannot change instantaneously. Thus, the capital account and the overall balance of payments are defined in the above system in terms of changes in the stock of foreign bonds and foreign reserves that occur through time.

These definitions, however, do not capture transactions that occur discretely, such as those that may be involved in the instantaneous exchange of domestic currency holdings for foreign bonds. Specifically, although the overall stock of foreign assets in the economy $F$ is predetermined, official reserves and the private stock of foreign bonds are allowed to jump in response to discrete movements in, say, domestic interest rates. Any instantaneous shift in private holdings of foreign bonds is associated with a compensating movement in the stock of foreign reserves held by the central bank—and a concomitant movement in the money supply, in the absence of sterilization—which leaves the economy's overall stock of foreign assets constant on impact.

As described in the Appendix, $b^*$ can be substituted out from equations (15)–(17) to yield the following system in $c$ and $F$, written as a linear approximation around the steady state:

$$\begin{bmatrix} \dot{c} \\ \dot{F} \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} c - \tilde{c} \\ F - \tilde{F} \end{bmatrix}, \tag{18}$$

where the coefficients $a_{hk}$, which satisfy

$$a_{11} > 0, \quad a_{12} < 0, \quad a_{21},\ a_{22} \gtrless 0,$$

are given in the Appendix. As can be inferred from the expressions provided there, if the sensitivity of $\theta$ with respect to $b^*$ is not too large, $a_{21} < 0$ and $a_{22} > 0$.

Saddlepath stability requires the determinant of the matrix of coefficients appearing in (18), $\Omega = a_{11}a_{22} - a_{12}a_{21}$, to be negative. This condition is interpreted graphically in Figure 3. In the North East quadrant, the locus $[\dot{F} = 0]$ gives the combinations of $c$ and $F$ for which the economy's holdings of foreign assets remain constant, whereas the locus $[\dot{c} = 0]$ depicts the combinations of $c$ and $F$ for which consumption does not change over time. Because $a_{22} > 0$, $\dot{F}$ is positive when $F$ is to the right of the $[\dot{F} = 0]$ locus and negative when $F$ is to the left. The negative sign of $a_{12}$ also implies that $\dot{c}$ is negative to the right of the $[\dot{c} = 0]$ locus and positive to the left of it. This explains the directions of the arrows. The perfect-foresight path SS (which has a positive slope) and the steady-state equilibrium (which is reached at point E) are also shown in Figure 3.

From equation (17), the current account must be in equilibrium, so that

$$\tilde{c} + g - y, = i^*\tilde{F} - \theta\tilde{b}^*, \tag{19}$$

which shows that the trade deficit $\tilde{c} + g - y$ must be matched by a surplus in the services account, $i^*\tilde{F} - \theta\tilde{b}^*$.

From equation (16), the real interest rate is equal to the rate of time preference in the steady state:

$$\tilde{r} = \tilde{\imath} - \varepsilon = \rho, \tag{20}$$

and is independent of the devaluation rate. Consequently, the nominal interest rate is equal to the sum of the rate of time preference and the devaluation rate, $\rho + \varepsilon$. From these results, the steady-state value of the stock of foreign bonds is thus equal to

$$\tilde{b}^* = \left(i^* - \rho\right)/\gamma, \tag{21}$$

which is also independent of the devaluation rate. Equation (21) shows that real holdings of foreign bonds are proportional to the difference between the safe world interest rate and the rate of time preference, indicating that in the long run domestic private

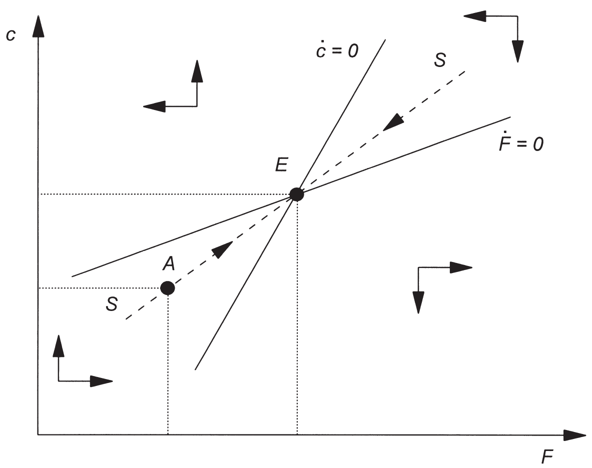


*Figure 3. Steady-State Equilibrium*

agents are net creditors (debtors) only if their rate of time preference is sufficiently low (high) relative to $i^*$. Finally, steady-state real money balances are given by

$$\tilde{m} = m(\tilde{c},\ \rho + \varepsilon). \tag{22}$$

## 4. Credibility, Stabilization, and Interest Rates

Using the dynamic model described in the previous sections, the short- and long-run effects of an exchange-rate-based stabilization program on the behavior of real interest rates can be examined. The analysis in this section begins by considering the case in which the reduction in the nominal devaluation rate $\varepsilon$ is unanticipated but permanent, that is, fully credible in the sense of Calvo and Végh (1993). It then proceeds to consider the case in which the reduction in $\varepsilon$ is temporary, that is, imperfectly credible in the Calvo–Végh sense.

Suppose that the economy is initially in a long-run equilibrium position. Consider the effect of a permanent, unanticipated reduction at $t = 0$ in the devaluation rate from $\varepsilon^h$ to $\varepsilon^s < \varepsilon^h$ with no discrete change in the level of the exchange rate. As can be inferred from (20) and (21), the reduction in $\varepsilon$ has no long-run effect on the real interest rate or private demand for foreign bonds. In particular, the real interest rate remains equal to the rate of time preference.

By contrast, the nominal interest rate falls in the same proportion as the devaluation rate in the long run. The reduction in the opportunity cost of holding money raises the demand for domestic cash balances (equation (22)). The official stock of foreign assets must therefore increase; and because private holdings of foreign bonds do not change, the economy's overall stock of foreign assets must be higher in the new steady state, implying that the initial surplus in the services account is also higher. To maintain external balance, and as required by equation (19), the initial trade deficit must increase—implying here that private consumption must rise. The increase in private expenditure also raises the demand for domestic cash balances.

On impact, as shown in the Appendix, consumption may either increase or fall. The reason is that, on the one hand, the reduction in $\varepsilon$ raises the real interest rate, which creates an incentive for domestic consumers to shift consumption toward the future. This tends to reduce private spending on impact. On the other hand, however, the fall in $\varepsilon$ lowers (at the initial level of domestic interest rates) the demand for foreign assets by the private sector, thereby reducing $\theta$ and increasing net interest payments; the positive income effect creates an incentive for domestic consumers to bring consumption forward in time. It will be assumed in what follows that consumption indeed rises on impact—in line with the evidence on exchange-rate-based stabilization programs discussed by Végh (1992) and Rebelo and Végh (1997).

The impact and long-run effects of a permanent reduction in the devaluation rate on consumption and the economy's stock of foreign assets in this case are illustrated in the upper panel of Figure 4. The curve $[\dot{c} = 0]$ shifts to the right, whereas the curve $[\dot{F} = 0]$ shifts to the left. Consumption jumps upward from point E to point A on impact, and continues rising afterward. The economy's stock of foreign assets rises continuously during the transition to the new steady state, which is reached at point E′.

As formally established in the Appendix, the reduction in $\varepsilon$ leads to a discrete reduction in private holdings of foreign assets and a concomitant increase in the demand for domestic money balances. The instantaneous portfolio adjustment takes place through purchases of foreign currency assets by the central bank accompanied by a discrete increase in the money stock.[10] The shift in the composition of assets is such

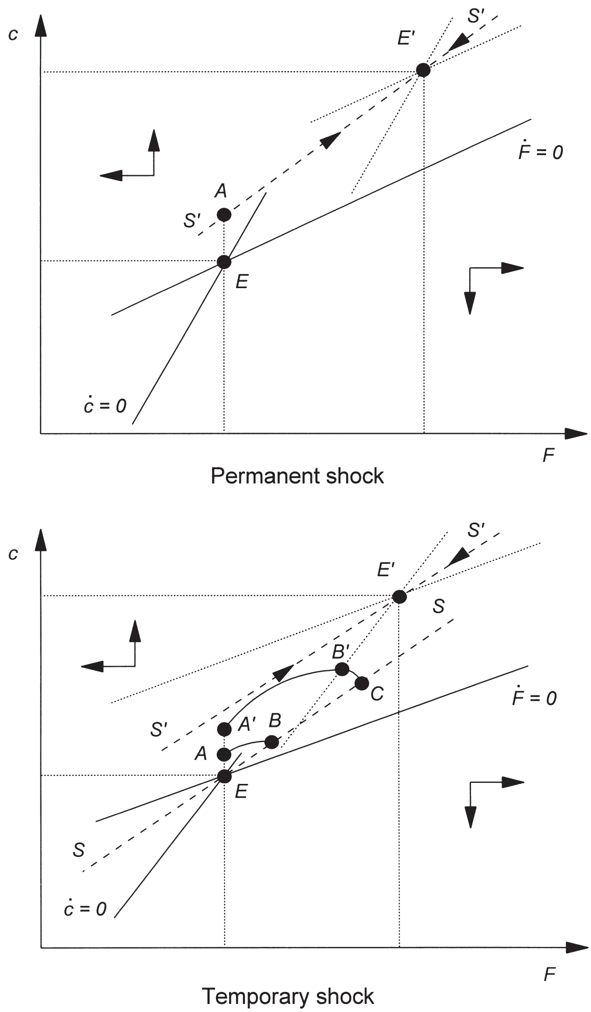


*Figure 4. Reduction in the Devaluation Rate*

that the economy's holdings of foreign bonds remains constant on impact. Because both consumption and the real money stock increase, however, the net impact effect on the nominal interest rate is ambiguous. As can be inferred from the results shown in the Appendix, if the degree of intertemporal substitution $\sigma$ is not too large, consumption will rise relatively little, and the nominal interest rate will fall on impact.[11] But regardless of the movement in the nominal interest rate, the reduction in the devaluation rate always raises the domestic real interest rate on impact.

The increase in consumption leads to a deterioration in the trade balance. At the same time, the positive income effect associated with the increase in interest payments on private holdings of foreign bonds raises the initial surplus of the services account. The net effect on the current account is positive ($\dot{F}_0 > 0$). Because the shock is permanent, the current account remains in surplus throughout the adjustment process. Consumption continues to increase, and the real interest rate falls gradually toward its initial steady-state level, given by the rate of time preference. Private holdings of

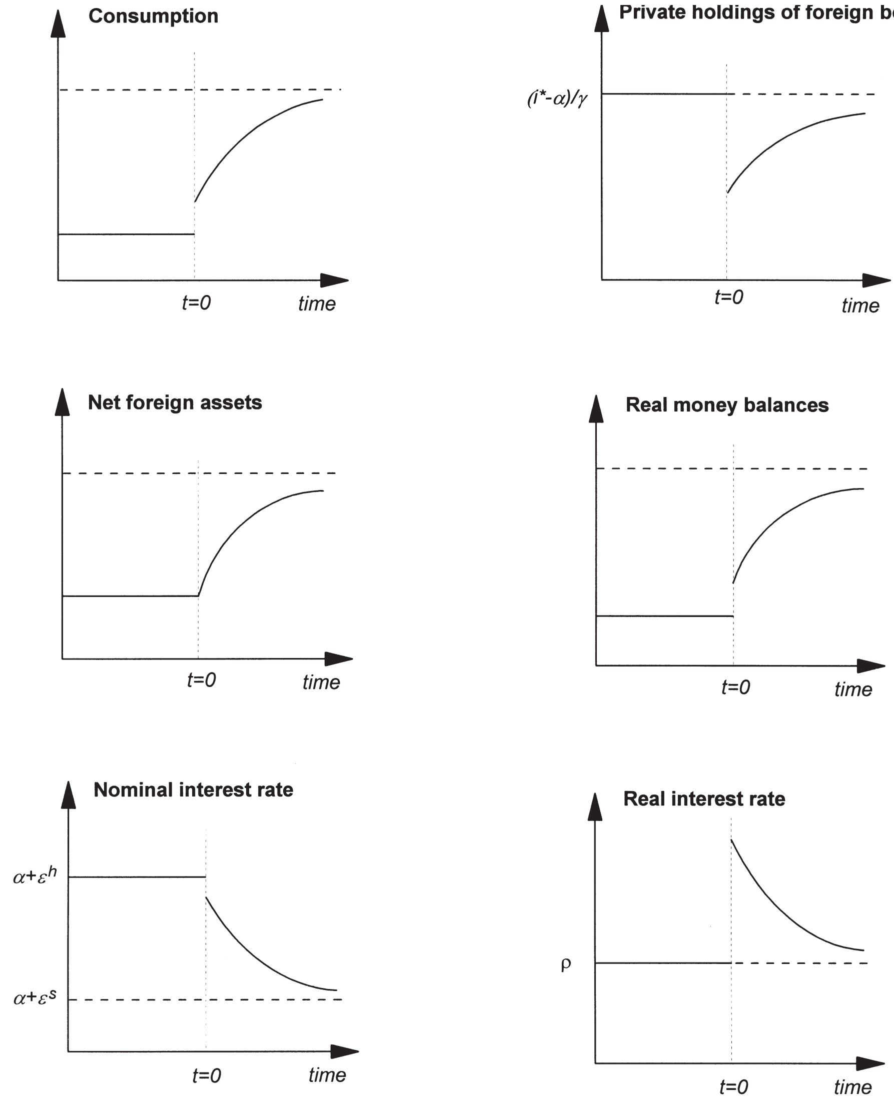


*Figure 5. Adjustment Path to a Permanent Reduction in the Devaluation Rate*

foreign bonds therefore increase over time, and return to their initial steady-state level. Because the real interest rate is falling, the nominal interest rate (regardless of whether it rose or fell initially) is also falling. And because consumption is rising and nominal interest rates are falling over time, real money balances—and thus official holdings of foreign reserves—also increase during the transition. The behavior over time of the key macroeconomic variables is illustrated in Figure 5, under the assumption that the nominal interest rate falls on impact. Of course, in such a case, because the real interest rate increases on impact, the nominal interest rate falls by less than the devaluation rate ($di_0/d\varepsilon < 1$).

A key feature of the dynamics described above is that the portfolio adjustment process occurs both instantaneously and over time and adjustments that occur in order to maintain portfolio balance. In turn, the source of these results is the assumption of unsterilized intervention by the central bank, coupled with the assumption of imperfect world capital markets and its corollary—imperfect asset substitutability.

It is also worth highlighting the difference between perfect and imperfect asset substitutability, or equivalently here, perfect and imperfect capital mobility. In the former case (which corresponds to $\gamma \to 0$), the uncovered interest parity condition $i = i^* + \varepsilon$ holds continuously and private holdings of foreign bonds can take any value *a priori*. The increase in the demand for real cash balances induced by the reduction in the opportunity cost of holding money is achieved through an instantaneous portfolio swap between money and holdings of foreign bonds: domestic households sell bonds to foreign residents, who acquire the foreign exchange by exchanging foreign currency for domestic currency at the central bank (whose foreign reserves therefore increase) in such a way that the economy's overall stock of assets remains constant. There are no real effects, and the adjustment process displays no dynamics; the economy jumps instantaneously to the new steady state. Although the composition of the economy's stock of foreign assets changes (with the share of official reserves increasing), the stock itself does not and neither does consumption.

By contrast, with capital market imperfections, private holdings of foreign assets in the long run are given by the difference between the world interest rate and the rate of time preference (see equation (21)) and therefore do not vary across steady states, in response to a change in the devaluation rate. Thus, the increase in real cash balances induced by the reduction in the opportunity cost of holding money cannot take place through a once-and-for-all adjustment in portfolios, as in the case of perfect capital mobility. For official reserves to expand as before and match the increased demand for money with an increase in supply requires now a sequence of current account surpluses. In turn, because higher official reserves imply a steady-state increase in the economy's stock of assets (private holdings of foreign bonds remaining unchanged in the long run), the higher surplus in the services account must be accompanied by a rise in the trade deficit; that is, an increase in private consumption.[12] Thus, with imperfect world capital markets, the adjustment process to a reduction in the devaluation rate is not only displaying transitional dynamics, it is also characterized by real effects.

The case in which the reduction in $\varepsilon$ is temporary (implemented at, say, $t = 0$ and reversed at $t = T$) is illustrated in the lower panel of Figure 4. As before, private consumption is assumed to increase on impact. But because the shock is temporary, the optimal smoothing response for the representative household is to increase consumption by less than it would if the shock were permanent. Depending on the length of the interval $(0, T)$, two adjustment paths are possible. If the duration of the shock $T$ is short, private consumption will jump from point E to a point like A, and will continue to increase until it reaches point B on the original saddlepath—which is reached exactly at T. The trade balance will deteriorate, but the current account will remain in surplus during that phase. Thereafter, consumption will begin falling, with the current account moving into deficit—until the economy returns to the original equilibrium point E.

On the contrary, if the duration of the shock is sufficiently long, private consumption will jump from point E to a point like A′, and will continue to increase until it reaches point B′, located on the curve $[\dot{c} = 0]$ corresponding to the new long-run steady state E′. This position is reached before period T. Thereafter, consumption starts falling, reaching point C on the original saddlepath at period T when the shock is reversed. Again, the trade balance deficit increases until period T, whereas the current account remains in surplus. Thereafter, with consumption falling between points C and E, the trade deficit begins to fall and the current account moves into deficit. In both cases, the predictions of the model under a temporary reduction in $\varepsilon$ accord well with some of the "stylized facts" of exchange-rate-based stabilization (see Végh, 1992): a consumption boom and an increase in the trade deficit, followed by a reduction in spending and an improvement in the trade balance.[13]

Regardless of whether the credibility of a reduction in the devaluation rate is perfect (in the sense of being permanent) or imperfect (in the sense of being temporary), the model predicts an initial increase in real interest rates at the inception of an exchange-rate-based stabilization program. In practice, therefore, the initial movement in real interest rates may not be a particularly reliable indicator of the degree of confidence that private agents attach to the program. More importantly, assuming that credibility is perfect or imperfect in the present model does not help to account for the contrasted pattern, noted in the introduction, in the behavior of real interest rates observed in the exchange-rate-based stabilization programs implemented in the 1970s and 1980s—here, real interest rates always increase on impact. The next section examines whether expectations regarding the fiscal component of a comprehensive exchange-rate-based program may help to explain this pattern.

## 5. Fiscal Policy, Credibility, and Exchange Rate Adjustment

As indicated in the introduction, fiscal policy measures were either announced or implemented (after the initial exchange rate adjustment) in almost all the exchange-rate-based stabilization programs of the 1970s and 1980s. Accounting for this component is thus important for understanding the short-run dynamics of real interest rates. Specifically, we focus in what follows on a stabilization program in which a permanent reduction in the nominal devaluation rate is implemented, but agents expect a future tax-financed increase in government spending.

Assume that the economy begins at $t = 0^-$ in a steady state, characterized by a "high" devaluation rate $\varepsilon^h$ and a level of government spending $g^s$. At $t = 0$, the government reduces the devaluation rate from $\varepsilon^h$ to $\varepsilon^s < \varepsilon^h$. At the same time that the reduction in the devaluation rate is implemented, the government announces its intention to maintain the initial level of public sector spending, $g^s$, unchanged for the indefinite future. However, the public does not fully believe the announcement. Specifically, suppose that agents attribute a given probability $1 - \alpha$ (with $0 < \alpha < 1$) that government spending will be maintained at $g^s$ as announced, and a probability $\alpha$ that, at period $T$ or some time after $T$, spending will increase to $g^h > g^s$—with a concomitant increase in lump-sum taxes.[14] There are various reasons why agents may expect spending to increase in the future. A particularly attractive one (although not explicitly embedded in the present model) is related to the idea that the transition from high to low inflation reduces bank profits and may lead borrowers to default on their liabilities—putting the whole banking system at risk. To the extent that the government is perceived as providing an implicit bail-out guarantee, public spending may be expected to rise. The empirical evidence suggests indeed that there are several examples of (at least partly successful) exchange-rate based programs in which the health of the banking system subsequently deteriorated, leading to (actual and expected) upward pressure on public expenditure.[15]

In this setting, then, the coefficient $\alpha$ can be viewed as a measure of the degree of credibility of the fiscal component of the program. A value of $\alpha$ close to zero indicates that agents are confident that public expenditure will be maintained at the initial level (as announced by the government), whereas a value of $\alpha$ close to unity indicates that the public believes that public expenditure will almost certainly increase in the future.

The level of spending that is expected to prevail from $t \geq T$ is thus equal to $(1 - \alpha)g^s + \alpha g^h$ (which is higher than $g^s$ as long as $\alpha$ is positive) and private agents will make their portfolio and consumption decisions accordingly. The dynamic path that the economy is expected to follow from $t \geq T$ is determined by a set of equations similar to equations (15)–(17), with equation (17) replaced by

$$\dot{F} = i^*F - \theta b^* + y - \left[\left(1-\alpha\right)g^s + \alpha g^h\right] - c. \tag{23}$$

The solution of the system described by equations (A2) and (A3) of the Appendix and (23) for $0 < t < T$ yields a "quasi" steady state, because it is associated with a policy shock that may or may not occur at $T$ or afterwards. Once period $T$ is reached, and for some time after $T$, the increase in public spending may or may not materialize. But for a sufficiently long period after $T$, uncertainty will eventually disappear and $\alpha$ will tend to unity or zero. Thus, there would normally be a jump in all variables at a moment in time after period $T$, after which the economy will begin converging to its "final" steady state.[16] Here only the quasi steady state will be studied, under the simplifying assumption (given the focus on the short-run behavior of real interest rates) that uncertainty never disappears. During the period $0 < t < T$, the solution of the model is such that the transition that takes place at $T$—with $g^s$ replaced by its "expected" value—is perfectly anticipated by private agents.

The mathematical details of the solution procedure are rather cumbersome and are relegated to an Appendix available upon request. Essentially, the system follows an unstable trajectory during the transition period. It can be shown that, starting from an initial steady state equilibrium with $F_0 = \tilde{F}$:

$$\text{sg}\left(c_0 - \tilde{c}\right) \gtrless 0, \tag{24}$$

which shows that the impact effect of the program on consumption is ambiguous. The reason is that the immediate effect of an expected future increase in government spending, in standard fashion, is a reduction in consumption.[17] At the same time, however, the immediate, permanent reduction in the devaluation rate tends (as indicated in the previous section) to increase private spending. Because the net effect on consumption is ambiguous, so will be the net impact on nominal and real interest rates. Of course, if the horizon $T$ is sufficiently far in the future, or if the coefficient $\alpha$ is sufficiently close to zero, the "crowding out" effect on private consumption on impact will be small, and real interest rates will tend to increase, as discussed previously. But if $T$ is sufficiently short, or if $\alpha$ is sufficiently close to unity (or if the likely increase in government spending is believed to be particularly large), the expectations effect will dominate, private consumption will fall, and the domestic real interest rate will drop on impact.

The thrust of the foregoing analysis is thus that, depending on the degree of confidence in the perceived fiscal stance accompanying an exchange-rate-based program, real interest rates at the inception of these programs may rise or fall on impact. In practice, therefore, movements in real interest rates will reflect both the type of policies that agents expect the government to implement in the future and changes in the perceived ability of policymakers to stick to their announcements. An empirical test of the importance of the time profile of fiscal policy as emphasized here is, of course, difficult to implement because expectations of future policy changes are not observed. Nevertheless, it is difficult to disprove the idea that the adjustment mechanism described in the foregoing discussion may have played a role in the contrasted pattern, noted in the introduction, in the behavior of real interest rates in the exchange-rate-based stabilization programs implemented in the 1970s and 1980s. As emphasized by many economists, lack of credibility has been a pervasive factor in the short-run dynamics associated with these experiments. However, while most observers have emphasized imperfect credibility of exchange rate adjustment *per se*, the analysis developed here has focused on the credibility of the fiscal component of these programs. In the experiment described above, the initial exchange rate adjustment is fully credible—in the sense that it is perceived to be permanent. What suffers from a lack of credibility is the announcement of no future increase in public expenditure.

## 6. Summary and Conclusions

This paper has examined the behavior of real interest rates in exchange-rate-based stabilization programs. The analysis was based on a one-good optimizing model with imperfect capital mobility. The analysis showed that a permanent (perfectly credible) or temporary (imperfectly credible) reduction in the devaluation rate typically leads to an increase in domestic real interest rates at the inception of the program. This result suggests that the use of changes in real interest rates at the inception of these programs to assess the degree of credibility in the macroeconomic policy stance may not be warranted. A rise in real interest rates does not necessarily signal a lack of confidence in the government's policy decisions, and may instead be the outcome of an optimal portfolio reallocation by forward-looking agents.

To explain the contrasted evolution in real interest rates observed between the 1970s and 1980s in Latin America, a program in which the policymaker implements an immediate, permanent reduction in the devaluation rate was then considered. At the same time, the policymaker announces its intention to refrain from increasing government spending in the future. Private agents, however, do not entirely believe the announcement regarding the fiscal stance, and attribute a positive probability to the possibility that the policymaker will actually increase public expenditure in the future. The movement in real interest rates at the inception of the program was shown to be ambiguous and to depend, in particular, on the degree of public confidence in (or the degree of credibility of) the policymaker's announcement. Thus, the observed behavior of real interest rates at the inception of actual exchange-rate-based stabilization programs may not reflect expectations about the sustainability of the initial exchange rate adjustment itself, but rather the degree of confidence that private agents attach to the fiscal policy stance in the course of the adjustment process.

## Appendix

This appendix shows how the model can be further condensed into a system involving $c$ and $F$. To begin with, note that

$$R^* = \left(R^* + b^*\right) - b^*,$$

or, using equation (15):

$$\begin{aligned} R^* &= F - \left[i^* + \varepsilon - i\left(c,\ R^*\right)\right] \Big/ \gamma \\ &= \left\{\gamma F - \left(i^* + \varepsilon\right) + i_c c\right\} \Big/ \left(\gamma - i_m\right), \end{aligned}$$

so that

$$R^* = \varphi\left(\overset{+}{c},\ \overset{+}{F};\ \bar{\varepsilon}\right), \tag{A1}$$

where

$$\varphi_c = i_c/\left(\gamma - i_m\right), \quad \varphi_F = \gamma/\left(\gamma - i_m\right), \quad \varphi_\varepsilon = -1/\left(\gamma - i_m\right).$$

Substituting this result into equation (16) yields

$$\dot{c}/c = \sigma\left\{i\left[c,\ \varphi\left(c,\ F,\ \varepsilon\right)\right] - \varepsilon - \rho\right\},$$

so that

$$\dot{c} = G\left(\overset{+}{c},\ \bar{F};\ \bar{\varepsilon}\right), \tag{A2}$$

where, setting $\Delta = \sigma\tilde{c}\gamma/(\gamma - i_m)$:

$$G_c = i_c\Delta, \quad G_F = i_m\Delta, \quad G_\varepsilon = -\Delta.$$

Substituting equation (A1) into (15) yields

$$b^* = \Lambda\left(\bar{c},\ \overset{+}{F};\ \overset{+}{\varepsilon}\right), \tag{A3}$$

where

$$\Lambda_c = -i_c/\left(\gamma - i_m\right), \quad \Lambda_F = -i_m/\left(\gamma - i_m\right), \quad \Lambda_\varepsilon = 1/\left(\gamma - i_m\right).$$

Using (A3), equation (17) can be written as

$$\dot{F} = i^*F + y - \theta\left[\Lambda\left(c,\ F,\ \varepsilon\right)\right]\Lambda\left(c,\ F,\ \varepsilon\right) - c - g. \tag{A4}$$

Equations (A2) and (A4) are linearized to give (18), with

$$a_{11} = G_c > 0, \quad a_{12} = G_F < 0,$$

$$a_{12} = -\left(\tilde{\theta} + \tilde{b}^*\theta_{b^*}\right)\Lambda_c - 1 \gtrless 0, \quad a_{22} = i^* - \left(\tilde{\theta} + \tilde{b}^*\theta_{b^*}\right)\Lambda_F \gtrless 0.$$

If $\nu$ denotes the negative root, the saddlepath solution can be written as

$$c - \tilde{c} = \kappa\left(F - \tilde{F}\right), \tag{A5}$$

where $\kappa \equiv (\nu - a_{22})/a_{21} = a_{12}/(\nu - a_{11})$. Assuming that the sensitivity of $\theta$ to $b^*$ is not too large implies the restrictions $a_{21} < 0$ and $a_{22} > 0$; thus, $\kappa > 0$, and the slope of SS in Figure 3 is positive.

It can be shown that

$$d\tilde{c}/d\varepsilon = \left(a_3G_F - a_{22}G_\varepsilon\right)/\Omega < 0, \tag{A6}$$

$$d\tilde{F}/d\varepsilon = \left(a_{21}G_\varepsilon - a_3G_c\right)/\Omega < 0, \tag{A7}$$

where $\Omega = a_{11}a_{22} - a_{12}a_{21} < 0$ and $a_3 = -(\tilde{\theta} + \tilde{b}^*\theta_{b^*})\Lambda_\varepsilon < 0$. We also have $d\tilde{b}^*/d\varepsilon = d\tilde{r}/d\varepsilon = 0$, and, from (22):

$$d\tilde{m}/d\varepsilon = m_c d\tilde{c}/d\varepsilon + m_i < 0,$$

because $m_c > 0$ and $m_i < 0$.

The impact effect of a reduction in $\varepsilon$ on consumption is given by, using equations (A5), (A6), and (A7) and noting that $dF_0/d\varepsilon = 0$:

$$dc_0/d\varepsilon = d\tilde{c}/d\varepsilon - \kappa\left(d\tilde{F}/d\varepsilon\right),$$
$$= -\nu G_\varepsilon\Big/\Omega + a_3\left(G_F + \kappa G_c\right)\Big/\Omega,$$

or, equivalently, because $G_F + \kappa G_c = \kappa\nu$:

$$dc_0/d\varepsilon = -\nu\left(G_\varepsilon - \kappa a_3\right)\Big/\Omega \gtrless 0.$$

For $dc_0/d\varepsilon < 0$, we must have $\kappa a_3 > G_\varepsilon$. With $\sigma$ small, $\kappa$ is close to $-a_{22}/a_{21}$ (which is positive), $G_\varepsilon$ is close to 0, and this inequality is more likely to hold.

From equation (A1), with $dc_0/d\varepsilon < 0$:

$$dm_0/d\varepsilon = dR_0/d\varepsilon = \varphi_c\left(dc_0/d\varepsilon\right) + \varphi_\varepsilon < 0. \tag{A8}$$

From equation (12):

$$\frac{di_0}{d\varepsilon} = i_c\left(\frac{dc_0}{d\varepsilon}\right) + i_m\left(\frac{dm_0}{d\varepsilon}\right),$$

so that, using (A8):

$$\frac{di_0}{d\varepsilon} = \left(i_c + i_m\varphi_c\right)\frac{dc_0}{d\varepsilon} + i_m\varphi_\varepsilon \gtrless 0. \tag{A9}$$

Because $i_c + i_m\varphi_c = \gamma i_c/(\gamma - i_m) > 0$, $i_m\varphi_\varepsilon > 0$, and $dc_0/d\varepsilon < 0$, the net effect on the nominal domestic interest rate is ambiguous. If the increase in consumption is not large, $di_0/d\varepsilon > 0$ (negative net effect of a reduction in $\varepsilon$).

The impact effect on the real interest rate $r = i - \varepsilon$ is, using (A9):

$$\frac{dr_0}{d\varepsilon} = \left(i_c + i_m\varphi_c\right)\frac{dc_0}{d\varepsilon} + \left(i_m\varphi_\varepsilon - 1\right) < 0, \tag{A10}$$

because $i_m\varphi_\varepsilon - 1 < 0$.

Because $F_0/d\varepsilon = 0$, $db_0^*/d\varepsilon = -dm_0/d\varepsilon$. Consequently:

$$db_0^*/d\varepsilon = -dm_0/d\varepsilon > 0,$$

or equivalently:

$$db_0^*/d\varepsilon = \gamma^{-1}\left\{1 - \frac{di_0}{d\varepsilon}\right\} = -\gamma^{-1}\left(\frac{dr_0}{d\varepsilon}\right) > 0.$$

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## Notes

1. In the figures, taken from Végh (1992), real interest rates are calculated by subtracting the one-quarter-ahead inflation rate from the nominal lending rate. Shaded areas indicate periods during which the programs were in place. The figures show that ex-post real interest rates remained high in several countries, in the first few quarters following the implementation of the program. However, ex-post rates may be significantly higher than ex-ante rates, if inflation expectations are slow to adjust owing to a lack of confidence in the program. This point has been emphasized by Kaminsky and Leiderman (1993), who derive estimates of ex-ante real interest rates based on a univariate model of the inflationary process.
2. See Agénor and Montiel (1996) and Calvo and Végh (1994) for a discusssion of the Rodríguez model, particularly the role played by backward-looking expectations and sticky prices.
3. See, for instance, Patinkin (1993). The restrictive credit stance was brought about through an increase in the discount rate and a rise in reserve requirement ratios on bank deposits.
4. The link between anticipations about future policies and current economic outcomes is, of course, central to rational expectations macroeconomics. Recent developments, in particular, have emphasized the relation between government deficits, fiscal policies, and inflation. See for instance Drazen and Helpman (1990).
5. Except as otherwise indicated, partial derivatives are denoted by corresponding subscripts, while the total derivative of a function of a single argument is denoted by a prime. To simplify notations, time subscripts are omitted. A tilde is used to denote steady-state values.
6. The view that private agents in the country considered are able to borrow (lend) more only at a higher (lower) rate of return is discussed at length in Agénor (1997). It should also be noted that, in general, the function $\theta$ may depend on various other factors in addition to $b^*$—including subjective perceptions of risk or the composition of the household. For simplicity, these factors are ignored.
7. Note that if individuals face a risk premium on foreign loans that does not depend on their own level of foreign debt, the marginal cost of borrowing would be equal to $i^* + \varepsilon - \theta$.
8. An early paper by Turnovsky (1985) provides a specification of households' portfolio decisions that leads to a result analytically similar to equation (8). An alternative approach that also yields an equation similar to (8) is to assume that interest income on foreign assets is taxed at a higher rate than interest income on domestic assets (in order to impede capital mobility), and that the tax rate is proportional to the household's holdings of foreign bonds. See Agénor (1998).

9. For simplicity, it is assumed that the central bank does not receive any interest on its loans to the government. Since, in what follows, only the consolidated budget of the public sector is considered, this assumption is inconsequential. Note also that the central bank is assumed to earn interest at the risk-free rate.
10. Since the central bank does not hold domestic government bonds, the existing stock of these assets cannot be altered through sterilization operations. Recall also that the *level* of the exchange rate does not change discretely.
11. The assumption that the degree of intertemporal substitution in consumption is small is consistent with the evidence for developing countries in general and Latin America in particular; see Agénor and Montiel (1996, Chapter 10). Note also that if capial market imperfections play a limited role (as implied by a small value of $\gamma$), the nominal interest rate will fall approximately by the same amount as the devaluation rate.
12. The services account improves unambiguously in the long run following a reduction in the devaluation rate because, with private holdings of foreign bonds remaining at their initial level, the steady-state value of $\theta b^*$ does not change. Of course, because of the instantaneous portfolio adjustment described earlier, the transitional dynamics of the economy involve changes in $\theta b^*$.
13. Note that the initial deterioration in external accounts predicted by the model relates to the trade balance and not the overall current account—as observed in several exchange-rate-based programs. Note also that because the model is one in which the economy produces one good and purchasing power parity holds continuously, the analysis cannot account for another well-documented feature of exchange-rate based stabilization, namely, an appreciation of the real exchange rate.
14. $\alpha$, $g^h$ and $T$ are all taken as given. The case in which $T$ is stochastic could be analyzed along the lines suggested by Drazen and Helpman (1990). Adopting a stochastic framework of this type would help relate fluctuations in real interest rates to changes in the degree of uncertainty about future government spending shocks.
15. The most recent case is the Real Plan in Brazil.
16. See Daniel (1989) for elaborations on this point.
17. The perceived future increase in lump-sum taxes associated with the expected rise in government expenditure leads private agents to reduce their spending immediately. Using Figure 3, it can be shown that, considered in isolation, an anticipated permanent increase in government expenditure leads to a shift in the $[\dot{F} = 0]$ curve to the right, leaving the $[\dot{c} = 0]$ curve unchanged. $c$ jumps downward on impact and continues to fall (along an unstable trajectory) until $T$, at which point it reaches the new saddlepath—and begins rising until the new equilibrium (which is characterized by a lower value of both $F$ and $c$) is reached.