6

Determinants of the Long-Run Equilibrium Real Exchange Rate: An Analytical Model

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In the previous chapter, the long-run equilibrium real exchange rate (LRER) was defined as the value of the real exchange rate that emerges from the economy's macroeconomic equilibrium when policy and exogenous variables are at sustainable "permanent" levels and when the operationally relevant subset of the economy's predetermined variables have settled into their steady-state configurations. As indicated there, the sustainable values of the policy and exogenous variables, as well as the actually prevailing values of the slower-adjusting predetermined variables, together constitute the set of "long-run fundamentals" that determine the long-run equilibrium real exchange rate.

Identifying these fundamentals precisely and concretely is an important step in estimating the LRER, because the dynamic behavior of these variables is what ultimately determines the path followed by the real exchange rate over time. Making this identification requires the use of a specific analytical model that is capable of explaining the time path followed by the real exchange rate in response to macroeconomic shocks. In the context of such a model, those shocks that alter the value of the real exchange rate in the economy's long-run equilibrium constitute the

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relevant set of long-run fundamentals. A wide variety of such shocks, operating on both the demand and supply sides of the economy, have been identified by economists at different times, using diverse analytical frameworks.[1] The purpose of this chapter is to present a unified treatment, within a single analytical framework, of the problem of identifying the long-run fundamentals for the real exchange rate.

As indicated in the previous chapter, an important step in identifying the fundamentals is determining how the economy's net international creditor position is to be treated. The issue is whether adjustment in the net creditor position is sufficiently rapid as to be completed within the policy horizon (in which case the net creditor position is endogenously determined and does not constitute a "fundamental") or whether slow adjustment in this variable makes it more appropriate to condition the LRER on a given value of the net creditor position (in which case that value becomes one of the fundamentals). The model described in this chapter is one in which the LRER is defined as the real exchange rate that is compatible with steady-state equilibrium for the economy's net international creditor position, conditioned on the permanent values of a variety of policy and exogenous variables. Thus, of the alternative definitions of "external balance" discussed in the previous chapter, the model developed here adopts the "stock" rather than "flow" approach, implying that the economy's international net creditor position does not appear among the set of conditioning long-run fundamentals. This set consists instead only of exogenous and policy variables.

The chapter's objectives are to identify the relevant set of variables, and to explore the direction of their influence on the LRER, in the context of an analytical model that is intended to be familiar and transparent, yet sufficiently general so as to accommodate a wide variety of factors that could potentially influence the LRER. The model adopted for the purpose is an extended version of a well-known model by Dornbusch (1983), which has become a familiar analytical tool for macroeconomists working on developing countries. By specifying a comprehensive set of "fundamental" LRER determinants in this familiar framework, and analyzing their effects on the long-run equilibrium real exchange rate, this chapter will set the stage for the empirical ones that follow.

The chapter is organized as follows: The first two sections describe the analytical framework and how the model can be solved for the long-run equilibrium real exchange rate. Then comes the heart of the chapter, titled "Long-Run Fundamentals," which explores the properties of the

1. The most comprehensive treatment of equilibrium real exchange rates in the developing-country context is in Edwards (1989). See also Mussa (1986), Montiel (1986), Khan and Lizondo (1987), as well as Khan and Montiel (1987).

long-run equilibrium using a graphical presentation relying on the concepts of internal and external balance that have become familiar in the literature on real exchange rate determination.[2] The focus of that section is specifically on how changes in exogenous variables affect the equilibrium value of the real exchange rate. A recap of the results in that section is then presented under "Summary and Conclusions."

The Analytical Framework

This section describes an analytical framework designed to identify the determinants of the long-run equilibrium real exchange rate in a "representative" developing country. The model is highly stylized and will obviously be a poor representation of any particular developing economy. However, it represents a common analytical framework used by many observers in thinking about real exchange rate issues in the context of such countries. Indeed, the model described below essentially adds several extensions to a framework originally developed by Dornbusch (1983).[3] The framework is not only a familiar one, but as illustrated in "Long-Run Fundamentals" below, it also has the virtue of ready adaptability to incorporate a variety of phenomena not built into its basic structure, but that may be empirically important in the circumstances of specific countries.

The model is intended to analyze the determination of the real exchange rate in a small open economy with a predetermined nominal exchange rate and flexible domestic wages and prices.[4, 5] The economy is given a two-

2. The formal dynamic solution to the model is not directly relevant to the narrow purpose of understanding the properties of its long-run equilibrium, so readers are referred to Montiel (1998), which also establishes the stability of the long-run equilibrium and describes how its qualitative properties can be established formally.

3. The key extensions are the introduction of money and of an endogenous country risk premium. Less importantly, the model is specified in continuous time, in contrast with the discrete-time formulation in Dornbusch (1983).

4. The assumption of wage-price flexibility merits some comment. The issue is problematic in the developing-country context. A review of evidence is presented in Agenor and Montiel (1999). The assumption of full wage-price flexibility is innocuous as long as the focus is on the long-run results of the section on long-run fundamentals, since the long run will be characterized by full employment in any event. It becomes very important, however, in the analysis of short-run misalignment and optimal management of the nominal exchange rate.

5. Officially determined exchange rates remain the rule for the vast majority of developing countries. Fully flexible rates are rare, and more exotic arrangements such as dual rates have become less common in recent years (see Agenor and Montiel 1999). The assumption of predetermined rates will be implemented in the form of a crawling peg below, which includes a fixed exchange rate as a special case.

sector "dependent economy" production structure, and is assumed to be financially open.[6] Trade restrictions are absent in the reference model described in this section, but are incorporated in the section on long-run fundamentals.

Production

The economy in question is assumed to be a price taker in the world market for what it buys and sells. Its domestic production structure is of the Swan-Salter variety, consisting of traded- and nontraded-goods sectors that produce outputs y_T and y_N respectively.[7] Output in each sector is produced with a fixed, sector-specific factor and homogeneous, perfectly mobile labor, and is subject to diminishing marginal returns to the variable factor.[8] Letting w denote the real wage measured in terms of *traded* goods and e the real exchange rate measured as the relative price of traded goods in terms of nontraded goods, employment in the two sectors is determined by the profit-maximizing conditions $y_T'(L_T) = w$ and $y_N'(L_N) = we$, which imply labor demand functions $L_T(w)$ and $L_N(we)$ with the usual properties. Labor market equilibrium is given by equation 6.1 below:

$$L_T(w) + L_N(we) = L \tag{6.1}$$

where L denotes the fixed labor force. This condition implies that the equilibrium real wage is a decreasing function of the real exchange rate, as shown by equation 6.2:

$$\begin{gathered} w = w(e), \text{ with} \\ w' = -wL_N' / (L_T' + L_N'e) < 0 \ . \end{gathered} \tag{6.2}$$

Aggregate real output in this economy, measured in terms of traded goods and denoted y, is thus given by equation 6.3:

6. For evidence that financial openness with imperfect substitutability has been the relevant empirical assumption for a "representative" developing country, see Montiel (1995).

7. To capture the effects of terms-of-trade changes and commercial policy on the equilibrium real exchange rate, a three-good structure (with exportables, importables, and nontraded goods) would be more appropriate. Rather than complicate the notation at this point, however, I will describe the model with the two-good dependent-economy framework and then indicate at the appropriate point how these phenomena can be incorporated into the analysis (see the subsection "Changes in the Terms of Trade" in the section on long-run fundamentals).

8. This assumption implies that the economy possesses a standard concave production possibilities frontier relating maximum values of y_T and y_N.

$$y(e) = y_T\left[L_T(w(e))\right] + y_N\left[L_N(w(e)e)\right]/e$$
$$= y(e), \text{ with:} \tag{6.3}$$
$$y' = -y_N / e^2 < 0\,.$$

Household Behavior

The demand side of the model reflects the actions of households and of the consolidated public sector. Households receive income from production, out of which they pay taxes, consume, and save. Their saving can be allocated to the accumulation of net foreign bonds or domestic money, and portfolio equilibrium is assumed to hold continuously.

The problem faced by the representative household can be described as follows: At each instant, it allocates its net worth, denoted *a*, between net bond holdings f_H and domestic money *m* (both measured in terms of traded goods), subject to the balance sheet constraint (equation 6.4):

$$a = f_H + m. \tag{6.4}$$

Bonds may be denominated in domestic or foreign currency. Foreign currency–denominated bonds pay the nominal interest rate i^*, while domestic currency–denominated bonds pay the interest rate *i*, and the two are related through the uncovered parity condition, defined by equation 6.5:

$$i = i^* + \varepsilon, \tag{6.5}$$

where ε is the rate of depreciation of the domestic currency.[9]

The holding of money is motivated by a desire to avoid the transactions costs associated with consumption. Such costs are given by equation 6.6:

$$T(m,c) = \tau(m/c)c;\ \tau' < 0, \tau'' > 0, \tag{6.6}$$

where *c* is total consumption expenditure measured in terms of traded goods. This specification postulates that transactions costs per unit of consumption are a decreasing function of the stock of money per unit of consumption, but that the productivity of money in reducing transactions costs is subject to diminishing returns. The accumulation of net

9. Adding an exogenous currency risk premium to this condition would not affect any of the properties of the model.

worth over time is the sum of household saving and net real capital gains or losses. It can be expressed in the form of the budget constraint shown by equation 6.7:

$$\dot{a} = y + (i^* + \varepsilon) f_H - t - (1 + \tau)c - \pi^* a \tag{6.7}$$

where t denotes real (lump-sum) taxes, and π^* is the rate of increase in the domestic-currency price of traded goods. The latter, in turn, is the sum of the rate of depreciation of the domestic currency and the external inflation rate, denoted π_W:

$$\pi^* = \varepsilon + \pi_W.$$

The path of consumption expenditure is determined by the maximization over an infinite horizon of an additively separable utility function in which future felicity (that is, the future flow of utility) is discounted at the constant rate of time preference ρ. Consumption of traded goods, denoted c_T, and of nontraded goods c_N, are the only direct sources of utility for the household. Thus the representative household will seek to maximize a function of the form:

$$\int u(c_T, c_N) e^{-\rho t} dt$$

To make the analysis more tractable, I will give the felicity function $u(c_T, c_N)$ a specific form. Following Dornbusch (1983), I will assume that the felicity function is of the constant relative risk aversion (CRRA) type in total consumption, while the intratemporal elasticity of substitution between the two types of goods is unity. This means that the felicity function can be written as equation 6.8:

$$u(c_T, c_N) = \frac{[c_T^{\theta} c_N^{1-\theta}]^{1-\sigma}}{1-\sigma} \tag{6.8}$$

The parameter θ represents the share of traded-goods consumption in total consumption expenditure (see below), while σ is the inverse of the intertemporal rate of substitution. The Cobb-Douglas specification for intratemporal substitution between the two types of goods implies that consumption expenditure is allocated in constant shares between the two types of consumption goods as shown in equation 6.9:

$$\begin{aligned} c_T &= \theta_c \\ c_N &= (1-\theta)ec \end{aligned} \tag{6.9}$$

where total consumption expenditure c is given by $c = c_T + c_N/e$. Using these in equation 6.8 permits us to express the felicity function in the indirect form in equation 6.10:

$$u(c_T, c_N) = v(e, c) = \frac{\kappa[e^{1-\theta}c]^{1-\sigma}}{1-\sigma} \tag{6.10}$$

where κ is a constant. The term in square brackets is the ratio of the price of traded goods to the "true" consumption price index $P_T^{\theta} P_N^{1-\theta}$ (where P_T is the domestic-currency price of traded goods, and P_N is the domestic-currency price of nontraded goods) times total consumption measured in terms of traded goods. Thus this term measures total consumption in units of the consumption bundle, which is the direct source of utility for the household.

The household's problem can thus be stated as follows: it chooses paths for consumption expenditure c and money m so as to maximize:

$$\int_0^{\infty} \frac{[\kappa e^{1-\theta}c]^{1-\theta}}{1-\sigma} \exp(-\rho t)dt \tag{6.11}$$

subject to the flow-budget constraint (equation 6.7) and a transversality condition. These constraints can conveniently be written as equation 6.12:

$$\begin{gathered} \dot{a} = y - t + ra - im - (1+\tau(m/c))c \\ \lim a \exp(-\int rdt) \succeq 0 \end{gathered} \tag{6.12}$$

where r is the real interest rate earned by domestic residents on their holdings of foreign bonds, measured in terms of traded goods ($r = i - \pi^*$). This is equivalent to the external nominal interest rate i^* faced by domestic residents, minus the foreign-currency rate of inflation in the price of traded goods:

$$r = i - \pi^* = (i^* + \varepsilon) - (\pi_W + \varepsilon) = i^* - \pi_W.$$

The present-value Hamiltonian for this problem can be written as:

$$H = (\frac{[\kappa e^{1-\theta}c]^{1-\sigma}}{1-\sigma} + \lambda\dot{a})\exp(-\rho t)$$

where λ is the costate variable for the household's financial wealth a, with economic interpretation as the marginal utility of wealth. The solution of this problem is characterized by the first-order conditions shown in equations 6.13.a through 6.13.b:

(6.13.a) $$\kappa e^{\gamma} c^{-\sigma} = \lambda(1 - \tau(m/c) - \tau'(m/c))c$$

(6.13.b) $$-\tau'(m/c) = i$$

(6.13.c) $$\lambda(\rho - r) = \dot{\lambda}$$

as well as the budget constraint and transversality conditions given in equation 6.12. These conditions have intuitive interpretations. Equation 6.13.a describes the necessary condition for the level of consumption to be at its optimal level at each instant, conditional on the marginal utility of wealth. It states that the marginal utility gain from an extra unit of consumption must be equal to its marginal utility cost—that is, the loss arising from forgone saving. The latter is the product of the marginal utility of wealth λ and the reduction in saving associated with an extra unit of consumption, given by the quantity $(1 + \tau + \tau')$, which includes the transaction costs associated with each extra unit of consumption. Equation 6.13.b is the necessary condition for the allocation of the household portfolio between money and bonds to be at its optimal level, conditional on the level of consumption expenditure. It states that the marginal gain from holding an extra unit of money, in the form of reduced transaction costs, must be equal to its marginal cost, in the form of forgone interest. Finally, equation 6.13.c is necessary for wealth to be allocated optimally over time. It states that since wealth should be drawn down more quickly (through increased consumption) when the household is more impatient (that is, when ρ is large relative to r), the marginal utility of wealth should rise more rapidly under those conditions.

These equations can be used to describe the household's demand for money, the path of its consumption expenditure, and its rate of accumulation of financial assets at each moment in time. Equation 6.13.b implicitly defines a relationship between money and consumption that resembles a standard money-demand equation, shown in equation 6.14:

(6.14) $$m = h(i)c, \; h' < 0.$$

Thus the demand for money depends in familiar fashion on the interest rate and the level of transactions. To derive an expression for the path of consumption expenditure, differentiate equation 6.13.a with respect to time. Using equations 6.13.b, 6.13.c, and 6.14, we can derive the time path of consumption. It is given by equation 6.15:

(6.15) $$\dot{c} = \sigma^{-1}\left[r + \gamma \dot{e}/e - \frac{h(i)\dot{i}}{1 + \tau(h(i)) + ih(i)} - \rho \right] c$$

where $\gamma = (1 - \sigma)(1 - \theta)$. This represents a generalization of the familiar Euler equation for the optimal time path of consumption under constant relative risk aversion, to incorporate changing relative prices of the two consumption goods as well as the role of the transactions technology. Note that, given the real interest rate measured in terms of traded goods r:

a. An expected real depreciation makes consumption cheaper in the future (since it implies a lower relative price of nontraded goods). This increases the consumption-based real interest rate (the opportunity cost of current consumption), which steepens the consumption path (thereby discouraging current consumption), and
b. A steepening of the path of the future nominal interest rate (a positive value of $\dot{i}$) would tend to increase the transactions costs associated with future consumption, thus decreasing the consumption-based real interest rate, which tends to tilt the consumption path toward the present, making it flatter.

The Consolidated Public Sector

The consolidated public sector includes both the government and the central bank. The economy operates with a predetermined exchange rate, administered as a crawling peg in which the domestic currency depreciates continuously at the policy-determined rate ε. The central bank's functions consist of maintaining the parity (by exchanging domestic and foreign currency for each other on demand in unlimited amounts at the official exchange rate) and providing credit to the government. The latter, in addition to credit from the central bank, receives lump-sum taxes from the private sector and spends by purchasing both traded and nontraded goods, in the amounts g_T and g_N, respectively. Thus the consolidated period-by-period (flow) budget constraint of the public sector can be expressed as equation 6.16:

(6.16) $$\dot{f}_C = t + rf_C + (\dot{m} + \pi^* m) - (g_T + g_N / e)$$

where $\dot{f}_C$, which may be positive or negative, is the stock of bonds held by the consolidated public sector. Like the private sector, the government has to respect an intertemporal budget constraint, given by lim $\dot{f}_C$ exp(-*r dt)>0.

For concreteness, I shall assume that it does so in a particularly simple way—by levying taxes in an amount sufficient to keep $\dot{f}_C - \dot{m} = 0$. Notice that this does not imply a balanced budget, but rather a reliance on the inflation tax to finance fiscal deficits.

Equilibrium Conditions

The model is closed with two equilibrium conditions. The first is an arbitrage relationship describing the terms on which the rest of the world will lend to the domestic economy, and the second characterizes equilibrium in the market for nontraded goods.

The Supply of Funds

Though the home country is a price taker in the world goods market, its financial liabilities are not perfect substitutes for those of the rest of the world, and thus the interest rate at which residents of the country can borrow abroad reflects a risk premium, which is an increasing function of the share of the country's liabilities held in world financial portfolios. This is incorporated in the model in the form of an upward-sloping supply-of-funds schedule relating the external interest rate confronted by the country's residents, i^*, to the country's net international indebtedness, as well as to world financial conditions, measured by the world interest rate i_W. The specific formulation expresses i^* as the sum of the world interest rate and a risk premium p, which is inversely related to the country's aggregate net creditor position, as expressed by equation 6.17:

(6.17) $$i^* = i_W + p(f),\ p(0) > 0,\ p' < 0.$$

The supply-of-funds schedule described by equation 6.17 is depicted as the curve i^* in figure 6.1.[10] The external interest rate faced by the economy is determined by the height of this schedule above the relevant value of the net external asset position f.

Equilibrium in the Market for Nontraded Goods

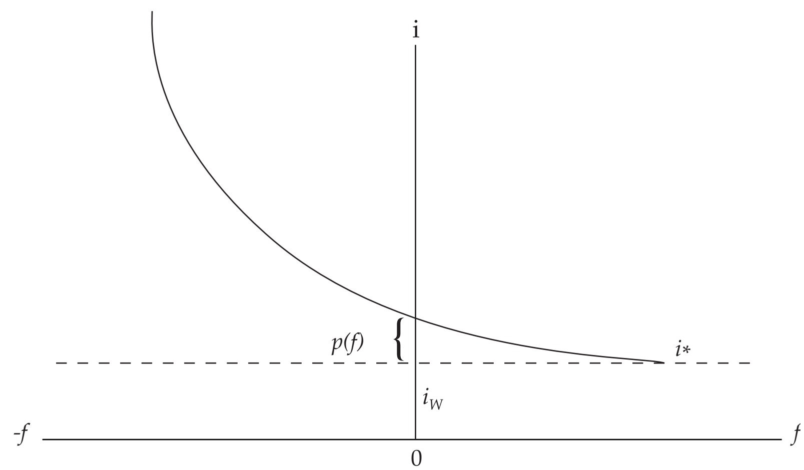
Finally the equilibrium condition in the market for nontraded goods can be expressed as equation 6.18:

(6.18) $$\begin{aligned} y_N(e) &= c_N + g_N \\ &= (1-\theta)ec + g_N \end{aligned}.$$

For future reference, it is worth noting that the specification of equilibrium in the nontraded-goods market (equation 6.18) implies that all

10. For a similar specification, see Bhandari, Haque, and Turnovsky (1990). Agenor (1997) provides more detail on this specification and how it relates to alternative approaches to modeling international capital market imperfections.

Figure 6.1 ***The Supply-of-Funds Schedule***



production of nontraded goods is available for consumption, either by the households or by the government. This has the consequence that the transactions costs associated with consumption must absorb traded goods only. This assumption is not necessary and is discussed further below.

Equation 6.18 can be solved for the value of the real exchange rate that clears the nontraded-goods market, conditional on the values of c and g_N. This short-run equilibrium real exchange rate is given by equation 6.19:

$$
\begin{aligned}
&e = e(c, g_N) \\
&e_1 = (1-\theta)e/(y_N' - (1-\theta)c) < 0 \\
&e_2 = 1/(y_N' - (1-\theta)c) < 0 \ .
\end{aligned}
\tag{6.19}
$$

The real exchange rate that solves equation 6.19 is a *short-run* equilibrium one in the sense that it clears the market for nontraded goods for a *given* value of private consumption expenditure c. Thus, this real exchange rate will be sustainable only to the extent that c is itself sustainable.

The Long-Run Equilibrium Real Exchange Rate

As shown in Montiel (1998), the model of the previous section can be solved to derive the entire dynamic path of the real exchange rate and other endogenous macroeconomic variables in response to a variety of macroeconomic shocks, be they transitory or permanent, occurring in the present, or expected to occur in the future. A key characteristic of the model is that the economy it describes tends to settle into a steady-state equilibrium after a shock in which the stock of net international indebtedness and the real exchange rate are both unchanging.[11]

This section examines the properties of that equilibrium. Since the focus is specifically on the determination of the long-run equilibrium real exchange rate, the solution method chosen in this section is one that focuses specifically on that variable and links up with the traditional literature that views the equilibrium real exchange rate as that value of the real exchange rate that is consistent with the simultaneous attainment of internal and external balance.

To solve the model, we first reduce it to a smaller number of key relationships. The first step is to consolidate the budget constraints of the household and public sectors. To do so, we differentiate the household balance sheet constraint (equation 6.4) and substitute into the flow-budget constraint (equation 6.12). This permits equation 6.12 to be written as equation 6.12´:

$$\dot{f}_H = y - t + rf_H - (\dot{m} + \pi^* m) - (1 + \tau(m/c))c \,. \qquad (6.12')$$

Adding equations 6.12' and 6.16 together, and using the definitions of y and c as well as the equilibrium condition in the nontraded-goods market (equation 6.18), we have equation 6.20:

$$\dot{f} = y_T(e) + rf - (\theta + \tau(m/c))c - g_T \,. \qquad (6.20)$$

This is the flow-budget constraint for the economy as a whole. Recalling that $c_T = \theta c$, and that transactions costs are assumed to be incurred in traded goods, aggregate demand for traded goods is given by $(\theta c + g_T)$, and aggregate supply is $(y_T - \tau c)$. Thus, aggregate excess supply of traded goods, equal to the real trade balance surplus, is $(y_T - \tau c)$ - $(\theta c - g_T) = y_T - (\tau + \theta)c - g_T$. Adding the receipt of real interest payments from abroad (recall that f is the country's international net creditor position) yields the inflation-adjusted current account surplus, measured in units of traded goods, which is the right-hand side of equation 6.20. This is equated to the change in the economy's real net creditor position ($\dot{f}$). This equation thus determines how the real net creditor position evolves over time.

11. As is common with models of this type, that equilibrium is unique and saddlepoint stable.

Private spending, in turn, evolves over time according to the Euler equation 6.15, reproduced here for convenience:

$$\dot{c} = \sigma^{-1}\left[r + \gamma\dot{e}/e - \frac{h(i)\dot{i}}{1+\tau(h(i))+ih(i)} - \rho \right]c \; . \tag{6.15}$$

As is evident from equation 6.15, the evolution of private expenditure over time is itself dependent on the paths of the real exchange rate and domestic nominal interest rates. These are determined respectively by the nontraded-goods market equilibrium condition (equation 6.19, reproduced below for reference) and the arbitrage condition (equation 6.5), reproduced below as equation 6.5´:

$$e = e(c, g_N) \tag{6.19}$$

$$i = (r + \pi_W + p(f)) + \varepsilon \tag{6.5´}$$

where equation 6.5 has been modified to take into account the foreign Fisher relationship and the supply-of-funds schedule (equation 6.17).

To analyze the properties of the long-run equilibrium real exchange rate, begin by imposing the long-run equilibrium conditions $\dot{c} = \dot{e} = \dot{i}$ in the Euler equation 6.15. This implies the steady-state condition equation 6.21:

$$\begin{aligned} \rho &= r \\ &= r_W + p(f). \end{aligned} \tag{6.21}$$

Since r_W and ρ are both exogenous, this equation determines the long-run equilibrium value of the net international creditor position for this economy, f^*.[12] Because the premium p is a decreasing function of the net creditor position f, the equation implies that countries with a high rate of time preference will be driven to have a smaller stock of net external claims in long-run equilibrium than those with lower rates of time preference.

Next, to derive the long-run equilibrium value of the domestic *nominal* interest rate, substitute equation 6.21 in 6.5′, yielding equation 6.22:

$$\begin{aligned} i &= (\rho + \pi_W) + \varepsilon \\ &= \rho + \pi^* \end{aligned} . \tag{6.22}$$

12. This value can be positive or negative, without violating the transversality conditions on the private and public sectors.

This value of i pins down the long-run values of consumption velocity h and transactions cost per unit of consumption τ, as expressed in equations 6.23 and 6.24:

$$h^* = h(i) = h(\rho + \pi^*) \tag{6.23}$$

$$\tau^* = \tau[h(i)] = \tau[h(\rho + \pi^*)]. \tag{6.24}$$

With these results in hand, the conditions that characterize the long-run equilibrium real exchange rate in this model can be described. Using equations 6.22 and 6.24 in 6.21 yields equation 6.25:

$$0 = y_T(e) + \rho \dot{f} - (\tau[h(\rho + \pi^*)] + \theta)c - g_T. \tag{6.25}$$

This is the long-run external balance condition in the model. It states that for the economy's real external net creditor position to reach an equilibrium value, the inflation-adjusted current account balance must be zero. An alternative and more useful formulation, however, focuses on the conventional (non-inflation-adjusted) current account balance. Adding the inflation adjustment $\pi_W f^*$ to both sides, we can write equation 6.25 as 6.25´:

$$\pi_W f^* = y_T(e) + (\rho + \pi_W) f^* - (\tau\lfloor h(\rho + \pi_W + \varepsilon\rfloor) + \theta)c - g_T. \tag{6.25´}$$

Condition 6.25´ states that in long-run equilibrium the real current account balance, which is equal to real national saving, must be equal to the inflationary erosion of the real value of the country's net claims on the rest of the world.[13] The latter represents the sustainable value of the country's capital account balance. A net creditor country (with a positive value of f^*) would run a sustainable current account surplus and capital account deficit that would enable it to acquire claims on the rest of the world that are sufficient to offset the inflationary erosion of its existing claims. By contrast, a net debtor country would run a sustainable current account deficit and capital account surplus, accumulating

13. The model from which equation 6.25 was derived does not feature growth of productive capacity. In a growth context—for example, with constant Harrod-neutral technical change at the rate n—steady-state equilibrium would require constancy of the country's net international creditor position per effective worker, so the left-hand side of equation 6.25 would be modified to $(n + \pi_W)f$. In a growth context, a net debtor country would be able to run larger sustainable current account deficits than in the static case.

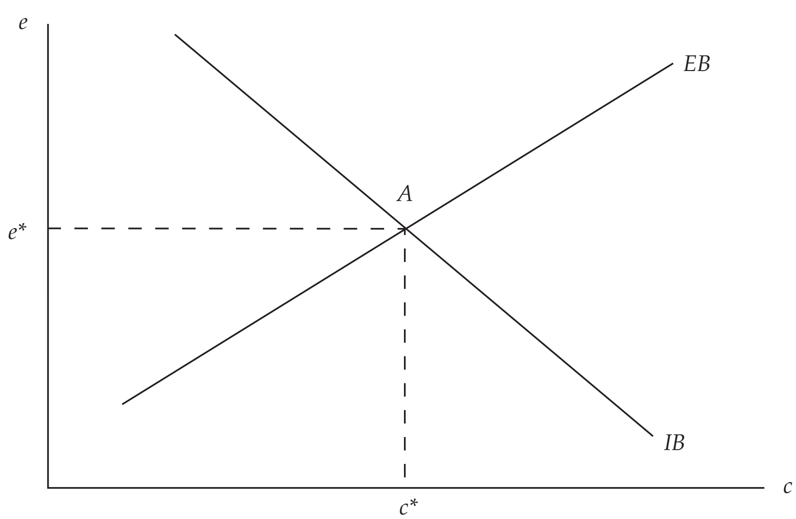
new debt sufficient to offset the effective amortization of its existing debt through the inflation component of its nominal interest payments.

Since y_T is increasing in the real exchange rate e, and since an increase in consumption expenditure reduces the trade surplus, the set of combinations of e and c that satisfies equation 6.25′ is plotted as the positively sloped external balance locus *EB* in figure 6.2. Internal balance is, of course, given by the nontraded-goods market clearing condition 6.19. As suggested by equation 6.19, the locus traced out by the set of combinations of e and c that are consistent with internal balance (IB) has a negative slope in figure 6.2. The long-run equilibrium real exchange rate is that which is simultaneously consistent with external and internal balances in the long run. It is defined by the intersection of the two loci at point *A* in figure 6.2, and is labeled e^*.

Long-Run Fundamentals

The response of the long-run equilibrium real exchange rate to its fundamental determinants can be established by examining the effects of permanent changes in the various exogenous variables included in the

Figure 6.2 ***Determination of the Long-Run Equilibrium Real Exchange Rate***



Note: An upward movement is a depreciation of the real exchange rate.

model on the location of the long-run equilibrium point *A*. In this section, I take up these fundamentals one at a time, identifying individual fundamentals as well as the qualitative nature of their influence on the long-run equilibrium real exchange rate.

Fiscal Policy

I begin by considering changes in government spending, holding the fiscal deficit constant. As is well known, effects on the long-run equilibrium real exchange rate depend on the sectoral composition of these changes.[14]

Changes in Government Spending on Traded Goods

An increase in government spending on traded goods has no effect on the internal balance locus, but it shifts the external balance locus upward—to *EB´* in figure 6.3. The increase in government spending creates an incipient trade deficit, which requires a real depreciation in order to maintain external balance. As indicated in figure 6.3, at the new long-run equilibrium *B*, the equilibrium real exchange rate depreciates, and private consumption of traded goods falls.[15] The reduction in private consumption of traded goods is smaller than the increase in government consumption, however, because the real depreciation induces an increase in the production of traded goods, allowing the accommodation of an increase in total spending on traded goods.

Changes in Government Spending on Nontraded Goods

In contrast to the previous case, the locus affected in this case is the internal balance locus *IB*. The increased demand for nontraded goods requires an increase in their relative price to maintain equilibrium in the nontraded-goods market, and the *IB* schedule thus shifts downward, to

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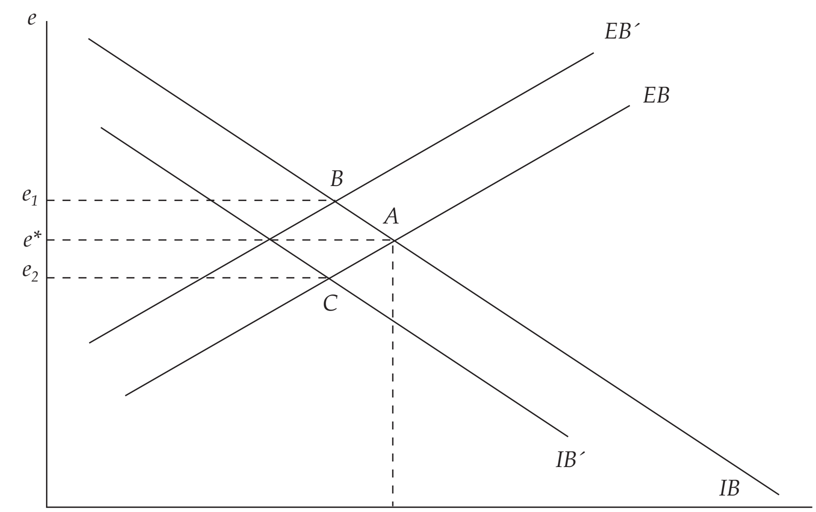
14. For earlier work on the effects of the composition of government spending on the long-run equilibrium real exchange rate see Montiel (1986) and Khan and Lizondo (1987).

15. In contrast, Penati (1987) finds that an increase in government spending on traded goods has no effect on the long-run equilibrium real exchange rate. The aspect of model specification that accounts for this difference is that in the present model, a steady-state equilibrium is ensured by an endogenous risk premium, while in Penati's model the same result is achieved by endogenizing the rate of time preference. This feature makes Penati's model block-recursive and permits external balance to be restored after an increase in government spending on traded goods through an increase in the economy's net claims on the rest of the world, with no repercussions for relative prices.

Figure 6.3 ***Effects of Changes in Government Spending on the Long-Run Equilibrium Real Exchange Rate***



Note: An upward movement is a depreciation of the real exchange rate.

IB´ in figure 6.3. The new equilibrium is at point *C*. As in the previous case, private consumption expenditure is crowded out in long-run equilibrium, but in this case the equilibrium real exchange rate appreciates. The upshot of this exercise and the previous one is that the long-run equilibrium real exchange rate is a function of the sectoral composition of government spending.

A Reduction in the Fiscal Deficit

Consider a reduction in the fiscal deficit, in the form of a tax increase. Since taxes are actually endogenous in the model under the assumptions made in the section on the analytical framework, this shock is equivalent to a reduction in the rate of monetary emission by the central bank, which in turn is equivalent to a reduction in the rate of crawl of the nominal exchange rate. The gain from a lower fiscal deficit in this model comes in the form of a reduction in the distortions associated with the inflation tax. A reduced rate of depreciation lowers the domestic interest rate, increases the demand for money, and reduces the transactions costs associated with consumption—in other words, τ^* falls. This has the effect of increasing the supply of real output. Whether the long-run equilibrium real exchange rate will appreciate or depreciate depends on whether transactions costs are borne in the form of traded or nontraded goods.[16] This will determine the form that the increase in real output takes. As currently specified, the model assumes that these costs are borne in the form of traded goods. The reduction in τ^* will thus increase the supply of such goods, shifting the external balance locus downward and resulting in a real appreciation, together with an increase in consumption. On the other hand, if transactions costs are incurred in nontraded goods, the external balance locus would remain fixed, and the internal balance locus would shift to the right. In that case, the equilibrium real exchange rate would depreciate, and consumption would rise.[17]

It may be worth noting that the effects of a reduction in the fiscal deficit brought about by changes in spending would simply be a combination of one of the first two shocks described above with the third. The effects would depend on whether the reduction in spending fell on traded or nontraded goods, as well as on the composition of transactions costs.

Changes in the Value of International Transfers

The other demand-side variable that enters the model is the external real interest rate r_W. Before analyzing the effects of changes in external financial conditions, however, it is useful as a point of reference to consider the effects on the equilibrium real exchange rate of changes in the level of international transfers received by the domestic economy. These will provide an interesting contrast with the case of interest rate changes. As formulated above, the model does not explicitly consider the role of international transfers. It is straightforward to add them, however. Such transfers would simply represent an addition to household incomes equal to the amount of the transfer. They would appear as an additive term in the household's budget constraint equation 6.7, in the dynamic equation 6.20 for f, and in the long-run equilibrium condition equation 6.25´.[18] Accordingly, the effect of a permanent increase in the receipt of transfer income would be to shift the external balance locus to the right—the

16. This property that the long-run equilibrium real exchange rate is affected by a change in the rate of monetary expansion—that is, the failure of superneutrality—also characterizes the model of Penati (1987).

17. A change in the foreign inflation rate π_W affects the model in exactly the same way as a change in the rate of depreciation ε, since the two variables enter only in the additive form $\pi^* = \varepsilon + \pi_W$ in equation 6.25.

18. It makes no difference in this model whether the transfer is received directly by the private sector or whether it goes to the government, since under the fiscal regime assumed above, the latter would transfer the proceeds to the private sector.

receipt of additional transfer income permits an expansion of consumption to be consistent with external balance at an unchanged exchange rate. There are no direct effects on the *internal balance* locus, so the equilibrium is at B in figure 6.4, with an equilibrium real *appreciation* and an increase in private absorption.

Changes in International Financial Conditions

The analysis of transfers is instructive because many observers' intuition about the effects of changes in capital inflows on the long-run equilibrium real exchange rate is derived from the corresponding effects of transfers. Capital inflows and transfers have in common the feature that they permit an expansion of absorption relative to income in the short run. However, the two phenomena differ in two important respects. First, the volume of capital inflows is an endogenous variable that can arise from a variety of changes in domestic and external economic conditions. Presumably, the change in the long-run equilibrium real exchange rate associated with a particular capital-inflow episode depends on the source of the shock that triggers the inflow. Second, unlike transfers, capital inflows create repayment obligations in the long run. These also will affect the long-run equilibrium real exchange rate.[19]

Consider, then, a particular shock that has been associated with the emergence of capital inflows: a reduction in world real interest rates.[20] Again, this shock directly affects only the external balance locus. To see in which direction the locus moves, differentiate equation 6.25´:

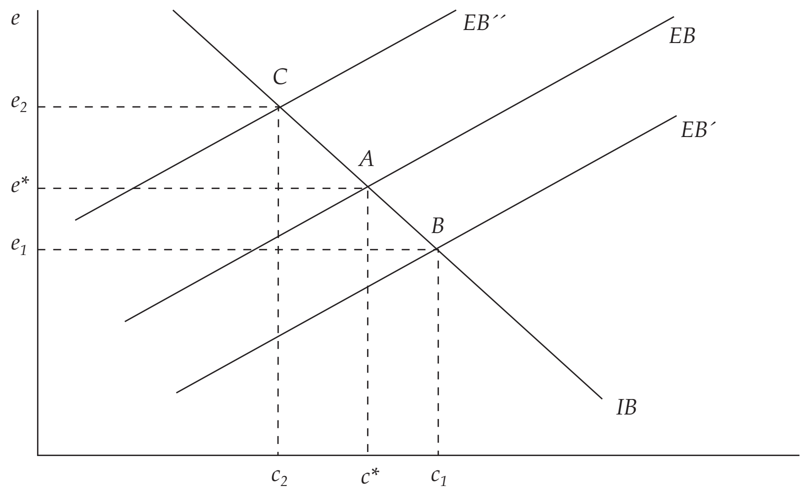
$$de/dr_W\Big|_{\dot{f}=0} = \frac{\rho + \pi_W}{p'y_T'} < 0.$$

Thus, the real exchange rate consistent with external equilibrium moves in a direction *opposite* to the world interest rate. In this case, when the world real interest rate falls, the external balance locus thus shifts

19. Such obligations will affect the long-run equilibrium real exchange rate under the "stock" approach to the definition of external balance described in the previous chapter, which is the approach adopted here. If the "flow" approach were adopted instead, the effects of capital inflows on the LRER would resemble those of transfers, except that the endogenous nature of capital inflows would cause those effects to depend on the source of the shock triggering the inflows.

20. The view that the capital-inflow episode affecting several large developing countries during the early 1990s was triggered by a reduction in interest rates in the United States, first put forward by Calvo, Leiderman, and Reinhart (1993), is now widely accepted. For a review of this episode, see Fernandez-Arias and Montiel (1996).

Figure 6.4 ***Effects of Changes in Foreign Transfers and World Real Interest Rates on the Long-Run Equilibrium Real Exchange Rate***



Note: An upward movement is a depreciation of the real exchange rate.

upward, to a position similar to *EB″* in figure 6.4, and the equilibrium real exchange rate, determined at point *C*, actually *depreciates*, contrary to what happens in the case of an increase in the level of transfer receipts.[21]

Why is this the case? Equation 6.25′ suggests that the effect of a change in world interest rates on the real exchange rate consistent with external balance depends on the effect of this change on the country's long-run net interest receipts. Thus, like those of a transfer, the effects of a change in external interest rates on the long-run equilibrium real exchange rate depend on their long-run implications for national income. In this model, however, the implications of a reduction in world interest rates for

21. Notice that de/dr_W does not depend on f^*. Thus, the direction of the shift in the external balance locus, and therefore the result that a change in r_W causes the long-run equilibrium value of e to move in the opposite direction, does not depend on whether the economy is initially a net external creditor or debtor. This result is also derived, with a different approach to modeling imperfect asset substitutability, by Agenor (1996). However, the dynamics of adjustment to the new equilibrium do indeed depend on the economy's initial international net creditor position, as shown in Montiel (1998).

national income are *negative* in the long run, unlike those of transfers. This is precisely because of the capital inflows induced by the change in world financial conditions. In the new long-run equilibrium, the country's net creditor position with the rest of the world deteriorates, reflecting the effects of net external borrowing (capital inflows) during the transition from one long-run equilibrium to the next.[22] The change in the external real interest rate has no other direct effects on the country's long-run current account balance (equation 6.25´). In particular, the interest rate that the country actually faces in world capital markets is unchanged from one long-run equilibrium to the next, because changes in the country's net external creditor position drive that interest rate to equality with the domestic rate of time preference. A higher risk premium, associated with a reduced net international creditor position, reconciles the constant effective interest rate faced by domestic residents in the long run with the lower world interest rate. Since, unlike in the case of transfers, the borrowing has to be repaid, this is reflected in a reduction in long-run equilibrium national income.[23]

The Balassa-Samuelson Effect

To capture the effects of differential productivity growth in the traded-goods sector, the production function in this sector can be respecified as shown by equation 6.26:

$$y_T = y_T(L_T, \alpha); \quad y_{T1} > 0, \quad y_{T2} > 0 \tag{6.26}$$

where α is a productivity parameter. Since the demand for labor in the traded-goods sector will now be a function of this productivity parameter, labor market equilibrium becomes equation 6.27:

$$L_T(w, \alpha) + L_N(w) = L \tag{6.27}$$

and the equilibrium real wage can be written as equation 6.28:

$$w = w(e, \alpha), \quad \text{with:} \qquad w_2 = \frac{L_{T2}}{L_{T1} + L_N' e} > 0. \tag{6.28}$$

This means that output in the traded- and nontraded-goods sectors are given respectively by equations 6.29 and 6.30:

22. The transition is described in Montiel (1998).
23. For a more extensive discussion of this issue, see Agenor (1996).

$$y_T = y_T[L_T[w(e,\alpha),\alpha],\alpha] \tag{6.29}$$
$$\frac{dy_T}{d\alpha} = y_{T1}L_{T2}\frac{L_N'e}{L_{T1}+L_N'e} + y_{T2} > 0.$$

$$y_N = y_N[L_N[w(e,\alpha)]], \quad \text{with:} \tag{6.30}$$
$$\frac{dy_N}{d\alpha} = y_N'L_N'w_2 < 0.$$

Thus, the effect of the productivity shock in the traded-goods sector is to increase the demand for labor in that sector, thereby increasing the equilibrium real wage. In turn, this causes the nontraded-goods sector to release labor, which is absorbed by the traded-goods sector. At a given real exchange rate, the traded-goods sector expands, while the nontraded-goods sector contracts.

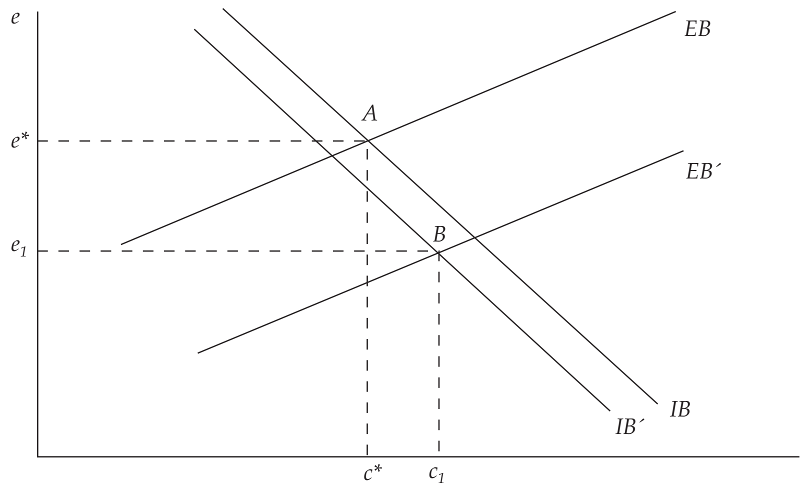
To examine the effects on the long-run equilibrium real exchange rate, notice that the productivity shock α enters the internal and external balance equations 6.19 and 6.25′ only through its effects on y_N and y_T, respectively. Since, according to equation 6.30, an increase in α reduces y_N, it creates excess demand in the nontraded-goods market, requiring a real appreciation to restore internal balance. In figure 6.5, the *IB* locus shifts downward. At the same time, however, by increasing production of traded goods (see equation 6.29), the shock gives rise to an incipient trade surplus, so a real appreciation is also required for the restoration of external balance. Thus, *EB* shifts downward as well. Both effects operate in the direction of equilibrium real appreciation, as proposed by the Balassa-Samuelson analysis. Thus, differential productivity growth in the traded-goods sector creates an appreciation of the equilibrium real exchange rate.[24]

Changes in the Terms of Trade

As indicated previously, the model as specified is not suitable for analyzing changes in the terms of trade, since exportable and importable goods are not distinguished from each other in the traded-goods sector. To make the necessary modifications, split up total traded-goods output into output of exportables y_X and importables y_Z, both produced under conditions described previously for y_T, that is, with a fixed

24. It can be shown that the downward shift in *EB* exceeds that in *IB.* The implication is that the favorable productivity shock results in an increase in real private absorption in equilibrium, as one would expect.

Figure 6.5 ***Effects of Differential Productivity Shocks and Terms-of-Trade Changes on the Long-Run Equilibrium Real Exchange Rate***



Note: An upward movement is a depreciation of the real exchange rate.

sector-specific factor and mobile labor, with sectoral employment levels L_X and L_Z. Let ϕ denote the terms of trade, defined as the price of exportables in terms of importables, and redefine the real exchange rate e as the relative price of *importables* in terms of nontraded goods. To keep the demand side of the model simple, assume that the exportable good is not consumed at home.

The analysis of the effects of terms-of-trade changes is, as might be expected, quite similar to that of productivity shocks to the traded-goods sector. Labor market equilibrium is now given by equation 6.31:

$$L_X(w/\phi) + L_Z(w) + L_N(we) = L \tag{6.31}$$

where w is now the real wage in terms of importables. The real wage that clears the labor market becomes:

$$w = w(e, \phi), \quad \text{with}$$
$$w_2 = \frac{L'_X w/\phi^2}{L'_X/\phi + L'_Z + L'_N e} > 0. \tag{6.32}$$

An improvement in the terms of trade increases the real wage, because this permits labor to be transferred from the importables and nontraded sectors to the expanding exportables sector. Sectoral supplies are now as expressed in equations 6.33, 6.34, and 6.35:

$$y_X = y_X[L_X[w(e,\phi)/\phi]] \qquad (6.33)$$
$$\frac{dy_X}{d\phi} = y'_X L'_X (w_2/\phi - w/\phi^2) > 0$$

$$y_Z = y_Z[L_Z[w(e,\phi)]] \qquad (6.34)$$
$$\frac{dy_Z}{d\phi} = y'_Z L'_Z w_2 < 0$$

$$y_N = y_N[L_N[w(e,\phi)e]] \qquad (6.35)$$
$$\frac{dy_N}{d\phi} = y'_N L'_N w_2 e < 0.$$

The internal balance equilibrium condition remains as before, with the exception that output of nontraded goods is now specified as in equation 6.35. The external balance condition (equation 6.25´), however, has to be modified to take into account that traded-goods production now involves output of both exportables and importables, yielding equation 6.36:

$$\pi_W f^* = \phi y_X(e,\phi) + y_Z(e,\phi) + (\rho + \pi_W) f^* - (\tau^* + \theta)c - g_Z \quad . \qquad (6.36)$$

As shown above, an improvement in the terms of trade results in a contraction in output of nontraded goods. The resulting excess demand in the nontraded-goods market causes the internal balance schedule to shift downward. The effects on the external balance schedule depend on whether the real value of total traded-goods output increases or decreases. This effect is given by:

$$\frac{\partial(\phi y_X + y_Z)}{\partial\phi} = y_X - \phi y'_X L'_N e w_2 > 0 \quad .$$

The value of traded-goods output increases through two channels: a valuation (income) effect arising from the higher relative price of exportables and an output effect arising from the absorption in the exportable sector of labor released by the nontraded-goods sector. The implication is that, as in the case of the favorable productivity shock, the external balance locus will shift downward—the incipient improvement in the trade balance requires a real appreciation to keep the trade balance at its sustainable level. Thus, the effects of a terms-of-trade improvement can also be represented as in figure 6.5.[25, 26]

Commercial Policy

Finally, consider the effects on the long-run real exchange rate of a liberalization of commercial policy, modeled as a reduction in export subsidies. This is the simplest case to model in the present context, because it makes using several of the results derived for the analysis of the effects of terms-of-trade shocks possible. Consider, in particular, an export subsidy set at the rate $(\phi - 1)$. In this case, the *internal* terms of trade will be ϕ, and the previous analysis can be repeated, at least on the supply side of the economy. In particular, an increase in the subsidy would pull labor out of the importable and traded-goods sectors into the exportables sector, just as would an equivalent favorable terms-of-trade shock. A direct implication is that effects of subsidy changes on the internal balance schedule *IB* are the same as those of an equivalent terms-of-trade shock. A subsidy increase causes *IB* to shift downward by creating an excess demand for nontraded goods, and a subsidy decrease causes it to shift upward.

Where matters differ is in regard to the effects of export subsidies on the external balance schedule. Because changes in the internal terms of trade have the same output effects whether brought about by external terms-of-trade changes or by subsidy rate changes, an increase in the subsidy rate would create an expansion in the output of traded goods and cause an incipient trade balance improvement, just as before. Again, the reason is because a subsidy increase draws labor from the nontraded to the exportables sector. However, the income effect is absent in this case. The reason is that, unlike in the case of an external terms-of-trade improvement, the increase in the price of exportables brought about by a subsidy increase has to be financed. In the case of the subsidy, a tax liability is created for the private sector in an amount equal to the subsidy rate times the output of exportables—that is, in the amount $(\phi - 1)y_X$. When this tax liability is taken into account in equation 6.36, the result is equation 6.37:

25. Just as before, it can be shown that the downward movement in *EB* exceeds that in *IB*, so the sustainable level of private absorption increases as a result of this shock.

26. As figure 6.5 suggests, an improvement in the terms of trade is associated with an appreciation of the long-run importables real exchange rate. Whether the long-run exportables real exchange rate, given by $e\phi$, depreciates or appreciates, however, is ambiguous in the model.

(6.37)

$$\begin{aligned}\pi_W f^* &= \phi y_X(e,\phi) + y_Z(e,\phi) + (\rho + \pi_W) f^* - (\phi - 1) y_X(e,\phi) - (\tau + \theta)c \\ &= y_X(e,\phi) + y_Z(e,\phi) + (\rho + \pi_W) f^* - (\tau + \theta)c.\end{aligned}$$

The implication is that a given change in the export subsidy rate would cause the external balance schedule to shift in the same direction, *but by a smaller amount*, than a terms-of-trade change that has an equivalent impact on the internal terms of trade.

In the case at hand, the issue concerns the effect on the real exchange rate of liberalization of commercial policy—that is, a reduction in the export subsidy rate. The results just established imply that a shock of this type would shift both the internal and external balance schedules upward, with the implication that commercial liberalization results in a depreciation of the equilibrium real exchange rate.

Summary and Conclusions

The objective of this chapter has been to analyze the determination of the long-run equilibrium real exchange rate in the context of a simple analytical framework that is flexible enough to accommodate a broad variety of potential influences on the real exchange rate. The long-run equilibrium real exchange rate was defined as the rate consistent with the steady-state value of a country's international net creditor position, given the paths of all relevant policy and exogenous variables.

The determinants of the long-run equilibrium real exchange rate identified here consisted of the following:

Domestic Supply-Side Factors. The most venerable theory regarding long-run real exchange rate determination is the Balassa-Samuelson effect. This was incorporated in the analysis in the form of an asymmetric productivity shock favoring the traded-goods sector. The equilibrium real exchange rate appreciates, both because excess demand is created in the nontraded-goods sector and because the trade balance tends to improve.

Fiscal Policy. Changes in the composition of government spending between traded and nontraded goods affect the long-run equilibrium real exchange rate in different ways. Additional tax-financed spending on nontraded goods creates incipient excess demand in that market, requiring a real appreciation to restore equilibrium. By contrast, tax-financed increases in spending on traded goods put downward pressure on the trade balance, and require a real depreciation to sustain external balance. The effects of a tax-based fiscal adjustment depend on the form in which transactions costs are incurred.

Changes in the International Economic Environment. The aspects of the world economic environment analyzed here consisted of the terms of trade for the domestic economy, the availability of external transfers, the level of world real interest rates, and the world inflation rate. Improvements in the terms of trade and increases in the flow of transfers received tend to appreciate the equilibrium real exchange rate, the former both by improving the trade balance and creating excess demand for nontraded goods, and the latter through positive effects on the current account. Reductions in world real interest rates and increases in world inflation, by contrast, cause the long-run equilibrium real exchange rate to depreciate. Lower world interest rates cause capital inflows, which reduce the country's net creditor position over time, and the long-run loss of net interest receipts requires a real depreciation to maintain external balance. Changes in world inflation affect the equilibrium real exchange rate through effects on transactions costs associated with changes in real money balances. In the case of an increase in world inflation, the long-run real exchange rate tended to depreciate in this model, though this conclusion is sensitive to an essentially arbitrary assumption about the form in which transactions costs are incurred.

Commercial Policy. Finally, trade liberalization, analyzed here in the form of a reduction in export subsidies, is associated with long-run real depreciation. The effect works by channeling resources into the nontraded-goods sectors. The emergence of incipient excess supply in the nontraded-goods market dictates the nature of the adjustment in the real exchange rate.