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CAPITAL-MARKET IMPERFECTIONS AND THE MACROECONOMIC DYNAMICS OF SMALL INDEBTED ECONOMIES

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1 INTRODUCTION

Since at least the debt crisis of the early 1980s, it has been well recognized that small indebted economies face imperfect world capital markets. International capital markets tend to discriminate among borrowers, and countries whose ability to repay is perceived as inadequate are typically forced to pay a premium when they borrow. Considerations of creditworthiness—whether or not based on economic fundamentals—often affect not only the cost of credit on international financial markets but also its availability: the perception that a country's creditworthiness has deteriorated (or is about to deteriorate) can lead to an abrupt curtailment of funding to all domestic borrowers, public and private. Such rationing has, in some cases, proved difficult to reverse.

In open-economy macroeconomics, the country risk premium has often been modeled as varying positively with the country's level of foreign debt or debt-to-output ratio. The present study departs from the conventional approach to world capital-market imperfections by relying on the notion of *individual* risk, rather than *country* risk. This difference of emphasis has important implications for the specification of intertemporal optimizing models of small indebted economies. In particular, deviations from uncovered interest parity emerge naturally in the present approach. Domestic interest rates tend to respond to both domestic and foreign financial factors—in contrast to the assumption of perfect capital mobility, which "ties" the rates of return on domestic and foreign assets.[1]

This study has benefited from comments and suggestions received on two earlier papers in which some of the ideas discussed here were first developed. I am particularly indebted to Joshua Aizenman, Edward Buffie, Betty Daniel, Rudiger Dornbusch, Ilan Goldfajn, Peter Montiel, Assaf Razin, Carmen Reinhart, Alejandro Werner, an anonymous referee, and participants at various seminars and conferences, including seminars at the Federal Reserve Bank of Atlanta, the Massachusetts Institute of Technology, the University of Virginia, and the World Bank. The views expressed here do not necessarily represent those of the International Monetary Fund.

[1]Although the degree of capital mobility has, without any doubt, increased

Chapter 2 discusses the links between individual default risk, capital-market imperfections, and world interest rates. Subsequent chapters show how such imperfections can be integrated into an optimizing framework and how they affect the dynamics of exogenous and policy shocks. Chapter 3 presents the basic elements of the model in a one-good setting in which purchasing-power parity holds continuously. Chapter 4 extends the analysis to a Salter-Swan dependent-economy framework.[2] The three subsequent chapters illustrate the functioning of the model: a reduction in the world interest rate is discussed in Chapter 5; a cut in government spending on home goods is considered in Chapter 6; and a reduction in the devaluation rate is examined in Chapter 7. Chapter 8 discusses various extensions of the basic framework, and Chapter 9 summarizes the main features and implications of the study and stresses the usefulness of the model as a framework for macroeconomic policy analysis in small indebted economies.

substantially in recent years (in line with financial-sector reforms and the dismantling of capital controls in many indebted countries), imperfect capital mobility remains a fairly common characteristic of less-advanced economies (see Agénor and Montiel, 1996).

[2] The derivation of the dynamic form of the model is not a trivial exercise; in order to enhance the pedagogical value of this study, intermediate algebraic steps are provided in both Chapters 3 and 4.

2 DEFAULT RISK AND WORLD INTEREST RATES

As noted in Chapter 1, there is a long tradition in international macroeconomics of models emphasizing the effect of country risk on the interest rate faced by small borrowing economies on world capital markets. Bardhan (1967), in one of the earliest papers on optimal borrowing, was one of the first economists to introduce the assumption that small borrowing countries face a world interest rate that increases with the level of external debt. As foreign indebtedness grows, so does the risk of default; to compensate for this risk, lenders charge a premium that raises the marginal cost of borrowing over the safe lending rate. The supply curve of funds on world capital markets is therefore upward sloping.[1] Bardhan's approach has been adopted in numerous studies in international macroeconomics, including papers by Obstfeld (1982), Pitchford (1989), Bhandari, Ul Haque, and Turnovsky (1990), and Fisher (1995).[2] Although specific formulations differ across studies, many of them have retained the assumption that the premium depends on the economy's absolute stock of foreign debt.[3] As pointed out by a number of authors—Sachs

[1] In Bardhan's model, foreign debt also generates disutility (at the margin) for the borrower. The shadow cost of additional borrowing therefore rises with the level of debt—even if the interest rate charged by lenders is itself unchanged.

[2] There is also a small empirical literature analyzing the effect of external debt to private creditors (often measured in proportion to output) on the risk premium faced by indebted economies; see, for instance, Edwards (1984) and, more recently, Rockerbie (1993). In practice, incorporation of a higher perceived risk of default in the terms of a loan agreement has taken the form not only of an interest spread charged over and above the safe world interest rate (proxied by the London interbank offer rate [LIBOR] or the U.S. Treasury bill rate), but also of a reduction in the maturity of the loan. See Eaton, Gersovitz, and Stiglitz (1986, pp. 504-507) for a critical discussion of the early empirical analysis of interest-rate spreads faced by small indebted economies.

[3] Extensions of the basic country-risk model make the premium depend on other variables as well. Some authors have, for instance, specified the premium as a function of the ratio of the economy's ratio of foreign debt to output of tradables (Murphy, 1991), or to output of exportables only (Otani and Villanueva, 1988), or as the ratio of foreign debt to capital (Bhandari, Ul Haque, and Turnovsky, 1990). Agénor and Santaella (1996) consider the case in which the premium depends not

(1984), for instance—the smooth relationship between the premium and the country's foreign borrowing may be valid only up to a point; default risk may lead to credit rationing once a sufficiently high level of indebtedness is reached.

In an intertemporal optimizing setting, the country-risk approach to world capital-market imperfections has one major implication: under conditions of atomicity, optimizing households do not internalize the effects of their intertemporal lending and borrowing decisions on the world interest rate. They take it, in effect, as given, even though from the perspective of the country as a whole, the cost of borrowing rises with the level of foreign indebtedness, owing to the rise in the probability of default. In turn, the rise in the probability of default induced by an individual's marginal borrowing creates a negative externality, because of the consequent increase in the expected default penalty inflicted on all domestic agents. This externality—which has also been characterized as an "over-borrowing" syndrome—provides a rationale for welfare-enhancing government intervention (Aizenman, 1989).

In the literature on country risk and sovereign-loan contracts, a key assumption is that loans to foreign governments cannot be fully collateralized; loan covenants cannot be used to precommit borrowers to a future line of action effectively, because the contracts are deemed unenforceable across borders. Such problems are generally considered to be unimportant in the context of loans to private entities—either because loan contracts are viewed as fully enforceable through the domestic legal system or because such loans are viewed as fully guaranteed (implicitly if not explicitly) by the country's government. Eaton and Gersovitz (1980, p. 4), for instance, state that

> in considering the default issue, we emphasize the distinction between an economic unit in a national economy and a government. A government enjoys national sovereignty; the individual does not. Ruling out forceful intervention by other nations, a government can refuse to pay its creditors and maintain control of its domestic assets. An individual, by contrast, would be stripped of his assets in bankruptcy proceedings.

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only on the level of external debt, but also on the long-run composition of the economy's output, as a measure of repayment capacity.

In the same vein, Cooper and Sachs (1985, p. 43) argue that

> both the external reputation of the country and the internal confidence in its institutions may be so closely tied to particular firms that in practice the government must guarantee their external debt or at least avoid any actions that would bring debt servicing into question. Thus, the national government provides guarantees—formal or informal—to the external creditors of the leading banks, and the expectations of the foreign lenders reflect this fact. This may also be true of other important commercial enterprises, especially those that are government-owned.

By contrast, in the individual-risk approach emphasized here, the lack of enforceability of international contracts in the context of cross-border lending to *private* agents becomes a key factor in the decision of foreign financial intermediaries to lend, thereby making private agents' own capacity to repay a key determinant of access to world capital markets. This view is consistent with the shift in international lending from loans to governments and government-related entities in the 1970s and 1980s to the more direct access to world capital markets by private entities in the 1990s.

In formal terms, this approach can be presented as follows. Suppose, in line with representative-agent models, that the economy is populated by identical households.[4] The marginal cost of borrowing faced by the representative household on world capital markets can be defined as $i^* + \theta$, which consists of an exogenous, risk-free interest rate, i^*, and an endogenous premium, θ, which is defined as[5]

$$\theta = (\overset{+}{L^*}, \overset{+}{\alpha}), \tag{1}$$

[4] The representative-agent framework has become the dominant paradigm in open-economy macroeconomics, as illustrated in recent books by Turnovsky (1995), Frenkel and Razin (1996), and Obstfeld and Rogoff (1996). For a critical discussion of its limitations, however, see Kirman (1992).

[5] Except as otherwise indicated, partial derivatives throughout this study are denoted by corresponding subscripts, and 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.

where L^* is the household's level of foreign debt, α is a shift factor, and θ is a continuously differentiable function over some given interval. Thus, the household-specific premium depends positively on the household's outstanding level of foreign indebtedness and on some exogenous elements. The parameter α may reflect two types of factors: characteristics of the household other than the level of foreign debt (such as the age composition of the household) or market sentiment toward the country under consideration—a country-specific risk element. As in the literature on country risk, the premium can be expected to rise at an increasing rate with the individual's level of debt, so that the second-order partial derivative of θ with respect to L^* is likely to be positive.[6]

The relationship between the risk premium and the world interest rate that individual domestic borrowers face on world capital markets may be derived from a simple *ex ante-ex post* stochastic model in which loans are not fully collateralized and households face random shocks to their income.[7] Such shocks make future (end-of-period) repayments on the debt contracted today (at the beginning of the period) uncertain and lead competitive and risk-neutral foreign lenders to charge a premium—which is such that the expected yield of the loan is in equilibrium equal to the yield that would be obtained if they were to lend at the risk-free interest rate. Put differently, in a setting where lenders on world capital markets perceive the risk of default to be rising with the level of borrowing, they will charge even a "small" borrower a higher interest rate as his or her level of indebtedness rises. If the probability of default is independent of the amount borrowed, and if there are no other exogenous risk-related factors, the risk-free interest rate will represent the marginal cost of borrowing to the agent. With the possibility of default, however, the marginal cost of borrowing will exceed the risk-free interest rate.

[6] Also in line with the conventional approach is the assumption that domestic agents lose complete access to world capital markets if the level of debt is high enough. Throughout this study, however, it will be assumed that the economy operates within a range in which rationing does not occur and θ is continuously differentiable.

[7] The analysis is developed in Agénor and Aizenman (1997b) and follows along the lines of Sachs (1984), Aizenman (1989), and Aizenman, Gavin, and Hausmann (1996).

In terms of its analytical implications, the individual-risk approach developed here departs in two respects from models emphasizing the effect of country risk on the country-specific world interest rate. First, the premium depends only on the private, not on the economy's, level of foreign debt; country risk matters only to the extent that it affects the parameter α. Second, private agents will be assumed to internalize the effect of their marginal borrowing decisions on the marginal cost of funds that they face. As a result, there is no "over-borrowing" syndrome here, and no negative externality for the country as a whole. As discussed in the following chapters, these features have important consequences for understanding the short-run dynamics of small indebted economies.

The focus on individual risk, as opposed to country risk, does not mean that the latter is irrelevant. Indeed, the distinction between private and country risk may lack meaning in a setting in which, as assumed in the early literature, foreign lenders are capable of securing (implicit or explicit) government guarantees on their loans to domestic private agents. In such a situation, what should matter to foreign lenders is the economy's, rather than the individual's, repayment capacity and potentiality to default. Implicit in the foregoing analysis, therefore, is the view that government guarantee schemes either do not exist or do not carry full credibility. In the following analysis, country risk (as commonly introduced in dynamic models of small indebted economies) is ignored so as to avoid unduly complicating the discussion. To the extent that country risk is viewed as reflecting exogenous factors, however, it can be captured by changes in the parameter α—as is the case in some interpretations of the Tequila effect, that is, the sudden loss of investor confidence in some Asian and Latin American countries following the December 1994 crisis of the Mexican peso (Agénor, 1997a). In the same vein, it is possible to make the premium a function of other endogenous macroeconomic variables—such as inflation, the real exchange rate, the size of the fiscal deficit, and the level of domestic public debt—which may affect market sentiment either directly or indirectly, through, for instance, their impact on the perceived degree of political instability. Because they may alter (qualitatively as well as quantitatively) the aggregate effects of the various shocks discussed below, these extensions might well be worth investigating. The notion that the premium depends on the agent's level of foreign debt, however, and that households internalize the effects of their level of borrowing on the interest rate that they face (while taking as given all other determinants of the premium, including macroeconomic factors), remains the defining feature of the class of models discussed in this study.

It is also worth stressing the differences between the approach adopted here and conventional models of credit rationing with heterogeneous borrowers of the Stiglitz-Weiss type (Jaffee and Stiglitz, 1990). In the conventional models, lenders (banks) do not adjust interest rates in the face of an excess demand for credit, for to do so would reduce their expected rate of return as a result of an increase in the probability of default. In turn, two factors may account for the possible inverse relationship between the lending rate and the expected rate of return to the lender: adverse selection (higher interest rates tend to reduce the proportion of low-risk borrowers) and moral hazard (higher interest rates induce borrowers to invest in riskier projects). In the present approach, there are no information asymmetries; lenders know the characteristics of the shocks affecting each borrower's capacity to repay. Lenders adjust the loan rate, rather than the size of the loan, to maintain an expected rate of return that is consistent with the safe rate of interest, because unforeseen events, such as liquidity shocks, may render borrowers unable to repay.[8] The model therefore appears to be at variance with the standard Stiglitz-Weiss approach to imperfect credit markets.

It should be noted, however, that extensions of the Stiglitz-Weiss approach along the lines of Milde and Riley (1988) bear some relation to the view adopted here. In the Milde-Riley model, borrowers can choose the size of the loan they wish to borrow. Loan size acts as a signal of the borrower's risk characteristics to lenders. 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 of the Stiglitz-Weiss variety occurs: the agent is unable to obtain additional loans at any interest rate. Thus, by highlighting the sorting effect (or

[8] It would be easy, of course, to introduce heterogeneity across agents by assuming that each borrower faces an idiosyncratic liquidity shock, but this would not add much to the present analysis.

self-selection aspect) of interest rate to loan-size schedules, the Milde-Riley analysis suggests that, as in the approach to individual default risk adopted here, there may exist a significant range of debt levels over which capital-market imperfections translate into an upward-sloping supply curve of funds.

3 THE MODEL WITH ONE GOOD

This chapter examines the implications of the theory of capital-market imperfections in the context of a one-good model with constant output. The model considers a small open economy in which four types of agents operate: producers, households, the government, and the central bank. Decisions rules of both categories of private agents are summarized by the behavior of representative agents. Domestic output consists of a tradable good produced using only labor, which is supplied in fixed quantity n^s. Wages are perfectly flexible, so that domestic production is fixed during the time frame of the analysis. Purchasing-power parity holds continuously. With the world price of the good normalized to unity, the domestic output price is thus equal to the nominal exchange rate, E, which is depreciated at a constant predetermined rate, ε, by the central bank. A fixed-exchange-rate regime corresponds, therefore, to $\varepsilon = 0$.

The following sections describe the behavior of households, the monetary and fiscal authorities, and equilibrium conditions. The dynamic form of the model is then derived, and its steady-state properties are examined.

Households

The representative household is infinitely lived and endowed with perfect foresight.[1] Two categories of assets are held: domestic money, which bears no interest, and domestic government bonds. The household borrows on world capital markets—subject to a rising risk premium, as discussed in Chapter 2. Foreigners do not hold domestic assets.

[1] As usual, the assumption of an infinite planning horizon can be rationalized along two lines. First, the household's planning horizon may be of sufficient length (given reasonable discount rates) to render the abstraction of an infinite horizon a reasonable approximation. Second, the existence of an operative chain of bequests from generation to generation may be captured by treating finitely lived individuals as having, in effect, an infinite planning horizon.

Preferences are intertemporally additive. Instantaneous utility is defined over consumption and real money balances and is separable in both arguments. Specifically, the representative household's discounted lifetime utility is defined as

$$\int_0^{\infty} \left\{ \frac{c^{1-\eta}}{1-\eta} + \chi \frac{m^{1-\phi}}{1-\phi} \right\} e^{-\rho t} dt, \quad \rho, \chi > 0, \tag{2}$$

where ρ denotes the constant rate of time preference, c is consumption, and m is real money balances;[2] η and ϕ are positive and different from unity, and $\sigma = 1/\eta$ is the constant elasticity of substitution in consumption.[3]

Real financial wealth (or net worth) of the representative household a is defined as

$$a = m + b - L^*, \tag{3}$$

where b denotes holdings of government bonds, and L^* (as defined earlier) is net private foreign borrowing.[4]

The representative household's flow budget constraint is given by

$$\dot{a} = y + ib - c - \tau - (i^* + \theta)L^* - (m + b)\varepsilon, \tag{4}$$

where $\dot{x} \equiv dx/dt$, y denotes domestic output (which is constant at $y(n^s)$), τ is lump-sum taxes levied by the government, i is the nominal interest rate on domestic bonds, and $\varepsilon \equiv \dot{E}/E$ is the predetermined rate of devaluation of the nominal exchange rate—which

[2] Conditions under which the money-in-the-utility-function approach used here is functionally equivalent to a "shopping-time" model are discussed by Feenstra (1986) and Croushore (1993).

[3] The logarithmic utility function $\ln c + \chi \ln m$ obtains as

$$\lim_{\eta, \phi \to 1} \left\{ \frac{c^{1-\eta} - 1}{1-\eta} + \chi \frac{m^{1-\phi} - 1}{1-\phi} \right\},$$

where the expression in brackets differs from the expression in (2) by subtracting the term -1 in the numerator of each term. The two specifications of instantaneous utility have identical implications.

[4] For simplicity, foreign loans are assumed to have infinite maturity and thus do not have to be amortized. Domestic government bonds are also considered net wealth. The absence of Ricardian equivalence appears to be well supported by the evidence for developing countries. See Seater (1993) and Agénor and Montiel (1996).

is, under the assumptions of purchasing-power parity and constant world prices, equal to the domestic inflation rate. The term $-(m+b)\varepsilon$ accounts for capital losses on real money balances and the stock of domestic government bonds resulting from inflation. As discussed in Chapter 2, the effective cost of borrowing faced by the representative household on world capital markets is equal to $i^* + \theta$, where i^* is the risk-free rate and θ is the risk premium, defined in (1).

Using equation (3), equation (4) can be written in the equivalent form

$$\dot{a} = y + ra - c - \tau - (i^* + \theta - r)L^* - im, \tag{5}$$

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

The representative household treats y, i, ε, i^*, α, and τ as given, internalizes the effect of its marginal borrowing decisions on θ, and maximizes (2) subject to (1) and the budget constraint (5) by choosing a sequence $\{c, m, b, L^*\}_{t=0}^{\infty}$. The optimality conditions are given by

$$m^d = \left\{\frac{\chi c^{\eta}}{i}\right\}^{1/\phi}, \tag{6}$$

$$i = (i^* + \theta + \varepsilon) + L^*\theta_{L^*}, \tag{7}$$

$$\dot{c}/c = \sigma(r - \rho), \tag{8}$$

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

Equation (6) is the money demand function and is obtained from the condition that the marginal rate of substitution between money balances and consumption be equal to the opportunity cost of holding money—the nominal interest rate on domestic government bonds. Equation (8) is the conventional Euler equation, which shows that consumption rises or falls depending on whether the domestic real interest rate exceeds or falls below the rate of time preference.

Equation (7) is an arbitrage condition that determines implicitly the demand for loans. To understand its derivation, consider, first, the case in which households face no risk premium on world capital markets ($\theta = 0$). In that case, clearly, optimality requires $i = i^* + \varepsilon$. Suppose, for instance, that $i > i^* + \varepsilon$; agents would then borrow unlimited amounts of funds on world capital markets and reap a net profit by buying government bonds. With $i < i^* + \varepsilon$, however, a corner solution would obtain, with households not borrowing at all from foreign lenders. Equilibrium (with a positive level of foreign debt) therefore requires equality between the marginal return, i, and the marginal cost of funds (measured in domestic-currency terms), $i^* + \varepsilon$.

Suppose now, as assumed above, that the premium rises with the level of private 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 rate of return on domestic bonds, the marginal cost of borrowing is given by $i^* + \theta + \varepsilon$ 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), $L^*\theta_{L^*}$.[5]

Taking θ as given for a moment, equation (7) can be rewritten as

$$L^* = [i - (i^* + \theta + \varepsilon)]/\theta_{L^*}, \tag{9}$$

which indicates that foreign borrowing is positively related to the difference between the domestic interest rate and the marginal cost of borrowing on world capital markets, given by the sum of the safe interest rate, the devaluation rate, and the risk premium. Moreover, the demand for foreign loans is proportional to the cost differential, with a proportionality factor that depends on the sensitivity of the risk premium to the level of private debt.

In general, of course, because θ is a function of L^*, equation (9) is not a (quasi-)reduced-form solution for the optimal level of borrowing. Such a solution can be obtained by taking a linear approximation to θ, so that

$$L^* = [i - (i^* + \theta_\alpha \alpha + \varepsilon)]/\gamma, \tag{10}$$

where $\gamma = 2\theta_{L^*} > 0$. Equation (10) indicates that the optimal level of foreign borrowing is negatively related to the safe world interest

[5] If individuals face a risk premium on foreign loans that does not depend on their own level of debt (as discussed in Chapter 2), the marginal cost of borrowing will be equal only to $i^* + \theta + \varepsilon$.

rate and the devaluation rate (as before), as well as the autonomous component of the risk premium.[6]

The Central Bank and the Government

There are no commercial banks in the economy, and the central bank does not lend to domestic agents. Thus, the counterpart to the monetary base consists only of foreign reserves, which bear interest at the risk-free rate, i^*. In addition to depreciating the nominal exchange rate at a constant rate, the central bank ensures, at any given moment in time and at the prevailing exchange rate, the costless conversion of domestic currency holdings into foreign currency. The real money supply is therefore equal to

$$m^s = R^*, \tag{11}$$

where R^* denotes the foreign-currency value of the stock of foreign assets held by the central bank. The central bank transfers to the government all its profits, which consist of interest on its holdings of foreign assets, i^*R^*, and capital gains on reserves, εR^*.

The government's revenue sources consist of lump-sum taxes on households and transfers from the central bank. It consumes goods and services in quantity g. Assuming that lump-sum taxes, τ, are varied so as to maintain fiscal equilibrium, and setting, for simplicity, the constant level of domestic bonds to zero, the budget constraint of the government can be written as

$$\tau = g - (i^* + \varepsilon)R^*. \tag{12}$$

Money-Market Equilibrium

To close the model requires specifying the equilibrium condition of the money market:

$$m^s = m^d.$$

[6]An early paper by Turnovsky (1985), using a one-good model of a flexible exchange-rate economy, provides a specification of households' portfolio decisions that leads to an asset demand equation that has qualitatively similar analytical properties to equation (10) with $\alpha = 0$. Turnovsky's analysis, however, is somewhat incomplete; in particular, he does not draw the implications of his results for the economy's aggregate budget constraint.

Given (6), the above equation can be solved for the market-clearing domestic interest rate:

$$i = i(\overset{+}{c}, \overset{-}{m}), \tag{13}$$

which shows that the equilibrium nominal interest rate depends positively on private consumption and negatively on the stock of real cash balances.

Dynamic Form and Steady State

Deriving the dynamic form of the model involves several steps. To begin with, note that equations (3) and (11) yield

$$a = R^* - L^*, \tag{14}$$

which shows that, given that the stock of domestic bonds is normalized to zero and that the central bank's and the government's net worth does not change, the counterpart to the private sector's net financial wealth consists of the economy's net stock of foreign assets, $R^* - L^*$.

Substituting (12) and (14) in the household's flow budget constraint (5) gives the economy's consolidated budget constraint:

$$\dot{L}^* - \dot{R}^* = i^*(L^* - R^*) + \theta(L^*, \alpha)L^* + c + g - y. \tag{15}$$

Equation (15) indicates that the counterpart to the current-account deficit, which is given as the sum of the trade deficit, $c+g-y$, and net interest payments on the outstanding foreign debt, $i^*(L^* - R^*) + \theta L^*$, is the change in net external liabilities. Integrating equation (15) yields the economy's intertemporal budget constraint:

$$L_0^* - R_0^* = \int_0^\infty (y - c - g - \theta L^*)e^{-\int_0^t i_h^* dh} dt + \lim_{t\to\infty} (L^* - R^*)e^{-\int_0^t i_h^* dh}.$$

The economy cannot remain indefinitely indebted with respect to the rest of the world, so the second term in the above expression must be zero. Thus, the economy's intertemporal budget constraint can be written, with i^* constant over time, as

$$L_0^* - R_0^* = \int_0^\infty (y - c - g - \theta L^*)e^{-i^* t} dt,$$

which indicates that the current level of foreign debt must be equal to the discounted stream of the excess of future output over domestic absorption $(c+g)$, adjusted for the loss in resources induced by capital-market imperfections.

Equations (8), (10), (11), (12), (13) and (15) describe the evolution of the economy along any perfect-foresight equilibrium path. The system can be rewritten as

$$L^* = [i(c, R^*) - i^* - \varepsilon - \theta_\alpha \alpha]/\gamma, \tag{16}$$

$$\dot{c}/c = \sigma[i(c, R^*) - \varepsilon - \rho], \tag{17}$$

$$\dot{L}^* - \dot{R}^* = i^*(L^* - R^*) + \theta(L^*, \alpha)L^* + c + g - y, \tag{18}$$

with equation (12) determining residually lump-sum taxes.

The above equations represent a differential equation system with three endogenous variables: c, R^*, and L^*. The dynamic form of the model can be further reduced to a system involving only two variables: consumption (which may jump in response to new information) and the economy's net external debt, $D = L^* - R^*$, which can change only gradually.[7] To do so, note that

$$R^* = (R^* - L^*) + L^*,$$

or, using equation (16),

$$R^* = -D + [i(c, R^*) - i^* - \varepsilon - \theta_\alpha \alpha]/\gamma,$$

and, taking a linear approximation to the function $i(\cdot)$,

$$R^* = \{-\gamma D - (i^* + \varepsilon + \theta_\alpha \alpha) + i_c c\}/(\gamma - i_m),$$

so that

$$R^* = \varphi(\overset{+}{c}, \overset{-}{D}; \overset{-}{i^* + \varepsilon}), \tag{19}$$

[7] Given the normalization rule for b, substituting (11) in (3) yields $D = -a = L^* - R^*$, which shows that, as a result of the assumption that the central bank and the government maintain continuously balanced budgets, the economy's net external-debt position is equal to the private sector's net financial liabilities.

where, setting $\beta \equiv 1/(\gamma - i_m) > 0$,

$$\varphi_c = \beta i_c, \quad \varphi_D = -\beta\gamma, \quad \varphi_{i^*+\varepsilon} = -\beta.$$

Substituting equation (19) in (17) yields

$$\dot{c} = \sigma c\{i[c, \varphi(\cdot)] - \varepsilon - \rho\} = G(\overset{+}{c}, \overset{+}{D}; \overset{+}{i^*}, \overset{-}{\varepsilon}), \tag{20}$$

where, with $\Delta = \sigma\beta\tilde{c}$,

$$G_c = \gamma i_c \Delta, \quad G_D = -\gamma i_m \Delta, \quad G_{i^*} = -i_m \Delta, \quad G_\varepsilon = -\gamma\Delta.$$

To relate private foreign borrowing to consumption and total foreign debt, substitute equation (19) into (16) to obtain

$$L^* = [i_c c + i_m \varphi(c, D; i^* + \varepsilon) - (i^* + \varepsilon) - \theta_\alpha \alpha]/\gamma,$$

so that

$$L^* = \lambda(\overset{+}{c}, \overset{+}{D}; \overset{-}{i^* + \varepsilon}), \tag{21}$$

where[8]

$$\lambda_c = (i_c + i_m \varphi_c)/\gamma = i_c\beta, \quad \lambda_D = i_m \varphi_D/\gamma = -i_m\beta, \quad \lambda_{i^*+\varepsilon} = -\beta.$$

Using (21), equation (18) can be written as

$$\dot{D} = i^* D + \theta[\lambda(\cdot), \alpha]\lambda(\cdot) + c + g - y,$$

or equivalently

$$\dot{D} = \Psi(\overset{+}{c}, \overset{+}{D}; \overset{?}{i^*}, \overset{-}{\varepsilon}) + g, \tag{22}$$

where, with a '$^-$' denoting initial steady-state values,

$$\Psi_c = 1 + (\tilde{\theta} + \tilde{L}^*\theta_{L^*})\lambda_c, \quad \Psi_D = i^* + (\tilde{\theta} + \tilde{L}^*\theta_{L^*})\lambda_D, \quad \Psi_\varepsilon = (\tilde{\theta} + \tilde{L}^*\theta_{L^*})\lambda_{i^*+\varepsilon}.$$

$$\Psi_{i^*} = \tilde{D} + (\tilde{\theta} + \tilde{L}^*\theta_{L^*})\lambda_{i^*+\varepsilon}.$$

[8] To derive $\lambda_{i^*+\varepsilon}$, note that $i_m\varphi_{i^*+\varepsilon} - 1 = -\gamma\beta$.

The partial derivative Ψ_{i^*} is, in general, ambiguous. On the one hand, an increase in the risk-free rate raises debt-service payments in proportion to the initial stock of foreign debt; on the other, the premium-related component of external debt service also falls along with the demand for foreign loans by private agents. The net effect on the current account (and thus the rate of accumulation of foreign debt) cannot be ascertained *a priori*. In the discussion that follows and in order to focus the discussion on the case of a highly indebted economy, it will be assumed that the net effect is positive; that is a rise in the risk-free world interest rate (at given levels of debt and consumption) increases the current-account deficit.

Equations (20) and (22) form a dynamic system in consumption and net external debt, which can be linearized around the steady state to give

$$\begin{bmatrix} \dot{c} \\ \dot{D} \end{bmatrix} = \begin{bmatrix} G_c & G_D \\ \Psi_c & \Psi_D \end{bmatrix} \begin{bmatrix} c - \tilde{c} \\ D - \tilde{D} \end{bmatrix}, \qquad (23)$$

In the above system, c is a jump variable, whereas D is a predetermined variable that evolves continuously from its initial level D_0. Saddlepath stability (in a local sense) therefore requires one unstable (positive) root. To ensure that this condition holds, the determinant of the matrix of coefficients in (23)—which is equal to the product of the roots—must be negative: $G_c\Psi_D - \Psi_c G_D < 0$. This condition is interpreted graphically below.

To understand the short-run dynamics of the model, it is important to emphasize that although net external debt evolves only gradually over time, both official reserves, R^*, and private foreign borrowing, L^*, may shift discretely in response to shocks. Discrete changes in private borrowing must nevertheless be accompanied by an offsetting movement (at the prevailing exchange rate) in the central bank's stock of foreign reserves (and thus money supply), in order to leave the overall level of debt, D, constant on impact. Discrete movements in the money stock may occur, it is important to note, because the central bank does not engage in sterilized intervention.

The steady-state solution is obtained by setting $\dot{c} = \dot{D} = 0$. From equation (17), the real interest rate is thus equal to the rate of time preference:

$$\tilde{r} = \tilde{i} - \varepsilon = \rho. \tag{24}$$

Substituting the above result in (10) yields

$$\tilde{L}^* = (\rho - i^* - \theta_\alpha \alpha)/\gamma, \tag{25}$$

which indicates that the steady-state level of foreign indebtedness by private agents is positive as long as the rate of time preference exceeds the autonomous component of the cost of foreign borrowing, measured in foreign-currency terms ($\rho > i^* + \theta_\alpha \alpha$). More generally, it indicates that the representative household will be a net debtor in the long run if the rate of time preference of domestic consumers is sufficiently high. An important implication of this result is that $\tilde{L}^*$ is invariant to shocks other than movements in i^*, ρ, or the autonomous component of the premium. In particular, steady-state private foreign borrowing is independent of the devaluation rate.

In the long run, the current account must be in equilibrium, so that

$$y - \tilde{c} - g = i^* \tilde{D} + \theta(\tilde{L}^*, \alpha)\tilde{L}^*, \tag{26}$$

which implies that the trade surplus, $y - \tilde{c} - g$, must match the deficit of the services account, given by $i^* \tilde{D} + \theta(\tilde{L}^*, \alpha)\tilde{L}^*$.

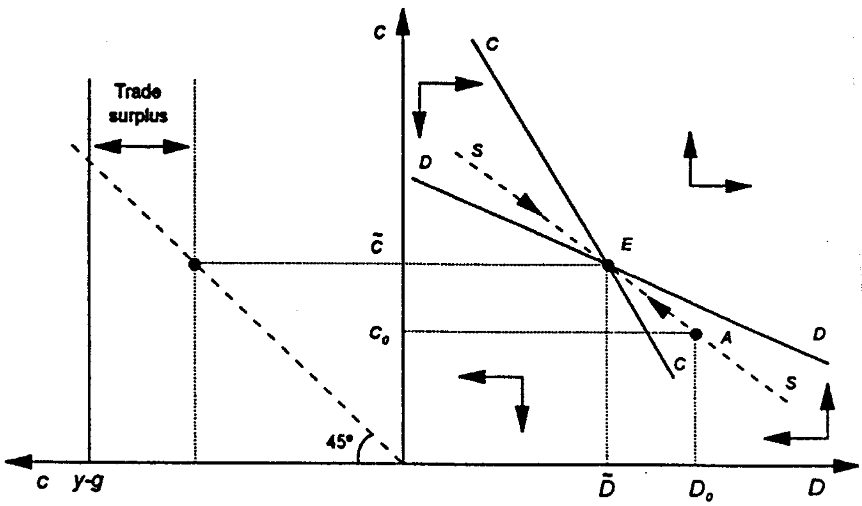
Finally, from (6), long-run real money balances are given by

$$\tilde{m} = m(\tilde{c}, \rho + \varepsilon). \tag{27}$$

The steady-state equilibrium of the model is depicted in Figure 1. In the panel on the right-hand side, the DD locus gives the combinations of c and D for which the current account is in balance, whereas the CC locus depicts the combinations of c and D for which consumption does not change over time. In particular, points above DD correspond to situations of current-account deficits (and an increasing level of debt), whereas points below the curve correspond to current-account surpluses. Points located to the right of CC represent situations in which the domestic real interest rate is higher than the rate of time preference and consumption is increasing. Conversely, points located to the left of CC represent situations of falling consumption. Saddlepath stability requires that CC be steeper than

DD. The saddlepath SS slopes downward, so that private consumption rises (falls) along the equilibrium path when the current account is in surplus (deficit) and the economy's debt is falling (rising).[9] The panel on the left-hand side shows the determination of the trade surplus $y - \tilde{c} - g$, which, as shown in equation (26), must match in equilibrium the deficit of the services account.

FIGURE 1
STEADY-STATE EQUILIBRIUM IN THE ONE-GOOD MODEL



If, for instance, the initial level of debt is D_0, consumption will be c_0 (point A on SS). The domestic real interest rate will exceed the rate of time preference, inciting the household to defer consumption until the future. Although the rate of growth of consumption remains positive throughout the adjustment process, it is falling over time and is accompanied by a reduction in the stock of foreign debt. This reduction in debt leads to a gradual reduction in the domestic

[9] From the expression giving the stable root of system (23), it can be established (using the implicit-function theorem) that the lower σ is, the flatter the saddlepath SS will be. Thus, all else being equal, the lower the degree of intertemporal substitution is, the smaller will be the initial jump in consumption induced by any given shock. This is an important property of the model, as discussed below.

nominal interest rate along the saddlepath, despite the increase in consumption; and because the inflation rate (which is equal to the devaluation rate) does not change, the real interest rate falls also. Central-bank reserves and real money balances, as can be inferred from (19), are rising, and private foreign borrowing is falling—in the first case, because of the reduction in the opportunity cost of holding money, and in the second, because the reduction in domestic interest rates makes foreign borrowing less attractive. As illustrated in the figure, the long-run equilibrium is reached when net external debt has fallen sufficiently for the rate of interest to be equal to the rate of time preference.

The theory of capital-market imperfections based on individual default risk emphasized here possesses several attractive features.

- First, the model yields the uncovered-interest-parity condition as a limit case. If $\alpha = 0$, and if the risk premium is independent of the level of debt (so that $\gamma \to 0$), equation (10) yields

$$i = i^* + \varepsilon.$$

- Second, it leads to the derivation of a *stock* demand function for net foreign assets (or net foreign borrowing) rather than a *flow* demand. In that regard, then, it is a more attractive approach than the modeling of world capital-market imperfections adopted, for instance, by Sutherland (1996). Specifically, Sutherland assumes that the friction on world capital markets results from convex adjustment costs to transactions in foreign assets (such as broker fees). A difficulty with his approach, however, is that it leads to a relationship between the interest-rate differential and *changes* in private holdings of foreign assets in the short run, with uncovered interest parity holding in the steady state. By contrast, here, deviations from uncovered interest parity persist even in the long run. Thus, the model is also consistent with the evidence for highly indebted economies in particular, and developing countries in general, which suggests significant departures from perfect capital mobility.

- Third, the model does not require the rate of time preference to be equal at all times to the world interest rate, as is the case in some standard, infinite-horizon optimizing models o small open economies (as, for instance, discussed by Turnovsky [1995]). The assumption that the rate of time preference is equal to the world interest rate in this kind of model is necessary to get a finite and positive consumption level in the steady state.[10] This feature of the model is particularly attractive when analyzing the effect of permanent changes in the world interest rate (as discussed in Chapter 6), because the arbitrary assumption that such shifts are accompanied by an equal change in the rate of time preference is not required.

[10] Alternative approaches, such as those based on Uzawa-type preferences (Uzawa, 1968) or finite lifetimes (as in the Blanchard-Yaari framework) could be adopted to alleviate this constraint.

4 A DEPENDENT-ECONOMY FRAMEWORK

The one-good model developed in the previous chapter is useful for presenting some of the core analytical implications of individual risk in an intertemporal setting. This chapter extends the one-good model to a dependent-economy framework with flexible prices in the home-goods sector and with market-clearing wages.

Suppose now that the economy produces two goods, using capital and homogeneous labor: a home good that is used only for final domestic consumption, and a tradable good, the price of which (measured in foreign-currency terms) is fixed on world markets and normalized to unity. In addition to a representative household, the government, and the central bank, a representative producer operates in each sector of the economy. The capital stock in each sector is fixed within the time frame of the analysis, and labor is perfectly mobile across sectors. By the assumption of a small open economy, the demand for the domestic tradable good is perfectly elastic at the given domestic-currency price of the good, so that output of tradables is determined by supply.

Households

As before, the representative household supplies labor inelastically; it also consumes both home and tradable goods. Financial assets consist, as before, of domestic money (which bears no interest) and domestic government bonds; financial liabilities consist of loans obtained on world capital markets.

Consumption decisions follow a two-step process: the representative household first determines the optimal level of total consumption and then allocates that amount between expenditure on the two goods.[1] In the first stage of the decision process, the representative household maximizes discounted lifetime utility given by equation (2), where c is now an index of total consumption expenditure, and

[1] Conditions under which a two-stage budgeting process of this type is optimal are discussed by Deaton and Muellbauer (1980).

real money balances, m, are measured in terms of the price of th consumption basket, P.

Real financial wealth of the representative household is also defined as in (3):

$$a = m + b - l^*, \qquad (28)$$

with a and b measured in terms of the price of the consumption basket and real foreign indebtedness, l^*, now defined as $l^* \equiv EL^*/P$. The flow budget constraint is now given by

$$\dot{a} = y + ib - c - \tau - (i^* + \theta)l^* - \varepsilon l^* - \pi a, \qquad (29)$$

where net factor income, y, is derived below and $\pi \equiv \dot{P}/P$ is the overall inflation rate. The term $-\pi a$ accounts for capital losses on total wealth resulting from inflation, whereas the term εl^* represents the increase in the domestic-currency value of external liabilities resulting from exchange-rate devaluation.

In the first stage of the consumption decision process, the representative household treats π, ε, y, i, i^*, and τ as given, internalizes again the effect of its borrowing decisions on θ, and maximizes (2) subject to (28) and (29) by choosing a sequence $\{c, m, b, L^*\}_{t=0}^{\infty}$.[2] Let $r = i - \pi$ denote the consumption-based domestic real rate of interest; the optimality conditions are given by equations similar to (6), (7), and (8), together with the transversality condition on financial wealth. The properties of all three equations are essentially the same as those described in Chapter 3. An important new element in the present setting, however, is that the intertemporal Euler equation (8) implies that overall expenditure growth depends on the real rate of interest measured in terms of the price of the consumption basket. Thus, as emphasized notably by Dornbusch (1983), even in the absence of capital-market imperfections ($\gamma \to 0$), the presence of nontradable goods prevents equalization of domestic and foreign real interest rates.[3]

[2] The assumption that the household chooses the foreign-currency value of foreign loans is adopted for simplicity. Note, however, that it is natural to retain the assumption that the risk premium depends on the foreign-currency value of private foreign borrowing, because it reflects the behavior of foreign lenders.

[3] Put differently, differential changes in the relative price of nontradable goods across countries imply different real rates of return even when nominal rates of return are equal.

In the second stage of the consumption decision process, the representative household maximizes a homothetic subutility function $V(c_N, c_T)$, subject to the static budget constraint $P_N c_N + E c_T = Pc$, where P_N denotes the price of the home good, and c_T (c_N) denotes expenditure on the tradable (nontradable) good.[4]

Let z be the relative price of the tradable good in terms of the home good, that is $z \equiv E/P_N$. Because the representative household's intratemporal preferences are homothetic, the desired ratio between home and tradable goods depends only on the relative price of these goods, and not on overall expenditure. Thus

$$V_{c_N}/V_{c_T} = z^{-1}.$$

Suppose that the subutility function is Cobb-Douglas, so that

$$V(c_N, c_T) = c_N^{\delta} c_T^{1-\delta},$$

where $0 < \delta < 1$ denotes the share of total spending falling on home goods. The desired composition of spending is thus

$$c_N/c_T = \delta z/(1-\delta),$$

which can be substituted in the intratemporal budget constraint, $c = z^{\delta}(c_T + c_N/z)$, to give

$$c_N = \delta z^{1-\delta} c, \quad c_T = (1-\delta) z^{-\delta} c. \tag{30}$$

From the indirect subutility function, the appropriate definition of the consumer-price index, P, is thus (Samuelson and Swamy, 1974)[5]

$$P = P_N^{\delta} E^{1-\delta} = E z^{-\delta}, \tag{31}$$

so that the inflation rate is

$$\pi = \varepsilon - \delta \dot{z}/z. \tag{32}$$

[4] Recall that the foreign-currency price of the tradable good is normalized to unity.

[5] Strictly speaking, the cost-of-living index should also include the opportunity cost of holding real money balances, that is, the domestic nominal interest rate. For simplicity, this component is ignored.

Output and the Labor Market

Technology for the production of tradable and nontradable goods is characterized by decreasing returns to labor:

$$y_h = y(n_h), \quad y_h' > 0,\ y_h'' < 0 \quad h = N, T, \tag{33}$$

where y_h denotes output of good h, and n_h is the quantity of labor employed in sector h. From the first-order conditions for profit maximization, the sectoral labor demand functions can be derived as

$$n_T^d = n_T^d(w_T), \qquad n_N^d = n_N^d(zw_T), \qquad n_T^{d\prime}, n_N^{d\prime} < 0, \tag{34}$$

where w_T is the product wage in the tradable-goods sector. Nominal wages are perfectly flexible, so that w_T can be solved for from the equilibrium condition of the labor market:

$$n_T^d(w_T) + n_N^d(zw_T) = n^s,$$

where n^s denotes the supply of labor, which is again taken to be constant. This equation implies that the equilibrium product wage is negatively related to the real exchange rate:

$$w_T = w_T(z), \quad w_T' < 0,\ |w_T'| < 1. \tag{35}$$

Substituting this result in equations (34), and noting that $d(zw_T)/dz = 1 + w_T' > 0$, yields the sectoral-supply equations

$$y_h^s = y_h^s(z), \qquad y_T^{s\prime} > 0,\ y_N^{s\prime} < 0. \tag{36}$$

The Central Bank and the Government

As before, there are no commercial banks in the economy, and the central bank does not provide credit to domestic agents. The real money supply is thus equal to

$$m^s = z^\delta R^*. \tag{37}$$

Real profits of the central bank, $(i^* + \varepsilon - \pi)z^\delta R^*$, are fully transferred to the government. With lump-sum financing, and setting the constant real stock of government bonds to zero, the government budget constraint can be written as

$$\tau + \pi m = z^{\delta}(g_T + g_N/z) - z^{\delta}(i^* + \varepsilon - \pi)R^*, \tag{38}$$

where g_T and g_N denote government spending on tradable and nontradable goods, respectively.

Market-Clearing Conditions

To close the model requires specifying the equilibrium conditions for the home-goods market and the money market—the latter being solved for the market-clearing interest rate. The former condition is given by

$$y_N^s = \delta z^{1-\delta} c + g_N, \tag{39}$$

and from (6) and (37), the market-clearing interest rate is given, as before, by (13).

Dynamic Form

Real factor income, y, measured in terms of cost-of-living units, is given by

$$y = z^{\delta}(y_T^s + y_N^s/z).$$

Equations (28) and(37) yield

$$a = z^{\delta}(R^* - l^*),$$

which has the same interpretation as (14). A key difference here, however, is that although $R^* - l^*$ is predetermined, the real exchange rate can change in discrete fashion; net financial wealth, a (or, equivalently, the domestic-currency value of the economy's stock of foreign assets), can therefore also jump on impact.

Using the above definition of a and equation (32) yields

$$\dot{a} = z^{\delta}(\dot{R}^* - \dot{L}^*) + (\varepsilon - \pi)a.$$

Substituting the above results, together with equations (30), (38), and (39) in (29) yields

$$\dot{L}^* - \dot{R}^* = i^*(l^* - R^*) + \theta(l^*, \alpha)L^* + (1-\delta)z^{-\delta}c + g_T - y_T^s, \tag{40}$$

which represents the consolidated budget constraint of the economy. As before, integrating equation (40) yields, subject to the transversality condition $\lim_{t\to\infty}(L^* - R^*)e^{-i^* t}$, the economy's intertemporal budget constraint.

From equations (30) and (39), the short-run equilibrium real exchange rate is obtained as

$$z = z(\overset{-}{c}; \overset{-}{g_N}), \tag{41}$$

where

$$z_c = \delta/[y_N^{s\prime} - \delta(1-\delta)\tilde{c}], \quad z_{g_N} = 1/[y_N^{s\prime} - \delta(1-\delta)\tilde{c}].$$

Equations (8), (10), (13), (32), (37), (40), and (41) describe the behavior of the economy over time. Setting $\alpha = 0$ for simplicity, these equations can be summarized as follows:

$$L^* = [i(c, m) - i^* - \varepsilon]/\gamma, \tag{42}$$

$$\dot{c}/c = \sigma[i(c, m) - \varepsilon + \delta\dot{z}/z - \rho], \tag{43}$$

$$z = z(c; g_N), \tag{44}$$

$$\dot{D} = i^* D + \theta(L^*, \cdot)L^* + (1-\delta)z^{-\delta}c + g_T - y_T^s(z), \tag{45}$$

$$m = z^{\delta} R^*, \tag{46}$$

with equation (38) determining residually lump-sum taxes and $D = L^* - R^*$ denoting, again, net external debt.

As before, to condense the dynamic form into a system involving only c and D, note that from equation (46),

$$m = z^{\delta}(L^* - D), \tag{47}$$

or, using equation (42),

$$m = z^{\delta}\left\{[i(c, m) - (i^* + \varepsilon) - \gamma D]/\gamma\right\}. \tag{48}$$

Substituting (44) in (48) yields

$$m = z(c; g_N)^{\delta} \beta \left\{i_c c - (i^* + \varepsilon) - \gamma D\right\}, \quad \beta \equiv 1/(\gamma - i_m), \tag{49}$$

so that

$$m = \varphi(\overset{?}{c}, \overset{-}{D}; i^* \overset{-}{+} \varepsilon, \overset{-}{g_N}), \tag{50}$$

where

$$\varphi_c = \beta(i_c + \delta\gamma z_c \tilde{R}^*), \quad \varphi_D = -\beta\gamma, \quad \varphi_{i^*+\varepsilon} = -\beta, \quad \varphi_{g_N} = \beta\delta\gamma z_{g_N} \tilde{R}^*.$$

Substituting (50) in (43) yields

$$\dot{c}/c = \sigma \left\{ i[c, \varphi(c, D; i^* + \varepsilon, g_N)] - \varepsilon + \delta\dot{z}/z - \rho \right\}. \tag{51}$$

Suppose that changes in g_N occur only in discrete fashion. Equation (44) therefore implies that $\dot{z} = z_c\dot{c}$, with $z_c < 0$. Substituting this result in (51) yields a dynamic equation that can be written in a form similar to (20):

$$\dot{c} = G(\overset{+}{c}, \overset{+}{D}; \overset{+}{i^*}, \overset{-}{\varepsilon}, \overset{+}{g_N}), \tag{52}$$

where, with now $\Delta = \sigma\tilde{c}/(1 - \sigma\tilde{c}\delta z_c) > 0$,[6]

$$G_c = (i_c + i_m\varphi_c)\Delta, \quad G_D = i_m\varphi_D\Delta,$$

$$G_{i^*} = i_m\varphi_{i^*+\varepsilon}\Delta, \quad G_\varepsilon = (i_m\varphi_{i^*+\varepsilon} - 1)\Delta, \quad G_{g_N} = i_m\varphi_{g_N}\Delta.$$

Substituting equation (50) into (42) yields

$$L^* = \lambda(\overset{+}{c}, \overset{+}{D}; i^* \overset{-}{+} \varepsilon, \overset{+}{g_N}), \tag{53}$$

where, as in equation (21),

$$\lambda_D = i_m\varphi_D/\gamma = -i_m\beta, \quad \lambda_{i^*+\varepsilon} = -\beta,$$

and now

$$\lambda_c = (i_c + i_m\varphi_c)/\gamma = \beta(i_c + i_m\delta z_c\tilde{R}^*), \quad \lambda_{g_N} = i_m\varphi_{g_N}/\gamma.$$

Finally, using equation (53), equation (45) can be written as

$$\dot{D} = \Psi(\overset{+}{c}, \overset{+}{D}; \overset{?}{i^*}, \overset{-}{\varepsilon}, \overset{+}{g_N}) + g_T, \tag{54}$$

[6]Note that $i_c + i_m\varphi_c = \gamma\beta(i_c + i_m\delta z_c\tilde{R}^*) > 0$; thus, G_c is positive regardless of whether φ_c is positive or negative. Note also that $i_m\varphi_{i^*+\varepsilon} - 1 = -\gamma\beta < 0$.

where Ψ_D, Ψ_{i^*}, and Ψ_ε are as given above (equation [22]), and

$$\Psi_c = -z_c[y_T^{s\prime} + \delta(1-\delta)\tilde{c}] + (1-\delta) + (\tilde{\theta} + \tilde{L}^*\theta_{L^*})\lambda_c,$$

$$\Psi_{g_N} = -z_{g_N}[y_T^{s\prime} + \delta(1-\delta)\tilde{c}] + (\tilde{\theta} + \tilde{L}^*\theta_{L^*})\lambda_{g_N},$$

with $\Psi_{i^*} > 0$ as before.

Equations (52) and (54) form again a dynamic system in c and D, which can be linearized around the steady state and written as in (23). Saddlepath stability again requires $G_c\Psi_D - G_D\Psi_c < 0$.

The steady-state solution is obtained by setting $\dot{c} = \dot{D} = 0$ in equations (52) and (54). From equation (32), the steady-state inflation rate and the rate of inflation in nontradable prices are thus equal to the devaluation rate:

$$\tilde{\pi} = \tilde{\pi}_N = \varepsilon. \tag{55}$$

As before, in the steady state, the current account must be in equilibrium:

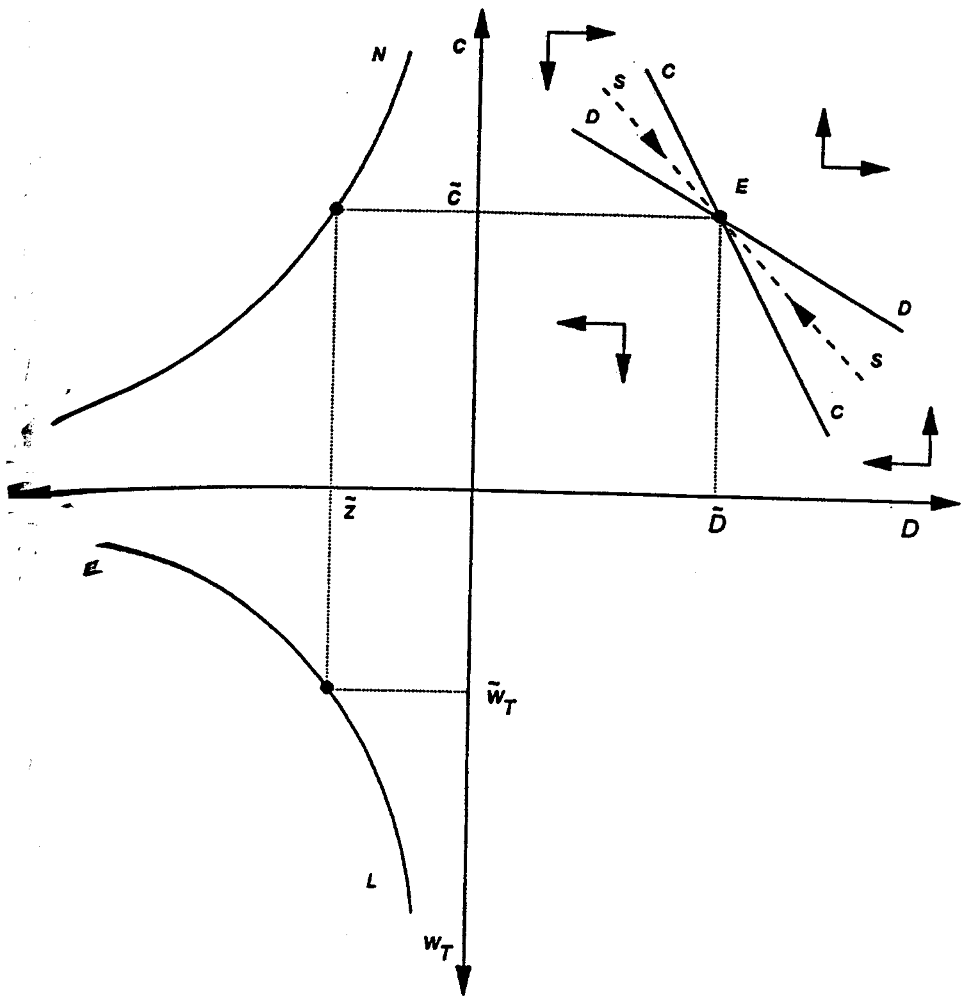
$$y_T^s(\tilde{z}) - (1-\delta)\tilde{z}^{-\delta}\tilde{c} - g_T = i^*\tilde{D} + \theta(\tilde{L}^*, \cdot)\tilde{L}^*. \tag{56}$$

The real (consumption-based) interest rate is again equal to the rate of time preference (equation [24]), and the household's steady-state level of foreign borrowing is given by (25).

The steady-state equilibrium is depicted in Figure 2. The NN curve in the northwest quadrant depicts combinations of private consumption, c, and the real exchange rate, z, that are consistent with equilibrium in the market for nontradable goods (equation [39]), whereas the LL curve in the southwest quadrant depicts combinations of the product wage in the tradable-goods sector, w_T, and the real exchange rate that are consistent with labor-market equilibrium (equation [35]). The interpretation of the CC and DD loci in the northeast quadrant is similar to the description provided in Chapter 3. In particular, points located to the right of CC represent situations in which the domestic real interest rate is higher than the rate of time preference, consumption is increasing, and the real exchange rate is appreciating to eliminate excess supply of nontradable goods. Conversely, points located to the left of CC represent situations of

FIGURE 2

STEADY-STATE EQUILIBRIUM IN THE DEPENDENT-ECONOMY FRAMEWORK



falling consumption, excess supply of home goods, and a depreciating real exchange rate. Saddlepath stability requires again that CC be steeper than DD.

The following three chapters focus on the "positive" implications of the model and illustrate its functioning (in the context of the dependent-economy framework) by considering three types of shocks: a reduction in the risk-free rate, a cut in government spending on home goods, and a reduction in the devaluation rate. The discussion considers both permanent and temporary shocks.[7]

[7] Derivations of the impact and steady-state effects of each shock are presented in the Appendix.

In the setting presented above, the long-run effects of a permanent reduction in the world safe interest rate, i^*, are a reduction in consumption, a depreciation of the real exchange rate, and an increase in foreign debt. The initial effect of the reduction in the cost of borrowing in world capital markets is an increase in private foreign indebtedness. At first sight, the net effect of the shock on external debt service—and thus the services account—would appear ambiguous, for two reasons. First, as noted in Chapter 4, a reduction in i^* has two types of partial effects: on the one hand, at the initial level of the economy's stock of foreign debt, it lowers interest payments; on the other, because the increase in private foreign borrowing raises the premium-related component $\theta\tilde{L}^*$, it tends to increase interest payments to foreign creditors. As indicated earlier, the former effect is assumed to dominate the latter, so that the services account tends to improve. Second, because the economy's stock of debt also increases, debt service at the initial risk-free rate tends also to increase. The latter effect dominates the former, so that the net effect is a deterioration of the services account.

To maintain external balance in the long run, the initial trade surplus (which matches the initial deficit in the services account) must therefore increase. In turn, at the initial level of the real exchange rate (and thus output of tradables), consumption must fall. This leads to a depreciation of the real exchange rate, which stimulates output of tradable goods and further improves the trade balance. Because the nominal interest rate remains constant at $\rho+\varepsilon$, real money balances fall also, as do official reserves, because the real exchange rate depreciates (see equation [27]). With foreign borrowing by private agents increasing, and net foreign assets held by the central bank falling, the economy's external debt unambiguously rises.

On impact, a permanent reduction in the world interest rate raises private spending and leads to an appreciation of the real exchange rate. The reason is that the wealth and intertemporal effects associated with this shock operate in the same direction: the reduction in i^* not only encourages agents to save less and consume more today (the intertemporal effect), but it also lowers the debt burden and generates a positive wealth effect.[1] Although the trade balance and the services account move in opposite directions (the former deteriorates, whereas the latter improves), the net effect is a current-account deficit on impact—and thus an increase in external debt. The economy experiences an inflow of private capital matched by an increase in income, which is such that the economy's stock of debt remains constant on impact. Because both consumption and the real money stock increase, the net effect on domestic interest rates is in general ambiguous. If the degree of intertemporal substitution is sufficiently low (so that consumption increases relatively little), the domestic interest rate will rise on impact.

The dynamic path of consumption, debt, and the real exchange rate are illustrated in the upper panel of Figure 3. Both CC and DD shift to the left, but the former shifts algebraically by more than the latter. Consumption jumps upward from point E to point A, and the real exchange rate appreciates from H to Q. Because of the permanent nature of the shock and the monotonic nature of the adjustment process, the current account remains in deficit (with the economy's external debt increasing) throughout the transition period; consumption falls toward its new, lower steady-state level, and the real exchange rate depreciates—both effects contributing to a gradual reversal of the initial deterioration in the trade deficit.

The lower panel of Figure 3 illustrates the dynamics of a temporary reduction in the world interest rate. Because the expected duration of the shock matters for the adjustment path, consider first the case in which the period of time, T, during which i^* falls is sufficiently large. The economy follows the path labeled $EABF$, with consumption jumping upward on impact and falling continuously af-

[1] Again, from the discussion in Chapter 3, it is assumed that a reduction in the risk-free world interest rate results in an improvement in the services account on impact. This effect is in general ambiguous, because it lowers interest payments on the economy's total foreign debt (which is given on impact) but increases private foreign indebtedness, thereby raising directly and indirectly the premium-related component of external debt service.

As discussed at length by Agénor (1996a, 1996b), if the economy is initially a net creditor with respect to the rest of the world, the impact effect of a reduction in the risk-free rate on consumption is ambiguous, because wealth and intertemporal effects operate in opposite directions.

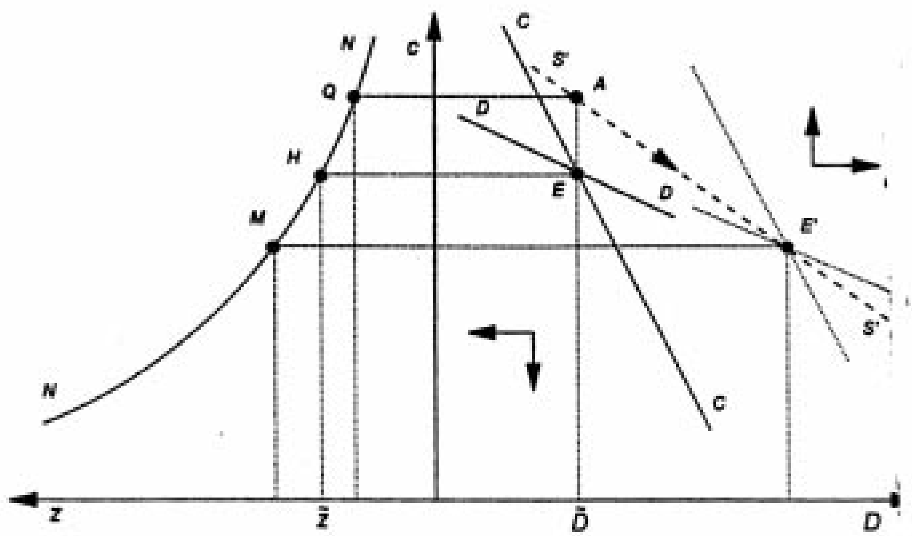
terward until reaching point F at period T. Because the shock is known to be temporary, the optimal response for households is to increase consumption on impact by less than they would if the shock were permanent. The real exchange rate depreciates gradually (from L to M), after an initial step appreciation. The current account moves into deficit during the first phase of the transition process; however, the real depreciation of the currency and the reduction in consumption lead progressively to a restoration of external balance (at point B, where $\dot{D} = 0$). Afterward, the economy generates a current-account surplus, and the stock of debt declines continuously over time, until the initial equilibrium (point E) is reached.

Suppose now that the length of time, T, during which the world interest rate falls is relatively short. In that case, the economy follows the path labeled $EA'B'$, which is characterized (as before) by an initial upward jump in consumption and a real appreciation. Consumption then starts falling, reaching the original saddlepath at point B' at T. Throughout the period during which the risk-free interest rate falls, the economy registers a current-account surplus, that is, a reduction in external debt. After T, the economy remains on the original saddlepath (between B' and E), and the stock of debt rises over time.

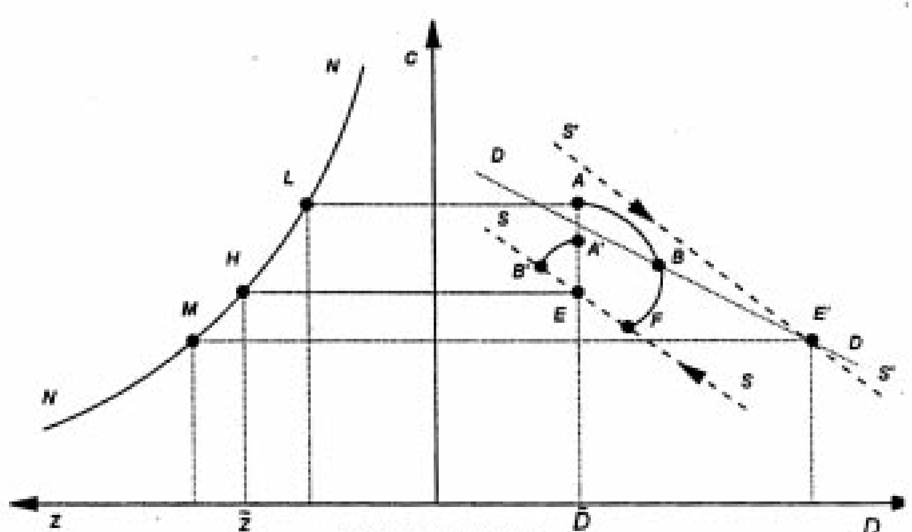
Intuitively, the reason why the adjustment path depends on the length of the period during which world interest rates fall is as follows. If the duration of the shock is sufficiently long, agents have an incentive to substitute intertemporally and to increase consumption on impact by a relatively large amount; the negative effect on the trade balance in that case outweighs the positive effect on the services account, so that the current account moves into deficit and external debt increases. By contrast, if the reduction in the world interest rate is expected to be short-lived, agents will not adjust their consumption path by much. The improvement in the services account will therefore outweigh the deterioration in the trade balance, and the current account will move into surplus—with external debt falling throughout the period during which the shock occurs.

FIGURE 3

REDUCTION IN THE WORLD RISK-FREE INTEREST RATE



Permanent shock



Temporary shock

6 INCREASE IN GOVERNMENT SPENDING ON HOME GOODS

Consider now the case of a tax-financed, permanent increase in g_N. Such a shock has no long-term effect on the domestic nominal interest rate, which remains equal to the rate of time preference plus the devaluation rate (see equation [24]). It also has no effect on foreign borrowing by the private sector, which depends (as indicated by equation [25] with $\alpha = 0$) only on the difference between the world risk-free interest rate and the rate of time preference. At the initial level of the real exchange rate, private consumption must fall to maintain equilibrium of the market for nontradable goods. Real money balances must therefore fall, as shown by (27), because domestic interest rates do not change. The reduction in private consumption is proportionally less than the increase in government expenditure, so that total domestic spending on home goods rises and the real exchange rate appreciates to maintain equilibrium in the home-goods market.

Although the real appreciation tends to reduce output of tradable goods, the trade-balance surplus (which, again, matches the initial deficit of the services account) must rise to maintain external balance, because the economy's stock of debt, D, increases, and the services account deteriorates. This increase in debt results from a reduction in net foreign assets held by the central bank, R^* (because holdings of foreign assets by the private sector, L^*, do not change), which accommodates the fall in the demand for real money balances.

On impact, private consumption falls—to an extent that depends on the degree of intertemporal substitution—because the increase in government spending raises households' lifetime tax liabilities and thus reduces their lifetime wealth. But the real exchange rate may now either appreciate or depreciate—depending on whether total spending on nontradable goods rises or falls. If the degree of intertemporal substitution in consumption, σ, is sufficiently low, private consumption will change relatively little on impact, and total spending will increase—thereby leading to an appreciation of the real exchange rate on impact.

The upper panel in Figure 4 illustrates the adjustment path to a permanent increase in g_N for the case in which the degree of intertemporal substitution is indeed low enough to ensure that the real exchange rate appreciates on impact. Curves CC and DD both shift to the left in the northeast panel.[1] The NN curve in the northwest panel shifts inward. Private consumption jumps downward from point E to point A located on the new saddlepath $S'S'$, and the real exchange rate jumps from point H to point Q located on the new NN curve. At the initial level of interest rates and official reserves, the real money stock falls on impact; the reduction in money demand induced by the fall in consumption is matched by a reduction in supply, resulting from the valuation effects on the domestic-currency value of official reserves associated with the appreciation of the real exchange rate. If valuation effects are not too large, the fall in private consumption leads to a reduction in the domestic nominal interest rate, despite the upward pressure induced by the reduction in money supply. Private foreign indebtedness therefore falls, and the economy registers an outflow of capital. Because the stock of foreign debt cannot change on impact, official reserves must fall concomitantly. The current account moves into deficit ($\dot{D}_0 > 0$) and—as a consequence of the steady-state increase in the stock of debt and the monotonicity of the adjustment path to the new equilibrium—remains in deficit throughout the transition process.[2] Private consumption continues to fall over time, and the real exchange rate depreciates. Because the domestic nominal interest rate falls on impact, it must be rising during the transition to the new long-run equilibrium in order to restore the equality between the real interest rate and the rate of time

[1] As noted in the Appendix, the movement of the CC locus shown in the figure is drawn under the empirically plausible assumption that valuation effects (which account for the indirect effect of government spending on changes in private consumption, through its impact on the real exchange rate) are not large.

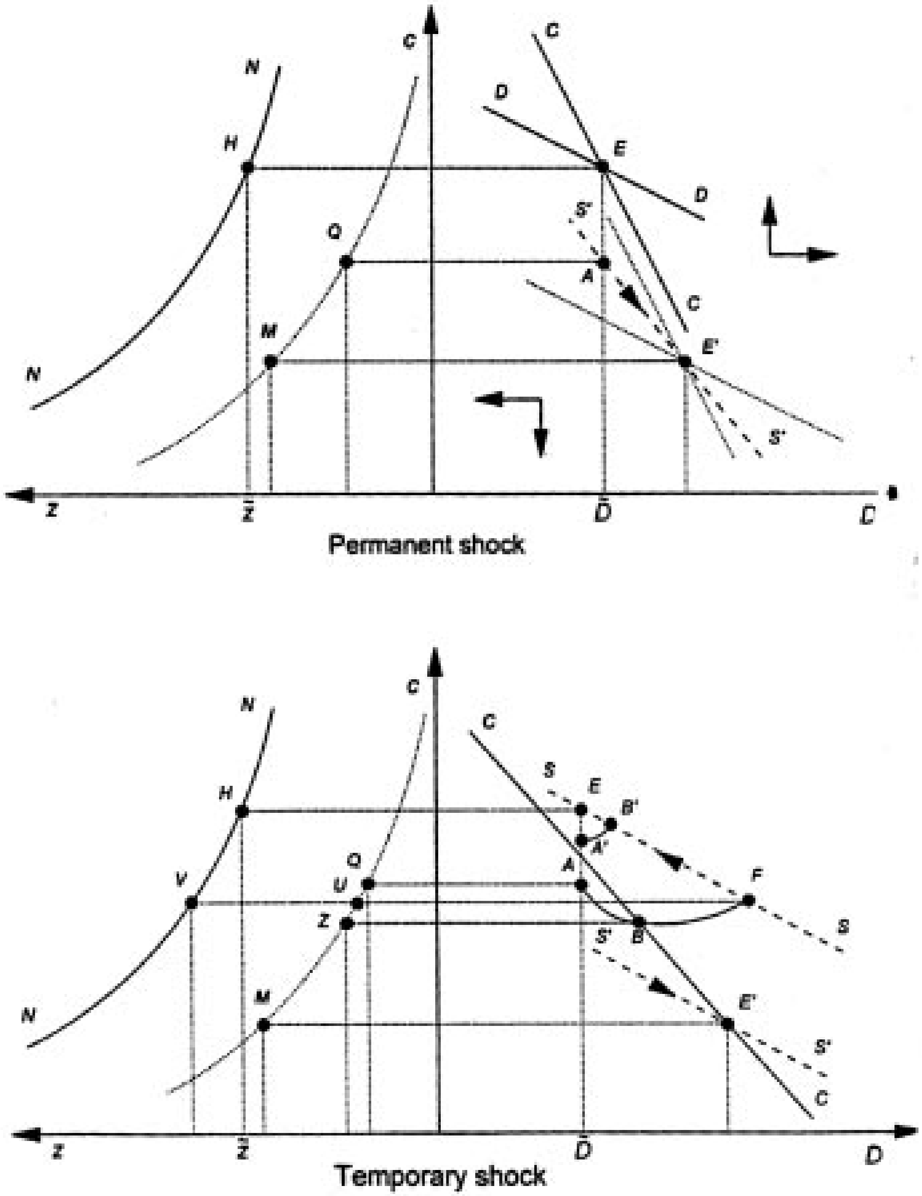
[2] The services account unambiguously improves, because the premium-related component of external debt service falls—as a result of both the reduction in private foreign borrowing and the reduction in the risk premium itself. For the current account to move into deficit on impact therefore requires the trade balance to deteriorate sufficiently to outweigh the improvement in the services account. And because private consumption falls, the reduction in output of tradable goods (resulting from the appreciation of the real exchange rate) must exceed the drop in consumption.

preference. Thus, private foreign indebtedness increases over time and the economy experiences net capital inflows, which continue until private borrowing on world capital markets returns to its initial value.

The lower panel in Figure 4 shows the dynamic path associated with a temporary increase in g_N (between periods 0 and T), under the same assumption regarding the degree of intertemporal substitution. The adjustment path depends again on the duration of the shock. Consider, first, the case in which T is sufficiently large. Private consumption drops to a point such as A on impact and continues to fall until it reaches point B (located on the CC curve passing through the new long-run equilibrium point E') and starts rising, reaching point F located on the original saddlepath SS at exactly period T. The real exchange rate appreciates from H to Q on impact and depreciates gradually afterward between Q and Z. At point Z, it begins appreciating (in line with the increase in consumption) until point U, which is reached exactly at T. At that point, a discrete real depreciation occurs (from point U to V) because the shock to public spending is reversed—shifting curve NN back to its original position. If the shock is of relatively short duration, private consumption will drop to a point such as A' only and will begin rising immediately (with the real exchange rate appreciating), reaching point B' at T. In both cases, throughout the interval of time $(0, T)$, the current account remains in deficit and the economy's external debt rises continuously. After T, the current account moves into surplus, and external debt begins falling toward its initial value.

FIGURE 4

INCREASE IN GOVERNMENT SPENDING ON HOME GOODS



7 EXCHANGE-RATE-BASED DISINFLATION

Consider now a permanent and unanticipated reduction in the devaluation rate, ε, which in the present model can be viewed as an attempt to reduce the long-run inflation rate.[1] The reduction in ε has no long-run effects on the real interest rate or on private foreign borrowing. But although the real interest rate remains equal to the rate of time preference in the new steady state, the nominal interest rate falls in the same proportion as the devaluation rate. The reduction in the opportunity cost of holding money raises the demand for domestic cash balances. The official stock of net foreign assets must therefore increase, and because private foreign borrowing does not change, the economy's external debt must be lower in the new steady state—implying that the initial deficit in the services account is also lower. To maintain external balance, the initial trade surplus must fall—or, equivalently, private consumption must rise. The increase in private expenditure leads to an appreciation of the real exchange rate and raises further the demand for domestic cash balances.

On impact, consumption falls, because the immediate effect of the reduction in ε is to increase the real interest rate, thereby creating an incentive for the household to shift consumption toward the future. The reduction in ε also leads to a discrete increase in private demand for foreign loans, thereby requiring an offsetting increase in official reserves (and thus a rise in the real stock of money) which is such that the economy's stock of debt remains constant on impact. Because consumption falls and the real money stock rises, the net initial effect on the nominal interest rate is unambiguously negative.[2]

[1] Because the initial steady state is, in the present setting, characterized by full employment (wages are fully flexible), it is not clear what the costs of inflation (and thus the benefits of disinflation) are. Given the illustrative nature of the exercise, however, it is sufficient to assume the existence of implicit distortions associated with the initial inflation-devaluation rate.

[2] If the degree of capital mobility (as measured by γ) is sufficiently high, the nominal interest rate will fall by approximately the same amount as the devaluation rate.

The fall in consumption requires a depreciation of the real exchange rate to maintain equilibrium between supply and demand for home goods. As a result of the reduction in private spending and the expansion of output of tradables induced by the depreciation of the real exchange rate, the trade-balance surplus increases. At the same time, the negative income effect associated with the increase in the premium-related component of interest payments (itself a result of the increase in private foreign borrowing) raises the initial deficit of the services account. The current account nevertheless improves, and external debt falls ($\dot{D}_0 < 0$). Because the shock is permanent, the current account remains in surplus throughout the adjustment process. Consumption begins increasing, and the real exchange rate appreciates. The real interest rate rises toward its initial steady-state level, given by the rate of time preference.

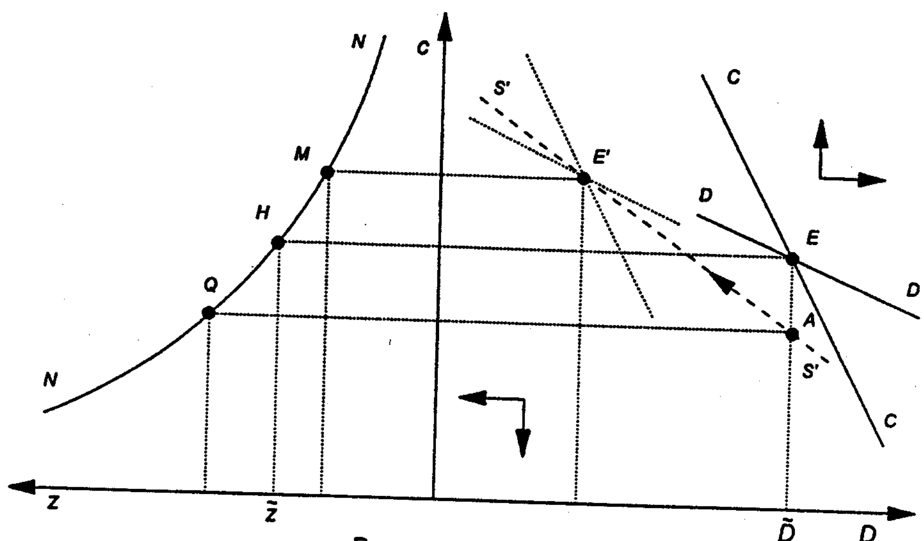
The upper panel of Figure 5 illustrates the dynamics of this shock. Both CC and DD shift to the left. Consumption jumps downward from point E to point A on impact and begins rising afterward. The economy's stock of foreign debt falls continuously during the transition to the new steady state, which is reached at point E'.

The case in which the reduction in ε is temporary is illustrated in the lower panel of Figure 5. Again, because the shock is temporary, the optimal smoothing response for the representative household is to reduce consumption by less than it would if the shock were permanent. Depending on the length of the interval $(0,T)$, two adjustment paths are possible. If the duration of the shock is short, private consumption will jump downward from point E to point A' and will begin to increase until reaching point B' on the original saddlepath at T. The trade balance will improve only slightly, because the short duration of the shock gives agents little incentive to alter their consumption path. The current account will therefore move into deficit (as a result of the deterioration in the services account), and external debt will increase until the shock is reversed. Thereafter, consumption will continue to increase, with the current account moving into surplus, until the economy returns to the original equilibrium point E.

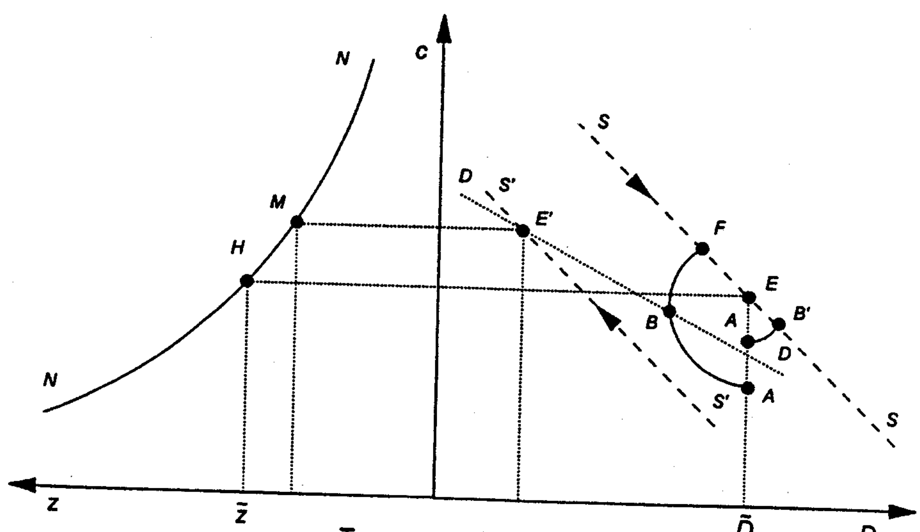
If the duration of the shock is sufficiently long, however, private consumption will jump from point E to point A and will start to increase until point F on the original saddlepath is reached at T.

FIGURE 5

REDUCTION IN THE DEVALUATION RATE



Permanent shock



Temporary shock

Thereafter, consumption starts falling along the original saddlepath SS, eventually reaching the original equilibrium point E. Although the current account remains in surplus during the first phase of the adjustment process (between A and B), it moves into deficit afterward (between points B and F). Point B is reached before period T. Thereafter, with consumption falling between points F and E, the current account remains in deficit, and external debt increases.[3]

It is important to emphasize the difference between the long-run predictions of the model under perfect and imperfect world capital markets. In the former case (which corresponds to $\gamma \rightarrow 0$), the uncovered-interest-parity condition, $i = i^* + \varepsilon$, holds continuously, and private foreign borrowing can take any value *a priori*. The increase in the demand for real cash balances induced by the reduction in the opportunity cost of holding money is achieved through an instantaneous increase in both money holdings and foreign indebtedness: the representative household increases borrowing on world capital markets, generating thereby a capital inflow that is monetized by exchanging the foreign exchange for domestic currency at the central bank (the foreign reserves of which therefore increase) in such a way that the economy's net stock of debt remains constant. There are no real effects, and the adjustment process displays no dynamics; the economy jumps instantaneously to the new steady state. Although the composition of the economy's net external debt changes (with the share of official foreign reserves increasing), the stock of debt itself does not, and neither do real variables.

With capital-market imperfections (that is, with $\gamma > 0$), by contrast, the long-run value of private foreign borrowing is "pinned down" by the difference between the world risk-free interest rate and the rate of time preference and therefore cannot vary across steady states in response to a change in the devaluation rate. Thus, the

[3]The initial drop and subsequent increase in expenditure predicted by the model is consistent with the "U-shaped" behavior of private consumption observed after the implementation of the July 1985 stabilization program in Israel, which was based in part on an exchange-rate freeze; see Helpman and Leiderman (1988, p. 27, and fig. 3). However, the "stylized facts" of exchange-rate-based stabilization programs suggest that in several other cases, consumption rose on impact and was accompanied by an appreciation in the real exchange rate. See Agénor and Aizenman (1997b) for a more detailed discussion of these issues.

increase in real cash balances induced by the reduction in the opportunity cost of holding money cannot take place directly through a once-and-for-all inflow of capital and an increase in private foreign indebtedness, as described above. For official reserves to expand, as before, and for the money supply to match the increased demand for money, requires now a sequence of current-account surpluses. In turn, because higher official reserves imply a reduction in the economy's net external debt (private foreign borrowing remaining constant), the lower deficit in the services account must be accompanied by a lower trade surplus, that is, higher private consumption.[4] Thus, with imperfect world capital markets, the adjustment process to a reduction in the devaluation rate displays transitional dynamics as well as steady-state real effects.

[4]The services-account deficit falls because, with private foreign borrowing remaining at its initial level, premium-related interest payments do not change in response to a reduction in the devaluation rate. Of course, as a result of the instantaneous portfolio adjustment described above, changes in the premium-related component of debt service affect the transitional dynamics of the economy.

8 EXTENSIONS

The analytical framework developed above can be extended in various directions. First, it is worth noting that households do not usually borrow directly on world capital markets, as is assumed in the model developed here. Private foreign borrowing is typically carried out through domestic financial intermediaries. By contrast, firms often borrow directly on world financial markets. Modeling firms' borrowing decisions—as a result of, say, investment-smoothing considerations—along the lines adopted here would be relatively straightforward. The risk premium, in particular, could be modeled as a function of the representative firm's ratio of debt to physical capital. The treatment of domestic financial intermediaries could proceed along the same lines, although some additional issues might arise in this context—such as the possibility, discussed by Agénor and Aizenman (1997a), that domestic lending rates may also incorporate a risk premium if the domestic credit market is imperfect.

Second, as noted in Chapter 2, the risk premium can be expected to be a convex function of the level of debt ($\theta_{L^*L^*} > 0$). Because the solution of the model was based on a linear approximation, however, the implications of this nonlinearity (a potential source of multiple equilibria) were not discussed. A more thorough examination of the stability properties of alternative long-run equilibria may provide additional insight into the dynamic adjustment to exogenous and policy shocks.[1]

Third, the use of the Cobb-Douglas utility function in the second stage of the consumption decision process, in addition to implying that expenditure shares are constant, imposes an intratemporal elasticity of substitution between consumption of home and tradable goods equal to unity. Empirical estimates, however, suggest a much smaller value. For instance, based on panel-data regressions

[1] As is well known, with multiple equilibria, comparative-statics exercises of the type conducted here may be difficult to interpret, because any exogenous shock might induce a switch from one equilibrium to another.

for thirteen developing countries, Ostry and Reinhart (1992) obtain an estimate of the intertemporal elasticity of substitution of about 0.3 and an estimate of the intratemporal elasticity of substitution in the range of 0.4 to 0.5.[2] Thus, the second-stage consumption decision process might be characterized better by using a more general constant elasticity of substitution utility function between tradable and nontradable goods.

Fourth, the assumptions of flexible wages and prices, although providing a useful benchmark, may not be realistic. Agénor (1997b) describes how backward- and forward-looking nominal-wage contracts can be integrated into the dependent-economy version of the model presented in this study. It is also relatively straightforward to introduce Dornbusch-type price stickiness in the home-goods sector.[3] Other extensions, such as endogenous labor supply, currency substitution (whereby both domestic and foreign currencies are held in agents' portfolios) could also prove valuable to study the dynamics of exogenous and macroeconomic policy shocks in the above setting. Nevertheless, the "core" features of the analysis remain those that were emphasized in the models presented above: with an upward-sloping supply curve of funds resulting from individual default risk, capital mobility is *de facto* imperfect. Domestic interest rates are determined by macroeconomic equilibrium conditions, rather than being tied to world interest rates. In addition, ensuring stationarity of consumption in the steady state does not require the rate of time preference to be equal at all times to the world interest rate. As was shown earlier, this is particularly important when considering permanent shocks to foreign interest rates.

[2] Almost all the evidence for developing countries, as reviewed by Agénor and Montiel (1996, chap. 10), suggests that the intertemporal elasticity of substitution, although significantly different from zero, is small. Reinhart and Végh (1995), for instance, estimate σ to be equal to 0.2 for Argentina, Chile, and Mexico, and to 0.5 for Uruguay. Atkeson and Ogaki (1996) estimate σ to be close to 0.3 for India. Okagi, Ostry, and Reinhart (1996) find that σ tends nevertheless to increase with the level of income and ranges from an average of 0.2 for low-income countries to 0.6 for middle-income countries.

[3] This material is available upon request.

9 CONCLUDING REMARKS

The purpose of this study has been to develop a model of imperfect world capital markets in which the cost of borrowing faced by individual domestic agents is positively related to their level of foreign borrowing, as well as to various idiosyncratic factors. The dependence of the risk premium on individual default risk has been viewed as a result of the absence (or lack of credibility) of government guarantees and of the possibility that private borrowers may not be capable (because of adverse liquidity shocks, for instance) of repaying the loan upon maturity. It should be emphasized that the argument is *not* that country risk—as measured by the overall economy's risk of default—does not exist or that it is irrelevant as far as private decisions are concerned; rather, the strategy has been to ignore it (or to capture it only to the extent that it possesses an exogenous component) in order to focus the analysis on the implications of individual default risk.

The analytical framework developed in this study departs from the existing literature in important ways. Some of the most popular intertemporal optimizing models used in open-economy macroeconomics assume perfect capital mobility. There are at least two difficulties with these models when dealing with small indebted economies in general and developing countries in particular. First, although the degree of capital mobility between many of these countries and the industrial world has certainly increased in recent years (and probably in dramatic fashion in some cases), the evidence continues to support the view that capital mobility is imperfect. Thus, the assumption of perfect capital mobility is potentially misleading. Second, to ensure a stationary level of consumption in the steady state, these models typically require that the rate of time preference be equal to the world interest rate. Such an assumption is not only arbitrary; it also implies that the dynamic adjustment process to policy shocks may exhibit a form of hysteresis.[1] The approach developed in this

[1] That is, the steady state may depend upon the economy's starting position, so that a temporary policy may have permanent effects. See Turnovsky (1995).

study does not impose these restrictions. It therefore offers a particularly useful framework for a positive (and, given its microeconomic foundations, normative) analysis of macroeconomic policy in small indebted economies.

This appendix establishes the impact and steady-state effects of the various shocks discussed in the text, using the dependent-economy version of the model.[1] To begin with, note that the linear approximation to the dynamic system (52) and (54) can be written as

$$\begin{bmatrix} \dot{c} \\ \dot{D} \end{bmatrix} = \begin{bmatrix} G_c & G_D \\ \Psi_c & \Psi_D \end{bmatrix} \begin{bmatrix} c - \tilde{c} \\ D - \tilde{D} \end{bmatrix}, \tag{A1}$$

with the equation of the saddlepath SS given by

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

where $\kappa \equiv (\nu - \Psi_D)/\Psi_c = G_D/(\nu - G_c) < 0$, ν denotes the negative root of (A1), and κ is the slope of SS.

Consider first a reduction in the risk-free rate, i^*. From equations (52) and (54), it can be established that

$$d\tilde{c}/di^* = (\Psi_{i^*}G_D - \Psi_D G_{i^*})/\Omega, \tag{A3}$$

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

where $\Omega = G_c\Psi_D - G_D\Psi_c < 0$ to ensure saddlepath stability, and (as discussed in the text) $\Psi_{i^*} > 0$. In order for $d\tilde{c}/di^* > 0$, it must be that

$$\Psi_{i^*}/\Psi_D < G_{i^*}/G_D = \varphi_{i^*+\varepsilon}/\varphi_D = \gamma^{-1}.$$

Equivalently, given the definitions of Ψ_{i^*} and Ψ_D,

$$\tilde{D} + (\tilde{\theta} + \tilde{L}^*\theta_{L^*})\lambda_{i^*+\varepsilon} < \gamma^{-1}\left[i^* + (\tilde{\theta} + \tilde{L}^*\theta_{L^*})\lambda_D\right],$$

or, because $\lambda_D = -i_m\beta$ and $\lambda_{i^*+\varepsilon} = -\beta$,

$$\tilde{D} - \beta(\tilde{\theta} + \tilde{L}^*\theta_{L^*}) < \gamma^{-1}\left[i^* - i_m\beta(\tilde{\theta} + \tilde{L}^*\theta_{L^*})\right],$$

[1]The derivations provided here refer only to permanent, unanticipated shocks. See Agénor (1996a) for the algebra of temporary shocks in models of this kind.

or again, because $\beta \equiv 1/(\gamma - i_m)$,

$$\gamma\tilde{D} < i^* + (\tilde{\theta} + \tilde{L}^*\theta_{L^*}).$$

Because $\tilde{\theta} + \tilde{L}^*\theta_{L^*} > 0$, it suffices to show that

$$\tilde{D} < i^*/\gamma. \tag{A5}$$

Now, because the initial steady-state level of debt is assumed to be positive, and with $\alpha = 0$, equation (25) yields $\tilde{D} = \tilde{L}^* - \tilde{R}^* = (\rho - i^*)/\gamma - \tilde{R}^* > 0$, or equivalently, $\rho/\gamma - \tilde{R}^* > i^*/\gamma$. Combining this result with condition (A5) on $\tilde{D}$ implies that $\rho/\gamma - \tilde{R}^* > \tilde{D}$ or equivalently, because $\tilde{D} = \tilde{L}^* - \tilde{R}^*$, $\rho/\gamma > \tilde{L}^*$. And because, by definition, $\tilde{L}^* = \rho/\gamma - i^*/\gamma$ and $i^* > 0$, inequality (A5) always holds and $d\tilde{c}/di^* > 0$.

Thus, from the equilibrium condition of the market for nontradable goods,

$$d\tilde{z}/di^* = z_c(d\tilde{c}/di^*) < 0, \tag{A6}$$

which shows that the real exchange rate depreciates.

To show that $d\tilde{D}/di^* < 0$, note that

$$d\tilde{D}/di^* = d\tilde{L}^*/di^* - d\tilde{R}^*/di^* = -\gamma^{-1} - d\tilde{R}^*/di^*,$$

From (27) and (A6), with $\tilde{z} = 1$,

$$d\tilde{R}^*/di^* = m_c d\tilde{c}/di^* - \delta\tilde{m}(d\tilde{z}/di^*) = (m_c - \delta\tilde{m}z_c)d\tilde{c}/di^* > 0,$$

which can be substituted in the previous equation to give

$$d\tilde{D}/di^* = -\gamma^{-1} - (m_c - \delta\tilde{m}z_c)d\tilde{c}/di^* < 0.$$

To determine the impact effects of a reduction in i^*, note that from equation (A2) and because $dD_0/di^* = 0$,

$$dc_0/di^* = d\tilde{c}/di^* - \kappa(d\tilde{D}/di^*),$$

which implies that, using (A3), (A4), and the definition of κ,

$$dc_0/di^* = \left[\Psi_{i^*}(G_D + \kappa G_c) - \nu G_{i^*})\right]/\Omega,$$

or equivalently, because $G_D + \kappa G_c = \kappa\nu$,

$$dc_0/di^* = -\nu(G_{i^*} - \kappa\Psi_{i^*})/\Omega < 0. \qquad \text{(A7)}$$

Thus, from the equilibrium condition of the market for nontradable goods

$$dz_0/di^* = z_c(dc_0/di^*) > 0, \qquad \text{(A8)}$$

and from (36), output of nontradable (tradable) goods rises (falls) on impact.

Suppose that the initial level of foreign debt is not too large, so that φ_c in equation (50) is positive. Equations (50) and (A7) imply that

$$dm_0/di^* = \varphi_c dc_0/di^* + \varphi_{i^*+\varepsilon} < 0, \qquad \text{(A9)}$$

so that real money balances increase on impact. This result also implies that, using equation (13),

$$\begin{aligned} di_0/di^* &= i_c(dc_0/di^*) + i_m(dm_0/di^*) \\ &= (i_c + i_m\varphi_c)(dc_0/di^*) + i_m\varphi_{i^*+\varepsilon} \gtrless 0, \end{aligned} \qquad \text{(A10)}$$

where, as shown in the text, $i_c + i_m\varphi_c = \gamma\beta(i_c + +i_m\delta z_c\tilde{R}^*) > 0$ and $i_m\varphi_{i^*+\varepsilon} = -i_m\beta > 0$. Because consumption rises on impact ($dc_0/di^* < 0$), the movement in the domestic nominal interest rate is ambiguous. If the degree of intertemporal substitution, σ, is sufficiently low, the domestic interest rate will fall on impact.

Because $dD_0/di^* = 0$, $dL_0^*/di^* = dR_0^*/di^*$. Thus, using (A8),

$$dL_0^*/di^* = dm_0/di^* - \delta\tilde{m}(dz_0/di^*) < 0, \qquad \text{(A11)}$$

so that private foreign borrowing increases on impact. Equivalently, because from (42),

$$dL_0^*/di^* = (di_0/di^* - 1)/\gamma, \qquad \text{(A12)}$$

it must be that $|di_0/di^*| < 1$. Put differently, if the domestic nominal interest rate falls, it must fall by less than the reduction in the world risk-free interest rate.

Consider now a shock to government spending on home goods, g_N. From equations (52) and (54),

$$d\tilde{c}/dg_N = (\Psi_{g_N} G_D - \Psi_D G_{g_N})/\Omega, \tag{A13}$$

$$d\tilde{D}/dg_N = (\Psi_c G_{g_N} - G_c \Psi_{g_N})/\Omega. \tag{A14}$$

For $d\tilde{c}/dg_N < 0$ to hold requires that

$$\Psi_{g_N}/\Psi_D > G_{g_N}/G_D = \varphi_{g_N}/\varphi_D = -\delta z_{g_N} \tilde{R}^*,$$

so that

$$\Psi_{g_N} + \delta z_{g_N} \tilde{R}^* \Psi_D > 0,$$

which always holds if the initial level of foreign assets held by the central bank $\tilde{R}^*$ is sufficiently small (because in that case, $\varphi_{g_N} \to 0$); this is the case depicted in Figure 4. From (27), $d\tilde{m}/dg_N = m_c(d\tilde{c}/dg_N) < 0$.

Similarly, for $d\tilde{D}/dg_N > 0$ to hold requires that, with $\tilde{R}^* \to 0$ and thus $G_{g_N} \to 0$,

$$\Psi_c/\Psi_{g_N} > 0,$$

which always holds.

From equation (41),

$$d\tilde{z}/dg_N = z_c(d\tilde{c}/dg_N) + z_{g_N}. \tag{A15}$$

For $d\tilde{z}/dg_N < 0$, it must be that, using (A13),

$$z_c(\Psi_{g_N} G_D - \Psi_D G_{g_N})/\Omega < -z_{g_N},$$

so that, given the definition of Ω and $G_{g_N} \to 0$ (that is, $\tilde{R}^*$ small),

$$\Psi_c - \frac{z_c \Psi_{g_N}}{z_{g_N}} > \frac{\Psi_D G_c}{G_D}.$$

Noting that $\lambda_{g_N} \to 0$ with $\tilde{R}^*$ small, this condition can be shown to be equivalent to

$$1 - \delta > -i^* i_c / i_m, \tag{A16}$$

which holds if the risk-free rate is small enough.[2]

Using equations (A2) and (A13) and noting that $dD_0/dg_N = 0$,

$$dc_0/dg_N = d\tilde{c}/dg_N - \kappa(d\tilde{D}/dg_N) = -\nu(G_{g_N} - \kappa\Psi_{g_N})/\Omega < 0, \quad \text{(A17)}$$

because, again, $G_D + \kappa G_c = \kappa\nu$. By implication,

$$dz_0/dg_N = z_c dc_0/dg_N + z_{g_N} \gtrless 0.$$

Equations (50) and (A17) imply that

$$dm_0/dg_N = \varphi_c(dc_0/dg_N) + \varphi_{g_N} < 0,$$

and, using equation (13),

$$di_0/dg_N = (i_c + i_m\varphi_c)(dc_0/dg_N) + i_m\varphi_{g_N}, \quad \text{(A18)}$$

which is, in general, ambiguous. As shown above, $i_c + i_m\varphi_c > 0$; if $\tilde{R}^*$ is sufficiently small, so that φ_{g_N} itself is sufficiently small, $di_0/dg_N < 0$. In that case, from (42) and (A18),

$$dL_0^*/dg_N = \gamma^{-1}(di_0/dg_N) < 0.$$

Finally, consider the case of a reduction in ε. The steady-state effects on c and D are given by

$$d\tilde{c}/d\varepsilon = (\Psi_\varepsilon G_D - \Psi_D G_\varepsilon)/\Omega, \quad d\tilde{D}/d\varepsilon = (\Psi_c G_\varepsilon - \Psi_\varepsilon G_c)/\Omega, \quad \text{(A19)}$$

where, as established in the text, $G_\varepsilon, \Psi_\varepsilon < 0$. To show that $d\tilde{c}/d\varepsilon < 0$ requires showing that $\Psi_\varepsilon G_D - \Psi_D G_\varepsilon > 0$ or that

$$\Psi_\varepsilon/\Psi_D > G_\varepsilon/G_D = (i_m\varphi_{i^*+\varepsilon} - 1)/i_m\varphi_D = i_m^{-1},$$

[2]Note that the saddlepath stability condition $\Omega < 0$ implies that $\Psi_c > \Psi_D G_c/G_D$ or equivalently

$$(1-\delta) > -i^* i_c/i_m + z_c[y_T^{s\prime} + \delta(1-\delta)\tilde{c}],$$

which always holds for i^* small enough.

or, equivalently,

$$(\tilde{\theta} + \tilde{L}^*\theta_{L^*})\lambda_{i^*+\varepsilon} > i_m^{-1}\left[i^* + (\tilde{\theta} + \tilde{L}^*\theta_{L^*})\lambda_D\right].$$

Again, with $\lambda_D = -i_m\beta$ and $\lambda_{i^*+\varepsilon} = -\beta$,

$$-\beta(\tilde{\theta} + \tilde{L}^*\theta_{L^*}) > i_m^{-1}\left[i^* - i_m\beta(\tilde{\theta} + \tilde{L}^*\theta_{L^*})\right],$$

or $i^*/i_m < 0$, which always holds. From the equilibrium condition of the home-goods market,

$$d\tilde{z}/d\varepsilon = z_c(d\tilde{c}/d\varepsilon) > 0. \tag{A20}$$

From the steady-state condition (24), $d\tilde{i}/d\varepsilon = 1$. From (27),

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

and from (A20),

$$d\tilde{R}^*/d\varepsilon = d\tilde{m}/d\varepsilon + \delta\tilde{m}(d\tilde{z}/d\varepsilon) < 0.$$

This result implies, because $d\tilde{L}^*/d\varepsilon = 0$,

$$d\tilde{D}/d\varepsilon = -d\tilde{R}^*/d\varepsilon > 0.$$

On impact, using (A2) and (A19) and noting that $dD_0/d\varepsilon = 0$ and $G_D + \kappa G_c = \kappa\nu$,

$$dc_0/d\varepsilon = d\tilde{c}/d\varepsilon - \kappa(d\tilde{D}/d\varepsilon) = -\nu(G_\varepsilon - \kappa\Psi_\varepsilon)/\Omega > 0,$$

so that

$$dz_0/d\varepsilon = z_c(dc_0/d\varepsilon) < 0. \tag{A21}$$

From the equilibrium condition of the money market,

$$di_0/d\varepsilon = (i_c + i_m\varphi_c)(dc_0/d\varepsilon) + i_m\varphi_{i^*+\varepsilon} > 0, \tag{A22}$$

because $i_c + i_m\varphi_c$ and $i_m\varphi_{i^*+\varepsilon}$ are both positive. It can be established that $di_0/d\varepsilon \to 1$ when $\gamma \to 0$, and that $di_0/d\varepsilon < 1$ for $\gamma > 0$.

Finally, from equation (42), and given that $di_0/d\varepsilon < 1$,

$$dL_0^*/d\varepsilon = \gamma^{-1}\{(di_0/d\varepsilon) - 1\} < 0.$$

Because $dD_0/d\varepsilon = 0$, $dR_0^*/d\varepsilon = dL_0^*/d\varepsilon < 0$. Thus, using (A21),

$$dm_0/d\varepsilon = d(z_0^\delta R_0^*)/d\varepsilon = \delta\tilde{R}^*(dz_0/d\varepsilon) + dR_0^*/d\varepsilon < 0.$$

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