A central focus of the macroeconomic policy advice that developing and transition economies have received over the past decade has been the importance of “getting prices right.” For transition economies this advice has an important microeconomic dimension. The decentralization that characterizes market economies implies that decisions about what and how much to produce, as well as about what and how much to consume, are made by individual economic agents, and relative prices are the signals and incentives that guide the decisions of these agents. In doing so, relative prices play a key role in allocating economic resources among competing uses. For both types of economies, however, the need to get prices right also has a key macroeconomic dimension. The two central macroeconomic relative prices are the price of goods in the present relative to the price of goods in the future (the real interest rate) and the price of domestic goods relative to the price of foreign goods (the real exchange rate).

These relative prices guide the broad allocation of production and consumption between today’s goods and tomorrow’s goods, as well as between domestic goods and foreign goods. Although the emphasis on getting relative prices right is well placed, identifying the “right” level of these macroeconomic relative prices has not been easy, either conceptually or empirically.

This chapter focuses on what it means to achieve the right level of the real exchange rate: that is, what it means to get this particular macroeconomic relative price right, how to determine the right level of the real exchange rate in practice, and how this value of the real exchange rate can be estimated empirically. It begins with an analysis of the conceptual and empirical issues that arise in defining the actual real exchange rate. This is followed by a discussion of the conceptual issues arising in the definition of the “appropriate” real exchange rate, concluding that the relevant measure is the long-run equilibrium real exchange rate (LRER). It then describes a theoretical model of the determinants of the LRER, a model that is designed to identify the relevant set of “fun-
fundamental” determinants of the LRER. After discussing the theory, the chapter analyzes measurement issues and concludes with observations on the state of the art in the empirical measurement of the LRER.

Defining the Real Exchange Rate: Conceptual and Empirical Issues

Two factors complicate real exchange rate economics: lack of a single definition of the real exchange rate and the fact that the term is sometimes used interchangeably with the terms of trade. Real exchange rate definitions differ for two reasons: first, because they serve different analytical frameworks, and second, because all of the empirical definitions amount to approximations—sometimes relatively crude ones—of the theoretical concepts they are intended to represent. For example, whereas the notion of what is a domestic good and what is a foreign good is relatively easy to pin down in theoretical models, most of which have only one to three goods, the real world is obviously more complicated because of the multiplicity of goods in it. This makes it difficult for analysts to come up with empirical counterparts to the theoretical concept they are trying to measure.

Alternative Concepts of the Real Exchange Rate

The definition of the real exchange rate is shaped primarily by the production structure adopted in the particular analytical macroeconomic model being used. A useful starting point, then, is to consider how the definition of the real exchange rate is affected by the alternative production structures used in some popular open-economy macroeconomic models. Some examples are described below.

The One-Good Model

The simplest production structure in open-economy macroeconomic models assumes that the domestic economy produces a single (perhaps composite) good, which is internationally traded but is identical to the (composite) good produced by the rest of the world. Models with a single tradable good have been widely used, primarily for the study of purely monetary phenomena (such as inflation, or monetary approaches to the balance of payments). Since any definition of the real exchange rate requires the existence of at least two goods, there is no meaningful real exchange rate concept in one-good tradable models.
Complete Specialization (Mundell-Fleming) Models

The Mundell-Fleming model (see Mundell, 1962; Fleming, 1962) is the workhorse of open-economy macroeconomic analysis for industrial countries. As in the one-good model, the domestic economy is assumed to be completely specialized in the production of a single good, which is internationally traded. Unlike in the single-good model, however, the domestic good is taken to be an imperfect substitute for the good produced by the rest of the world. Mundell-Fleming models are widely used for industrial countries, whose trade consists largely of manufactured goods that are imperfect substitutes for what the rest of the world produces.

The real exchange rate is well defined in this context. It is the number of units of the foreign good that have to be given up for each unit of the domestically produced good. However, this also happens to be the definition of the terms of trade (the price of exports relative to the price of imports) in the Mundell-Fleming model, and these two concepts cannot be distinguished in the context of this production structure.

The Dependent-Economy (Swan-Salter) Model

In the Swan-Salter model (see Swan, 1960; Salter, 1959), the domestic economy is no longer assumed to be completely specialized in production. The domestic production structure consists of two goods, one of which is produced at home and consumed only at home (the nontraded good), whereas the other (traded) good is produced and consumed both at home and abroad. The single traded good is assumed, as in the one-good model, to be a perfect substitute for the traded good produced by the rest of the world.

Since only the traded good can be bought and sold across international boundaries, it is natural, despite its being produced at home as well as abroad, to consider it the foreign good. Thus, in the context of the Swan-Salter model, this implies a definition of the real exchange rate as the number of units of the foreign (traded) good required to purchase one unit of the domestic (nontraded) good:

\[ e = \frac{P_N}{P_T}, \]

where \( P_N \) and \( P_T \) are, respectively, the domestic-currency prices of the nontraded good and the traded good. Notice that, since there is only one type of foreign good, the relative price of exports in terms of imports must always equal unity—that is, there are no well-defined terms of trade in this model. Another, more general, way of thinking about this model is that there is more than one type of foreign good, but be-
cause the home country is small, it cannot affect the relative prices among them. In particular, it cannot affect the relative price between the foreign goods that it tends to export and the foreign goods that it tends to import—that is, its terms of trade. Thus, the Swan-Salter model is useful for countries whose terms of trade are exogenous, so long as it is applied to the analysis of issues for which the role of changes in the internal terms of trade are not important, such as the effect of domestic macroeconomic policies in small countries.

The Three-Good Model

However, if changes in the terms of trade and in trade policy matter, a three-good model is required, with a production structure that distinguishes between two imperfectly substitutable “foreign” (traded) goods: exportables and importables. With two foreign goods, however, there is no single relative price of “the” foreign good in terms of the domestic good. In other words, this production structure implies the existence of two distinct real exchange rates, consisting of the relative price of the domestic good in terms of each of the two foreign goods:

\[ e_x = \frac{P_N}{P_X} \] (the real exchange rate for exportables)
\[ e_Z = \frac{P_N}{P_Z} \] (the real exchange rate for importables).

As previously indicated, this model is useful for analyzing the effects of terms of trade changes and trade policies that affect the domestic relative prices of exportables and importables.

Unlike in the Mundell-Fleming model, the real exchange rate and the terms of trade have distinct meanings in this model. We define the economy’s terms of trade (TOT):

\[ TOT = \frac{P_X}{P_Z}, \]

expressed as the number of units of the importable good that can be bought with one unit of the exportable good. This model in effect contains two independent relative prices, since the real exchange rate for exportables can be expressed as the real exchange rate for importables divided by the terms of trade.

For the analysis of real exchange rate issues, a model with two production sectors is desirable, so that incentives to produce and to consume foreign versus domestic goods can both be represented. This argues for a dependent-economy framework, and much of the discussion in the rest of this chapter employs this framework. The three-good model is obviously more general, but whether it is necessary to incor-
porate three goods depends on whether the effects of terms of trade changes and changes in trade policy are relevant to the analysis. The analytical model of the LRER to be considered later incorporates such a framework.

**Problems of Empirical Measurement**

Although the dependent-economy model is attractive as an analytical framework, its empirical application is problematic because conventional price indices do not distinguish between traded and non-traded goods. The most common approach to this problem is to proxy the relevant domestic price of traded goods through the use of an aggregate foreign price index, converting it to domestic-currency terms by multiplying it by a nominal exchange rate index. The price of non-traded goods, in turn, is proxied by an aggregate domestic price index. Because an aggregate foreign price index is used to measure the domestic-currency price of traded goods, the former is referred to as an external real exchange rate. Since the real exchange rate concept arising out of the Swan-Salter framework concerns domestic relative prices, it is commonly referred to as the internal real exchange rate.

To apply this procedure, four questions have to be addressed:

1. Which of the widely available price indices should be used—the consumer price index (CPI), the wholesale price index (WPI), the GDP deflator, or some other index?
2. Should the same price index be used for the foreign and the domestic countries? If not, why not?
3. How should a foreign price index be constructed when a country has multiple trading partners?
4. If there is more than one exchange rate against some foreign currency (parallel exchange rates), which one should be used?

The most common set of choices in answer to these questions results in the use of a trade-weighted CPI in domestic currency for the foreign price index, and the CPI for the domestic price index. The exchange rate calculated in this way is referred to as the consumption-based real effective (or multilateral) exchange rate (REER). It is computed as

\[ REER = \frac{P}{\prod_{i=1}^{n} S_i^{e_i} P_i^{d_i}} \]

1Detailed discussion of real exchange rate measurement issues can be found in the papers by Hinkle and Nsengiyumva in Hinkle and Montiel (1999).
where $P$ is the domestic economy’s CPI, $\theta_j$ is the share of the $j$th partner country in the total trade (exports plus imports) of the domestic economy, $S_j$ is the bilateral exchange rate against the $j$th trading partner (the foreign-currency price of the domestic currency), and $P_j$ is the $j$th partner country’s CPI. With regard to the questions posed above, the answers that lead to this choice of indicator are the following:

- The CPI has the advantage of greater breadth of coverage than the WPI. In particular, the WPI is much more heavily weighted toward traded goods; hence it is inappropriate as an indicator of the prices of domestic goods. Relative to the GDP deflator, the CPI has the advantage of being available for almost all countries in a timely fashion and at frequent intervals.

- However, it is not obvious that the CPI should be used for both the domestic and the foreign countries. Because it contains prices of both traded and nontraded goods, the denominator will not appropriately reflect the domestic prices of traded goods, because it will be contaminated by changes in the foreign internal real exchange rate, which is not relevant for domestic agents. For this reason, some economists (such as Edwards, 1989) prefer to use the WPI in the denominator, on the grounds that it contains a larger share of traded goods.

- The real exchange rate, rather than a bilateral one, reflects the fact that the average domestic price of traded goods is a composite of the domestic-currency prices of goods traded with many countries, and the weights are intended to reflect the contribution made by each trading partner to that composite.\footnote{Alternatively, weights could be based on the shares of trading partners in \textit{world} trade, or on market shares of the country’s main competitors in export markets. When using the consumption-based REER as a proxy for the \textit{internal} real exchange rate, however, these alternatives are difficult to justify, since trade weights should be much better indicators of the contributions of individual partner countries to the domestic-currency prices of traded goods.}

- Finally, when multiple foreign exchange rates exist against particular currencies, the relevant measure of the bilateral exchange rate against that currency is taken to be that which is “representative”—that is, either a weighted average reflecting the shares of trade transacted at the different exchange rates or, in the likely case that such information is not available, the single exchange rate at which most of the trade with the relevant country takes place.
Although the CPI-based REER has the advantage that it relies on high-frequency data of a type that tends to be readily available in most countries, it has several problems as a proxy for the theoretically desired measure of the relative price of traded goods in terms of nontraded goods. One is that because the numerator is a weighted average of domestic traded- and nontraded-goods prices, the indicator will only show changes in the internal real exchange rate in muted form. For example, if the price of nontraded goods changes by \( x \) percent, the numerator will change in the same direction, but the change in the numerator will fall short of \( x \) percent by an amount that depends on the share of nontraded goods in the domestic consumption basket. A second problem is that, since the denominator cannot pick up the effects of changes in commercial policies on the domestic prices of traded goods, when such policies change, the measure will fail to indicate the appropriate changes in the incentives facing domestic agents.

The Equilibrium Real Exchange Rate: Conceptual Issues

How do we assess whether a country has gotten the relative price of foreign goods in terms of domestic goods—the actual real exchange rate—right? In the macroeconomic context, getting this price right means avoiding misalignment of the actual real exchange rate with its equilibrium value.

The Meaning of Equilibrium

What do we mean by an equilibrium real exchange rate? This is not a trivial issue. In particular, “equilibrium” does not necessarily mean “desirable.” In principle, the concept of equilibrium as applied to the real exchange rate is no different from what it is in other economic applications: quite simply, a real exchange rate is in equilibrium if there is no tendency for it to change.

This broad definition needs further elaboration. First, precisely because the real exchange rate is an important part of the macroeconomic adjustment mechanism, it will tend to change whenever the economy is subjected to new shocks. Consequently, as elsewhere in economics, the notion of equilibrium cannot refer to an absence of change even in the presence of shocks. If it did, there would be no such thing as an
equilibrium real exchange rate, since the arrival of shocks will cause it to change continuously. Thus, the equilibrium real exchange rate must refer to the value to which the real exchange rate would tend in the absence of new shocks.

Second, since the economy is presumably in some kind of equilibrium at any given moment, we need to be more precise about the distinction between an actual and an equilibrium real exchange rate. In other words, what makes us think the real exchange rate would change at all without some new shock? The answer is that although the economy may be in some kind of equilibrium at every instant, the nature of that equilibrium depends on the current and expected future values taken on by certain macroeconomic variables. That means that the equilibrium is not static, but rather changes over time as the values of those variables change. It thus is useful to distinguish between short-run and long-run equilibrium. The difference between the two is often referred to as exchange rate misalignment.

To be more concrete, consider the following example. Suppose the real exchange rate at any moment is determined by the reduced-form relationship

\[ e = F(X_1, X_2), \]  

where \( X_1 \) represents the sustainable values of a set of real exogenous and policy variables, and \( X_2 \) represents the current values of a set of predetermined variables.\(^3\) The latter represent macroeconomic variables, such as the nominal wage, the economy's net international creditor position, and capital stocks in the traded- and nontraded-goods sectors, whose values are fixed at any moment but change gradually through time:

\[ \dot{X}_2 = G(X_1, X_2). \]  

Then the value of \( e \) given by equation (11.1) is its short-run equilibrium value. It is a short-run value in that it is conditioned on the current values of \( X_2 \), which, according to equation (11.2), will themselves be changing over time.

When the macroeconomic variables in \( X_2 \) stop changing—that is, when they reach a long-run equilibrium—we have

\[ 0 = G(X_1, X_2). \]  

\(^3\)Note that \( X_1 \) does not necessarily contain all policy variables. For example, in an economy operating with a fixed exchange rate, it would not contain the nominal exchange rate. Instead, the value of the nominal exchange rate affects the real value of the predetermined variables.
We can solve this equation for the long-run values of $X_2$:

$$X^*_2 = H(X_1).$$  \hfill (11.3)

Substituting the values of $X_2$ back into equation (11.1), we have:

$$e^* = F [X_1, H(X_1)],$$  \hfill (11.4)

where $e^*$ is the LRER. It depends only on the sustainable values of the exogenous and policy variables that affect $e$ directly or indirectly (through $X_2$). These are called the "long-run fundamentals."

**Defining the Long Run**

The simplicity of the specification of the long-run equilibrium shown above is deceptive, however. Analytically, it depicts a situation in which all of the variables in $X_2$ have come to rest. In practice, however, the meaning of the term "long run" is much more problematic. The difficulty is that predetermined variables, such as the nominal wage, the country’s net international creditor position, and sectoral capital stocks may approach their long-run values at different speeds, and some of these may be very slow. This raises the question of whether all of these variables should be required to reach a stationary position in an operational definition of the long run, as the previous description would seem to suggest. The problem is that if this requirement were imposed, the LRER concept derived from it would be of little operational use, since it might be approached too slowly.

For guidance on this problem, we can consult the common definition of the LRER as the value of the real exchange rate that is simultaneously consistent with internal and external balance, conditioned on sustainable values of exogenous and policy variables. **Internal balance** refers to a situation in which the markets for nontraded goods and labor are both in equilibrium. Thus, it corresponds to short-run macroeconomic equilibrium (full employment). **External balance** refers to a situation in which the current account deficit is equal to the value of the sustainable capital inflow.

What do these concepts have to do with the long-run equilibrium perspective adopted above, and how can this definition be used to determine the relevant meaning of the long run? The answer is that internal balance requires that cyclical adjustment mechanisms operating through the labor market cease to be operative. At the same time, this definition appears to reflect the view that allowing for full capital stock adjustment is excessive—that is, the span of time required to achieve

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full adjustment of the sectoral capital stocks would be too long to be of much policy relevance.4

External balance, on the other hand, requires that we specify the level of sustainable capital inflow. But there is no consensus on how to do this. The dynamic framework described in the previous section offers one approach: a capital inflow or outflow is sustainable when the country’s net international creditor position (a predetermined variable) is not changing. Under this definition, the sustainable level of capital flows would be that required to maintain the economy’s debt-to-GDP ratio. This implies a definition of the long run as being long enough for the labor market to clear and the economy’s net creditor position to reach a sustainable level, but not necessarily long enough to achieve full capital stock adjustment. Others would argue that even waiting for the net creditor position to stabilize is too long a perspective. Instead, they would condition the long run on a stable level of capital flows. As in the case of the capital stock, the implicit assumption is that these flows have very small effects on the net creditor position over the relevant horizon. Both definitions of external balance have been used in the literature.5

Equilibrium Versus Optimal Real Exchange Rate

It is important to emphasize that equation (11.4) expresses the long-run equilibrium as a function of exogenous and policy variables that are only required to be sustainable. Conceptually, this is particularly appropriate for exogenous variables. If they are truly exogenous, their sustainability is not under the control of domestic policymakers. With them the only empirical issues are determining how to estimate their sustainable levels and assessing how those levels affect the LRER. Beyond this, there is nothing anyone in the economy can do about exogenous variables except to adjust to them.

The case of policy variables, however, is more delicate. What if the policies in place are not good ones? The argument has been made that an LRER is not truly an equilibrium rate if it is conditioned on bad policies.

4Note that in such a long run there would be ongoing investment (a flow), and thus ongoing changes in the size of the capital stock. Since changes in the capital stock would in principle alter the “long run” equilibrium real exchange rate under my definition, the implicit assumption is that ongoing investment flows have a negligible effect on the size of the capital stock over policy-relevant horizons.

5For studies utilizing the “stock” approach, requiring the stock of net international indebtedness to be in steady-state equilibrium, see Faruqee (1995), Montiel (1997a), and MacDonald (1997). The “flow” approach, based on an exogenously determined level of sustainable net capital inflows, is used by Edwards (1989) and Williamson (1994), among others.
For example, an LRER may be sustained by severe trade or capital account restrictions, or by highly distortionary forms of taxation. Supporters of this view would maintain that a real exchange rate that is rendered sustainable by such policies is not truly an equilibrium rate. In their view, the true equilibrium real exchange rate is the one that would prevail under appropriate policies (call it the desirable LRER, or DLRER).

Is this a more useful concept than the LRER? If bad policies are not sustainable whenever superior policies are available, then the LRER and the DLRER are not distinct concepts. The LRER is conditioned on sustainable policies, so if only optimal policies are sustainable, the LRER must be conditioned on such policies, making it equivalent to the DLRER. The issue turns on what one would do with an estimate of the DLRER conditioned on good policies if such policies are in fact unlikely to be implemented—that is, if the inappropriate policies prove to be sustainable. In that case, since the dynamics of the real exchange rate would be determined by the actual policies, the DLRER would provide a misleading indication of where the real exchange rate is heading, making the LRER the relevant concept for formulating exchange rate policy.

In addition to this conceptual problem, important estimation issues arise in the implementation of the DLRER. To find the LRER, an empirical estimate of equation (11.4) is required. Consider how we might proceed from such an estimate to an estimate of the DLRER. The simplest procedure would be to determine the optimal values of $X_1$, $(X_1^*)$ and then substitute them into equation (11.4).

$$DLRER = F [X_1^*, H(X_1^*)].$$

(11.4a)

There are at least two serious problems with this procedure, however. First, as argued later, the problem of estimating equation (11.4) empirically is challenging. The need to find $X_1^*$ makes the empirical determination of the DLRER even more daunting. Second, an additional complication arises in the form of the Lucas critique. The parameters of equation (11.4), estimated under the prevailing policy regime, may not be invariant with respect to a policy intervention that moves the economy to an optimal policy configuration. Determining how the parameters of equation (11.4) would change under such an intervention significantly complicates the estimation of the DLRER.

Why Do We Care About Misalignment?

Regardless of whether the policies underlying it are desirable or not, the LRER is of separate importance because of the macroeconomic
problems posed by exchange rate misalignment. Misalignment presents macroeconomic problems because the adjustment of the actual real exchange rate to its long-run equilibrium value can be disruptive and costly. To see why, write the real exchange rate as

\[ e = \frac{P_N}{sP^*_f}, \]

where \( s \) is the nominal exchange rate and \( P^*_f \) is the foreign-currency price of traded goods. Since \( P^*_f \) cannot be affected by the domestic economy, this means that adjustment must come about through \( s \) or \( P_N \), or both. Both mechanisms may be associated with substantial macroeconomic costs.

Adjustment Through \( P_N \)

Consider first adjustment through \( P_N \). If the currency is overvalued, a domestic recession may be necessary to keep the domestic inflation rate below the foreign rate. If it is undervalued, a bout of domestic inflation may be required to achieve the adjustment. This adjustment will come about automatically through the relative price mechanism if the nominal exchange rate is unchanged (this, of course, is what we mean by an equilibrium).

The adjustment mechanism has two components: changes in the level of expenditure and changes in the composition of expenditure. In the case of overvaluation, in an economy that is financially open, expenditure reduction will be brought about through an increase in the real interest rate through real interest arbitrage. High domestic interest rates associated with the expectation of real exchange rate depreciation will depress total spending, including spending on domestic goods, which will tend to reduce the domestic rate of inflation. Moreover, whether the economy is financially open or not, expenditure switching will be at work. An overvalued currency means that domestic goods will be expensive, thus reducing the demand for such goods until their relative price falls. The operation of these mechanisms was blamed by Dornbusch and Werner (1994), for example, for the depressed state of the Mexican economy in the period leading up to the Mexican financial crisis at the end of 1994, and similar mechanisms may have accounted for the slow growth of the CFA franc countries of Africa preceding the devaluation of the CFA franc in January 1994.

In the case of undervaluation, these mechanisms operate in reverse. The domestic real interest rate will be exceptionally low, causing an in-
crease in domestic spending, and home goods will be relatively cheap, stimulating demand for them.

Adjustment Through Changes in the Nominal Exchange Rate

Alternatively, adjustment could come through discrete changes in the nominal exchange rate. The problem with this mechanism, in economies that are financially integrated with the rest of the world, is that overvaluation may be associated with disruptive capital outflows in anticipation of capital losses associated with devaluation, and undervaluation with disruptive inflows in anticipation of revaluation. With regard to the first, many researchers have recently examined the empirical determinants of currency crises. The evidence suggests that one of the best predictors of currency crises has been the emergence of currency overvaluation (Kaminsky, Lizondo, and Reinhart, 1997). But matters are worse than this. The evidence on the role of overvaluation in currency crises suggests that overvaluation may be necessary for a crisis, but it leaves open the possibility that a crisis could be avoided despite overvaluation. Goldfajn and Valdes (1999), however, found that when misalignment is sufficiently large, it has invariably been followed by a nominal devaluation. Knowing this, capital markets will react, with the implication that a sufficiently large misalignment may be a sufficient condition for a crisis. Examples of the links between currency overvaluation and subsequent currency crises abound in recent years, including the cases of Italy, the United Kingdom, and other European Union countries in 1992, Mexico in 1994, and Thailand and other Southeast Asian countries in 1997.

Among the best known instances of disruptive inflows, on the other hand, are the cases of Germany in 1971 and Malaysia in 1993. In Malaysia, net private capital inflows amounted to more than 20 percent of GDP (World Bank, 1997).

The Equilibrium Real Exchange Rate: Theory

What, then, determines an economy’s LRER? This requires specifying the components of the $X_1$ vector (the fundamentals) and determining their qualitative relationship with the LRER. A simple analytical model that addresses both of these issues is described below.

A Model of the Long-Run Equilibrium Real Exchange Rate

What is needed to identify the fundamentals is a specific model within which the dynamics of the real exchange rate in response to a
broad variety of shocks can be investigated. The model described next, taken from Montiel (1999), is designed precisely to synthesize a wide range of previous research exploring the analytical determinants of the LRER.

This model is based on the three-good production structure described earlier. It is a representative-agent dynamic model developed in a static framework—that is, with no capital accumulation or continuous productivity growth. The economy in question is assumed to be small but a monopoly supplier of its financial liabilities to the rest of the world, and thus it faces an upward-sloping external supply-of-funds schedule, with the risk premium extracted by external creditors increasing with the domestic economy’s net international debtor position. The model possesses a long-run equilibrium that is approached along a unique saddle path. For present purposes, this long-run equilibrium can be described as an extension of the standard Swan-Salter internal-external balance diagram.

The condition for simultaneous equilibrium in the markets for labor and nontraded goods can be expressed as

$$y_N(e, \phi) = (1 - \theta)c/e + g_N.$$  \hspace{1cm} (11.5)

This condition simply states that the supply of nontraded goods $y_N$, given by the left-hand side, must be equal to the demand for such goods from the private $[(1 - \theta) c/e]$ and public $(g_N)$ sectors, given by the right-hand side. The signs under the arguments of the function $y_N(\cdot)$ refer to the partial derivatives with respect to the arguments of the function directly above them. The supply of nontraded goods is an increasing function of the (importables) real exchange rate $e$, as well as a decreasing function of the terms of trade $\phi$. These are implications of labor market equilibrium, since a real depreciation draws labor out of the nontraded-goods sector and into the exportables and importables sector, whereas an improvement in the terms of trade draws labor out of the nontraded-goods and importables sectors into the exportables sector. The specification of private demand for nontraded goods reflects the assumption of constant expenditure shares (Cobb-Douglas utility) for importables and nontraded goods (domestic residents are assumed not to consume exportables), with $\theta$ denoting the share of spending devoted to im-

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6However, discrete sectoral productivity shocks are introduced as exogenous events.
7A list of the symbols used in the analytical model discussed in this section is contained in the appendix at the end of this chapter.
The Long-Run Equilibrium Real Exchange Rate

Figure 11.1. Internal Balance, External Balance, and the Long-Run Equilibrium Real Exchange Rate

![Figure 11.1](image)

Figure 11.1: Internal Balance, External Balance, and the Long-Run Equilibrium Real Exchange Rate

Portables and $c$ the level of total private expenditure, measured in units of importables. Since an increase in private spending creates an excess demand for nontraded goods, requiring a real appreciation to restore equilibrium, this condition generates a positively sloped internal balance locus in $e-c$ space, denoted $IB$ in Figure 11.1.

The external balance condition is given by

$$
\pi^*f^* = \Phi y_X(c, \phi) + y_Z(c, \psi) + (r^* + \pi^*)/\kappa - [\tau(e + \pi^*) + \theta]c - g_z \ldots (11.6)
$$

This condition states that in long-run equilibrium the current account balance, given by the right-hand side, must be equal to the sustainable capital inflow, given by the left-hand side. The latter is equal to the inflationary erosion of the real value of the country's net debt to the rest of the world. With the country's real net international creditor position given by $f^*$ and the world inflation rate by $\pi^*$, the sustainable capital inflow is thus $-\pi^* f^*$. The right-hand side of this equation consists of the trade balance plus net interest receipts from the rest of the world. The trade balance is given by the sum of domestic production of exportables $y_X$ (measured in terms of importables by multiplying by the terms of trade $\phi$) and importables $y_Z$, minus private and public demand.
for importables (given by \([\tau + \theta]c\) and \(g_Z\), respectively). Net interest receipts from (payments to) the rest of the world are given by \((r^* + \pi^*)f^*\), where \(r^*\) is the external real interest rate faced by the domestic economy, so that \(r^* + \pi^*\) is the external nominal interest rate.

Two features of this equation deserve special attention. First, the private demand for importables has two components. The component \(\theta c\) reflects the assumption, mentioned previously, that a share \(\theta\) of total private spending is devoted to importable goods, so that \(c_Z = \theta c\). The component \(\tau c\), on the other hand, corresponds to the assumption that transaction costs associated with the act of spending (consisting of \(\tau\) goods per unit of consumption) are incurred in the form of traded goods. Such costs can be mitigated through the holding of money balances, but doing so is discouraged when domestic inflation is high. Letting \(\varepsilon\) denote the rate of depreciation of the nominal exchange rate, the domestic long-run rate of inflation must be equal to \(\varepsilon + \pi^*\), and \(\tau\) is thus increasing in \(\varepsilon + \pi^*\), as indicated above.

Second, the country’s net international creditor position, given by \(f^*\), depends only on the external real interest rate, and so is unaffected by other shocks in the model. The reason is that in the steady state the domestic real interest rate must be equal to the rate of time preference, which is exogenous. Since the external real interest rate is exogenous as well, and so necessarily equal to the rate of time preference, what reconciles the two is the risk premium on lending to the domestic economy, which is a function of \(f^*\). Thus, \(f^*\) will remain unchanged in the absence of changes in \(r^*\).

Since the production of traded goods \(\phi y_x + y_z\) is decreasing in the real exchange rate \(e\), and since an increase in consumption expenditure reduces the trade surplus, the set of combinations of \(e\) and \(e\) that satisfies the external balance condition is plotted as the negatively sloped locus \(EB\) in Figure 11.1. The intersection of this locus with the positively sloped \(IB\) locus derived previously determines the long-run equilibrium value of the real exchange rate as well as private expenditure. Comparative-statics exercises with this long-run model can be used to identify the set of fundamentals, as well as the qualitative nature of their effects on the LRER.

**Comparative Statics**

**Fiscal Policy**

Changes in government spending on traded goods. Consider the effects of changes in sector-specific government spending, holding the fiscal
deficit constant. An increase in government spending on traded goods has no effect on the internal balance locus, but it shifts the external balance locus $EB$ downward, as shown in Figure 11.2. The increase in government spending creates an incipient trade deficit, which requires a real depreciation to maintain external balance. Since the real depreciation would create excess demand for nontraded goods in the absence of changes in spending, the new equilibrium must feature adjustment through a combination of LRER depreciation and reduction in the level of private spending, shown at point C in Figure 11.2.

Changes in government spending on nontraded goods. In contrast to the previous case, changes in government spending on nontraded goods affect the internal balance locus. 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 upward, as shown in Figure 11.2. In this case, the real appreciation required to clear the market for nontraded goods would create an unsustainable deficit in the current account. Consequently, adjustment to the shock requires a combination of LRER appreciation and reduction in private spending, as at point B. The upshot of this exercise and the
previous one is that the LRER 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, the deficit reduction can be captured through a reduction in the rate of monetary emission by the central bank, which is what would happen with higher tax revenue and unchanged spending. In the long run this is equivalent to a reduction in the rate of crawl of the nominal exchange rate, so this is the variable that one ultimately has to shock in this model to simulate the effects of deficit reduction.

In this model, the gain from a lower fiscal deficit comes in the form of lower distortions associated with the inflation tax. A reduced rate of depreciation lowers the domestic interest rate, increases the demand for money, and reduces the transaction costs associated with consumption—that is, \( \tau^* \) falls. This has the effect of increasing the supply of real output. Whether the LRER will appreciate or depreciate depends on whether transaction costs absorb traded or non traded goods. This will determine the form that the increase in real output takes. As specified above, the model assumes that these costs are borne in the form of traded goods. The reduction in \( \tau^* \) will thus increase the supply of such goods, shifting the external balance locus upward and resulting in a real appreciation, together with an increase in consumption. On the other hand, if transaction costs are incurred in non traded goods, the external balance locus will remain fixed, and the internal balance locus will shift to the right. In that case, the equilibrium real exchange rate would depreciate, and consumption would rise.

Changes in the Value of International Transfers

As summarized 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 transfer. They would appear as an additive term in the external balance condition in equation (11.6). Accordingly, the

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8It makes no difference in this model whether the transfer is received directly by the private sector or goes to the government, since under the fiscal regime assumed above, the latter would transfer the proceeds to the private sector. Note that this transfer does not appear in the internal balance locus directly, since its influence on the nontraded-goods market is exerted through its effects on private spending, \( c \).
Effect of a permanent increase in the receipt of transfer income would be to shift the external balance locus to the right, as in Figure 11.3 (because the receipt of additional transfer income permits an expansion of consumption to be consistent with external balance at an unchanged real exchange rate). There are no direct effects on the internal balance locus \( IB \), so the LRER undergoes an equilibrium real appreciation, and private absorption increases, as indicated at point \( B \).

Changes in International Financial Conditions

Capital inflows and transfers have in common 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 result from a variety of changes in domestic and external economic conditions. Presumably, the change in the LRER associated with a particular episode of capital inflow depends on the source of the shock that triggers the inflow. Second, unlike transfers, capital inflows create an obligation of repayment in the long run. These also affect the LRER.

Consider, then, the effect on the LRER of a permanent reduction in the risk-free world real interest rate. In this model, the domestic real in-
terest rate is unaffected in the long run, since it is determined by the constant domestic rate of time preference, and so is the real interest rate in world capital markets that the country actually faces. The latter must also be unchanged from one long-run equilibrium to the next, because with a constant value of the real exchange rate, the world real interest rate must be equal to the domestic real interest rate. 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. Thus, the effect of a lower international real interest rate in the model is to reduce $f^*$. The change in the external real interest rate has no other direct effects in the model.

Again, this shock affects only the external balance locus directly. Given that $f^*$ moves in the same direction as $r^*$, it can be verified from equation (11.6) that the real exchange rate consistent with external equilibrium moves in the same direction as the world interest rate. When the world real interest rate falls, the external balance locus shifts downward, to a position similar to $EB''$ in Figure 11.3, and the LRER actually depreciates, contrary to what happens when transfer receipts increase. The intuition for this result relies on the fact 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 LRER depend on their long-run implications for national income. In this model, however, the implications of a reduction in world interest rates for 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. Because in this case the borrowing has to be repaid (unlike in the case of transfers), the repayment is reflected in a reduction in long-run equilibrium national income.

**The Balassa-Samuelson Effect**

The term *Balassa-Samuelson effect* (see Balassa, 1964; Samuelson, 1964) refers to the effects on the LRER of differences in sectoral productivity growth. Although the model on which this discussion is
based does not incorporate trend productivity growth, the impact on the LRER of such growth at differing sectoral rates can be determined by examining the effects of permanent shocks to sectoral productivity levels.

To examine the effects of sector-specific productivity growth on the LRER, notice that a productivity shock would enter the internal and external balance equations only through its effects on output of nontraded goods $y_N$ and traded goods $(\phi y_X + y_Z)$, respectively. Since a favorable productivity shock to the traded-goods sectors would tend to reduce $y_N$, it creates excess demand in the nontraded-goods market, requiring a real appreciation to restore internal balance—that is, the $IB$ locus shifts upward, to a position such as $IB'$ in Figure 11.4. At the same time, however, by increasing production of traded goods, the shock gives rise to an incipient trade surplus, so a real appreciation is also required to restore external balance. Thus, $EB$ shifts upward as well, to $EB'$. 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, as shown at point B.9

Changes in the Terms of Trade

For a given level of private expenditure, an improvement in the terms of trade results in a contraction in output of nontraded goods, because resources are drawn out of the production of importables and nontraded goods into the production of exportables. The resulting excess demand in the nontraded-goods market causes the internal balance schedule to shift upward. The effects on the external balance schedule depend on whether the real value of total traded-goods output increases or decreases at a given level of private expenditure. 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 by 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 upward—the incipient improvement in the trade balance requires a real appreciation to keep the trade balance at a sustainable level. Thus, the effect of a permanent improvement in the terms of trade is to appreciate the LRER.

Trade Policy

Finally, consider the effects on the LRER of a liberalization of trade policy, modeled as a reduction in export subsidies. This is the simplest case to model in the current context, because it makes possible the use of the results derived for analyzing the effects of terms of trade shocks. Consider, in particular, an export subsidy set at the rate \( (\theta - 1) \). In this case, for a given value of the external terms of trade, the internal terms of trade will be determined by \( \phi \), and the previous analysis of the effects of changes in the external terms of trade on the LRER can be applied directly to determine the effects of changes in \( \phi \), at least on the supply side of the economy. In particular, an increase in the subsidy

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9The Balassa-Samuelson effect is often analyzed in the context of the external rather than the internal real exchange rate discussed here. With no productivity changes in the country's trading partners, it is the home country's external real exchange rate that would appreciate together with its internal real exchange rate under circumstances explained here. It is conceivable, however, that if the country's trading partners were to experience sector-specific productivity shocks, resulting in appreciation of their internal real exchange rate, the home country's external real exchange rate would depreciate while its internal real exchange rate would appreciate.
would pull labor out of the importables and nontraded-goods sectors into the exportables sector, just as would an equivalent favorable terms of trade shock. A direct implication of this is that the effects of subsidy changes on the internal balance schedule are the same as those of an equivalent terms of trade shock. An increase in the subsidy causes IB to shift upward by creating an excess demand for nontraded goods, and a decrease in the subsidy causes it to shift downward.

Where matters differ is with 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 changes in subsidy rates, an increase in the subsidy rate would cause output of traded goods to expand, resulting in an incipient improvement in the trade balance, just as before. Again, the reason is that a subsidy increase draws labor from the nontraded-goods sector to the exportables sector. However, the income effect is absent in this case because, 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 the external balance condition, the result is

\[
\pi^e_{\text{net}} = \phi y_X(e,\phi) + y_Z(e,\phi) + \pi^e_P - (\phi - 1)y_X(e,\phi) - (\tau + \theta)c
\]

\[
= y_X(e,\phi) + y_Z(e,\phi) + \pi^e_P - (\tau + \theta)c. \tag{11.7}
\]

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) as a terms of trade change, which 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 a liberalization of trade 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 the external balance schedules downward, with the implication that commercial liberalization results in a depreciation of the equilibrium real exchange rate.

**Estimating the Equilibrium Real Exchange Rate**

Having examined the conceptual underpinnings of the equilibrium real exchange rate and analyzed its fundamental determinants, we
now need to know how to estimate it. A variety of techniques are avail­
able, depending on the circumstance. Some of these, classified as
"structural" and "nonstructural," are taken up below.

**Structural Techniques**

*Simulations of General-Equilibrium Models*

A straightforward approach to estimating the LRER for a particular
developing country would mimic the analytical exercise we just con­
ducted by simulating an empirical dynamic macroeconomic model,
using parameter values and data appropriate for that country. Given a
reliable empirical macroeconometric model of a specific developing
country, model simulations for specified paths of policy and exogenous
fundamentals would yield steady-state values of the real exchange rate
that would correspond to the LRER, just as in the case of the analytical
model. Indeed, this is the preferred approach among researchers who
have explored this issue in the industrial country context (see Clark
and others, 1994; Williamson, 1994; and Stein, Allen, and associates,
1995). This approach, however, requires the availability of a well-artic­
ulated, ready-made model (or a vector autoregressive model) with a
proven track record that can be applied in this context. Such a model is
not readily available for many developing countries. Specifying and
estimating a ready-made model for each application would of course
be feasible, but such models would probably command little confi­
dence, and the approach would be expensive.

*The Partial-Equilibrium Trade-Elasticities Approach*

The alternatives to this procedure consist of abridged, partial­
equilibrium models and single-equation estimation. The most common
partial-equilibrium technique might be referred to as the "trade­
elasticities" approach. This methodology has been used recently by
Wren-Lewis and Driver (1997) to estimate LRERs for the G-7 countries,
and it was used in the World Bank to estimate LRERs for the CFA zone
countries prior to the January 1994 devaluation of the CFA franc (see
Ahlers and Hinkle, 1999).

The technique can be described as follows. Relying on the internal­
external balance conceptualization of the LRER, write the external bal­
ance condition as

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10For a review of the state of applied macroeconomic modeling in developing countries, see
Montiel (1997a, b).

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where \( K \) is the sustainable level of capital flows, \( Y \) and \( Y^* \) are the full-employment levels of domestic and foreign real GDP, and \( i^* \) is the interest rate on the country’s net external debt \( D \). The function \( B() \) expresses the trade balance as the difference between the external demand for the country’s exports (depending on relative prices and partner country incomes) and the domestic demand for imports (depending on relative prices and domestic income). The assumption underlying this specification is that both the domestic supply of exportable goods and the foreign supply of importable ones are perfectly elastic. Now suppose we know both the level of domestic foreign real GDP at full employment and the sustainable level of capital flows.

Then, if we set \( Y \) and \( Y^* \) equal to their full-employment levels to impose internal balance and set \( K \) equal to its sustainable level, estimating the LRER for a given level of \( D \) boils down to estimating the single function \( B() \), including determining how the trade balance responds to the real exchange rate. Given the values of \( Y, Y^*, K, \) and \( D \), with \( i^* \) determined exogenously and the function \( B \) estimated, the LRER is the value of \( e \) that solves this equation.

An alternative version of this approach is more directly applicable to small countries that primarily export homogeneous primary commodities. For such goods, foreign demand may be perfectly elastic, but domestic supply will not be. In that case, the trade balance would reflect the difference between the domestic supply of exportables (rather than the foreign demand for them) and the domestic demand for importables. Assuming that, as a first approximation, the exportable good is not consumed at home and the importable good is not produced at home, the supply of exports would be a function of the relative price of exports in terms of domestic goods (the exportables real exchange rate) and the demand for imports would depend on the relative price of imports in terms of domestic goods (the importables real exchange rate), as well as domestic income. Equation (11.8) would then become

\[
K = B(P_D/P_X, P_D/P_Z, Y) + i^*D, \tag{11.9}
\]

where \( P_X, P_Z, \) and \( P_D \) are the domestic-currency prices of exports, imports, and domestic goods, respectively. Letting \( e \) now denote the importables real exchange rate \( P_D/P_Z \) and \( \phi \) the terms of trade \( (\phi = P_X/P_Z) \), we can write the equation as

\[
K = B(\phi, e, Y) + i^*D. \tag{11.9a}
\]
The implementation of this version is the same as that of the previous one, except that it requires an export supply elasticity instead of an export demand elasticity.\textsuperscript{11}

This simple trade-elasticities approach has a number of advantages. First, it is structural, so the mechanism that determines the LRER can be understood. Second, it makes use of a small set of behavioral parameters that are widely estimated and thus readily available. Econometrically, all that is required is an estimate of whichever version of the $B(\cdot)$ function is to be applied. An extensive empirical literature is available on estimating trade equations (see Goldstein and Khan, 1985, for a survey). Moreover, estimates of export and import functions that closely approximate the $B(\cdot)$ function are available for many developing countries. Even where estimation of such functions is problematic, reasonable estimates of the parameters of the functions that can be imposed ex ante are either available or can be readily constructed.\textsuperscript{12} Finally, the trade-elasticities approach has the virtue of simplicity. Although it requires an estimate of the sustainable value of $K$, this would be true of any attempt to measure the LRER that adopts a “flow” specification of external balance.

The approach also has some serious disadvantages, however. Although estimates of trade elasticities tend to be widely available, they are typically small and tend to be imprecisely estimated. This creates a wide range of uncertainty for the estimated LRER (see Kramer, 1996). And it becomes especially problematic given the uncertainty in the estimation of sustainable capital flows, $K$. For small, low-income countries, $K$ may be exogenous and relatively predictable, but for most other countries, this step in the estimation is troublesome, and lack of confidence in the estimation of $K$ is magnified with respect to the estimate of the LRER when the real exchange rate elasticities in $B(\cdot)$ are small and imprecisely estimated. An additional problem is estimating $D$, net external debt. \textit{Hysteresis} may become a factor in this regard, since the estimate of $D$ in long-run equilibrium depends on how long it takes to reach the equilibrium, and thus on how exactly the economy is assumed to get there.\textsuperscript{13} The most fundamental problem, however, is the ad hoc nature of the current account specification used in this ap-

\textsuperscript{11}For an application, see Devarajan, Lewis, and Robinson (1993), who derived an equation like equation (11.9) from a simple computable general-equilibrium model.

\textsuperscript{12}Chei and Pritchett (1999), for example, provide reasonable estimates of the real exchange elasticities for application in such cases.

\textsuperscript{13}To address this we have two choices: either specify a model that describes the transition, or interpret the exogenous variable in terms of the resource balance, $K - r^*D$. 

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The model described previously suggests a specification more like the following:

\[ K(X_t) = B[e, A(X_t), X_t] + i^*D(X_t). \] (11.10)

In other words, the proper scale variable is absorption rather than income, and the fundamentals are likely to affect the level of net capital inflows, the “scale” variable, and the stock of net international debt, and to enter the trade balance directly.

Because these shortcomings make the method less reliable, it is perhaps best suited for first-pass “back of the envelope” estimation. However, in country applications where data limitations prevent the implementation of the more sophisticated approaches (described below), or in circumstances in which time and resource constraints are severe, the trade-elasticities approach, despite its limitations, may be the method of choice.

Nonstructural Techniques

The alternatives to the structural techniques are time-series techniques or techniques that essentially rely on reduced-form equations. Within this restricted set of procedures, the appropriate empirical technique depends on the time-series properties of the real exchange rate, in the following sense: what the analyst is interested in is the value of the LRER at a particular time. What can actually be observed is the time series of the real exchange rate. The question is whether movements in the real exchange rate during the period of observation represented fluctuations around a stable value of the LRER—that is, one that is still expected to prevail at the moment for which the LRER is being estimated—or whether the LRER would be expected to have changed. If the real exchange rate is stationary, past values can be interpreted as variations around a stable LRER. If it is nonstationary, then the LRER prevailing today may not be the one underlying past observations of the real exchange rate.

Estimating the LRER When the Real Exchange Rate Is Stationary

When tests of nonstationarity reject the presence of a unit root in the real exchange rate, approaches to estimating the LRER based on the assumption that the LRER is constant can be rigorously justified. The theory described earlier, linking the LRER to its fundamental determinants, implies a reduced-form relationship between the real exchange
rate and those determinants, which would be stable for stable policy regimes. But that theory holds whether the fundamentals are stationary or nonstationary. Thus, the interpretation of the rejection of nonstationarity in light of the analytical model described previously is that the relevant set of fundamentals is itself stationary—that is, the variables in this set do not undergo permanent shocks during the sample period. In that case, the model would predict that the LRER should be constant, albeit with transitory deviations caused by temporary changes in some subset of the fundamentals.

To estimate the LRER in the stationary case, it may or may not be necessary to estimate this relationship. Whether it is desirable to estimate the reduced-form equation linking the LRER to its fundamentals depends on how much structure one is willing to impose on the problem. In principle, to get an estimate of the constant LRER during the sample period, one would like to remove all transitory influences that caused the real exchange rate to deviate from the LRER during that period. These would include, for example, transitory shocks to the real fundamentals, temporary effects of observable nonfundamental variables (for example, nominal shocks), the lingering effects (through real exchange rate dynamics) of past shocks, and the effects of unobservable random shocks.

The purchasing power parity approach. The simplest and most agnostic way to estimate the constant LRER is to use as the LRER estimate the sample average of the observed real exchange rates. For example, when information is unavailable beforehand on the extent to which fluctuations in the fundamentals are outside the normal range during the sample period, the best estimate of the permanent levels of the fundamentals is likely to be their sample means. In this case, estimating the effects of the fundamentals on the LRER through a reduced-form regression of the real exchange rate on the fundamentals would not improve the precision of the LRER estimate over the simpler procedure of calculating the sample mean of the real exchange rate. This is because the fitted value of the regression evaluated at the sample mean of the fundamentals would simply reproduce the sample mean of the real exchange rate itself. This approach to estimating the LRER can be dubbed the purchasing-power-parity (PPP) approach, named after PPP theory, which postulates a constant LRER.

However, this approach runs into a small-sample problem. Although all the deviations of the real exchange rate from the LRER listed above would cancel out over a sufficiently long sample period, they are not guaranteed to do so within a given finite sample. Thus, the sample av-
The Long-Run Equilibrium Real Exchange Rate

Average of the observed real exchange rates may not provide a good approximation of the LRER. The alternatives to this simple procedure depend on how much information one has about the economy. For example, if independent information is available suggesting that the “normal” values of some subset of the fundamentals differ from their sample means, then removing the “abnormal” influence of the fundamentals during the sample would yield a more precise estimate of the LRER. This could be done by estimating the reduced-form regression for the real exchange rate and calculating the fitted values for the known normal levels of the fundamentals.14

Estimates of reduced-form equations. A more ambitious approach is to use reduced-form estimation to remove as many of the transitory influences on the real exchange rate as possible. Perhaps the best-known examples of this are two studies by Edwards (1989 and 1994). Edwards (1994), for example, used panel data for 12 developing countries over the period 1962–84 to estimate a regression of the real exchange rate on potential fundamentals, as well as on other variables interpreted as not affecting the LRER, but potentially causing the real exchange rate to deviate from the LRER.15 The equation also included a lagged dependent variable to capture the dynamics of adjustment of the real exchange rate to the LRER. Edwards used his estimated regression to calculate estimates of the LRER as follows: by setting the values of the variables expected to have a transitory effect on the real exchange rate equal to zero and setting the current and lagged real exchange rates equal to each other, he solved for the long-run coefficients of the fundamentals. He then used five-year moving averages to estimate the permanent values of these variables. Calculating the fitted values of the real exchange rate with coefficients and explanatory variables derived in this manner, he produced estimated time series for the LRER for several of the countries in his sample.

This approach essentially eliminates transitory, very short-run deviations of the real exchange rate from the LRER arising from shocks to

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14 This procedure essentially generalizes some common informal methods of estimating PPP-based LRERs. For example, choosing the real exchange rate prevailing in some particular base year as an estimate of the PPP-based LRER essentially requires the strong assumptions that all fundamentals are stationary (so their permanent values have not changed) and were known to have been at their permanent values in the base year. Similarly, dropping abnormal years before calculating an average real exchange rate over some subset of the sample period requires the prior knowledge that the average values of the fundamentals in that year were not representative of their permanent values.

15 These included primarily proxies for temporary aggregate demand shocks and the change in the nominal exchange rate.
the equation, changes in nominal variables, short-run movements in the fundamentals, and short-run real exchange rate dynamics. What are left are longer-run movements in the fundamentals that may cause relatively long-lasting fluctuations in the real exchange rate around a stable, PPP-driven LRER. These smooth, longer-run movements in the real exchange rate, although not permanent, may nevertheless be sufficiently sustained to be of relevance to policy.

**Estimating the LRER When the Real Exchange Rate Is Nonstationary**

If the real exchange rate proves not to be stationary over the sample period, PPP-based approaches will not be appropriate, because observations of the real exchange rate generated under permanent values of the fundamentals that are different from the current ones will be uninformative about the current value of the LRER, unless the estimation controls for the effects on the LRER of changes in the permanent values of the fundamentals. Incorporating the possibility of changes in the permanent values of the fundamentals thus requires adopting an alternative empirical approach. The structural approaches described previously could be applied in this case, or the reduced-form approach just discussed could be used, employing unit-root econometrics.

*Estimation using unit-root econometrics.* If the real exchange rate proves to be nonstationary, the interpretation that follows from theory is that the LRER has changed within the sample period. This can be attributed to permanent changes in at least some subset of the fundamentals—that is, to nonstationarity among at least some of the fundamentals. The theory suggests that, in this case, the real exchange rate and the nonstationary fundamentals must be cointegrated, with the cointegrating relationship representing the reduced-form equation linking the LRER to its fundamental determinants. The task of estimation is to extract the permanent component from the time series of the real exchange rate, since this component represents the estimate of the LRER. In parallel with the stationary case, it may or may not be necessary to estimate the reduced-form relationship between the real exchange rate and the fundamentals in order to generate this estimate.

In the absence of a priori knowledge about the permanent values of the fundamentals, all that is needed to extract an estimate of the LRER from time-series observations on the real exchange rate is a technique for separating movements in the real exchange rate into its transitory and permanent components. A Beveridge-Nelson decomposition, for example, could be used to extract an estimate of the permanent com-
ponent of the real exchange rate, and thus to estimate the LRER. This is the counterpart in the nonstationary case of the use of the sample mean or the fitted trend to estimate the LRER in mean and trend stationary cases. When independent information is available about the permanent values of the fundamentals, however, estimating the relationship between the LRER and the fundamentals becomes important. Cointegrating equations with the relevant set of fundamentals would reveal this long-run relationship between the real exchange rate and its fundamental determinants. Thus, estimating the LRER involves estimating the cointegrating relationship between the real exchange rate and its fundamentals, and calculating the fitted values of the cointegrating equation for the permanent values of the fundamentals. Applications of this method have proliferated in recent years, following Elbadawi (1994). To illustrate the method, consider an application for Thailand taken from Montiel (1997a). Thailand’s real effective exchange rate proved to be nonstationary over the sample period 1960–94, as did each of a broad set of potential fundamental determinants suggested by theory. A cointegrating regression linking the real exchange rate to this set of fundamentals produced the following result:

\[
\log (RER) = 6.117 - 0.008 \text{TIME} - 0.018 \text{INFL} + 0.414 \log (\text{TOT}) \\
+ 0.364 \log (\text{OPNTX}) + 0.286 \log (\text{CGR})
\]

(0.003) (0.005) (0.121)

(0.094) (0.085)

Likelihood ratio = 115.08**.

In this regression, \text{INFL} is the external rate of inflation; \text{TOT} is an index of the terms of trade; \text{OPNTX} is a measure of trade policy, defined as the ratio of import tax receipts to the total value of imports; \text{CGR} is the ratio of government consumption to \text{GDP}, used as a proxy for government spending on nontraded goods; and \text{TIME} is a time trend intended to capture the effects of differences in sectoral productivity growth. The signs of the fundamentals in the cointegrating equation are consistent with the theory described in the last section.

Generating an estimate of the LRER requires fitted values of this equation using permanent values of the fundamentals. To illustrate, I

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16Conceptually, therefore, the procedure is similar to that applied in the stationary case, except for the econometric techniques employed.


18The numbers in parentheses are standard errors.
constructed two alternative estimates of the permanent values of the exogenous and policy fundamentals, by passing each of the fundamentals through a Hodrick-Prescott filter and by generating five-year moving averages. The corresponding estimates of the LRER over the 1965–94 period are plotted along with the actual values of log (RER) in Figure 11.5, and are denoted HP and MA, respectively. The estimated year-to-year variability in the estimated LRER is sensitive to how much smoothing one is prepared to impose in extracting the permanent movements in the fundamentals from the observed series, but the general interpretation of Thailand’s recent exchange rate experience is similar in the two cases. Both estimates of the LRER suggest a secular depreciation in Thailand’s LRER. This is only partially driven by the trend variable, which contributes a secular depreciation of a little less than 1 percent a year. More important are secular changes in the trade policy regime associated with trade liberalization, and the declining share of government consumption in GDP.

Focusing on the period since 1980, the baht appears to have become overvalued during the early 1980s (reflecting the effective nominal appreciation of the dollar, to which it was effectively pegged). Nominal devaluations in mid-decade corrected the overvaluation and indeed somewhat overshot the equilibrium rate, presumably in support of the export-oriented strategy adopted by Thailand at that time. By the late
1980s, the real exchange rate was again above its long-run equilibrium value, consistent with upward pressure on the real exchange rate caused by the arrival of substantial capital inflows. Nonetheless, the gap between the real exchange rate and the LRER remained relatively small through 1994, especially using the moving-average measure of the permanent values of the fundamentals, suggesting that misalignment was not a problem for Thailand through the end of the sample period.19

More recently, Tanboon (1998) has applied this methodology to Thailand with updated data and with the addition of a variable intended to capture the effects on Thailand’s external competitiveness of the emergence of China as a major exporter during the 1990s. Tanboon supplemented the previous specification with a variable consisting of the share of Chinese exports in world exports, which can be interpreted as refining the terms of trade variable already included in the cointegrating equation reported above.20 He found that, by 1997, Thailand’s currency was overvalued by about 30 percent in real terms, and that much of the depreciation in the country’s LRER during the decade was attributable to competition from new exporters. Thus, the methodology points to an important reason why Thailand underwent a balance of payments crisis in 1997.

Conclusions

Exchange rate misalignment—defined as the existence of a gap between the real exchange rate and the LRER—is costly, and may be becoming even more so in many developing countries as financial integration reduces the margin of error for policymakers in formulating exchange rate policy. The best way to avoid these costs is to avoid the emergence of a large misalignment in the first place. Economies in which exchange rates continue to be managed by the authorities have, in principle, two ways of doing this:

- The nominal exchange rate can be moved quickly to track underlying changes in the LRER.
- Alternatively, the policy component of the fundamentals can be adjusted to move the LRER closer to the actual value of the real exchange rate.

19Indeed, the gap between the real exchange rate and the LRER in 1994 was not statistically significant under either measure of the permanent values of the fundamentals.
20To the extent that China’s exports are close but imperfect substitutes for those of Thailand, an expansion of Chinese export capacity would tend to deteriorate Thailand’s terms of trade.
The problem with the second option, of course, is that policy fundamentals may need to meet other objectives (for example, should trade policy be tightened to cope with a depreciation of the LRER caused by an adverse movement in the terms of trade?). The key problem, however, is that both alternatives require the availability of a reliable method of estimating the LRER—one in which policymakers can place some degree of confidence.

Unfortunately, in this area, theory is ahead of estimation. Although a substantial body of analytical work is available on the determinants of the LRER, there is no widely agreed, reliable method for estimating the value of the LRER for a particular country at a given moment. The task is complicated, of course, by the fact that, as theory suggests, the LRER can change over time if there are permanent changes in its underlying real fundamental determinants. Reliance on simple PPP calculations is likely to prove seriously misleading in such cases.

Fortunately, recent advances in unit-root econometrics provide a methodology for estimating the LRER when the real exchange rate proves to be nonstationary—that is, precisely when PPP calculations are most likely to prove problematic. This methodology is particularly well-suited for estimating the LRER, because it relies on an appropriate specification of long-run relationships while accommodating a substantial degree of empirical ignorance about short-run mechanisms of adjustment—a situation that accurately characterizes the state of the art in the economics of real exchange rate determination. However, the methodology is relatively new and data intensive. Whether it will offer major advances in the empirical measurement of the LRER in developing countries remains to be seen.

In the meantime, how can exchange rates be managed so as to avoid misalignment (the first option above) if reliable, systematic techniques for estimating the LRER are not yet in hand? Where does this leave nominal exchange rate management? Two choices appear to be available:

- Policymakers can continue to manage exchange rates by relying on the judgment of skilled practitioners who are guided by theory and by the available systematic evidence.
- Alternatively, policymakers can adopt nominal exchange rate regimes that place less urgency on the need to make such judgments or that reduce the costs of misalignment. Fully flexible exchange rates at one extreme, and currency boards or monetary unions at the other, may satisfy both objectives.
Some observers have concluded that recent increases in financial integration may drive many countries to such polar exchange rate arrangements. Flexible exchange rates, although not guaranteed to avoid misalignment, may reduce the costs associated with it. Currency board arrangements may also do so by increasing the flexibility of domestic wages and prices. Recent experience in Mexico and Southeast Asia suggests that time may indeed be running out on managed exchange rates unless progress is made in identifying and measuring the LRER.

Appendix 11.1: Notation for the Analytical Model

The following notation is used in the analytical model consisting of equations (11.5) and (11.6) in the text:

\( c = \) total private sector expenditure, measured in units of importables
\( e = \) importables real exchange rate
\( f^* = \) real net international creditor position of the domestic economy, measured in units of importables
\( g_N = \) government spending on nontraded goods
\( g_z = \) government spending on importable goods
\( r^* = \) external real interest rate faced by the domestic economy
\( y_N = \) output of nontraded goods
\( y_x = \) output of exportable goods
\( y_z = \) output of importable goods
\( \varepsilon = \) rate of depreciation of the domestic currency
\( \phi = \) terms of trade
\( \tau = \) transaction costs per unit of private spending, measured in units of importable goods
\( \pi^* = \) world rate of inflation
\( \theta = \) share of importables in private expenditure.

Bibliography


