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

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June 1994

Abstract

This paper examines the behavior of real interest rates in exchange-rate based stabilization programs. The analysis is based on a model with imperfect capital mobility and optimizing agents. A permanent reduction in the devaluation rate is first shown to have an ambiguous effect on real interest rates on impact. The analysis is then extended to consider a stabilization program characterized by an initial reduction in the rate of devaluation of the nominal exchange rate, and the announcement of a future increase in income taxes. The impact effect on real interest rates is shown to depend upon the degree of credibility of the announcement. Real interest rates may fall if agents do not believe that taxes will be raised, and rise if the future tax reform is sufficiently credible.

JEL Classification Numbers:
E43, F32, F41

*I am grateful to Joshua Aizenman, José De Gregorio, Donald Mathieson, Jorge Roldós, Murat Ucer and Carlos Végh for many helpful discussions and comments on preliminary versions of this paper.
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Summary

This paper examines the effect of expectations about future fiscal policy on the behavior of real interest rates in exchange-rate based stabilization programs. The analysis is based on an optimizing model with imperfect capital mobility. The effects of a once-and-for-all (or fully credible) reduction in the devaluation rate are first examined. The steady-state effects are shown to be an increase in the marginal value of wealth, real money balances, private wealth, consumption, a concomitant fall in the nominal interest rate, and no effect on the real stock of foreign bonds or the after-tax real interest rate. On impact, while the nominal interest rate falls unambiguously, the effect on the real after-tax interest is indeterminate and is shown to depend, in particular, on the degree of capital mobility. The distinction between instantaneous and gradual portfolio adjustments plays a key role in understanding the short- and long-run dynamics induced by policy shocks.

The analysis then considers a two-stage policy sequence in which policymakers implement an immediate, permanent reduction in the devaluation rate as the first step in a disinflation program. They also announce their intention to increase the tax rate on income in the future. Private agents, however, do not entirely believe the announcement regarding the fiscal component of the program, and attribute a positive probability to the possibility that the authorities will not implement the pre-announced increase in income taxes. The behavior of real interest rates at the inception of the program is shown to depend on the degree of credibility in the policymakers' announcements. When agents believe that the increase in taxes is unlikely to be implemented domestic real interest rates are likely to fall if the degree of capital mobility is sufficiently high. By contrast, when private agents believe with a high degree of certainty that the increase in the income tax rate will be effectively implemented, real interest rates may rise on impact. Thus, the behavior of real interest rates at the inception of 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 future implementation of the fiscal measures that may be announced in conjunction with the initial set of deflationary policies.
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I. 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 portrayed 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. 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.

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 cycle 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. 1/ 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, since 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 and requires an upward initial adjustment in interest rates to accommodate the increase in domestic money demand associated with a reduction in the devaluation and inflation 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. 2/ However,

1/ See Agénor and Montiel (1994) and Calvo and Végh (1994) for a discussion of the Rodríguez model, particularly the role played by backward-looking expectations and sticky prices.

2/ See, for instance, Patinkin (1993). The restrictive credit stance was brought by an increase in the discount rate and the level of reserve requirements on bank deposits.
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 to the experiments of the 1970s. Thus, the puzzle would seem to persist.

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, lump-sum transfers to private agents, income tax rates, 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. 1/ The second issue relates to the observation that in 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 the so-called "exchange-rate based stabilization programs" of the 1970s and 1980s, fiscal and other policy measures figured prominently with the initial exchange rate adjustment (see Agénor and Montiel, 1994). In many cases, these measures were either implemented at the inception of the programs (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 in exchange-rate based stabilization programs, 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 an overall program consisting not only of an initial exchange rate adjustment, but also a future tax reform. Section II develops an optimizing model of a small

1/ The link between anticipations about future policies and current policy 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).
Figure 1
Real Interest Rates in the Tablita Experiments
(Real lending rates, in percent per year)

Argentina

Chile

Uruguay


Notes: 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.
Figure 2

Real Interest Rates in Heterodox Experiments

(Real lending rates, in percent per year)

Argentina

Brazil

Israel

Mexico


Notes: 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.
open economy with imperfect capital mobility. 1/ Section III begins by examining the short-run dynamics associated with a once-and-for-all reduction in the rate of devaluation of the nominal exchange rate. Section IV then considers fiscal factors, in the context of a two-stage stabilization program characterized by an initial reduction in the devaluation rate coupled with an announced intention to increase the tax rate on income at a given date in the future. But private agents do not completely believe that the policymakers will adhere to their intention to implement the fiscal adjustment. Section V summarizes the major implications of the analysis and discusses some possible extensions.

II. The Analytical Framework

Consider a small open economy in which there are three types of agents: households, 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 $\epsilon$ by the central bank, whose stock of foreign assets adjusts to equilibrate supply and demand for foreign exchange. Households are endowed with perfect foresight and hold three categories of assets in their portfolios: domestic money, foreign bonds, and domestic government bonds. Domestic money bears no interest, but the transactions technology is such that holding money reduces transactions costs. Domestic and foreign bonds are imperfectly substitutable financial assets. The domestic interest rate adjusts to maintain equilibrium in the money market, while (as a result of the small country assumption) the real rate of return on foreign bonds is determined on world capital markets. The government consumes goods and services, collects lump-sum taxes, and pays interest on its domestic debt. It finances its budget deficit either by issuing domestic bonds, by borrowing from the central bank, or by varying taxes on households.

The representative household’s discounted lifetime utility is given as

1/ Imperfect capital mobility arises here not as a result of domestic restrictions on flows or on holdings of foreign assets, but from imperfect substitutability between domestic and foreign bonds. The role of imperfect asset substitutability in analyzing the response of real interest rates to disinflation measures was emphasized by Kamin and Spigelman (1988) in a portfolio-balance framework.

2/ Except 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.
where \( a > 0 \) denotes the constant rate of time preference, and \( c_t \) consumption. For simplicity, the instantaneous utility function is assumed to be of the logarithmic form.

Nominal wealth of the representative household \( A_t \) is given by

\[
A_t = M_t + B_t + E_t b^*,
\]

where \( M_t \) denotes the nominal money stock, \( B_t \) the stock of government bonds, and \( E_t b^* \) the domestic-currency value of the stock of foreign bonds, with \( E_t \) denoting the nominal exchange rate and \( b^* \) the foreign-currency value of foreign bonds. Letting \( m_t = M_t / E_t \) denote real money balances, \( b_t = B_t / E_t \) the real stock of government bonds, real wealth \( a_t \) can be defined as

\[
a_t = m_t + b_t + b^*.
\]

The flow budget constraint is given by

\[
\dot{a}_t = (1 - i^s) q + i_t b_t + i^*_t b^* - [1 + v(m_t / c_t)] c_t - r_t
\]

\[
- (m_t + b_t) \epsilon_t - \gamma (b_t^*)^2 / 2,
\]

where \( q \) denotes domestic output (assumed exogenous), \( r_t \) the real value of lump-sum taxes, \( 0 < i^s < 1 \) the income tax rate, \( i_t \) the domestic nominal interest rate, \( i^*_t \) the interest rate on foreign bonds, and \( \epsilon_t = \dot{E}_t / E_t \) the predetermined rate of depreciation of the exchange rate. The function \( v() \) characterizes transactions costs associated with consumption (see Kimbrough, 1992). Holding money is assumed to reduce transactions costs--so that \( v' < 0 \)--but entails diminishing returns (\( v'' > 0 \)). The term \( (m_t + b_t) \epsilon_t \) accounts for capital losses on the stocks of money and domestic bonds resulting from inflation. The last term in equation (3) is used to capture the imperfect substitutability between domestic and foreign bonds. In the context of a developing country, it can be viewed as a measure of the perceived cost associated with a risk of expropriation: the higher the individual's holdings of foreign bonds are, the easier it is for the government to identify asset holders (for tax purposes, in particular)

\[
\int_0^\infty u(c_t)e^{-\alpha t} dt, \quad u(c_t) = ln c_t,
\]
and the greater the risk of confiscation. The coefficient \( \gamma \) is used below to parameterize the degree of capital mobility. For simplicity, the income tax is taken to be levied at the same rate on factor income and interest payments on domestic and foreign bonds.

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

\[
\dot{a}_t = \rho_t a_t + (1 - i^S) \frac{p_t}{q_t} - (1 + v(\frac{m_t}{c_t})^\frac{1}{\gamma} - (1 - i^S) i^*_t m_t - \tau_t, \tag{3'}
\]

\[
+ ((1 - i^S) i^*_t - \rho_t) b^*_t - \gamma b^*_t^2/2,
\]

where \( \rho_t = (1 - i^S) i^*_t - \epsilon_t \) denotes the after-tax domestic real interest rate.

Households treat \( i^S, i^*_t, q_t, \epsilon_t, \) and \( \tau_t \) as given and maximize (1) subject to (3') by choosing a sequence \( \{c_t, m_t, b_t, b^*_t, \}_{t=0}^\infty \). The required optimality conditions are given by:

\[
\frac{1}{c_t} = \lambda_t \left\{ [1 + v(\frac{m_t}{c_t})] - m_t c_t \frac{1}{\gamma} v\left(\frac{m_t}{c_t}\right) \right\}, \tag{4a}
\]

\[
- v'(\frac{m_t}{c_t}) = (1 - i^S) i^*_t, \tag{4b}
\]

\[
b^*_t = [(1 - i^S) (i^*_t - i_t) + \epsilon_t]/\gamma = ((1 - i^S) i^*_t - \rho_t)/\gamma, \tag{4c}
\]

\[
\dot{\lambda}_t = (\alpha - \rho_t) \lambda_t, \tag{4d}
\]

and the transversality condition \( \lim_{t \to \infty} (a_t e^{-\alpha t}) = 0 \). The costate variable associated with the flow budget constraint, \( \lambda_t \), measures the marginal utility of wealth.

Equation (4a) shows that total consumption is inversely related to marginal transactions costs and the marginal utility of wealth, whose dynamics are described in equation (4d) as a function of the difference between the discount rate and the real domestic interest rate. Equation (4b) states that households equate at the margin the reduction in transactions costs that result from holding an additional

---

1/ This specification has been used, in a different context by Turnovsky (1985), who also provided a different rationale. The stock treatment adopted here differs substantially from the flow formulation adopted in nonoptimizing models, such as Kiguel (1987).
unit of money holdings to its opportunity cost—the after-tax domestic nominal interest rate. It determines implicitly the demand for real money balances. Equation (4c) indicates that holdings of foreign bonds depend positively on the differential between the after-tax rates of return on foreign and domestic assets. When the degree of capital mobility is perfect (γ → 0), the modified uncovered interest parity condition obtains: \((1-\tau^S)\bar{c}_t = \hat{c}_t^s + \epsilon_t\). By contrast, when capital mobility is low (so that \(\gamma\) is large), holdings of foreign bonds will tend to zero.  

Equation (4b) can be written as

\[
m_t = m[(1-\tau^S)\bar{c}_t]c_t, \quad m' = -\frac{1}{1+v'} < 0
\]  

which shows that the demand for money depends positively on the level of transactions—as measured by consumption expenditure—and negatively on the after-tax nominal interest rate. Substituting equations (4b) and (5) in (4a) yields

\[
c_t^{-1} = \lambda_t\left\{1 + \psi[m()] + (1-\tau^S)\bar{c}_t m()\right\} = \lambda_t p((1-\tau^S)\bar{c}_t), \tag{4a'}
\]

where \(p()\) denotes the effective price of the consumption good in period \(t\). This price is equal to the direct price of the good (unity) plus the transactions costs associated with purchasing the good and the opportunity cost of holding domestic money balances to facilitate transactions. For a given level of the marginal utility of wealth, a rise in the after-tax nominal interest rate raises transactions costs as well as the opportunity cost of the existing stock of real money holdings, thus increasing the marginal cost of purchases. The effective price is thus an increasing function of the opportunity cost of holding money. Equation (4a') implies that net consumption expenditure is given by

\[
c_t = c[\lambda_t, (1-\tau^S)\bar{c}_t]. \tag{6}
\]

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

\[1/\text{ Appropriate restrictions must be imposed on } \alpha \text{ to ensure that steady-state consumption is stationary under perfect capital mobility and that the real interest rate is independent of the foreign interest rate under zero capital mobility; see Turnovsky (1985).} \]
\[ M_t = D_t + E_t R_t, \]  

(7)

where \( D_t \) denotes the stock of domestic credit allocated by the central bank to the government, and \( R_t \) the stock of net foreign assets, measured in foreign currency terms. Changes in the real credit stock are given by

\[ \dot{d}_t = (\mu_t - \epsilon_t) d_t, \]  

(8)

where \( d_t = D_t/E_t \) and \( \mu_t \) denotes the rate of growth of the nominal credit stock.

The central bank receives interest on its holdings of foreign assets. \( \Omega_t \) Real profits of the central bank \( \Omega_t \) are therefore determined by

\[ \Omega_t = i^* R_t + \epsilon_t R_t \]  

(9)

where \( \epsilon_t R_t \) measures capital gains on reserves.

The government’s revenue sources consist of lump-sum taxes on households and transfers from the central bank. It consumes goods and services and pays interest on its domestic debt. It finances its budget deficit by borrowing from the central bank or issuing nontraded bonds. In nominal terms, the flow budget constraint of the government can be written as:

\[ \bar{B}_t + \bar{b}_t = E_t S + (1-i^S) B_t - i E_t (q+i^* B_t) - E_t (r+\Omega_t), \]  

(10)

where \( \bar{g} \) denotes non-interest government spending, assumed exogenous. Equation (10) can be written in real terms as

\[ \dot{d}_t + \dot{b}_t + \epsilon_t m_t - \bar{g} + \beta_t b_t - i^S (q+i^* B_t) - \epsilon_t R_t - \tau_t. \]  

(11)

Equation (11) states that government spending plus net interest payments on the domestic debt, minus income taxes, lump-sum taxes and interest income on reserves, must be financed by seignorage revenue \((\epsilon_t m_t)\), issuance of bonds, or an increase in real domestic credit. Solving equation (11) yields the government’s intertemporal budget

---

\(1/\) For simplicity, we assume that the central bank does not receive any interest on its loans to the government. Since we consider only the consolidated budget of the public sector in what follows, this assumption is inconsequential.
constraint, which equalizes the present value of government purchases of goods and services to initial holdings of net foreign assets plus the present value of lump-sum taxes, subject to the transversality conditions

$$\lim_{t \to \infty} b_t \exp(-\rho t) - \lim_{t \to \infty} d_t \exp(-\rho t) = 0.$$ 

To close the model requires specifying the equilibrium condition for the money market. Equations (5) and (6) imply

$$m_t = m[(1-i)^S)\lambda_t] c[\lambda_t,(1-i)^S)\lambda_t],$$

which can be solved for the market-clearing domestic interest rate:

$$i_t = \Phi(\lambda_t,m_t)/(1-i).$$

Substituting equation (13) in (6) yields

$$c_t = c(\lambda_t,m_t).$$

An increase in the real money stock raises aggregate consumption since it reduces the domestic interest rate, which stimulates private expenditure. An increase in the marginal value of wealth affects consumption both directly and indirectly. For a given level of the domestic interest rate, it lowers directly private spending. As a result, however, the interest rate falls to maintain money market equilibrium, thus lowering the opportunity cost (or the effective price) of consumption and stimulating spending. It will be assumed in what follows that the former effect dominates the latter, so that an increase in the marginal value of wealth reduces private expenditure.

Combining equations (3'), (7), (8) and (11) yields the consolidated budget constraint of the economy

$$\dot{b}_t + b^*_t - q - \bar{g} - [1 + v(\frac{m_t}{c_t})]c_t + i^*_c(R_t + b^*_t) - \gamma b^*_t^2/2,$$

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

Equations (4c), (4d), (8), (11), (13), (14) and (15) describe the evolution of the economy along any perfect foresight equilibrium path. The system can be re-written as

$$b^*_t = [(1-i)^S)\lambda_t] c[\lambda_t,(1-i)^S)\lambda_t]/\gamma,$$

$$\dot{\lambda}_t = [\alpha - \Phi(\lambda_t,m_t)]\lambda_t,$$

$$\dot{\lambda}_t = [\alpha - \Phi(\lambda_t,m_t) + \epsilon_t]\lambda_t,$$

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\[ \dot{R}_t + b^*_t = \dot{q} - \dot{g} + \dot{c}(R_t + b^*_t) - c(\lambda_t, m_t) - \gamma b^*_t^2 / 2, \quad (16c) \]
\[ \dot{d}_t + b_t - \rho b_t + \dot{g} - \dot{s}(q + t b^*_t) - \dot{i}^*_t R_t - \dot{r}_t - \epsilon m_t, \quad (16d) \]
\[ d_t = (\mu_t - \epsilon_t) d_t, \quad (16e) \]
\[ \dot{m}_t = \dot{d}_t + \dot{R}_t, \quad (16f) \]

where \( c() = [1 + v(m(\Phi)) \] denotes private consumption expenditure in gross terms, with \( c_\lambda < 0 \) and \( c_m > 0 \). Equations (16) represent a first-order differential equation system with six endogenous variables, \( \lambda_t, b_t, b^*_t, R_t, d_t, \) and \( m_t \). It is worth noting that 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 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 is predetermined, official reserves and the private stock of foreign bonds are allowed to jump in response to sudden movements in domestic interest rates. An instantaneous shift in private holdings of foreign bonds is thus associated with a compensating movement in the stock of foreign reserves held by the central bank.

III. Credible Stabilization and Interest Rates

Using the dynamic model described in the previous section, 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 considers the case in which the reduction in the nominal devaluation rate is unanticipated but permanent, that is, fully credible in the sense of Calvo and Vegh (1993).

Suppose that the devaluation rate is initially constant at \( \epsilon^h \). The central bank sets the rate of growth of nominal credit so as to compensate the government for the loss in value of the outstanding

\[ 1/ \] The net effect of a change in the real money stock on gross consumption is in general ambiguous. On the one hand, an increase in real money balances raises net consumption (by reducing the nominal interest rate), while on the other (for a given level of expenditure) it reduces transactions costs. We assume, however, that the net effect is positive.
stock of credit due to inflation \( \mu_t = \epsilon_i \), and the government foregoes the issuance of bonds to finance its deficit--varying instead lump-sum taxes to balance the budget. Since the credit rule implies that \( d_t = 0 \), equation (16d) yields

\[
\tau_t = -\bar{g} + \rho_t \bar{b} - (i_t^* + \epsilon_t^h)R_t - \epsilon_t^d,
\]

(17)

where \( \bar{b} \) and \( \bar{d} \) denote the constant levels of domestic bonds and credit, which are set to zero for simplicity. As a result, \( m_t = R_t \). In addition, since \( \dot{a}_t = m_t + b_t^* - \dot{R}_t + b_t^* \) from equation (2), equations (16a)-(16c) can be written as

\[
\gamma b_t^* = (1 - i^s) i_t^* + \epsilon_t^h - \Phi(\lambda_t, m_t),
\]

\[
\lambda_t = \left[ (\alpha - \Phi(\lambda_t, m_t) + \epsilon_t^h) \lambda_t, \right.
\]

\[
\dot{a}_t = -\bar{q} - \bar{g} + i_t^* a_t - c(\lambda_t, m_t) - \gamma b_t^*/2,
\]

(18a)-(18c)

with equation (18) determining \( \tau_t \) residually. From equation (2), since \( b = 0 \), \( m_t = a_t - b_t^* \). Substituting this result in (18a) and taking a linear approximation to \( \Phi() \) yields

\[
b_t^* = ((1 - i^s) i_t^* + \epsilon_t^h - \Phi(\lambda_t, m_t))/(\gamma - \Phi_m) = H(\lambda_t, a_t; i^*, \epsilon^h),
\]

(19)

where \( H_a = -\Phi_m/(\gamma - \Phi_m) < 1 \). Given this result, we have

\[
m_t = a_t - b_t^* = a_t - H(\lambda_t, a_t) = h(\lambda_t, a_t; i^*, \epsilon^h),
\]

(20)

where \( h_a = \gamma/(\gamma - \Phi_m) < 1 \). Substituting equations (19) and (20) in equations (19b) and (19c) yields the following system--obtained as a linear approximation around the initial steady state, with the initial value of the stock of foreign bonds set to unity--in \( \lambda_t \) and \( a_t \):

\[
\begin{bmatrix}
\dot{\lambda}_t \\
\dot{a}_t
\end{bmatrix} =
\begin{bmatrix}
-\tilde{\lambda}(\Phi + \Phi \bar{h}_m) & -\tilde{\lambda} \Phi \bar{h}_m a_t \\
-c(\gamma - \lambda_m) & i^* - \gamma + h_a(\gamma - c)_m
\end{bmatrix}
\begin{bmatrix}
\lambda_t - \tilde{\lambda} \\
a_t - \tilde{a}
\end{bmatrix},
\]

(21)

where \( \tilde{\lambda} \) and \( \tilde{a} \) denote steady-state values. Real financial wealth is a predetermined variable, with a given initial value \( a_0 = \bar{a}_0 \). As indicated above, we will assume that the degree of capital mobility is relatively high, so that, in particular, \( \gamma < c_m \). The system described

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by (21) is saddlepath stable if the determinant of its coefficient matrix is negative, a condition that always holds if the world interest rate is small enough. If \( \nu \) denotes the negative root, the solution can be written as

\[
\lambda_t = \tilde{\lambda} - \left( \frac{\lambda h a_m}{\nu + \tilde{\lambda}(\lambda h a_m)} \right)^{-1} (a_t - \tilde{a}),
\]

(22b)

Setting \( \tilde{q} = \tilde{g} = 0 \) for simplicity yields

\[
\tilde{\lambda} = \Omega^{-1} \left[ (\alpha + (1 - \Phi h) \epsilon^h - \Phi h \epsilon^S)(\gamma - h_a (\gamma - c_m)) - \Phi h_a (\gamma - c_m)(h \epsilon^h + h \epsilon^S) \right],
\]

(23a)

\[
\tilde{a} = \Omega^{-1} \left[ (\gamma - c_m)(\Phi a_m + \Phi h_m)(h \epsilon^h + h \epsilon^S) - \Phi h_a (\gamma - c_m)(\epsilon - h_a (\gamma - c_m)) \right].
\]

(23b)

where \( \Omega = (\gamma - h_a (\gamma - c_m)) \Phi a_m + \Phi h_m - \Phi h_a (c_m - h_a (\gamma - c_m)) < 0. \)

The perfect-foresight equilibrium path \( \tilde{S} \) (which has a negative slope) and the steady-state equilibrium are shown in Figure 3.

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 \( \epsilon^h \) to \( \epsilon^S < \epsilon^h \) with no discrete change in the level of the exchange rate. Using equations (23), it is readily established that the net effect of a reduction in the devaluation rate on private wealth \( \tilde{a} \) depends on the sign of

\[
(\gamma - c_m) h_a \Phi a_m + \Phi h_m - \Phi h_a (c_m - h_a (\gamma - c_m)),
\]

which can be shown to be

\[
\ll 1/ \text{ The determinant of the coefficient matrix is given by }
\]

\[
\Delta = - \tilde{\lambda}[(\lambda^* + h_a (\gamma - c_m)) (\Phi a_m + \Phi h_m) + \Phi h_a (c_m - h_a (\gamma - c_m))].
\]

The second term in the expression in brackets is always positive. Also, since

\[
\lambda h_a - \Phi h_m (\gamma - c_m) - (\Phi a_m + \Phi h_m)(\gamma - c_m) < 0.
\]

Therefore, a sufficient (although not necessary) condition for obtaining \( \Delta < 0 \) is \( \lambda^* < \gamma - h_a (\gamma - c_m). \)
equivalent to \((\gamma - c_m) h_m \lambda (1 - \Phi_m) - c_m (1 - \Phi_m)\). Since, from equations (19) and (20), \(h_m = -1/(\gamma - \Phi_m) < 0\), \(0 < \Phi_m < 1\) and \(h_m \Phi_m \lambda = 0\), this expression is positive. The net effect on the marginal value of wealth depends on the sign of \(1 - \Phi_m (\gamma - c_m) - (\gamma - c_m) \Phi_m h_m \lambda\), or equivalently on \(\gamma (1 - h_m \Phi_m) + h_m \lambda\). It can be verified from equations (19) and (20) given above that \(h_m \Phi_m = 1\), which implies that the long-run effect of a reduction in the devaluation rate on \(\lambda\) is also positive. From equations (18), \(d^* = (1 - \Phi_m)/\gamma\), which is independent of \(\epsilon^h\). But since \(\lambda\) rises, it must be the case that \(m^*\) rises. Also, from equation (18b), the after-tax real interest rate is equal to the rate of time preference in the steady state, and is independent of \(\epsilon^h\). Thus, the nominal interest rate--whose initial steady-state value is equal to \((a + e^h)/(1 - t)\)--must fall in the same proportion as the devaluation rate. Finally, from (18c), since real wealth rises, gross consumption must also increase in the steady state. But since both real balances and the marginal value of wealth rise, it can be inferred from equation (16) that the movement in net consumption is ambiguous. To summarize, the steady-state effects of the reduction in the devaluation rate on wealth, real money balances, private wealth, gross consumption (and possibly net consumption), a concomitant fall in the nominal interest rate, and no effect on the real stock of foreign bonds or the after-tax real interest rate.

To determine the impact effects of a reduction in the devaluation rate, note that from equations (22), and since \(da_0/d\epsilon = 0\):

\[
\frac{d\lambda_0}{d\epsilon} = -\left(\frac{d\lambda}{d\epsilon}\right) + \kappa \left(\frac{d\lambda}{d\epsilon}\right) < 0, \quad \kappa = \left(\frac{\lambda \Phi_m h_m}{\nu + \lambda (\Phi_m h_m)}\right) > 0
\]

(24)
since, as shown above, \(d\lambda/d\epsilon < 0\) and \(d\lambda/d\epsilon < 0\). Consequently

\[
(1 - \epsilon^S) \frac{di_0}{d\epsilon} = (\Phi_m h_m) \left(\frac{d\lambda_0}{d\epsilon}\right) + \Phi_m h_m
\]

(25)
so that

\[
\frac{d\rho_0}{d\epsilon} = (1 - \epsilon^S) \frac{di_0}{d\epsilon} - 1 = (\Phi_m h_m) \left(\frac{d\lambda_0}{d\epsilon}\right) - (1 - \Phi_m h_m).
\]

Since \(0 < \Phi_m h_m < 1\), the first result establishes that \(d\lambda_0/d\epsilon > 0\), or that the lower devaluation rate reduces the nominal interest rate on impact. Since, as shown above, \(\Phi_m h_m = \Phi_m (\gamma - \Phi_m)\) and \(1 - \Phi_m h_m = \gamma/\gamma \Phi_m\), the second expression can also be written as
Figure 3

Steady-State Equilibrium
\[
\frac{dp_0}{d\epsilon} = -\gamma \left\{ \phi_\lambda (\frac{d\lambda_0}{d\epsilon}) - 1 \right\},
\]

(26)

which shows that if capital is perfectly mobile (\(\gamma \to 0\)), the net effect on the after-tax real interest rate (which is tied continuously to the rate of time preference in this case) is zero. The model thus possesses no transitional dynamics in this case: the nominal interest rate falls by exactly the same amount as the devaluation rate, and all variables (except private holdings of foreign bonds, which do not change) jump immediately to their new steady-state values. In general, however, the impact effect on the real interest rate is ambiguous. Since we also have, from equation (16a) and the budget constraint, \(db^*_0/d\epsilon - dm_0/d\epsilon = -\gamma^{-1}dp_0/d\epsilon\), the impact effect on private foreign bonds and the real money stock are also indeterminate.

Finally, given the definition of gross consumption, we have

\[
\frac{dc_0}{d\epsilon} = c_\lambda (\frac{d\lambda_0}{d\epsilon}) + c_m (\frac{dm_0}{d\epsilon}) > 0,
\]

(27)

which indicates that, since \(c_\lambda < 0\), \(c_m > 0\) and \(d\lambda_0/d\epsilon < 0\), gross consumption falls unambiguously on impact only if real money balances also fall—i.e., as shown above, only if the real after-tax interest rate falls. In the case where the after-tax real interest rate rises initially, however, the net effect on gross consumption is ambiguous.

From equation (26), the condition under which the after-tax real interest rate falls as a result of a reduction in the devaluation rate (\(dp_0/d\epsilon > 0\)) is given by

\[
\phi_\lambda > (d\lambda_0/d\epsilon)^{-1}.
\]

(28)

This condition does not have a straightforward interpretation. Intuitively, however, the source of the ambiguity is clear: since both the nominal interest rate and the devaluation rate fall on impact, whether the real after-tax interest rate rises or falls depends on the relative strength of these two effects. In turn, the behavior of the real interest rate determines the path of the stock of foreign bonds, real money balances and consumption.

An alternative way to establish a condition for determining the initial movement in real interest rates can be derived as follows. Let a prime denote a post-shock steady-state value. During the transition period, given that \(\bar{a}_0 = \ddot{a} < \dddot{a}'\), equations (22) indicate that total wealth rises continuously after the exchange rate adjustment takes place, while the marginal utility of wealth falls—following its initial upward jump. From equations (13) and (20), the behavior over time of the nominal interest rate after the policy shock implemented at \(t=0\) can be written as
or, using equations (22):

\[ i_t - \alpha + \epsilon_S = \frac{1}{1 - i_S} \left\{ (\Phi_\lambda + \Phi_\lambda h)(\lambda_\lambda - \lambda') + \Phi h (a_t - \tilde{a}') \right\}, \quad t > 0 \]

which indicates that whether the nominal interest rate rises or falls during the transition depends on the sign of \( \Phi h - \kappa(\Phi_\lambda + \Phi_\lambda h) \). Given that \( \bar{a}_0 < \bar{a}' \), for the nominal interest rate to rise requires that

\[ \gamma \left( \frac{\Phi_m - \kappa \Phi_\lambda}{\gamma - \Phi_m} \right) < 0, \quad (30) \]

a condition that holds continuously (since \( \kappa \to 0 \) for \( \gamma \to 0 \)) if the degree of capital mobility is sufficiently high.

Conditions (28) and (30) are not independent: for if the nominal interest rate, say, rises during the adjustment period, the real interest rate must return to its initial equilibrium, it must be that on impact it fell--or equivalently that the nominal interest rate (which, as established above, falls unambiguously on impact) fell by more than the devaluation rate. Conversely, if the nominal interest rate is falling during the adjustment period, the real after-tax interest rate must have risen on impact since it also is falling over time. Put differently, if condition (30) holds, condition (28) will also hold.

It is therefore necessary to distinguish between two cases in examining the short-run dynamics of the model, depending on whether condition (30) is satisfied or not. In both cases, as indicated above, the behavior on impact of the marginal value of wealth and the nominal interest rate is unambiguous: the former jumps upwards, while the latter jumps downwards. As shown in Figure 4, the curves \[ \dot{\lambda}_t = 0 \] and \[ \dot{a}_t = 0 \] both shift to the right as a result of the reduction in the devaluation rate. The marginal value of wealth jumps from point \( E \) to point \( A \), and begins falling afterwards. Private financial wealth rise continuously during the transition to the new steady state, which is reached at point \( E' \).

The initial adjustment in the real stock of foreign bonds, real money balances, and consumption depends on the movement of the after-tax real interest rate on impact. To begin with, suppose that during the transition period the nominal interest rate is falling, so that condition (30) is reversed. As argued earlier, it must be that
Figure 4
Permanent Reduction in the Devaluation Rate
the real interest rate rose on impact. Figure 5 displays the behavior over time of major macroeconomic variables in this case. The rise in the after-tax domestic real interest rate leads to a discrete reduction in the demand for foreign bonds and a rise in the demand for real money balances by the private sector. The instantaneous portfolio adjustment takes place through purchases of foreign currency assets by the central bank accompanied by a discrete increase in the domestic money stock. The shift in the composition of assets is such that real private wealth remains constant on impact. The money supply expansion exerts downward pressure on the domestic nominal interest rate, in order to maintain equilibrium of the money market. As a result of the reduction in the nominal interest rate, the opportunity cost of real money balances falls, thus stimulating private expenditure. In general, the impact effect on gross consumption is ambiguous (as indicated by equation 27), depending on whether the adverse effect of the upward jump in the marginal value of wealth dominates or not the expansionary effect resulting from the reduction in the effective price of consumption. In Figure 5, the net initial effect on private spending is shown to be negative. The fall in consumption generates a current account surplus. Over time, the marginal value of wealth falls and consumption rises—thus eroding the initial trade surplus. The nominal interest rate is falling during the transition process—thus exerting an additional positive effect on private expenditure—and the after-tax real interest rate returns to its initial steady-state level. Since consumption is increasing while the nominal interest rate is falling during the transition, real money holdings are rising over time. Moreover, the increase in real balances—and thus in the central bank's holdings of foreign assets—takes place at a rate that is sufficiently large to offset the upward pressure on the nominal interest rate exerted by the increase in consumption. For this to occur requires that the speed at which consumption is rising (following the initial reduction in expenditure) be small enough relative to the rate at which interest income on the economy's total stock of foreign assets is growing, to ensure that the current account remains in surplus throughout the entire adjustment period. Moreover, this surplus must be large enough to fully offset the negative effect on central bank reserves resulting from capital outflows induced by the gradual reduction in the domestic real interest rate. The increase in the stock of foreign bonds and real money balances over time raises total private wealth during the adjustment process. In the new steady state holdings of domestic currency are higher than initially, while holdings of foreign bonds return to their initial steady-state value.

The case where the nominal interest rate rises during the transition period (so that condition 30 holds), or that the after-tax

\[\text{Since the central bank does not hold domestic government bonds, the existing stock of these assets cannot be altered through sterilization operations. Recall also that the level of the exchange rate does not change.}\]
real interest rate falls on impact, is shown in Figure 6. Private holdings of foreign bonds rise initially while real money balances fall, due to the instantaneous portfolio shift described above. Consumption falls unambiguously on impact since (as indicated earlier) the marginal utility of wealth rises and real money balances fall. Over time, the nominal interest rate rises to allow the real after-tax interest rate to return to its initial steady-state. The induced increase in the effective price of consumption is not large enough to prevent a gradual increase in private spending, induced by the continuous fall in the marginal value of wealth throughout the adjustment process. In the long run, as before, the stock of foreign bonds is unchanged, while real money balances are higher than in the initial steady state.

A key feature of the dynamics described above is the existence of adjustments that occur through time and adjustments that occur instantaneously, in order to maintain portfolio balance. The movement in real interest rates at the inception of an exchange-rate based stabilization program is in general ambiguous. Depending on the structural and behavioral parameters of the economy, real interest rates may rise or fall on impact. It is worth noting that this pattern does not depend on credibility factors here: the initial exchange rate adjustment is permanent and thus fully credible, in the sense of Calvo and Végh (1993). 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 stabilization program.

Changes in behavioral rules may thus 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. However, rather than relying on arbitrary shifts of this sort to explain the observed movement in real interest rates over time, we now turn our attention to the role of expectations about fiscal policy reforms. As indicated in the introduction, fiscal policy measures were either announced or implemented (after the initial exchange rate adjustment) in almost all the so-called "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 two-stage stabilization program in which a permanent reduction in the nominal devaluation rate represents the first component of the policy sequence, and a future adjustment in the income tax rate (which is announced at the moment when the devaluation rate takes place) the second component.

1/ See for instance Frenkel and Rodríguez (1975) for a model that also features both types of adjustments. As indicated earlier, under perfect capital mobility the model has no transitional dynamics, and only the instantaneous portfolio adjustment takes place.
Figure 5

Effects of a Reduction in the Devaluation Rate—Case I

Marginal value of wealth

Holdings of foreign bonds

Consumption

Real money balances

Nominal interest rate

Real after-tax interest rate

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Figure 6
Effects of a Reduction in the Devaluation Rate—Case II
IV. Fiscal Reform, Credibility, and Exchange Rate Adjustment

Before examining the role of fiscal policy expectations in a two-stage stabilization program, let us consider first a permanent, unanticipated increase in the income tax rate from $i^s$ to $i^h > i^s$. The steady-state effects of this policy shock are a reduction in the marginal value of wealth, the stock of foreign bonds, real money balances, real wealth and gross consumption, an increase in the before-tax nominal interest rate, and no effect on the real after-tax interest rate. 1/ The impact effects are given by

\[
\frac{d\lambda_0}{dt} = \left( \frac{d\lambda}{dt} \right) + \kappa \left( \frac{d\lambda}{dt} \right) < 0, \tag{31a}
\]

\[
\frac{d\lambda_0}{dt} = \frac{1}{1 - i^s} \left\{ \left( \Phi^*_\lambda + \Phi^*_h \lambda \right) \left( \frac{d\lambda_0}{dt} \right) + \Phi^*_h + \gamma \right\} > 0, \tag{31b}
\]

\[
\frac{dp_0}{dt} = - \zeta + \left( 1 - i^s \right) \frac{d\lambda_0}{dt} = \left( \Phi^*_\lambda + \Phi^*_h \lambda \right) \frac{d\lambda_0}{dt} + \Phi^*_h \lambda < 0, \tag{31c}
\]

The increase in the income tax rate reduces on impact the rate of return on foreign bonds by more than the change in the rate of return on domestic assets. The result is an instantaneous reduction in private holdings of foreign assets, which is matched by an increase in official reserves and the real money stock. The marginal value of wealth jumps downwards on impact (as indicated by equation 31a) and raises consumption. In general, since both consumption and the real money stock rise, the net effect on the nominal interest rate and the after-tax real interest rate is ambiguous, as indicated by equations (31b) and equations (31c). 2/ A more precise characterization of the initial effects can be established along the lines indicated above.

During the transition process, the path followed by the nominal interest rate is determined by an equation similar to equation (29):

1/ Steady-state effects can be derived along the lines discussed above. For instance, since $b^* = ((1 - i^s)\lambda^* - \alpha)/\gamma$ and $\zeta = \left( \alpha + \gamma \right)/(1 - i^s)$ in the initial steady state, an increase in the tax rate lowers the stock of foreign bonds and raises the nominal interest rate.

2/ Regardless of whether the nominal interest rate rises or falls initially, private holdings of foreign bonds always fall (as indicated earlier) since, using equations (18) to (20):

\[
\frac{db_0}{dt} = \left\{ -i^* \left( \Phi^*_\lambda + \Phi^*_h \lambda \right) \frac{d\lambda_0}{dt} - \Phi^*_h \lambda \right\} \gamma = - h_i - h_\lambda \left( \frac{d\lambda_0}{dt} \right) < 0.
\]

Real money balances therefore always rise on impact.

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\[ i_t = \frac{\alpha + \epsilon^h}{1 - \iota^h} + \frac{1}{1 - \iota^h} (\Phi \lambda^h \alpha - \kappa (\Phi^+ \lambda^h \lambda)) (a_t - a'). \quad t > 0 \]

However, since now \( a_0 > a' \), the condition under which the nominal interest rate rises during the adjustment period (equation 30) is now reversed. Put differently, assuming that the degree of capital mobility is sufficiently high—so that condition (30) holds—implies that a reduction in the devaluation rate will lead to a gradual increase in nominal and real interest rates after the initial shock, while an increase in the tax rate on income will lead to a gradual fall in interest rates. In this case, therefore, both the nominal interest rate and the real after-tax interest rate must rise on impact. For the sake of the argument that follows, we will focus on the case where the degree of capital mobility is high enough to ensure that condition (30) holds.

The increase in the opportunity cost of money holdings dampens the initial rise in private expenditure. Over time, the marginal value of wealth rises after its initial downward jump, thus exerting downward pressure on consumption. The nominal interest rate must fall to ensure that the after-tax real interest rate returns to its initial steady-state level, which thus dampens the negative effect of the increase in the marginal value of wealth on private expenditure. Since private agents increase over time their holdings of foreign bonds as a result of the fall in domestic interest rates (thus leading to capital outflows), the central bank's holdings of foreign assets—and thus the real money stock—may in principle either fall or rise during the transition period. But since private wealth falls during the adjustment process and private holdings of foreign bonds are rising, real money balances—and thus the stock of foreign assets of the central bank—must be falling. In turn, the reduction in real money balances over time implies that although both consumption and the nominal interest rate are falling, the former effect dominates the latter. In addition, since interest income on the economy's total stock of foreign assets falls over time, the current account may remain in deficit throughout the entire adjustment process. The increase in the stock of foreign bonds takes place at a rate that is less rapid than the increase in real money balances, to ensure that private wealth falls over time. As shown in Figure 7, both curves \([a^h_t = 0]\) and \([a^l_t = 0]\) shift to the left. The marginal value of wealth jumps downwards from point \( E \) to point \( A \), and begins rising afterwards towards the new steady state, which is reached at point \( E' \). Figure 8 displays the behavior of major macroeconomic variables over time.

Assume now that the economy begins at \( t = 0 \)—in a steady state, characterized as described in Section II by a high devaluation rate \( \epsilon^h \) and a low income tax rate \( \iota^S \), and consider the following policy sequence. At \( t = 0 \), the government reduces the devaluation rate from
Figure 7
Permanent Increase in the Income Tax Rate
Dynamic Effects of an Increase in the Income tax Rate

Marginal value of wealth

Holdings of foreign bonds

Consumption

Real money balances

Nominal interest rate

Real after-tax interest rate
\( \epsilon^h \) to \( \epsilon^S < \epsilon^h \). At the same time that the reduction in the devaluation rate is implemented, the government announces its intention to increase the income tax rate from \( \epsilon^S \) to \( \epsilon^h \) in the future, at period \( T \) or some time after \( T \). The value \( \epsilon^h \) is common knowledge. However, the public does not entirely believe the policy announcement, and attributes only a given probability \( 0 < \sigma < 1 \) that the increase in the income tax rate will be effectively implemented. The coefficient \( \sigma \) can thus be viewed as a measure of the degree of credibility of the fiscal component of the stabilization program. A value of \( \sigma \) close to unity indicates that agents are almost certain that the policy reform will eventually be carried out, while a value of \( \sigma \) close to zero indicates that the public has little confidence in the government’s intention to adjust the income tax rate.

The income tax rate that is expected to prevail from \( t > T \) is thus equal to \( \sigma \epsilon^h + (1-\sigma) \epsilon^S \) (which is greater than \( \epsilon^S \) as long as \( \sigma \) is positive) and private agents will make their portfolio and consumption decisions accordingly. The dynamics of the economy from \( t > T \) are now determined by a set of equations similar to equations (18), with equation (18a) replaced by

\[
\gamma^*_{t} = \left[ \frac{1}{\lambda_{t}} \frac{\Phi(\lambda_{t}, m_{t})}{\lambda_{t}} \right] \epsilon^S - \lambda_{t}^S - \Phi(\lambda_{t}, m_{t}), \tag{32}
\]

The solution of the system described by equations (18b), (18c) and (32) yields a "quasi" steady state, since it is associated with a policy shock that may or may not occur at \( T \) or afterwards. Once period \( T \) is reached, the policy is either implemented or agents become convinced it will never be. Uncertainty eventually disappears and \( \sigma \) becomes 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. We will here study only the quasi steady state, since the focus of attention is the short-run behavior of real interest rates. During the adjustment period \( 0 < t < T \), the solution of the model is such that the transition that takes place at \( T \) is perfectly anticipated. As shown in the Appendix, the system follows an unstable trajectory during the transition period.

\( \sigma \) Since lump-sum taxes are endogenously adjusted to equilibrate the budget, there is no intrinsic rationale in the present model for justifying the use of distortionary taxation from the point of view of public finance. However, the decision to raise the income tax rate may rest on distributional considerations being pursued simultaneously with the stabilization objective, or because a tax hike is viewed as having a "signaling" effect regarding the policymakers’ commitment to reform and adjustment.

\( \sigma \) See Daniel (1989) for elaborations on this point.
Suppose that the system is initially in a steady-state position, with $\varepsilon = \varepsilon^h$ and $\iota = \iota^s$, so that $(\lambda_0, a_0) = (\bar{\lambda}, \bar{a})$. Using the solutions provided in the Appendix, the marginal utility of wealth can be shown to jump to

$$
\lambda_0 = \bar{\lambda} - \kappa_{\bar{A}_1} + \kappa_{\bar{A}_2},
$$

where $\kappa_{\bar{A}_2} > 0$, and $\bar{A}_1, \bar{A}_2$ are given by (see the Appendix), with $\psi > 0$:

$$
\bar{A}_1 = (\bar{a}_0 - \bar{a}) + \psi^{-1}\left(\kappa(\bar{a}) - \bar{a}^s\right) + (\bar{\lambda} - \bar{\lambda})\exp(-\psi^2 T)/(\kappa + \kappa^2),
$$

$$
\bar{A}_2 = -\psi^{-1}\left(\kappa(\bar{a}) - \bar{a}^s\right) + (\bar{\lambda} - \bar{\lambda})\exp(-\psi^2 T)/(\kappa + \kappa^2),
$$

where $\psi^2 > 0$ is the positive root of system (21) and $\bar{a}_0 = \bar{a}$. In the above expressions, $\bar{z}$ (for $z = \lambda, a$) is defined by equations (23) with $\varepsilon^h$ replaced by $\varepsilon^s$, and $\bar{z}$ is given by replacing both $\varepsilon^h$ by $\varepsilon^s$ and $\iota^s$ by $\iota$ in equations (23).

Given the results provided above, $\bar{a}_0 - \bar{a} < 0$ and $\bar{z} - \bar{z} > 0$, for $z = \lambda, a$. Thus, $\bar{A}_2 < 0$, while $\bar{A}_1 > 0$. We thus have

$$
sg(\lambda_0 - \bar{\lambda}) < 0.
$$

The impact effect of a program consisting of an immediate reduction in the rate of devaluation and the announcement of a future tax reform on the marginal value of wealth is in general ambiguous. This result can be illustrated graphically, by combining the movements displayed in Figures 4 and 7. The reduction in the devaluation rate shifts both curves $[\bar{a}_t = 0]$ and $[\bar{\lambda}_t = 0]$ to the right, while the announcement of a future increase in the income tax rate shifts them

$1/$ Note that $A_2 \to 0$ and $\bar{A}_1 \to \bar{a}_0 - \bar{a} < 0$, if the horizon $T$ is very large—that is, if the fiscal adjustment is announced to take place in the very distant future. This occurs regardless of the value of $\sigma$, and returns us to the case of a permanent reduction in the devaluation rate only, with $(\lambda_0 - \bar{\lambda}) > 0$. 

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to the left. The net effect on wealth and the marginal value of wealth is thus ambiguous, and so is the impact on the real interest rate.

Intuitively, to understand the short-run dynamics of real interest rates, it is worth considering the two polar cases: \(\sigma\) close to zero and \(\sigma\) positive. The case where \(\sigma\) is close to zero corresponds to the case of a permanent, unanticipated reduction in the devaluation rate only at \(t = 0\), described in the previous section. Suppose, as indicated earlier, that the degree of capital mobility is relatively high, so that condition (30) holds and the system evolves along the path depicted in Figure 6. If the announcement of a future income tax adjustment carries little credibility, therefore, the real after-tax interest rate is likely to fall on impact.

The case where \(\sigma\) is close to unity does not correspond directly to the unanticipated, permanent income tax adjustment examined before, since now the devaluation rate changes initially and the fiscal policy shock is only an eventuality that may occur in the future. However, in the absence of any exchange rate adjustment, it is clear that the economy would follow a path similar to that described in Figure 8, upon announcement of the future reform. 1/ If the initial reduction in the devaluation rate is not too large, the real after-tax interest rate would still rise on impact. Formally, this obtains because if \((\bar{\sigma} - \sigma) \to 0\), then \(\lambda^0 \to -\lambda^2\), which is positive. From equation (33), therefore, since \((\lambda^0 - \lambda)\) also tends to zero, \(\lambda^0\lambda^2 = (\kappa + \kappa^2)\lambda^2 < 0\), as depicted in Figures 7 and 8. As can be inferred from equations (A3) of the Appendix, the higher \(\sigma\) is, the larger will be the downward jump in the marginal value of wealth, and the larger will be the increase in the after-tax real interest rate.

The thrust of the foregoing analysis is thus that, as long as \(\sigma\) is positive, the net movement in real interest rates at the inception of a two-stage exchange-rate based stabilization program of the type discussed here is indeterminate. Depending on the degree of confidence in fiscal reform (as well as the degree of capital mobility, the size of the initial exchange rate adjustment, and the likely increase in the income tax rate), real interest rates may rise or fall. In practice, therefore, movements in real interest rates will not only reflect the type of policies that agents expect the government to implement in the future but also 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 since expectations of future policy changes are not observed by the

1/ The quasi steady-state nominal interest rate, in particular, would rise from \((\alpha + \epsilon^h)/(1 - \sigma)\) to \((\alpha + \epsilon^h)/(1 - (\sigma - \alpha)\epsilon + (1 - \sigma)\epsilon^h)).
Nevertheless, the adjustment mechanism described in the foregoing discussion may have played an important 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 fiscal dimension of the credibility issue in these programs. In our framework, 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 a future tax reform. Our analysis thus suggests that, even when the exchange rate policy component of an exchange-rate based stabilization program is fully credible, large fluctuations in real interest rates will be observed in the course of the adjustment process if the degree of confidence in the fiscal policy component of the program varies over time.

V. 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 although a once-and-for-all reduction in the devaluation rate led at the inception of the program to a fall in nominal interest rates, the net effect on real interest rates is in general ambiguous. In particular, when the degree of capital mobility is high, the real interest rate is likely to fall on impact. These movements in interest rates were shown to reflect both instantaneous and gradual portfolio adjustments. Thus, the contrasted evolution in real interest rates observed between the 1970s and 1980s in Latin America may have reflected changes in private agents' behavioral rules, rather than credibility factors (as emphasized by some economists) or the use of monetary policy instruments in addition to the exchange rate. While this interpretation is rather mechanical, it suggests that the use of changes in real interest rates at the inception of stabilization programs to assess the degree of credibility in the macroeconomic policy stance may not be warranted under all circumstances. A rise in real interest rates for instance 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.

We then considered a two-stage policy sequence in which the policymaker implements an immediate, permanent reduction in the devaluation rate as the first step in a disinflation program. It also announces its intention to increase at some date in the future the tax rate on income. Private agents, however, do not entirely believe the announcement regarding the fiscal policy component of the program, and
attribute a positive probability to the possibility that the authorities will not implement the pre-announced increase in income taxes. The behavior of real interest rates at the inception of the program was shown to depend, in particular, on the degree of public confidence (or the degree of credibility) in the policymakers' announcement. When agents believe that the increase in taxes is unlikely to be implemented, domestic real interest rates are likely to fall if the degree of capital mobility is sufficiently high. By contrast, when private agents believe with a high degree of certainty that the increase in the income tax rate will be effectively implemented, real interest rates may rise on impact.

The analysis developed here can be extended in a variety of directions. Endogenizing output and the real exchange rate in a two-sector framework would allow a more comprehensive assessment of the implications of real interest rates behavior. A particularly important issue would be to examine whether in an extended framework the expectational factors highlighted here can help account for other features that typically characterize exchange-rate based stabilization programs—a boom-recession pattern, and a sustained appreciation of the real exchange rate (see Végh, 1992). Another possibility would be to consider the case where the date of the future tax adjustment is pre-announced but uncertain, 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 the policy horizon. These extensions, however, are unlikely to alter the central message of this paper: the behavior of real interest rates at the inception of 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 future implementation of the fiscal measures that may be announced in conjunction with the initial set of deflationary policies.
APPENDIX

The perfect foresight solution requires that at $T$, the transition to the system with $0 < \sigma < 1$ occur without a jump in either the marginal utility of wealth or the stock of wealth. Consider first the solution that obtains for $t \geq T$, and suppose for the moment that no exchange rate adjustment takes place at period $t = 0$. The solution of the model consisting of equations (18b), (18c) and (31) is given by, with $\iota = \sigma \iota^s + (1-\sigma)\iota^d$:

$$
a_t = a + A \exp(\nu t), \quad t \geq T \quad (A1a)
$$

$$
\lambda_t = \lambda - \kappa (a_t - a) = \lambda - \kappa A \exp(\nu t), \quad t \geq T \quad (A1b)
$$

where

$$
\lambda = \Omega^{-1} [(\alpha + (1-\Phi_\mu \iota^s) \epsilon^{h_\mu \phi_\mu h_\lambda}) (\gamma (\alpha (\gamma - \iota^s)) - \Phi_\mu \alpha (\gamma - \iota^s) (h^{h_\mu + h_\iota})],
$$

$$
a = \Omega^{-1} [(\gamma (\alpha (h^{h_\mu + h_\iota})) (\Phi_\mu \alpha (\gamma - \iota^s)) - (\alpha + (1-\Phi_\mu \iota^s) \epsilon^{h_\mu \phi_\mu h_\lambda}) (c^{h_\iota} + h_\iota (\gamma - \iota^s))]
$$

where $\Omega$ is as defined in the text, and $\bar{q} = \bar{g} = 0$. $A$ is a constant term determined below.

The solution of the model that prevails during the transition period is the general solution to system (21). Let $\nu_1$ ($= \nu$) be the negative root and $\nu_2$ the positive root of system (21). We then have

$$
a_t = \bar{a} + A_1 \exp(\nu_1 t) + A_2 \exp(\nu_2 t), \quad 0 < t < T \quad (A2a)
$$

$$
\lambda_t = \bar{\lambda} + \kappa_1 A_1 \exp(\nu_1 t) + \kappa_2 A_2 \exp(\nu_2 t), \quad 0 < t < T \quad (A2b)
$$

where $\kappa_1 = - \kappa < 0$, $\kappa_2 > 0$, $A_1$ and $A_2$ are constant terms, and $\bar{a}$ and $\bar{\lambda}$ are as given in the text (equations 23). Since $\iota > \iota^s$ as long as $\sigma$ is positive, we have

$$
\bar{\lambda} - \bar{\lambda} = \gamma \Phi_\mu h_\lambda \sigma (\iota^{h_\mu - \iota^s})/\Omega > 0, \quad (A3a)
$$

$$
\bar{a} - \bar{a} = [(\gamma (\alpha (h^{h_\mu + h_\iota})) \Phi_\mu \alpha (\gamma - \iota^s)) h_\iota \sigma (\iota^{h_\mu - \iota^s})/\Omega > 0 . \quad (A3b)
$$

To determine the values of $A$, $A_1$ and $A_2$ requires three conditions: the initial condition on private wealth ($a_0 = \bar{a}_0$) and the
conditions that no jumps take place at $T$ in either $a_t$ or $\lambda_t$. These conditions are given by

$$
\begin{align*}
\bar{a}_0 - \bar{a} + A_1 + A_2, \\
\bar{a} \bigg|_\sigma + A \exp(\nu_1 T) - \bar{a} + A_1 \exp(\nu_1 T) + A_2 \exp(\nu_2 T), \\
\bar{\lambda} \bigg|_\sigma - \kappa \lambda \exp(\nu_1 T) - \bar{\lambda} + \kappa_1 A_1 \exp(\nu_1 T) + \kappa_2 A_2 \exp(\nu_2 T).
\end{align*}
$$

Solving this system yields

$$
\begin{align*}
A &= \left( a_0 - \bar{a} \right) + \Psi^{-1}\left( \left( \bar{a} - \bar{a} \right)_\sigma \left( \kappa \lambda \exp(\nu T) + \kappa_2 \exp(\nu_2 T) \right) \right) + \left( \bar{\lambda} - \bar{\lambda} \right)_\sigma \left( \exp(\nu T) - \kappa_2 \exp(\nu_2 T) \right), \quad (A4a) \\
A_1 &= \left( a_0 - \bar{a} \right) + \Psi^{-1}\left( \left( \bar{a} - \bar{a} \right)_\sigma \left( \kappa \lambda \exp(\nu T) + \kappa_2 \exp(\nu_2 T) \right) \right) \exp(\nu T), \quad (A4b) \\
A_2 &= -\Psi^{-1}\left( \left( \bar{a} - \bar{a} \right)_\sigma \left( \kappa \lambda \exp(\nu T) + \kappa_2 \exp(\nu_2 T) \right) \right) \exp(\nu T), \quad (A4c)
\end{align*}
$$

where $\Psi = (\kappa + \kappa_2) \exp[(\nu + \nu_2) T] > 0$. It is easy to verify that, given equations (A3) and $\bar{a}_0 = \bar{a}$, $A \geq 0$, $A_1 > 0$, $A_2 < 0$. Equations (A4) confirm that if $\sigma = 0$, then the steady-state values remain unchanged (as indicated by equations A3), $A = A_1$ and $A_2 = 0$. Note also that if $T \to \infty$, $A_1 \to (\bar{a}_0 - \bar{a})$ while $A_2 \to 0$, even if $\sigma > 0$.

Assume now that a reduction in the devaluation rate takes also place at $t = 0$. The solutions for $A_1$ and $A_2$ are now given by

$$
\begin{align*}
\tilde{a}_1 &= \left( \bar{a}_0 - \bar{a} \right)_\epsilon + \Psi^{-1}\left( \kappa \bar{a} - \bar{a} \right)_\sigma \left( \tilde{\lambda} - \tilde{\lambda} \right)_\sigma \left( \exp(\nu T) \right) \geq 0, \quad (A5a) \\
\tilde{a}_2 &= -\Psi^{-1}\left( \kappa \bar{a} - \bar{a} \right)_\sigma \left( \exp(\nu T) \right) \geq 0, \quad (A5b)
\end{align*}
$$

where $\tilde{z}_\epsilon$ is given by equations (23) with $\epsilon^h$ replaced by $\epsilon^s$, and $\tilde{z}_\sigma$ is given by replacing both $\epsilon^h$ by $\epsilon^s$ and $\epsilon^s$ by $\epsilon$, with $z = \lambda, a$. The expressions $(\tilde{z}_\epsilon - \tilde{z}_\sigma)$ are also given by equations (A3).
References


