IMF Working Paper

WP/97/86   INTERNATIONAL MONETARY FUND

Research Department

Borrowing Risk and the Tequila Effect

Prepared by Pierre-Richard Agénor[1]

Authorized for distribution by Eduardo Borensztein

July 1997

Abstract

This paper models the Tequila effect (triggered by the collapse of the Mexican peso in December 1994) as a temporary increase in the risk premium faced by domestic private borrowers on world capital markets. The effects of this shock are studied in an intertemporal optimizing framework where firms' demand for working capital is financed by bank credit. Under the assumption that the perceived duration of the shock is sufficiently long, the model is capable of reproducing some of the main features of Argentina's economic downturn in the aftermath of the collapse of the Mexican peso: the rise in domestic interest rates, the reduction in net private capital inflows and the drop in official reserves, the reduction in bank deposits and credit supply, the fall in private consumption, the contraction in output, and the increase in unemployment.

TABLE OF CONTENTS

SUMMARY

The collapse of the Mexican peso in December 1994 triggered exchange market pressures and increased financial market volatility in a number of developing countries. But while most countries regained financial and exchange market stability fairly rapidly, a full-fledged economic crisis developed in Argentina. Many observers have attributed Argentina's economic downturn to the contagion or Tequila effect—a massive net outflow of capital triggered by a sudden loss of investor confidence in the country's economic prospects.

The paper uses an intertemporal optimizing framework to examine contagion effects of this type. The main feature of the model is the link between the financial sector and the supply side of the economy via firms' working capital needs, namely, the need to finance labor costs prior to the sale of output. The Tequila effect is then modeled as a temporary increase in the autonomous component of the risk premium that domestic private borrowers must pay (above the safe lending rate) on world capital markets.

The short-run dynamics of the model are shown to depend on the degree of intertemporal substitution in consumption and the duration of the shock. Under the assumptions that the degree of intertemporal substitution is not too large, and that the shock is perceived to be of a sufficiently long duration, the model is shown to be capable of reproducing some of the main features of Argentina's economic downturn in 1995: an increase in domestic interest rates, a reduction in foreign borrowing (or, equivalently, an increase in net capital outflows), a sharp drop in official reserves and the monetary base, a reduction in bank credit, a contraction in output, an increase in unemployment, a fall in consumption, and an improvement in external accounts.

I. INTRODUCTION

The collapse of the Mexican peso on December 20, 1994 triggered exchange market pressures and increased financial market volatility in a number of developing countries.[1] In Latin America, two economies were hit particularly severely: Argentina and Brazil. In both countries, gyrations in market sentiment led in early 1995 to a sharp reduction in net capital inflows, a fall in official reserves, and intense pressure on asset prices. Between December 1994 and February 1995, the cumulative decline in stock market prices (measured in terms of US dollars) reached 24.8 percent in Argentina and 22.6 percent in Brazil.

Whereas in subsequent months most countries that initially suffered from market turbulences regained financial and exchange market stability, a full-fledged economic crisis developed in Argentina. As illustrated in Figure 1, output contracted significantly in 1995, whereas bank deposits and domestic credit (as measured by bank claims on the private sector) fell dramatically. For 1995 as a whole, industrial output fell by 6.7 percent, real GDP by 4.6 percent, real private consumption by 6.1 percent, real domestic investment by 16 percent, and bank credit to the private sector by 5.5 percent in real terms.[2] The unemployment rate increased sharply, peaking at 18.5 percent in May 1995.[3] The liquidity crunch led to a sharp rise in bank lending rates, on both peso- and US dollar-denominated loans. The spread between the lending rates on these two categories of loans widened significantly between February and May 1995 (as shown in Figure 1), reflecting an increase in the perceived risk of a collapse of the currency board regime introduced in 1991 and a subsequent large exchange rate depreciation. Although the contraction in output and the expansion of merchandise exports (by 27 percent in volume terms for 1995 as a whole) led to an improvement in the trade balance, the massive shift away from peso deposits, capital flight and the reduction in new borrowing led to a collapse of foreign reserves, and a dramatic fall in the monetary base.

---

[1]For an overview of the events leading to the Mexican peso crisis, see for instance Masson and Agénor (1996). The role of fundamentals and arbitrary changes in market sentiment in these turbulences are analyzed by Sachs, Tornell and Velasco (1996).

[2]The decline in bank credit to the private sector in 1995 may have been exacerbated by the process of concentration in the banking industry, which is widely perceived to have entailed a loss of information about borrowers' net worth, thereby making banks more cautious in their lending decisions; see Cañonero (1997) and Catão (1997). It should also be noted that total credit (including credit to the public sector) actually increased between end-1994 and end-1995.

[3]The recession compounded the already unfavorable trends in the labor market. Unemployment rose steadily from around 6 percent in the immediate aftermath of the introduction of the Convertibility Plan in April 1991 to 12.5 percent in October 1994, despite an average rate of real output growth of more than 7 percent during the same period. The low output-employment elasticity has been attributed by some observers to a rise in the participation rate and increased substitution of capital for labor.

Figure 1
Argentina: Macroeconomic Indicators 1/
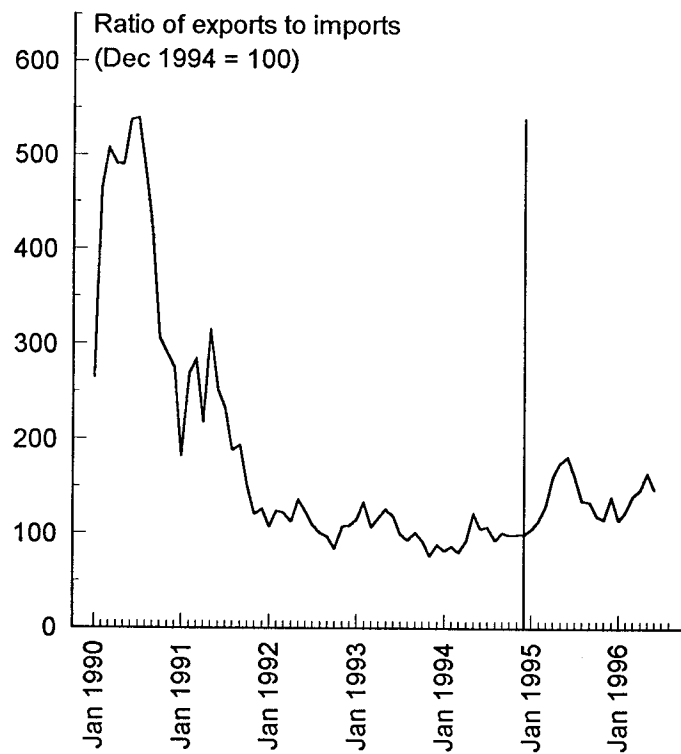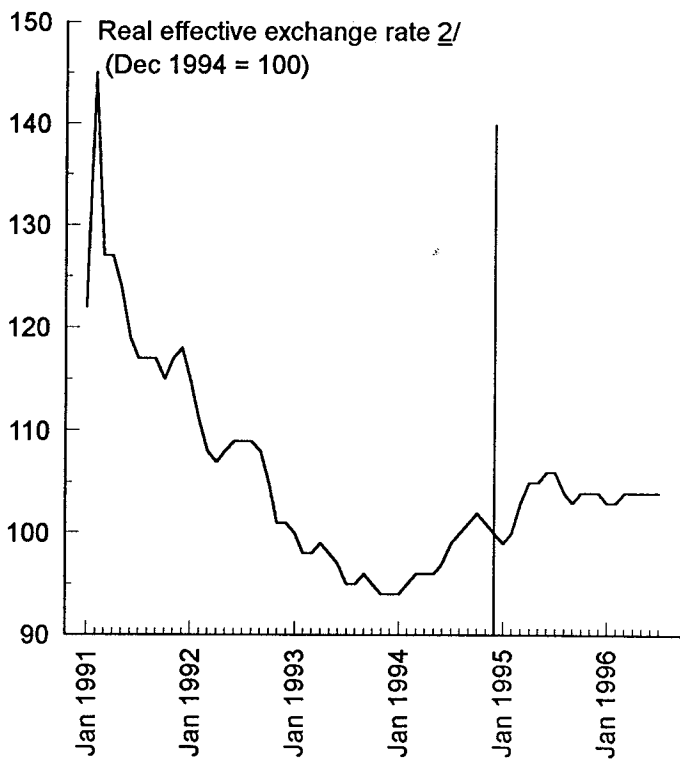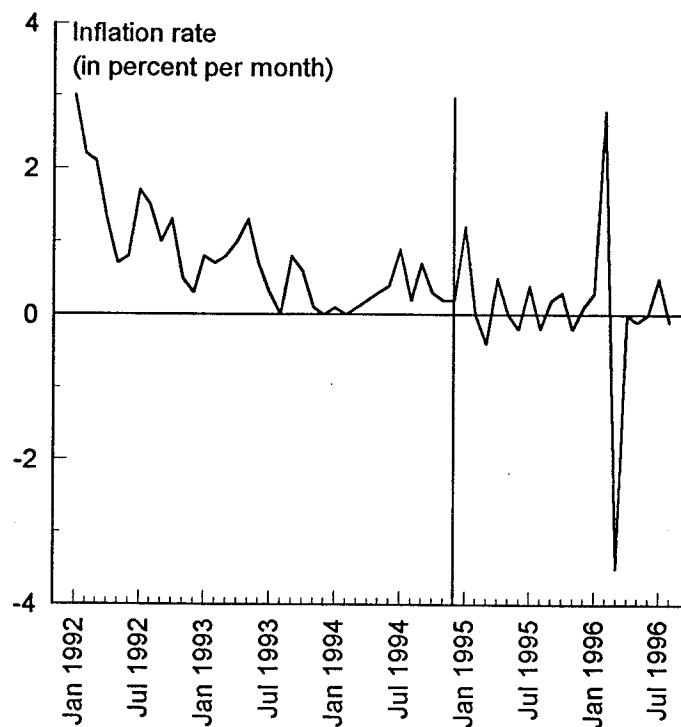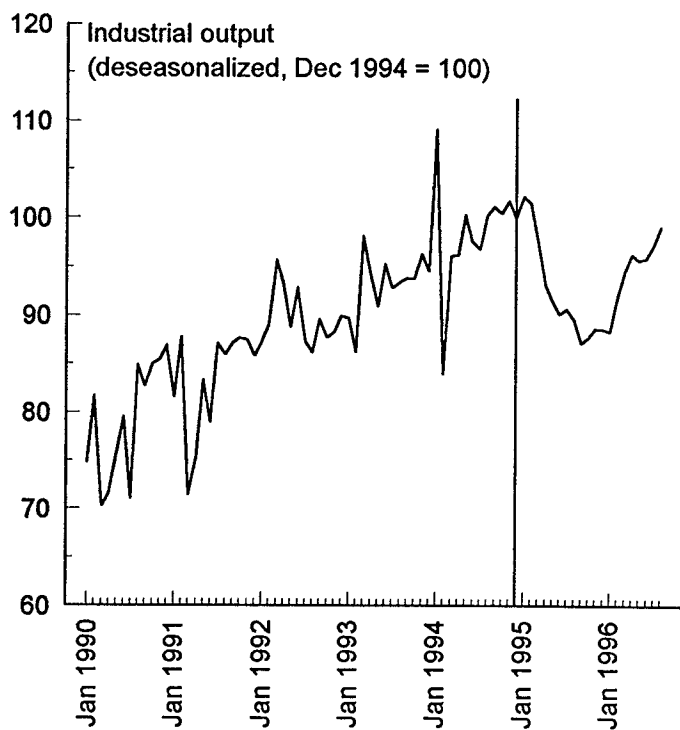
Sources: FIEL, IFS, INS.

1/ The horizontal line corresponds to the Mexican peso crisis (December 1994) .

2/ An increase is a depreciation.

Figure 1 (concluded)
Argentina: Macroeconomic Indicators 1/

Reserve money
(in billions of pesos)

Claims on private sector
(rate of growth, in percent per month)

Foreign exchange
(in billions of U.S.$)

Lending rate
(in percent)

in peso terms

in U.S. dollar terms
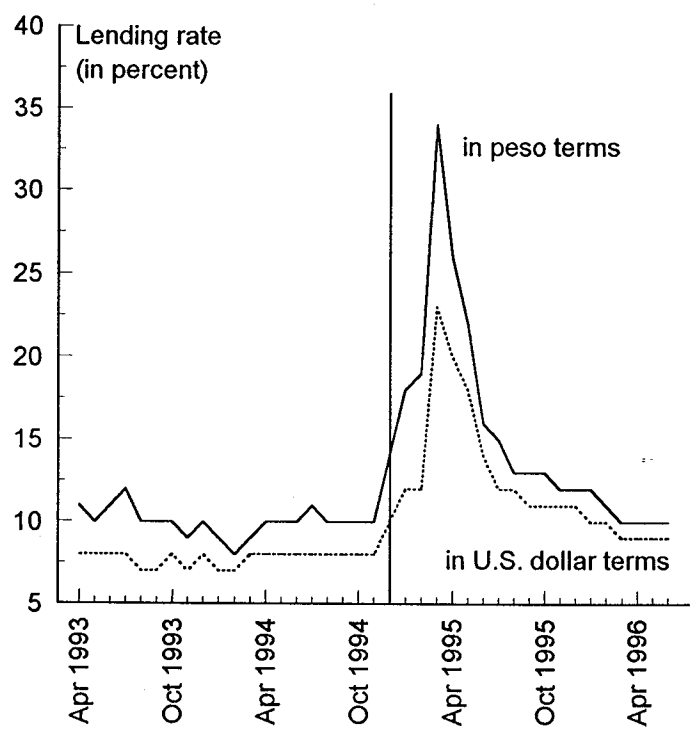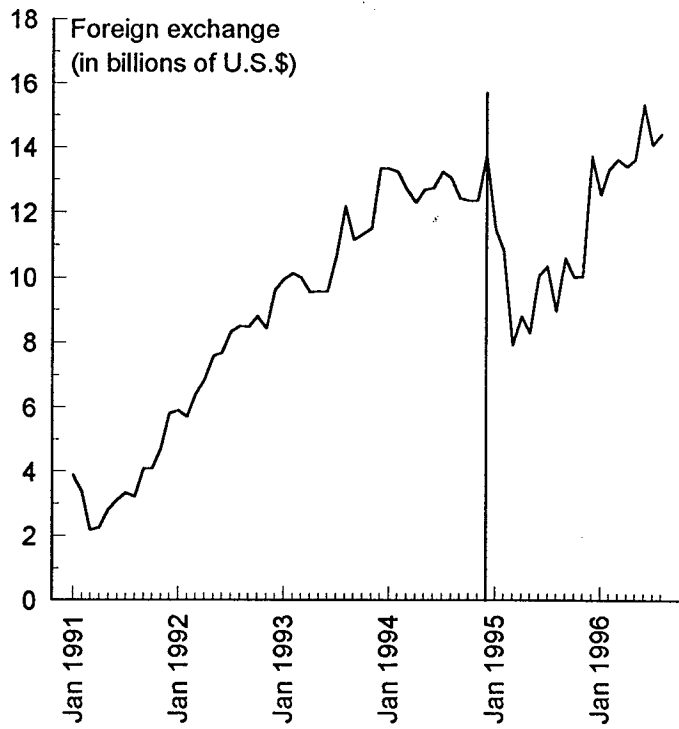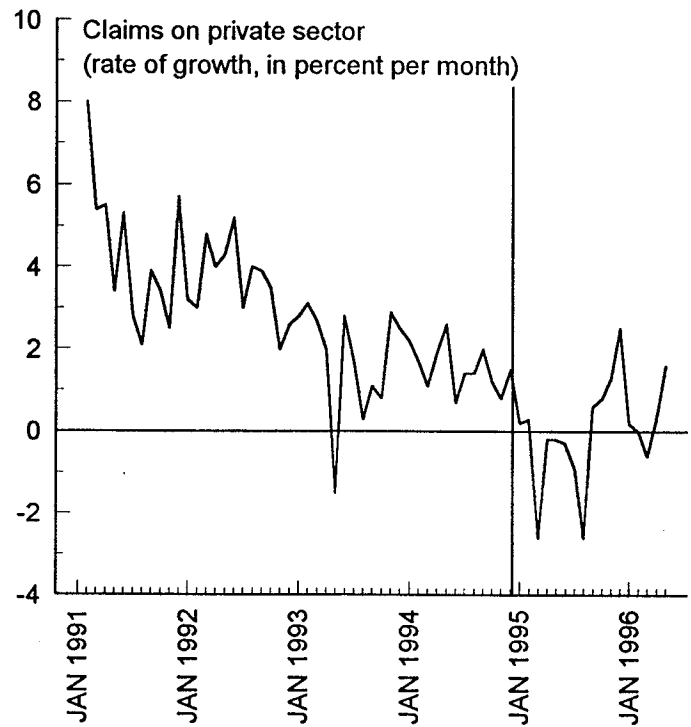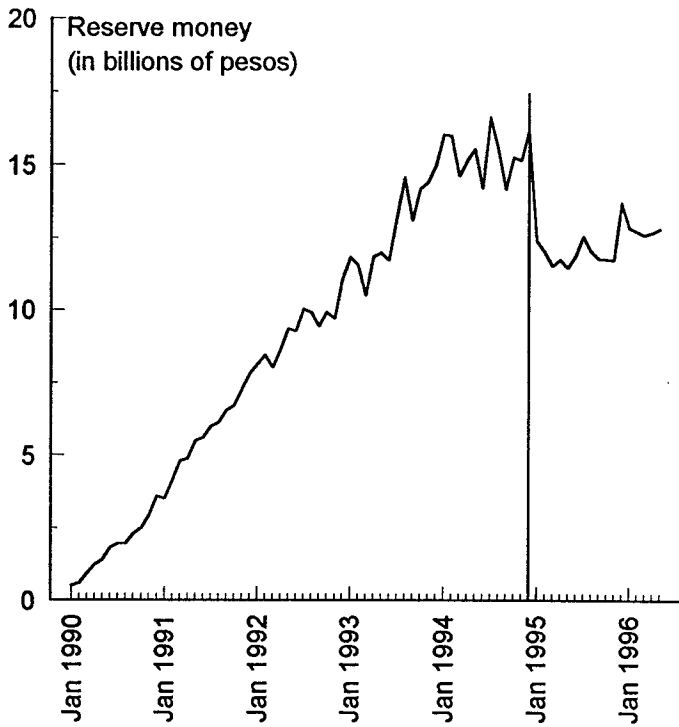
Source: IFS.

1/ The horizontal line corresponds to the Mexican peso crisis (December 1994) .

Of course, whether a crisis would have occurred anyway in 1995, given the large appreciation of the real exchange rate and the consumption-induced deterioration in the external accounts recorded since the adoption of the Convertibility Plan in April 1991, is difficult to say. The logic of the "boom-recession" cycle that often characterizes exchange-rate based stabilization programs would have indeed predicted an eventual recession (Végh, 1992; Agénor and Montiel, 1996, Chapter 10). In part due to high residual inflation (an average of 24.9 percent in 1992 and 10.6 percent in 1993, compared to 171.7 percent in 1991), Argentina's real effective exchange rate based on consumer prices appreciated by nearly 27 percent between April 1991 and December 1994.[4] At the same time, the current account deficit increased from 0.1 percent of GDP in 1991 to 2.8 percent in 1992, 3.1 percent in 1993, and 3.7 percent in 1994—reflecting a sharp increase in consumption and gross domestic investment, the latter rising by more than 5 percentage points of GDP between 1991 and 1994). Nevertheless, several observers have attributed the timing and severity of the economic downturn in Argentina to the contagion or "Tequila" effect—a massive capital outflow (or a reduction in net foreign borrowing) triggered by a loss of confidence of investors in the country's economic prospects, and the perception that the exchange rate regime was about to suffer the same fate as Mexico's.

In a recent paper, Uribe (1996) attempted to formalize the Tequila effect in an intertemporal optimizing model of a small open economy. He assumes that domestic agents learn at a given moment in time (say, $t = 0$) that, at some point in the future (say, $t = T$), foreign investors will liquidate their holdings of domestic assets—in effect imposing a binding borrowing constraint on domestic agents. He considers, in a basic version of his model with constant output, both the case in which T is known with certainty and the case in which T is random. In both cases, at $t = 0$ consumption falls sharply, and capital begins flowing out of the country. The domestic interest rate (under uncertainty) jumps above the world interest rate at $t = 0$, and jumps downward at T. In an extension of his basic model, in which he introduces capital accumulation, Uribe shows that the domestic interest rate remains constant at period $t = 0$ and jumps upward at T—converging slowly afterward to its pre-crisis level. Mimicking the pattern of domestic interest rates, output and investment drop sharply at T. These predictions of the model, he argues, are consistent with the path of output, investment, and real interest rates observed in Argentina in 1995.[5]

---

[4]This estimate is based on calculations made by the International Monetary Fund. It should be noted, however, that estimates of the real effective exchange rate based on wholesale prices and unit labor costs show a significantly lower cumulative appreciation during the same period.

[5]Some recent studies of contagious currency crises are also capable of explaining some features of Argentina's economic misfortunes in 1995; see, for instance, Goldfajn and Valdés (1997), whose study highlights the role of liquidity factors in the spread of exchange market pressures across countries. Eichengreen, Rose and Wyplosz (1996) provide a brief overview of the literature in this area.

This paper offers an alternative formalization of the Tequila effect, based on an intertemporal optimizing model of a small open economy facing imperfect world capital markets. Specifically, domestic individual borrowers are assumed to face an upward-sloping supply curve of credit, with a risk premium that depends positively on the individual's level of debt and a set of exogenous factors, which capture "market sentiment." Domestic agents are assumed to internalize the effect of their marginal borrowing decisions on the marginal cost of funds that they face on world capital markets. In this setting, the Tequila effect is modeled as a temporary increase in the exogenous component of the risk premium faced by domestic borrowers.[6] This interpretation is consistent with the sharp increase in interest rate spreads (relative to US rates) on liabilities issued by private—as well as public—borrowers from Argentina in the immediate aftermath of the Mexican peso crisis (International Monetary Fund, 1996, pp. 112-13). The real and monetary effects of this shock are analyzed by modeling portfolio decisions (namely, the allocation of financial wealth across bank deposits, cash balances, and foreign currency liabilities), real wage rigidity, and the link between bank credit and the supply side through firms' demand for working capital—a key feature of Argentina's financial system.[7]

The remainder of the paper proceeds as follows. The model is presented in Section II, and its dynamic form is derived in Section III. Section IV characterizes the adjustment process to a temporary increase in the autonomous component of the risk premium faced by domestic borrowers on world financial markets. Section V considers some extensions of the analysis, and offers some final remarks.

II. THE FRAMEWORK

Consider a small open economy in which perfect foresight prevails and five types of agents operate: households, producers, commercial banks, the government, and the central bank. The nominal exchange rate is fixed and normalized to unity for simplicity. The economy produces a tradable good using only labor. The price of the good is fixed on world markets, and purchasing power parity holds continuously.[8]

---

[6] Thus, instead of assuming, as done by Uribe, that agents learn today ($t = 0$) that they will forever be unable to borrow from the rest of the world after T, here agents face a transitory increase in the cost of borrowing between period $t = 0$ and T.

[7] As documented for instance by Rojas-Suárez and Weisbrod (1995), banks account for between 50 and 90 percent of the financing needs of firms in Latin American countries. Some recent papers in which the link between firms'working capital needs and bank credit is explicitly considered include Edwards and Végh (1997), Greenwald and Stiglitz (1993), and Isard et al. (1996).

[8] Except otherwise indicated, partial derivatives are denoted by corresponding subscripts, whereas the total derivative of a function of a single argument is denoted by a prime. A sign over a variable refers to the sign of the corresponding partial derivative, and $\dot{x} \equiv dx/dt$. Time subscripts are omitted for simplicity. A '~' is used to denote steady-state values.

A. Producers

Firms must finance their working capital needs prior to the sale of output. They have no direct access to world capital markets, and borrow only from commercial banks.[9] Working capital needs are here assumed to consist solely of labor costs. Total production costs faced by the representative firm are thus equal to the wage bill plus the interest payments made on bank loans needed to pay labor in advance. Formally, the maximization problem faced by the representative firm can be written as

$$\max_{y} \{y - wn - r_L l\},\tag{1}$$

where y denotes output, w the real wage, n the quantity of labor employed, $r_L = i_L - \pi^*$ the real lending rate, given by the difference between i_L, the nominal (contractual) lending rate charged by commercial banks, and the world inflation rate, π^*—which, under the assumption of purchasing power parity, is also the domestic inflation rate. l is the real amount of loans obtained from commercial banks.

The output-employment relationship takes the form

$$n = y^{\beta}, \quad \beta > 1\tag{2}$$

whereas the firm's financial constraint is given by

$$l \geq wn.\tag{3}$$

Constraint (3) will be assumed to be continuously binding, because the only reason for firms to demand loans is to finance labor costs.

Maximizing equation (1) subject to (2) and (3) yields

$$y^s \equiv [1/\beta w(1 + r_L)]^{1/(\beta-1)},\tag{4}$$

which shows that output supply is inversely related to the effective cost of labor, $w(1 + r_L)$. Substituting equation (4) in (2) yields labor demand as

$$n^d = n^d[w(1 + r_L)]. \quad n^{d\prime} < 0\tag{5}$$

Using equations (3) and (5), the firm's demand for credit is given by

$$l^d = wn^d = l^d(\bar{w}, \bar{r_L}).\tag{6}$$

---

[9]For simplicity, it is assumed that there is no substitute for bank loans, so that firms cannot issue equities or bonds (claims on their capital stock) to finance their working capital needs.

Real wages are set according to

$$w = \mathbf{w}(\overset{+}{w_m}, \overset{-}{u}), \tag{7}$$

which shows that wages are positively related to workers' reservation wage w_m (or, more generally, the opportunity cost of effort), and negatively to the unemployment rate u.[10] With labor supply fixed at n^s, the unemployment rate is a direct, negative function of labor demand n^d, so that:

$$w = w(n^d). \quad w' > 0$$

Solving this equation for n^d and equating the result to (5) yields

$$w = \omega(r_L), \quad \omega' < 0 \tag{8}$$

which relates real wages negatively to the lending rate. If wages are not sensitive to unemployment ($\mathbf{w}_u$ and thus $w' \to 0$), of course, $\omega' \to 0$.

In the above setting, an increase in the lending rate has conflicting effects on effective labor costs per worker, $w(1 + r_L)$. On the one hand, it increases directly effective unit labor costs, which tends to reduce output and labor demand. On the other, by reducing labor demand, it raises unemployment and lowers wages, which tends to reduce effective unit labor costs. In what follows it is assumed that the sensitivity of wages to unemployment is not too high, so that the direct effect dominates.[11] Thus, substituting (8) in equations (4) and (6) yields

$$l^d = l^d(r_L), \quad y^s = y^s(r_L). \quad l^{d\prime}, y^{s\prime} < 0 \tag{9}$$

The financial counterpart to firms' bank credit is assumed to consist of domestic cash held outside the banking system ($m_f = l^d$), on which the inflation tax is levied at the rate π^*. Firms do not invest. They transfer their net income, q_f, to their owners, domestic households:

$$q_f = y^s - (1 + r_L)l^d - \pi^* m_f. \tag{10}$$

---

[10] A wage-setting equation like (7) can be derived from a variety of efficiency-wage models—as in the case, for instance, in which firms face turnover costs and the quit rate tends to rise when labor market conditions become more favorable. Alternatively, (7) may also be derived from a setting in which a utility-maximizing trade union operates, and the relative weight attached to employment (as opposed to wages) in the union's objective function increases with the level of unemployment.

[11] Some recent estimates suggest that real wages in Argentina's tradables sector have responded with some degree of downward flexibility to the increase in unemployment in 1995. However, the sensitivity to unemployment of *aggregate* real wages (which account for wage movements in the nontradables sector as well) appears to have been more limited. This is consistent with the assumption that $\mathbf{w}_u$ is relatively small.

B. Households

Households supply labor inelastically, consume the domestic good, and hold two categories of financial assets in their portfolios: domestic cash balances (which bear no interest), and domestic-currency deposits with the banking system. They borrow only from foreign lenders.[12]

The representative household maximizes discounted lifetime utility, given by

$$\int_0^\infty [\frac{c^{1-\eta}}{1-\eta} + \ln m_h]e^{-\rho t}dt, \quad \rho, \eta > 0, \ \eta \neq 1 \tag{11}$$

where ρ denotes the rate of time preference (assumed constant), c consumption expenditure, $\sigma = 1/\eta$ the intertemporal elasticity of substitution in consumption, and m_h real cash balances.[13]

Real wealth of the representative household a is defined as

$$a = m_h + d - l^*, \tag{12}$$

where l^* denotes the real (foreign-currency) value of loans received from foreign lenders, and d the real value of deposits with the banking system. For simplicity, foreign loans are assumed to have an infinite maturity.

The flow budget constraint is given by

$$\dot{a} = q + i_d d - c - \tau - (i^* + \theta)l^* - \pi^* a, \tag{13}$$

where q is total income received from firms and domestic banks, τ the real value of lump-sum taxes, and i_d the deposit interest rate. The term $-\pi^* a$ accounts for capital losses on total financial wealth resulting from inflation. The cost of borrowing on world capital markets $i^* + \theta$ consists of an exogenous, risk-free interest rate i^* and a risk premium θ, which is defined as

$$\theta = \theta(l^*, \alpha), \tag{14}$$

---

[12]The assumption that households do not borrow from domestic banks is consistent with the evidence suggesting that in Argentina (as in many developing countries), the share of private credit allocated to households is relatively small. Using a broad measure of bank credit to the private sector indicates that, for the period June 1993-December 1994, this share is about 0.4. Using a more narrow concept (which excludes overdraft credits, since available data on that category of loans do not distinguish between households and enterprises) gives a figure closer to 0.2 for the same period.

[13]A more general specification would be to enter both cash and bank deposits in the instantaneous utility function, by assuming that both types of assets generate (imperfectly substitutable) liquidity services. This would, however, complicate the analysis without adding much in terms of substance.

where α is a shift factor. Although α may in general capture various household characteristics other than the level of borrowing (such as the composition of the household), it will here be taken to reflect market "sentiment" or "mood" toward the country in question—in effect, a country-specific risk factor that reflects foreign lenders' idiosyncratic perceptions of the country's creditworthiness. The premium is positively related to both l^* and α.[14] The assumption that domestic private agents are able to borrow more on world capital markets only at a higher rate of interest captures the existence of individual default risk. As in the literature on sovereign debt—see for instance Eaton and Fernandez (1995)—the domestic agent's borrowing options are restricted by his or her capacity to repay and the enforceability of international contracts.[15]

Households treat q, i_d, i^*, π^* and τ as given, internalize the effect of their portfolio decisions on the marginal cost of borrowing, and maximize (11) subject to (12), (13) and (14) by choosing a sequence $\{c, m_h, d, l^*\}_{t=0}^{\infty}$. Let $r_d = i_d - \pi^*$ be the real domestic deposit rate, and $r^* = i^* - \pi^*$ the world risk-free real interest rate. The optimality conditions are given by:

$$c^{\eta}/m_h = i_d \;\Rightarrow\; m_h = m_h(\overset{+}{c}, \overset{-}{r_d + \pi^*}),\tag{15}$$

$$r_d = r^* + \theta + l^*\theta_{l^*},\tag{16}$$

$$\dot{c}/c = \sigma(r_d - \rho),\tag{17}$$

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

Equations (15) and (17) are standard conditions in optimizing models of this type. (15) relates the demand for cash positively to consumption and negatively to the bank deposit rate. It is derived by equating the marginal rate of substitution between consumption and real cash balances to the opportunity cost of holding cash, the

---

[14]It is also plausible to assume that the premium is convex in l^* (so that $\theta_{l^*l^*} > 0$), that the cross-derivative $\theta_{l^*\alpha}$ is positive, and that for l^* sufficiently high a binding borrowing constraint is eventually reached. In what follows it is assumed that the economy operates on the upward-sloping portion of the supply curve of funds, rathen than at any absolute borrowing ceiling, and that θ is continuously differentiable in that range.

[15]See Agénor (1997) for a more detailed discussion. The assumption that the (household-specific) premium depends positively on the agent's level of debt—rather than the economy's total debt—leads naturally to the assumption that agents internalize the effect of their borrowing decisions on θ, as discussed below.

nominal deposit rate. Equation (17) is the Euler equation, which shows that total consumption rises or falls depending on whether the real deposit rate exceeds or falls below the rate of time preference. The size of the intertemporal elasticity of substitution σ determines the extent to which households adjust their consumption profile in response to changes in the differential between the rate of time preference and the real deposit rate—which measures the rate of return on saving.

Equation (16) is the arbitrage condition that holds under the assumption of imperfect world capital markets. To understand its derivation, consider first the case in which households face no risk premium on world capital markets ($\theta = 0$). In that case, interest rate arbitrage requires $r_d = r^*$. Suppose, for instance, that $r_d > r^*$; households would then borrow unlimited amounts of funds on world capital markets and reap a net profit by depositing these funds in domestic banks. On the contrary, with $r_d < r^*$, a corner solution would obtain, with no borrowing abroad. Equilibrium (which implies an indeterminate level of foreign borrowing) would therefore require equality between the marginal return and the marginal cost of funds.

Now suppose that, as assumed above, the premium rises with the level of debt. Optimality requires, as before, that households borrow up to the point where the marginal return and the marginal cost of borrowing are equalized. Here, however, although the marginal return is again equal to the bank deposit rate, the real marginal cost of borrowing is given by $r^* + \theta$ plus the increase in the cost of servicing the existing stock of loans induced by the marginal increase in the risk premium (itself resulting from the marginal increase in borrowing), $l^*\theta_{l^*}$—as stated by equation (16).[16]

The arbitrage condition (16) determines implicitly the demand for foreign loans. Taking a linear approximation to θ yields

$$l^* = (r_d - r^* - \theta_\alpha \alpha)/\gamma, \tag{18}$$

where $\gamma = 2\theta_{l^*} > 0$. Equation (18) shows that the optimal level of foreign borrowing is positively related to the difference between the domestic deposit rate and the exogenous component of the cost of borrowing on world capital markets, given by the sum of the safe interest rate and the autonomous component of the risk premium.

Using equations (12), (15) and (18), the demand for bank deposits can be derived as

$$d = a + l^* - m_h = \Phi(\bar{c}, \overset{+}{r_d}, \overset{+}{a}; \bar{\alpha}), \tag{19}$$

---

[16]Note that if individuals faced a risk premium on foreign loans that does not depend on their own level of debt, the cost of borrowing would be equal to $i^* + \theta$.

where

$$\Phi_c = -m_{hc}, \quad \Phi_{r_d} = \gamma^{-1} - m_{hr_d}, \quad \Phi_a = 1, \quad \Phi_\alpha = -\theta_\alpha/\gamma.$$

Equation (19) indicates that the demand for bank deposits depends positively on the domestic deposit rate and net financial wealth, and negatively on consumption and the autonomous component of the risk premium.

C. Commercial Banks

Assets of commercial banks consist of credit extended to domestic firms l^s, and reserves held at the central bank, RR; for simplicity, banks hold no excess reserves. Bank liabilities consist of deposits held by households. Assuming that banks have no net worth, their balance sheet can be written as

$$d = l^s + RR. \tag{20}$$

Reserves held at the central bank do not pay interest and are determined by

$$RR = \mu d, \quad 0 < \mu < 1 \tag{21}$$

where μ is the coefficient of reserve requirements.

The actual level of deposits held by the private sector is demand determined and, from equations (20) and (21), the supply of credit is given by

$$l^s = (1 - \mu)d. \tag{22}$$

Banks have no operating costs. Under a zero-net-profit condition, the lending rate is determined by

$$r_L = r_d/(1 - \mu). \tag{23}$$

From (19) and (22), the supply of credit can be written as

$$l^s = l^s(\bar{c}, \overset{+}{r_d}, \overset{+}{a}; \bar{\alpha}), \tag{24}$$

where $l^s_x = (1 - \mu)\Phi_x$, with $x = c, i_d, a, \alpha$.

Finally, since banks do not accumulate assets, net revenue transferred to households is given by

$$q_b = (1 + r_L)l^s - r_d d - \pi^* RR,$$ (25)

where the term $\pi^* RR$ measures the inflation tax paid on required reserves.

D. The Central Bank and the Government

The only function of the central bank is to ensure the costless conversion of domestic currency holdings into foreign currency, at the prevailing exchange rate. The central bank does not extend credit; its balance sheet is thus given by

$$R^* = m + RR,$$ (26)

where $m \equiv m_f + m_h$ denotes total cash balances held by private agents and R^* the central bank's net stock of foreign assets, measured in foreign currency terms. Real Interest on the central bank's holdings of foreign assets, $r^* R^*$, is transferred to the government.

In addition to transfers from the central bank, the government levies lump-sum taxes on households and collects the inflation tax on cash balances and required reserves. It consumes the domestic good, in quantity g. The budget constraint of the government is thus

$$g - \tau = r^* R^* + \pi^* (m + RR).$$

Assuming that the government maintains a balanced budget by adjusting lump-sum taxes yields

$$\tau = g - i^* R^*.$$ (27)

E. Equilibrium of the Credit Market

To close the model requires specifying the equilibrium conditions of the currency and credit markets. By Walras' Law, these two conditions are not independent; here I shall focus on the equilibrium condition of the credit market. This condition is given by, using (9) and (24):

$$l^s(c, r_d, a; \alpha) = l^d(r_L). \tag{28}$$

Using (23), the above equation can be solved for the equilibrium bank lending rate:

$$r_L = r_L(\overset{+}{c}, \overset{-}{a}; \overset{+}{\alpha}), \tag{29}$$

where $\partial r_L / \partial x = -\Omega^{-1}\Phi_x$, with $x = c, a, \alpha$, and

$$\Omega = (1 - \mu)\Phi_{r_d} - \frac{l^{d\prime}}{1 - \mu} > 0.$$

Equation (29) shows that the equilibrium real lending rate depends positively on consumption and the autonomous component of the risk premium, and negatively on the household's net financial wealth. An increase in α, for instance, lowers bank deposits and reduces the supply of credit, requiring an increase in domestic interest rates to maintain equilibrium of the credit market.

Substituting (23) and (29) in (19), the demand for bank deposits can be written as

$$d = d(\overset{-}{c}, \overset{+}{a}; \overset{-}{\alpha}), \tag{30}$$

where

$$d_x = [1 - (1 - \mu)\Phi_{r_d}/\Omega]\Phi_x, \quad \text{with } x = c, a, \alpha,$$

and $(1 - \mu)\Phi_{r_d}/\Omega$ less than unity.

III. DYNAMIC STRUCTURE AND STEADY STATE

To characterize the dynamic structure of the model, the first step is to note that from equation (26), $m = R^* - m_f - RR$. This result implies that, using (21) and (22) and noting that $m_f = l$:

$$m_h = R^* - (1 - \mu)d - \mu d = R^* - d.$$

Substituting this expression for m_h in equation (12) yields

$$D^* = -a = l^* - R^*, \tag{31}$$

which shows that, because the central bank does not accumulate assets and the government maintains a continuously balanced budget, the private sector's net financial liabilities are equal to the economy's net stock of foreign debt, D^*.

Substituting the government budget constraint (27) in equation (13) yields

$$\dot{D}^* = c + g + i^* D^* + \theta l^* - q - i_d d - \pi^* D^*,$$

with $q = q_f + q_b$. Using the banks' zero-net-profit condition (which implies that $r_d d - r_L l^s = 0$) together with (10) and (25) yields an expression for q, which can be substituted in the above equation to give

$$\dot{D}^* = c + g + r^* D^* + \theta(l^*, \alpha) l^* - y^s. \tag{32}$$

Equation (32) represents the consolidated flow budget constraint of the economy.[17]

Equations (18) and (29) yield

$$l^* = [(1 - \mu) r_L(c, D^*; \alpha) - r^* - \theta_\alpha \alpha]/\gamma,$$

which can be written as

$$l^* = \lambda(\overset{+}{c}, \overset{+}{D^*}; \bar{\alpha}), \tag{33}$$

where

$$\lambda_x = \gamma^{-1}[(1 - \mu)\partial r_L/\partial x] = -(1 - \mu)\Phi_x/\gamma\Omega, \text{ with } x = c, D^*$$

$$\lambda_\alpha = \gamma^{-1}[(1 - \mu)\partial r_L/\partial \alpha - \theta_\alpha],$$

so that

---

[17]Integrating equation (32) yields the economy's intertemporal budget constraint

$$D_0^* = \int_0^\infty (y^s - c - g - \theta l^*) e^{-\int_0^t r_h^* dh} dt + \lim_{t \to \infty} D^* e^{-\int_0^t r_h^* dh}.$$

The economy must eventually repay all its debt to foreign creditors, so the second term on the left-hand side in the above expression must be zero. Thus, the current level of debt must be equal to the discounted stream of the excess of future production over domestic absorption plus premium-related interest payments on private foreign borrowing.

$$\lambda_\alpha = \frac{\theta_\alpha}{\gamma\Omega} \left\{ (1 - \mu)m_{hr_d} + \frac{l^{d\prime}}{1 - \mu} \right\}.$$

Equation (33) shows, in particular, that the net effect of an increase in α (despite its indirect, positive effect on domestic interest rates) is a reduction in the demand for foreign loans.

Equations (17), (23), (29), (30), (32) and (33) describe the evolution of the economy along any perfect foresight equilibrium path. These equations can be summarized as follows:

$$l^* = \lambda(c, D^*; \alpha), \quad d = d(c, D^*; \alpha), \tag{34}$$

$$\dot{c}/c = \sigma[(1 - \mu)r_L(c, D^*; \alpha) - \pi^* - \rho], \tag{35}$$

$$\dot{D}^* = c + g + r^*D^* + \theta[\lambda(\cdot), \alpha)]\lambda(\cdot) - y^s[r_L(c, D^*; \alpha)], \tag{36}$$

with $d_{D^*} = -d_a < 0$, and equation (27) determining residually lump-sum taxes.

Equations (35) and (36) form a dynamic system in consumption c, which may jump in response to new information, and net external debt D^*, which can change only gradually. This system can be written as

$$\dot{c} = G(\overset{+}{c}, \overset{+}{D^*}; \overset{+}{\alpha}). \tag{37}$$

$$\dot{D}^* = \Psi(\overset{+}{c}, \overset{+}{D^*}; \overset{?}{\alpha}) + g, \tag{38}$$

where

$$\Psi_c = 1 + (\tilde{\theta} + \tilde{l}^*\theta_{l^*})\lambda_c - y^{s\prime}\frac{\partial r_L}{\partial c}, \quad \Psi_{D^*} = r^* + (\tilde{\theta} + \tilde{l}^*\theta_{l^*})\lambda_{D^*} - y^{s\prime}\frac{\partial r_L}{\partial D^*},$$

$$\Psi_\alpha = \tilde{l}^*\theta_\alpha + (\tilde{\theta} + \tilde{l}^*\theta_{l^*})\lambda_\alpha - y^{s\prime}\frac{\partial r_L}{\partial \alpha}.$$

Equation (38) shows that, in general, the net effect of an increase in the autonomous component of the risk premium on the current account deficit is ambiguous. The net effect can be decomposed into:

- A *portfolio effect*, which results from the fact that the increase in α lowers directly (at the initial level of the premium) the demand for foreign loans by domestic households. This is measured by the term $\tilde{\theta}\lambda_\alpha$, and tends to reduce the current account deficit.

- A *composite income effect*, which operates through two channels. First, an increase in α raises directly the premium, and increases interest payments on the existing stock of foreign debt held by the private sector. This is measured by the term $\tilde{l}^*\theta_\alpha$, which tends to increase the current account deficit. Second, the direct reduction in private foreign borrowing induced by the rise in α lowers also the premium, at the initial level of debt. This is measured by the term $\tilde{l}^*\theta_{l^*}\lambda_\alpha$, which tends to reduce the current account deficit. Thus, the composite income effect has an ambiguous effect on the current account.

- A *supply-side effect*, which is due to the fact that the increase in α raises the lending rate (by reducing the supply of bank deposits and thus the supply of credit), and lowers output. This effect is captured by the term $y^{s\prime}(\partial r_L/\partial\alpha)$, and tends to increase the current account deficit.

The fact that the composite income effect is ambiguous implies that the net effect of a change in α on the premium-related debt service payments by the private sector θl^*—given by $\tilde{l}^*\theta_\alpha + (\tilde{l}^*\theta_{l^*} + \tilde{\theta})\lambda_\alpha$—cannot be determined a priori. In what follows, it will be assumed that the sum of all three effects is such that the current account deteriorates, that is, $\Psi_\alpha > 0$. As shown in the Appendix, a sufficient (although not necessary) condition for this inequality to hold is that the elasticity of the demand for foreign loans with respect to α be less (in absolute terms) than the elasticity of the premium with respect to α. In turn, this condition ensures that an increase in α raises premium-related debt service payments by households $(\partial(\theta l^*)/\partial\alpha > 0)$, or equivalently that the sum of the portfolio and income effects is positive.

Linearizing equations (37) and (38) around the initial steady state gives

$$\begin{bmatrix} \dot{c} \\ \dot{D}^* \end{bmatrix} = \begin{bmatrix} G_c & G_{D^*} \\ \Psi_c & \Psi_{D^*} \end{bmatrix} \begin{bmatrix} c - \tilde{c} \\ D^* - \tilde{D}^* \end{bmatrix}. \tag{39}$$

Saddlepath stability requires one unstable (positive) root. To ensure that this condition holds, the determinant of the matrix of coefficients in (39) must be negative: $G_c\Psi_{D^*} - G_{D^*}\Psi_c < 0$. This condition is interpreted graphically below.

A key feature of the above model is the assumption that the central bank does not engage in sterilized intervention.[18] As a result, although net external debt evolves only gradually over time, both official reserves and private foreign borrowing may shift discretely in response to changes in domestic or foreign interest rates. Discrete changes in private borrowing must nevertheless be accompanied by an offsetting movement (at the official exchange rate) in the stock of foreign reserves held by the central bank, in order to leave net external debt D^* constant on impact.

The steady-state solution is obtained by setting $\dot{c} = \dot{D}^* = 0$. From equation (35), the real deposit rate must be equal to the rate of time preference:

$$\tilde{r}_d = \tilde{i}_d - \pi^* = \rho. \tag{40}$$

Substituting this result in (18) yields

$$\tilde{l}^* = [\rho - (r^* + \theta_\alpha \alpha)]/\gamma, \tag{41}$$

which indicates that the steady-state level of foreign borrowing is positive as long as $\rho > r^* + \theta_\alpha \alpha$. Put differently, as long as the rate of time preference of domestic households exceeds the exogenous component of the real effective cost of foreign borrowing (that is, if domestic agents value the future sufficiently), domestic agents will be net debtors in the long run.

Equations (9) and (23) yield

$$\tilde{l}^d = l^d \left(\frac{\rho}{1-\mu}\right), \quad \tilde{y}^s = y^s \left(\frac{\rho}{1-\mu}\right), \tag{42}$$

which show that in this setting—taking labor supply and other determinants of the wage-setting equation (7) as exogenous—output supply and firms' demand for credit are invariant to shocks other than changes in the rate of time preference or reserve requirements.

From equation (36), the current account must be in equilibrium:

$$\tilde{y}^s - \tilde{c} - g = r^* D^* + \tilde{\theta} \tilde{l}^*. \tag{43}$$

Finally, from (15) and (40), real cash balances held by households are given by

$$\tilde{m}_h = m_h(\tilde{c}, \rho + \pi^*). \tag{44}$$

---

[18]As noted by Uribe (1996, p. 6), the Central Bank of Argentina engaged in massive sterilization operations in March 1995, after the crisis erupted. However, intervention was not sterilized in the first two months of that year. A large fall in the monetary base occurred during that period, as documented in Figure 1.

The steady-state equilibrium of the model is depicted in Figure 2. The locus $[\dot{D}^* = 0]$ gives the combinations of c and D^* for which net external debt (measured in foreign-currency terms) remains constant, whereas the locus $[\dot{c} = 0]$ depicts the combinations of c and D^* for which consumption does not change over time. Points above the $[\dot{D}^* = 0]$ curve correspond to situations of current account deficits (with the stock of debt increasing), whereas points below the curve represent surpluses (and the level of debt is falling). Points located to the left of the $[\dot{c} = 0]$ curve represent situations in which the domestic real deposit rate is lower than the rate of time preference, and consumption is falling. Conversely, points located to the right of the $[\dot{c} = 0]$ curve represent situations in which consumption is rising. Saddlepath stability requires that the $[\dot{c} = 0]$ curve be steeper than the $[\dot{D}^* = 0]$ curve. The saddlepath SS has a negative slope (as formally established in the Appendix) and defines the only convergent path to the steady-state equilibrium (obtained at point E).

IV. INCREASE IN THE RISK PREMIUM

As indicated earlier, the Tequila effect can be modeled in the above setting as a temporary increase in the autonomous component of the risk premium that domestic private borrowers face on world capital markets, that is, an increase in α, which captures a sudden change (unrelated to fundamentals) in market sentiment about the economy's prospects. Specifically, it is assumed that the perceived degree of country risk, as measured by α, increases at $t = 0$ but returns to its initial value at a future date T.

To understand the dynamics associated with a temporary increase in α, consider first the long-run effects associated with a permanent shock. As can be inferred directly from equation (41), net private borrowing on world capital markets falls. The nominal deposit rate remains constant at $\rho + \pi^*$ and the lending rate remains also constant. From (42), output therefore does not change, and neither does the demand for credit by firms. The supply of credit (from (28)) and bank deposits (from (22)) are also unaffected.

Despite the reduction in private foreign indebtedness, the increase in the premium (as assumed above) is sufficiently large to ensure that interest payments abroad increase and thus that the services account deteriorates. Maintaining current account equilibrium therefore requires an improvement in the trade balance. And because output does not change, consumption must fall. Households' real cash balances therefore also fall. But because the demand for credit by domestic firms—and thus firms' holdings of cash—remain constant, the fall in households' holdings of domestic currency must be accompanied by a reduction in official reserves. The overall effect on the economy's net external debt (the difference between private foreign debt and foreign

Figure 2
Steady-State Equilibrium
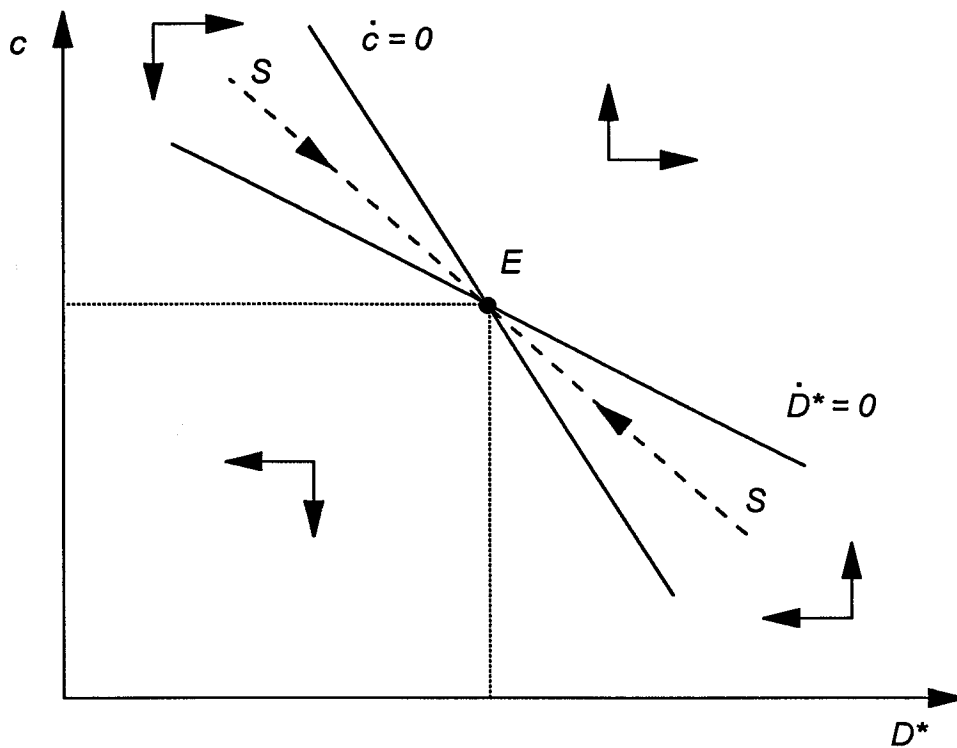
assets held by the central bank) is nevertheless negative.[19] Graphically, as illustrated in Figure 3, both the $[\dot{c} = 0]$ locus and the $[\dot{D}^* = 0]$ locus shift to the left. Point E' is the equilibrium position at which the economy would settle if the increase in α were permanent, with a lower level of consumption and lower external debt.

On impact, foreign borrowing by the private sector falls. The discrete reduction in private foreign borrowing is accompanied by an offsetting reduction in official reserves, because the economy's total debt can change only gradually. The reduction in the central bank's net foreign assets tends to reduce the money supply. But at the initial level of consumption and interest rates (that is, at the initial level of cash balances held by the household), the reduction in private foreign borrowing induces the household to decrease his or her demand for bank deposits. The reduction in deposits lowers the supply of credit, thereby requiring an increase in the domestic lending rate (which reduces firms' demand for loans) to maintain equilibrium of the credit market. The increase in the real interest rate creates an incentive for the household to shift consumption toward the future, so that consumption falls on impact.[20] Output also falls on impact, because the increase in the lending rate translates into a rise—despite a reduction in wages—in the effective price of labor. The reduction in output and labor demand on impact raises unemployment.[21]

Whether the trade balance (which, in the initial equilibrium, is characterized by a surplus equal to net interest income payments on the economy's external debt) improves or not depends on how much consumption falls relative to output. At the same time, although private foreign borrowing falls, the net effect of an increase in α on the services account is a rise in interest payments by the household to foreign creditors (as assumed earlier) and therefore an increase in the deficit of the services account.[22]

---

[19] It can be shown that, although the reduction in net foreign indebtedness lowers debt service payments at the risk-free rate, the services account always deteriorates—thereby ensuring that in the long run the trade balance improves and consumption falls, as indicated above.

[20] Note that here, since the household is a net debtor in the initial steady state, wealth and intertemporal effects operate in the same direction. On the one hand, the increase in the premium encourages agents to save more (and consume less) today, since the cost of foreign borrowing has risen (the intertemporal substitution effect). On the other, the increase in the cost of borrowing leads the household to expect a net increase in debt service (despite the reduction in the demand for foreign loans) in the long run, thereby reducing permanent income, lowering private expenditure and increasing saving today (the wealth effect). Consumption falls as a result of both effects.

[21] As shown in the Appendix, the fall in consumption (by reducing the demand for cash balances) tends to increase the demand for bank deposits, which in turn puts downward pressure on the domestic lending rate. If the degree of intertemporal substitution is not too high—a reasonable assumption in light of the evidence, as discussed by Reinhart and Végh (1995)—the impact effect on consumption will be limited and the demand for bank deposits will unambiguously fall. The reduction in credit supply will therefore require (as assumed above) an increase in the lending rate to maintain credit market equilibrium and eliminate the excess demand for loans at the initial interest rate.

[22] Remember that the economy's stock of foreign debt does not change on impact; thus, the increase in debt service refers only to the premium-related component.

Figure 3
Temporary Increase in the Risk Premium
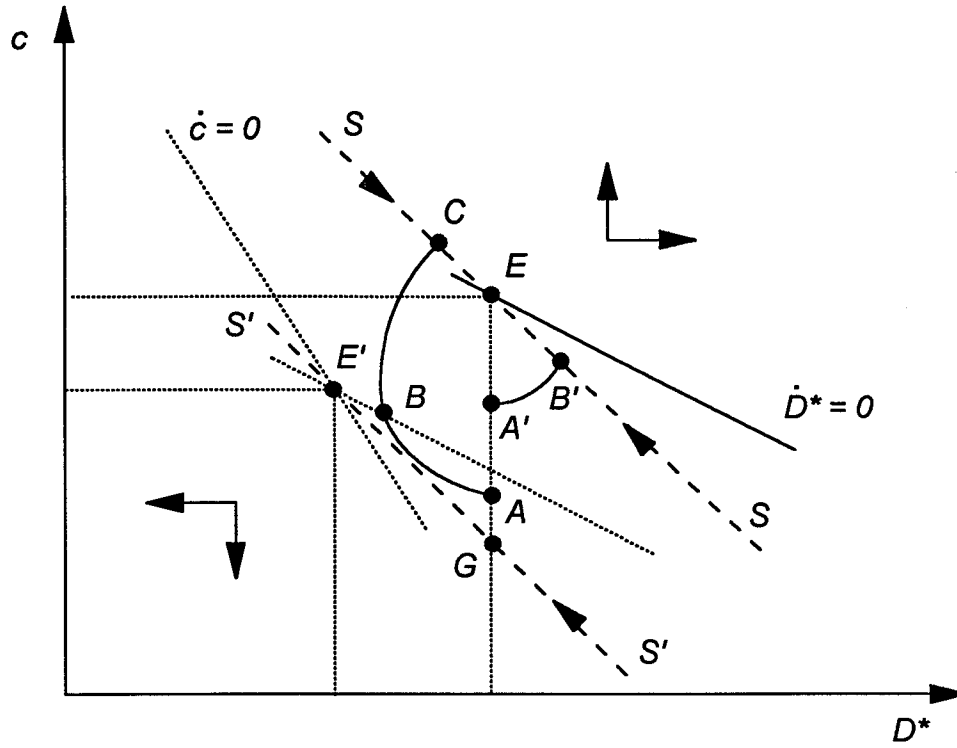
With a permanent shock, the net effect is a current account surplus on impact $(\dot{D}^* < 0)$, which implies that the reduction in consumption is not only large enough to generate an improvement in the trade balance, but also a trade surplus that is sufficiently large to outweigh the effect of the deterioration in the services account on the current account balance. Graphically, consumption would jump downward from point E to point G, located on the new saddlepath.

With a temporary shock, however, although consumption also falls on impact, the net effect on the current account remains ambiguous and depends on the duration of the shock, T. The dynamics of a temporary shock are also illustrated in Figure 3. Consider first the case in which the period of time T during which the autonomous component of the risk premium increases is sufficiently large. Given that the shock is temporary, the optimal "smoothing response" is such that consumption falls initially (from E to a point such as A) by less than it would if the shock was permanent. As in the case of a permanent shock, despite the deterioration in the services account and the fall in output, the reduction in consumption is large enough to ensure that the economy generates trade and current account surpluses on impact $(\dot{D}^* < 0)$. During the first phase of the transition period, consumption begins rising (toward $S'S'$) after the initial downward jump, the current account remains in surplus, and the economy reduces its net external debt. However, as time goes by, the expected future reversal of the shock becomes gradually more important in consumption decisions, and agents at some point during the transition begin to reduce the rate of change of expenditure. Formally, this occurs at the point in which the path of the system crosses the $[\dot{D}^* = 0]$ curve corresponding to the long-run equilibrium point E', that is, at point B, where the current account is in equilibrium. After that point, consumption continues to rise, and the current account moves into deficit $(\dot{D}^* > 0)$. The saddlepath SS corresponding to the original equilibrium position is reached exactly at T (point C). After that point, consumption begins falling, and the current account continues to deteriorate (and external debt to increase), until the economy returns to its original equilibrium position at point E.

During the first phase of the transition period, with consumption increasing and net external debt falling, bank deposits are increasing, credit supply is rising, and the bank lending rate is falling.[23] Foreign borrowing by the private sector is therefore falling, so that the economy is registering net capital outflows. Domestic cash balances are rising, as well as official reserves held by the central bank. In the second phase of the transition (between points B and C), with consumption rising and the stock of debt increasing, the domestic lending rate is also rising, and private foreign borrowing begins to increase. At period T (with consumption beginning to fall and net external debt continuing to increase), both the bank lending rate and private foreign borrowing fall

---

[23]The ensuing discussion assumes that the degree of intertemporal substitution, and thus the initial impact of the shock on consumption, is not too large.

discretely. By contrast, real cash balances (and thus official reserves) jump upward. The path of output mirrors the adjustment path of the lending rate. Figure 4 illustrates the adjustment path of the main variables of the economy.

Consider now the case in which the length of time T during which the premium increases is relatively short. In contrast to the previous case, a temporary rise in α will be accompanied by an initial deficit in the current account—induced by a deterioration in the trade balance (resulting itself from a fall in output and limited adjustment in consumption) and a deterioration in the services account. This deficit will persist as long as the shock lasts, followed by a subsequent improvement (in line with consumption) toward the original steady state. This adjustment path is labeled $E A' B'$ in the figure. Intuitively, a fairly short temporary shock generates little incentives for private agents to engage in intertemporal substitution; as a result, initial consumption does not adjust by much and, because output falls, there is a tendency for the trade balance to deteriorate—thereby compounding the adverse effect of the increase in the exogenous component of the risk premium on the services account. The deterioration in external accounts is not, however, consistent with Argentina's experience described earlier; in the context of the present model this would tend to suggest that the reduction in the risk premium was perceived by domestic agents, in that particular case, to be of a sufficiently long duration, as illustrated by the path $EABC$.

V. SUMMARY AND CONCLUSIONS

This paper has used an intertemporal optimizing framework to examine the macroeconomic effects of a temporary increase in the risk premium that individual borrowers face on world capital markets. The model's specification is based on the (now standard) assumption that only changes in intertemporal relative prices (that is, the real interest rate) are associated with a reallocation of private expenditure between periods. The financial sector and the supply side of the economy are linked via firms' working capital needs—namely, the need to finance labor costs prior to the sale of output. The Tequila effect is then modeled as a temporary increase in the autonomous component of the risk premium that domestic private borrowers must pay (above the "safe" lending rate) on world capital markets. The short-run dynamics of the model were shown to depend on the degree of intertemporal substitution in consumption and the duration of the shock. Under the assumptions that the degree of intertemporal substitution was not too large, and that the shock was perceived to be of a sufficiently long duration, the model was shown to be capable of reproducing some of the main features of Argentina's economic downturn in 1995, as documented in the introduction: an increase in domestic interest rates, a reduction in foreign borrowing (or, equivalently, an increase in net capital outflows), a sharp drop in official reserves and the monetary

Figure 4

Adjustment Path to a Temporary Increase in the Risk Premium
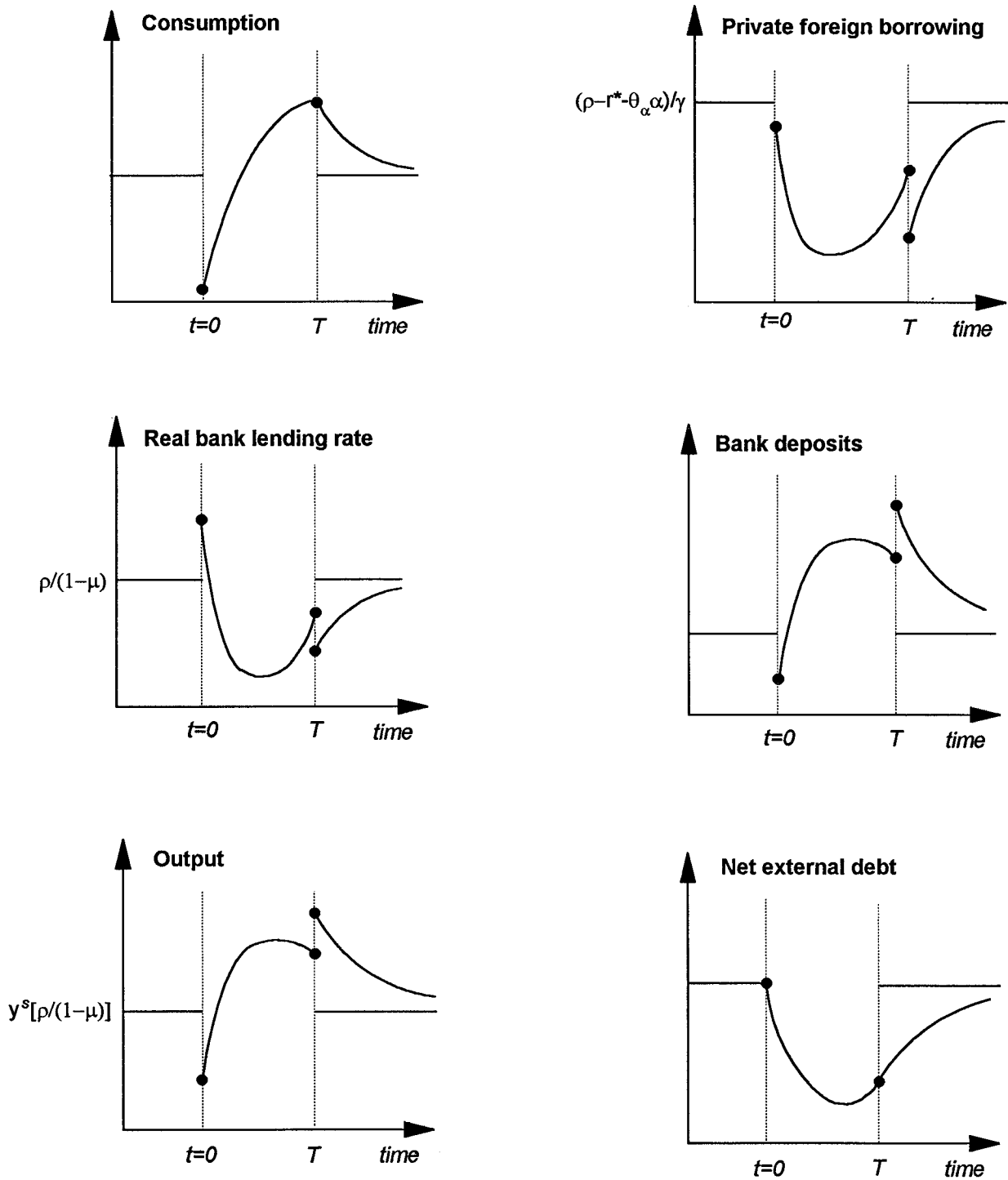
base, a reduction in bank credit, a contraction in output, an increase in unemployment, a fall in consumption, and an improvement in external accounts.[24]

The analysis could be extended in several directions. The model presented in this paper does not capture the collapse in investment that characterized Argentina's recent experience in the aftermath of the Mexican peso crisis. In part for tractability, the capital stock was assumed fixed within the time frame of the analysis. However, it is intuitively clear that introducing capital accumulation might not affect some of the qualitative features of the transmission mechanism highlighted here, if it assumed that firms also borrow at a premium on world capital markets to finance their investment plans.

More debatable assumptions, perhaps, are those of a competitive credit market and of a constant financial intermediation spread. As documented by several observers, the spread between domestic lending and deposit rates (measured in both peso and dollar terms) increased sharply at the inception of the crisis in Argentina. Such an increase cannot be rationalized in the present setting; to do so requires accounting for imperfections on domestic credit markets.[25] One line of investigation, developed by Agénor and Aizenman (1997), is to assume that domestic banks borrow at a premium on world capital markets, and that domestic producers (whose demand for credit also results from working capital needs) borrow at a premium from domestic banks. In such a setting, financial intermediation spreads are determined by a markup that compensates for the expected cost of contract enforcement and state verification, and for the expected revenue lost in adverse states of nature. A contagious shock, viewed as an increase in the volatility of aggregate shocks impinging on the domestic economy, increases financial spreads as well as the producers' cost of capital, resulting in lower output, lower employment, and higher incidence of default.[26]

---

[24]In the case of Argentina, the shift in market sentiment prior to the economic downturn may have been influenced by the behavior of fundamentals. As noted in the Introduction, the real real exchange rate appreciated and the current account deficit increased between 1991 and 1994, raising concerns about external sustainability. In addition, the overall public sector deficit increased in the second half of 1994 (amounting to 1.8 percent of GDP for the year as a whole, compared to a deficit of 0.2 percent in 1993), with a possible adverse effect on the perceived degree of default risk. Since the model is of the one-good variety and the government budget is assumed to be continuously balanced, these factors cannot be explicitly accounted for.

[25]The assumption, in the model, that the only determinant of the spread is the reserve requirement rate is not supported by the evidence for Argentina. Reserve requirements were tightened between 1993 and 1994, and sharply lowered during the crisis. It should be noted, however, that the purpose of the analysis is only to understand the sources of the economic downturn, not to explain the policy reaction that ensued.

[26]In addition, Agénor and Aizenman interpret contagion effects as a perceived increase (triggered by events occurring elsewhere) in the volatility of aggregate shocks impinging on the domestic economy. Higher volatility of producers' productivity shocks increases both financial spreads and the producers' cost of capital, resulting in lower employment and higher incidence of default.

Another line of investigation—which appears to be consistent with some of the evidence for Argentina—would be to introduce credit rationing of the Stiglitz-Weiss variety (see Jaffee and Stiglitz, 1990).[27] In that regard, a potentially useful approach might to consider the extension of the Stiglitz-Weiss model provided by Milde and Riley (1988), who assume that agents can choose the size of the loan they wish to borrow. In their framework, borrowers use the loan size to signal their characteristics to banks. The result is that the more the agent borrows, the higher the interest rate that he or she faces. Beyond a certain level of debt, credit rationing occurs: the agent is unable to obtain additional loans, at any interest rate. Thus, the Milde-Riley analysis suggests, as in the approach to individual default risk that underlies the analysis presented here, that there may exist a significant range of debt levels over which imperfect capital markets lead to a non-decreasing interest rate schedule. Incorporating the Milde-Riley approach into the intertemporal macroeconomic model developed in this paper would make the analysis of capital market imperfections more symmetric and could alter the transmission mechanism of an adverse shift in market sentiment on the real and financial sides of the economy. However, the extent to which the main qualitative implications of the present analysis are affected remains to be established.

---

[27]For an attempt to dwell on the Stiglitz-Weiss approach to explain the credit crunch in Argentina, see Kaufman (1996). In this interpretation, the increase in interest rates that occurred at the beginning of 1995 led to a rise in the share of insolvent (as well as, in practice, illiquid) borrowers among banks' potential customers and, by making it more difficult to distinguish between borrowers with high credit risk from "safe" ones, exacerbated adverse selection problems. Kaufman's analysis does not, however, identify the factors leading to the increase in domestic interest rates in the first place.

Appendix

A sufficient (although not necessary) condition for $\Psi_\alpha > 0$ is

$$\partial(\theta l^*)/\partial\alpha = \tilde{l}^*\theta_\alpha + (\tilde{\theta} + \tilde{l}^*\theta_{l^*})l^*_\alpha > 0,$$

where $l^*_\alpha = \lambda_\alpha$. The term on the right-hand side, multiplied by $\alpha/\tilde{\theta}\tilde{l}^*$, can be written as

$$\frac{\alpha\theta_\alpha}{\tilde{\theta}} + \left(\frac{\alpha l^*_\alpha}{\tilde{l}^*}\right)\left(1 + \frac{\tilde{l}^*\theta_{l^*}}{\tilde{\theta}}\right) > 0.$$

Let $\eta_{z/x} = |(dz/z)/(dx/x)|$ denote (the absolute value of) the elasticity of z with respect to x. The above condition can be written as

$$\eta_{l^*/\alpha} < \eta_{\theta/\alpha}, \tag{A1}$$

where $\eta_{\theta/\alpha} = \eta_{\theta/\alpha}\big|_{l^*=\tilde{l}^*} - \eta_{\theta/l^*}\eta_{l^*/\alpha}$, and $\eta_{\theta/\alpha}\big|_{l^*=\tilde{l}^*} = \alpha\theta_\alpha/\tilde{\theta}$.

To establish the impact and steady-state effects of an increase in α, note that the saddlepath of the economy is given by

$$c - \tilde{c} = \kappa(D^* - \tilde{D}^*), \tag{A2}$$

where $\kappa \equiv (\nu - \Psi_{D^*})/\Psi_c = G_{D^*}/(\nu - G_c) < 0$ and ν denotes the negative root of the system.

As assumed in the text, $\Psi_\alpha > 0$. From (39):

$$d\tilde{c}/d\alpha = (\Psi_\alpha G_{D^*} - \Psi_{D^*}G_\alpha)/\Omega, \tag{A3}$$

$$d\tilde{D}^*/d\alpha = (\Psi_c G_\alpha - G_c\Psi_\alpha)/\Omega, \tag{A4}$$

where $\Omega = G_c\Psi_{D^*} - G_{D^*}\Psi_c < 0$. For $d\tilde{c}/d\alpha < 0$, it must be that

$$\Psi_\alpha/\Psi_{D^*} > G_\alpha/G_{D^*} = (\partial r_L/\partial\alpha)/(\partial r_L/\partial D^*) = \theta_\alpha/\gamma.$$

Equivalently, given the definitions of Ψ_α and Ψ_{D^*}:

$$\tilde{l}^*\theta_\alpha + (\tilde{\theta} + \tilde{l}^*\theta_{l^*})\lambda_\alpha - y^{s\prime}\frac{\partial r_L}{\partial \alpha} > \frac{\theta_\alpha}{\gamma}\left[r^* + (\tilde{\theta} + \tilde{l}^*\theta_{l^*})\lambda_{D^*} - y^{s\prime}\frac{\partial r_L}{\partial D^*}\right],$$

Let $\beta = 1/\gamma\Omega$ and $\Lambda = \tilde{\theta} + \tilde{l}^*\theta_{l^*}$. Because $\lambda_{D^*} = -(1-\mu)\Phi_{D^*}/\gamma\Omega = (1-\mu)\beta$, $\partial r_L/\partial\alpha = \theta_\alpha\beta$, and $\lambda_\alpha = \theta_\alpha[(1-\mu)\beta - 1]/\gamma$:

$$\tilde{l}^*\theta_\alpha + \tilde{l}^*\theta_\alpha\left\{\Lambda((1-\mu)\beta - 1)/\gamma - \beta y^{s\prime}\right\} > \frac{\theta_\alpha}{\gamma}\left[r^* + (1-\mu)\beta\Lambda - y^{s\prime}\frac{\partial r_L}{\partial D^*}\right],$$

or

$$\tilde{l}^*\theta_\alpha > \frac{\theta_\alpha}{\gamma}\left[r^* + (\tilde{\theta} + \tilde{l}^*\theta_{l^*}) - y^{s\prime}(\frac{\partial r_L}{\partial D^*} - \gamma\beta)\right].$$

It can be verified that $\partial r_L/\partial D^* = \gamma\beta$. We thus have

$$\gamma\tilde{l}^* > r^* + (\tilde{\theta} + \tilde{l}^*\theta_{l^*}).$$

Because $\gamma = 2\theta_{l^*}$, the above expression can be written as $\tilde{l}^*\theta_{l^*} > r^* + \tilde{\theta}$, that is $\eta_{\theta/l^*} > (r^* + \tilde{\theta})/\tilde{\theta}$, or, $\eta_{l^*/\theta} < \tilde{\theta}/(r^* + \tilde{\theta})$. But because $\eta_{l^*/\theta} = \eta_{l^*/\alpha} \cdot \eta_{\alpha/\theta}$, and because $\eta_{\alpha/\theta} = \eta_{\theta/\alpha}^{-1}$, the above condition becomes

$$\frac{\eta_{l^*/\alpha}}{\eta_{\theta/\alpha}} < \frac{\tilde{\theta}}{r^* + \tilde{\theta}} < 1.$$

If the risk-free real interest rate is not too large, and given the sufficient condition (A1), this inequality always holds.

For $d\tilde{D}^*/d\alpha < 0$, it must be that

$$\Psi_c/\Psi_\alpha > G_c/G_\alpha = (\partial r_L/\partial c)/(\partial r_L/\partial\alpha) = \Phi_c/\Phi_\alpha = m_{hc}\gamma/\theta_\alpha,$$

that is, given the definitions of Ψ_c and Ψ_α:

$$1 + (\tilde{\theta} + \tilde{l}^*\theta_{l^*})\lambda_c - y^{s\prime}\frac{\partial r_L}{\partial c} > \frac{m_{hc}\gamma}{\theta_\alpha}\left\{\tilde{l}^*\theta_\alpha + (\tilde{\theta} + \tilde{l}^*\theta_{l^*})\lambda_\alpha - y^{s\prime}\frac{\partial r_L}{\partial\alpha}\right\}.$$

From the definitions in the text, $\partial r_L/\partial\alpha = \theta_\alpha\beta$. Thus

$$1 + (\tilde{\theta} + \tilde{l}^*\theta_{l^*})\lambda_c > \frac{m_{hc}\gamma}{\theta_\alpha}\left\{\tilde{l}^*\theta_\alpha + (\tilde{\theta} + \tilde{l}^*\theta_{l^*})\lambda_\alpha\right\} + y^{s'}\left\{\frac{\partial r_L}{\partial c} - \frac{m_{hc}}{\Omega}\right\}.$$

It can be verified that $\partial r_L/\partial c = m_{hc}/\Omega$, so that

$$\theta_\alpha\left\{1 + (\tilde{\theta} + \tilde{l}^*\theta_{l^*})\lambda_c\right\} > m_{hc}\gamma\left\{\tilde{l}^*\theta_\alpha + (\tilde{\theta} + \tilde{l}^*\theta_{l^*})\lambda_\alpha\right\}.$$

Because $\lambda_c = (1 - \mu)m_{hc}\beta$, given the definition of λ_α given above, this expression can be simplified to

$$1 > m_{hc}\left\{\gamma\tilde{l}^* - (\tilde{\theta} + \tilde{l}^*\theta_{l^*})\right\},$$

or, with $\gamma = 2\theta_{l^*}$:

$$1 > m_{hc}\tilde{\theta}\left(\frac{\tilde{l}^*\theta_{l^*}}{\tilde{\theta}} - 1\right) = m_{hc}\tilde{\theta}(\eta_{l^*/\theta} - 1).$$

As assumed above, $\eta_{l^*/\theta} < \tilde{\theta}/(r^* + \tilde{\theta}) < 1$. The right-hand side of the above equation is thus negative, and the inequality always holds.

That the services account always deteriorates can be established by showing that

$$r^*\frac{d\tilde{D}^*}{d\alpha} + \frac{d(\tilde{\theta}\tilde{l}^*)}{d\alpha} = (r^* + \tilde{\theta})\frac{d\tilde{l}^*}{d\alpha} + \tilde{l}^*\frac{d\tilde{\theta}}{d\alpha} - r^*\frac{d\tilde{R}^*}{d\alpha} > 0.$$

We also have

$$d\tilde{l}^*/d\alpha = -(\theta_\alpha/\gamma) < 0, \quad d\tilde{m}_h/d\alpha = m_{hc}(d\tilde{c}/d\alpha) < 0,$$

$$d\tilde{i}_L/d\alpha = d\tilde{i}_d/d\alpha = 0, \quad d\tilde{y}/d\alpha = d\tilde{l}_f^d/d\alpha = 0.$$

The effect on bank deposits is given by

$$d\tilde{d}/d\alpha = d_c(\frac{d\tilde{c}}{d\alpha}) + d_{D^*}(\frac{d\tilde{D}^*}{d\alpha}) + d_\alpha,$$

so that, because $\tilde{D}^* = \tilde{l}^* - \tilde{R}^*$:

$$d\tilde{d}/d_\alpha = (d_c - d_{D^*}m_{hc})(\frac{d\tilde{c}}{d\alpha}) + (\theta_\alpha/\gamma) + d_\alpha,$$

or, because $d_\alpha = -\theta_\alpha/\gamma$, $d_c = -m_{hc}$, and $d_{D^*} = -1$ (so that $d_c - d_{D^*}m_{hc} = 0$):

$$d\tilde{d}/d\alpha = d\tilde{l}^s/d\alpha = 0.$$

Because $d\tilde{m}_f/d\alpha = d\tilde{l}^d_f/d\alpha = 0$, and $d\tilde{d}/d\alpha = 0$:

$$d\tilde{m}/d\alpha = d\tilde{m}_h/d\alpha + \mu d\tilde{d}/d\alpha = d\tilde{R}^*/d\alpha < 0.$$

To determine the sign of $d\tilde{D}^*/d\alpha$, note that:

$$d\tilde{D}^*/d\alpha = d\tilde{l}^*/d\alpha - d\tilde{R}^*/d\alpha = -(\theta_\alpha/\gamma) - m_{hc}(d\tilde{c}/d\alpha),$$

which is negative if m_{hc} is not too large.

The impact effect of an increase in α on consumption is given by, using equations (A2) and (A4), and noting that $dD^*_0/d\alpha = 0$:

$$\begin{aligned} dc_0/d\alpha &= d\tilde{c}/d\alpha - \kappa(d\tilde{D}^*/d\alpha), \\ &= -\nu G_\alpha/\Omega + \Psi_\alpha(G_{D^*} + \kappa G_c)/\Omega, \end{aligned}$$

or equivalently, because $G_{D^*} + \kappa G_c = \kappa\nu$:

$$dc_0/d\alpha = -\nu(G_\alpha - \kappa\Psi_\alpha)/\Omega < 0, \qquad (A5)$$

and consumption falls on impact. The effect on the lending rate is

$$\frac{dr_L(0)}{d\alpha} = (\frac{\partial r_L}{\partial c})(\frac{dc_0}{d\alpha}) + \frac{\partial r_L}{\partial \alpha}, \qquad (A6)$$

which is ambiguous because $dc_0/d\alpha < 0$. If σ is sufficiently small, the lending rate will rise on impact. The effect on bank deposits is

$$\frac{dd_0}{d\alpha} = d_c(\frac{dc_0}{d\alpha}) + d_\alpha, \qquad (A7)$$

which is also ambiguous. If the degree of intertemporal substitution is not too high, bank deposits will fall.

The supply of credit and output fall on impact, if as assumed above the lending rate rises. For private foreign borrowing,

$$\frac{dl_0^*}{d\alpha} = \gamma^{-1}\left[\frac{(1-\mu)dr_L(0)}{d\alpha} - \theta_\alpha\right] = \lambda_c\left(\frac{dc_0}{d\alpha}\right) + \lambda_\alpha, \tag{A8}$$

so that, because $\lambda_c > 0$ and $\lambda_\alpha < 0$, and consumption falls on impact, private foreign borrowing also falls unambiguously.

Because $dD_0^*/d\alpha = 0$,

$$dR_0^*/d\alpha = dl_0^*/d\alpha < 0. \tag{A9}$$

From equation (15):

$$\frac{dm_h(0)}{d\alpha} = m_{hc}\left(\frac{dc_0}{d\alpha}\right) + (1-\mu)m_{hr_d}\frac{dr_L(0)}{d\alpha},$$

or, using (A6):

$$\frac{dm_h(0)}{d\alpha} = \left\{m_{hc} + (1-\mu)m_{hr_d}\left(\frac{\partial r_L}{\partial c}\right)\right\}\left(\frac{dc_0}{d\alpha}\right) + (1-\mu)m_{hr_d}\frac{\partial r_L(0)}{\partial \alpha}. \tag{A10}$$

From the definition of $\partial r_L/\partial c$, it can be established that

$$m_{hc} + (1-\mu)m_{hr_d}\left(\frac{\partial r_L}{\partial c}\right) = m_{hc}\left\{1 + \frac{(1-\mu)m_{hr_d}}{\Omega}\right\},$$

with

$$1 + \frac{(1-\mu)m_{hr_d}}{\Omega} = \gamma^{-1} - \frac{l^{d\prime}}{1-\mu} > 0.$$

Because the partial effect $\partial r_L(0)/\partial \alpha$ is always positive, the second term on the right-hand side of (A10) is negative. Thus, given the above result, the first term is also negative and $dm_h(0)/d\alpha < 0$.

Because the shock considered here is temporary, the general solution of system (39) can be written as

for $0 \leq t \leq T$:

$$D^* = \tilde{D}_{t\leq T}^* + C_1 e^{\nu_1 t} + C_2 e^{\nu_2 t}, \tag{A11}$$

$$c = \tilde{c}_{t \leq T} + \kappa_1 C_1 e^{\nu_1 t} + \kappa_2 C_2 e^{\nu_2 t}, \tag{A12}$$

for $t \geq T$:

$$D^* = \tilde{D}_0^* + C_1' e^{\nu_1 t} + C_2' e^{\nu_2 t}, \tag{A13}$$

$$c_t = \tilde{c}_0 + \kappa_1 C_1' e^{\nu_1 t} + \kappa_2 C_2' e^{\nu_2 t}, \tag{A14}$$

where $\nu_1 (= \nu)$ denotes the negative root and ν_2 the positive root of the system, and $\kappa_h = G_{D^*}/(\nu_h - G_c)$, $h = 1, 2$. The four arbitrary constants C_1, C_2, C_1' and C_2' are determined under the assumptions that a) $C_2' = 0$ (for the transversality condition to hold); b) D^* evolves continuously from its initial given value $\tilde{D}_0^* = D_0^*$, so that $D_0^* = \tilde{D}_{t \leq T}^* + C_1 + C_2$; and c) the time paths for c and D^* are continuous for $t > 0$. In particular, at time $t = T$, the solutions for (A11) and (A13); and (A12) and (A14) must coincide, yielding two more equations which, together with the above condition on D_0^*, uniquely determine the solution for C_1, C_2, and C_1'. The solutions are given by:

for $0 \leq t \leq T$:

$$D^* = \tilde{D}_{t \leq T}^* - \chi \Delta (D_0^* - D_{t \leq T}^*) e^{\nu_1 t} + \chi \nu_1 (\nu_2 - G_c)(D_0^* - \tilde{D}_{t \leq T}^*) e^{\nu_2 (t-T)},$$

$$c = \tilde{c}_{t \leq T} - \chi \Delta \kappa_1 (D_0^* - \tilde{D}_{t \leq T}^*) e^{\nu_1 t} + \chi \nu_1 G_F (D_0^* - \tilde{D}_{t \leq T}^*) e^{\nu_2 (t-T)},$$

and for $t \geq T$:

$$D^* = D_0^* - \chi (D_0^* - \tilde{D}_{t \leq T}^*) e^{\nu_1 t} \left\{ \Delta - \nu_2 (\nu_1 - G_c) e^{-\nu_1 T} \right\},$$

$$c = \tilde{c}_0 + \kappa_1 (D^* - D_0^*),$$

where

$$\chi = 1/G_c(\nu_2 - \nu_1), \quad \Delta = -\chi + \nu_1 (\nu_2 - G_c) e^{-\nu_2 T}.$$

References

Agénor, Pierre-Richard, 1997, "Capital-Market Imperfections and the Macroeconomic Dynamics of Small Indebted Economies," unpublished, International Monetary Fund (May). Forthcoming, *Princeton Studies in International Finance.*

Agénor, Pierre-Richard, and Joshua Aizenman, 1997, "Contagion and Volatility with Imperfect Credit Markets," unpublished, International Monetary Fund (June).

Agénor, Pierre-Richard, and Peter J. Montiel, 1997, *Development Macroeconomics,* Princeton University Press (Princeton, New Jersey).

Aizenman, Joshua, 1989, "Country Risk, Incomplete Information and Taxes on International Borrowing," *Economic Journal,* Vol. 99 (March), pp. 147-61.

Aizenman, Joshua, Michael Gavin, and Ricardo Hausmann, 1996, "Optimal Tax and Debt Policy with Endogenously Imperfect Creditworthiness," Working Paper No. 5558, National Bureau of Economic Research (May).

Cañonero, Gustavo, 1997, "Bank Concentration and the Supply of Credit in Argentina," IMF Working Paper No. 97/40 (Washington: International Monetary Fund, April).

Catão, Luis, 1997, "Bank Credit in Argentina in the Aftermath of the Mexican Crisis: Supply or Demand Constrained?," Working Paper No. 97/32 (Washington: International Monetary Fund, March).

Cavallo, Domingo, 1981, "Stagflationary Effects of Monetary Stabilization Policies in Economies with Persistent Inflation," in *Development in an Inflationary World,* ed. by June Flanders and Assaf Razin, Academic Press (New York).

Drazen, Allan H., and Elhanan Helpman, 1990, "Inflationary Consequences of Anticipated Macroeconomic Policies," *Review of Economic Studies,* Vol. 57 (January), pp. 147-66.

Edwards, Sebastian, and Carlos A. Végh, 1997, "Banks and Macroeconomic Disturbances under Predetermined Exchange Rates," Working Paper No. 5977, National Bureau of Economic Research (March).

Eichengreen, Barry, Andrew Rose, and Charles Wyplosz, 1996, "Contagious Currency Crises: First Tests," *Scandinavian Journal of Economics,* Vol. 98 (December), pp. 463-84.

Goldfajn, Ilan, and Rodrigo Valdés, 1997, "Balance of Payments Crises and Capital Flows: The Role of Liquidity," unpublished, Department of Economics, Massachusetts Institute of Technology (February).

Greenwald, Bruce C., and Joseph E. Stiglitz, 1993, "Financial Market Imperfections and the Business Cycle," *Quarterly Journal of Economics*, Vol. 108 (February), pp. 77-114.

International Monetary Fund, 1996, *International Capital Markets: Developments, Prospects, and Key Policy Issues*, World Economic and Financial Surveys, International Monetary Fund (Washington DC).

Isard, Peter, Donald J. Mathieson, and Liliana Rojas-Suárez, 1996, "A Framework for the Analysis of Financial Reforms and the Cost of Official Safety Nets," *Journal of Development Economics*, Vol. 50 (June), pp. 25-79.

Masson, Paul, and Pierre-Richard Agénor, 1996, "The Mexican Peso Crisis: Overview and Analysis of Credibility Factors," unpublished, International Monetary Fund (October).

Jaffee, Dwight, and Joseph Stiglitz, 1990, "Credit Rationing," in *Handbook of Monetary Economics*, Vol. II, ed. by Benjamin M. Friedman and Frank H. Hahn, North Holland (Amsterdam).

Kaufman, Martin D., 1996, "An Incursion into the Confidence Crisis-Credit Rationing-Real Activity Channel: Evidence from the Argentine 'Tequila' Crisis," unpublished, Central Bank of Argentina (February).

Eaton, Jonathan, and Raquel Fernández, 1995, "Sovereign Debt," in *Handbook of International Economics*, ed. by Gene Grossman and Maurice Obstfeld, Vol. III, North Holland (Amsterdam).

Milde, Hellmuth, and John Riley, 1988, "Signaling in Credit Markets," *Quarterly Journal of Economics*, Vol. 103 (February 1988), pp. 101-29.

Reinhart, Carmen M., and Carlos A. Végh, 1995, "Nominal Interest Rates, Consumption Booms, and Lack of Credibility," *Journal of Development Economics*, 46 (April), pp. 357-78.

Rojas-Suárez, Liliana, and Steven Weisbrod, 1995, "Financial Fragilities in Latin America: The 1980s and 1990s," Occasional Paper No. 132, International Monetary Fund (October).