Part III

Methodologies for Estimating the Equilibrium RER: Empirical Applications
The estimation of long-run equilibrium RERs (LRERs) and measurement of misalignment have traditionally relied on two approaches with strong operational advantages: a relative purchasing power parity-based methodology that assumes a stationary LRER and a target resource balance methodology that employs trade equations or elasticities. In addition, in cases of split or multiple exchange rates, the parallel market rate has sometimes been used as an indicator of misalignment.

The two traditional approaches are still widely used in operational applications in both industrial and developing countries, particularly when the data or time required for implementing more complex methodologies are not available. Even when it is feasible to employ the general-equilibrium methodologies discussed in the subsequent chapters in Part III of this volume, the traditional operational approaches still provide good starting points for the analysis, and transparent reference points for cross-checking the plausibility, of the results from the more complex methodologies. Most of the input data required to implement

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1. The term resource balance is used in this chapter to refer to the difference between exports of goods and nonfactor services, and imports of goods and nonfactor services. The resource balance equals the current account balance exclusive of net interest and other factor service payments.
the two operational approaches are needed for the other methodologies in any case.

When the RER is stationary in a time-series sense, long-run equilibrium exchange rates may be estimated on the basis of relative purchasing power parity (PPP) by using either a base-year or a trend approach. The base-year approach first establishes a base period in which the observed RER is believed to be at its equilibrium level. Misalignment is then measured as the difference between the observed RER and its base-period value, on the implicit PPP assumption that the LRER has remained at its base level. The utility of this PPP-based methodology is limited because of its inability to allow for permanent changes in the LRER that would cause the RER to be nonstationary. The methodology is, however, still useful for analyzing situations where the LRER is believed to have remained unchanged, such as when shocks to the economy have primarily affected nominal variables or when shocks to the “real” fundamentals have been transitory. In both cases, relative PPP would hold during the sample period. Alternatively, the LRER may be estimated as the trend or mean value to which the RER tends to return in the long term under PPP theory; and misalignment is then measured as the deviation from this trend or mean value.

Since all the other methodologies for measuring misalignment, including the trade-equations approach, are much more time-consuming to implement than the above relative PPP-based approaches, these are often the only feasible methodologies for multicountry studies in which the amount of time that can be devoted to individual country cases is limited. For the same reason, PPP-based graphical analysis is also widely used for making initial diagnoses of individual countries and for identifying hypotheses for analysis using more sophisticated techniques.

The trade equations–elasticities methodology is the second of the standard operational approaches for estimating the LRER. Although there are a number of variations of this methodology, the key quantitative relationships in each are relatively straightforward and transparent. Each of the variants of this methodology involves the same three basic analytical tasks. First, trade equations or trade elasticities are used to establish a quantitative relationship between the RER, imports, exports, and, hence, the resource balance. Second, a target, norm, or equilibrium resource balance is determined using independent projections of the saving-investment balance or of sustainable capital flows. And, third, the actual resource balance in the initial year is adjusted for changes in cyclical, exogenous, and policy variables that affect it in order to estimate the underlying structural balance and provide an appropriate basis for computing the change required in the initial RER. The quantitative relationship between the RER and the resource balance established in the
first step is then used to calculate the appreciation or depreciation in the initial RER required to move the resource balance from its adjusted level in the initial year to the target level, everything else remaining the same. The estimated long-run equilibrium RER is the one that corresponds to the target or equilibrium resource balance.

The trade-equations-elasticities methodology permits taking into account permanent changes in some of the fundamental determinants of the RER. The methodology can directly address the relative price effects of changes in the terms of trade and tariff rates, and cover, at least in a back-of-the-envelope fashion, permanent changes in most of the other fundamental exogenous and policy variables in which one may be interested. Like the relative-PPP-based approach, the trade-equations methodology can also provide useful inputs for more complex ones. For example, adjusting the initial resource balance, determining a target resource balance, and projecting exogenous variables are steps common to many of the approaches used for estimating equilibrium real exchange rates. The analytical techniques for carrying out these steps, which are set out in this chapter, are used both with the trade-equations methodology and with some of the other methodologies discussed in the subsequent chapters of Part III of this book.

As noted above, a parallel exchange rate has sometimes been used as an additional indicator of distortions in the foreign exchange market and potential misalignment. However, because exchange rate misalignment does not necessarily lead to the development of a parallel market and parallel rates are much less common than they were a decade ago, opportunities to apply this approach are limited. Moreover, the approach turns out to be fraught with analytical difficulties. For both reasons, the existence of a parallel foreign exchange market is considered as a special case in Part IV of this volume. There the chapter by Ghei and Kamin examines the relationship between the parallel and the unified equilibrium exchange rates and considers the usefulness of the parallel rate as a guide for determining a unified exchange rate.

This chapter discusses the two standard operational approaches for estimating the LRER. The structure of the chapter is as follows. The following section first sets the PPP-based approach in the context of recent theoretical and empirical work on the determination of equilibrium RERs and then discusses the interpretation and usefulness of PPP-based estimates of misalignment. The remainder of the chapter goes on to consider alternative ways of carrying out the three basic analytical tasks involved in implementing the trade-equations methodology. Since the trade-equations methodology is more complex than the PPP-based approach, the rest of the chapter is considerably longer than the discussion in the following section on the PPP-based approach. The first section on
the trade-equations approach discusses the use of trade equations and trade elasticities to establish quantitative relationships between the RER and the resource balance. It also presents a specific example of a trade-elasticities methodology employing a three-good framework (with exports, imports, and domestic goods) that is suitable for use in low-income countries with minimal data in which changes in the terms of trade and commercial policy are important considerations. Then come two sections on the resource balance. The first of these examines alternative methods of determining a target resource balance using saving-investment balance and sustainable capital flows approaches. The second then considers techniques for adjusting the initial resource balance to reflect changes in cyclical, exogenous, and policy variables affecting it in order to estimate the underlying structural balance. The final section concludes with a brief discussion of the advantages and limitations of the trade-equations methodology. The various analytical techniques are illustrated with empirical examples for Côte d’Ivoire at the time of the devaluation of the CFA francs in 1994.

The Relative PPP-Based Approach to RER Misalignment

As noted above, the simplest methods of estimating the long-run equilibrium RER are based on relative PPP. Although more sophisticated methodologies that take into account variations in the fundamentals determining the LRER have been developed, the PPP-based approaches are still widely used in both graphical analyses of individual countries and in econometric analyses of large multicountry samples because of the relative ease with which these can be implemented.

The use of a relative-PPP-based methodology can be justified in either of two ways. On the one hand, the analyst may simply adopt ex ante the traditional relative-PPP view on the determination of the long-run equilibrium real exchange rate, which essentially takes the LRER to be a constant. On the other hand, the analyst may view the LRER as being determined by a broad set of fundamentals, which may turn out ex post to be stationary in a time-series sense for the specific country concerned. In the first case, the decision to apply the PPP approach would be made without considering the data. In the second case, the PPP approach would be adapted only after the RER for the country concerned passes a test of stationarity.

Whichever justification for using relative PPP is adopted in a specific case, theoretical and empirical work on PPP has suggested that the equilibrium RER may be estimated in two ways—using either a base-year or a long-term trend value. This section gives an updated presentation of
these two standard techniques for estimating the LRER and then discusses the interpretation of such PPP-based analyses.

**Base-Year Estimates of the Equilibrium RER**

When relative PPP is assumed to hold ex ante, measuring the equilibrium real exchange rate essentially involves removing the effects of nonsystematic transitory shocks. In practice, these are eliminated by identifying a base period in which such shocks are believed, on the basis of independent evidence, to have been negligible—a procedure that ensures that the actual RER coincided with its equilibrium-PPP value in the base period. Thus the actual RER in the base period represents the estimate of the equilibrium rate, and the nominal exchange rate consistent with the LRER from that moment on can be calculated by simply adjusting the nominal exchange rate for the cumulative difference between domestic and foreign inflation.

The alternative case is that the LRER is interpreted as subject to change in response to changes in underlying fundamentals but turns out empirically to be stationary for a particular country. In this case, the stationarity of the RER forces the analyst to take the position that its fundamental determinants are either individually stationary—that is, their “permanent” values have not changed during the sample period although the fundamentals may have been subject to transitory variations—or that any nonstationary fundamentals must be cointegrated among themselves. In either situation, the LRER can still be measured using a base-year value, although the identification of a suitable base year is more complicated under their interpretation. In this case, the base-year method for estimating the equilibrium RER involves analyzing the movements in the fundamental variables determining the LRER to identify a base year in which, on average, these fundamentals, and hence the RER, were at sustainable levels. If the fundamental variables do not change after the base year, or return to their level in that year, then the LRER should also remain at the base-year level. Misalignment is then measured as the difference between the actual RER in the current year and its (unchanged) equilibrium value in the base year.\(^2\) Note that the expenditure-PPP version of the external RER (usually computed with CPIs) should be used both in the base-year analysis and in the trend analysis discussed below since this RER concept is the one employed in relative-PPP theory.

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\(^2\) Appreciations, depreciations, and misalignment may be expressed in either domestic- or foreign-currency terms. Formulas for converting from one to the other are given in appendix C.
The base-year approach is most useful in cases in which all movements after the base year result from either nominal shocks (which temporarily cause the actual RER to diverge from its equilibrium level) or from transitory movements in the fundamentals. However, if the fundamentals change permanently after the base year, so too will the LRER. In this case, the base-year approach will provide little guidance on the RER’s new equilibrium value until a new base year has been established.

In the base-year approach everything thus depends upon the identification of a suitable base year.

The definition of the long-run equilibrium RER in Part II suggests the criteria for selecting a representative base or equilibrium year. Recall that this definition requires that the current account deficit can be financed by a “sustainable” level of capital flows and that the market for nontraded (or domestic) goods also be in a sustainable equilibrium for given values of the predetermined, exogenous, and policy variables that influence these objectives. As mentioned above, the procedure for choosing the base year also depends upon whether the rationale underlying the procedure is a simple ex ante relative-PPP-based one or a more sophisticated one in which the real exchange rate is driven by stationary fundamentals. In the simple PPP case, the “independent evidence” of equilibrium referred to previously is likely to concern the behavior of a particular outcome variable, such as the resource balance.

In contrast, from the “stationary fundamentals” perspective, the base year chosen should be a recent year in which the actual exchange rate is believed to have been close to its equilibrium value because all the fundamentals were close to their sustainable values. As explained in the survey of empirical estimation in Chapter 5, the set of fundamentals to be considered in choosing a base year may include both exogenous and policy variables. In practice, when selecting base years, one usually focuses first on the external balance criteria, typically interpreted as choosing a year with a reasonable or normal current account (or resource) deficit for the country concerned. For assessing the sustainability of exogenous variables, the analyst looks for terms of trade that are reasonably close to their likely long-term trend levels and capital flows that are consistent in amount and terms both with the likely longer-term availability of capital and with the country’s debt-servicing capacity. For assessing the sustainability and desirability of policy or objective variables, one looks at growth, investment, employment, and inflation performance and compares these to the country’s long-run policy targets.

3. In addition, if the law of one price does not hold or only holds loosely, the return to a base-year value could be quite slow even after a purely nominal shock to the exchange rate, as domestic prices may be quite sticky and the actual RER will tend to follow the nominal RER.
Other things being equal, it is also desirable to select as recent a base year as possible to minimize the changes in the economy’s structure taking place between the base year and the current year. Because a year that is appropriate as a base for a particular country may not be appropriate for another, country-specific rather than standardized base years should be used when measuring misalignment relative to a base year.4

The Devarajan-Lewis-Robinson (DLR) constant-elasticities model, the econometric model, and the reduced-form econometric methodology presented in Chapters 8, 9, and 10, respectively, also employ base periods, like those used here, in which the observed RER equals the equilibrium RER. The criteria for selecting these base periods are essentially the same under these methodologies so that the base period used for the relative-PPP-based analysis may also be used with the more sophisticated methodologies.

A common problem in determining an appropriate base year is that, because of policy shortcomings and external constraints, years in which exogenous variables are at sustainable levels are not always years in which policy variables were at desirable levels. For example, historically, desirable growth and investment levels have sometimes been attained only when the terms of trade have been temporarily inflated or capital flows have been unsustainable. Conversely, sustainable terms of trade and capital flows have often been associated with undesirable growth and investment outcomes. Hence, in determining when the RER was near its long-run equilibrium value and selecting a corresponding base year, one is often forced to make tradeoffs between sustainability and desirability and to take these tradeoffs into account in an ad hoc way in subsequent qualitative analysis. Moreover, in both historical and forward-looking analysis, some care is needed in analyzing the movements of the fundamentals to identify shifts in these or breaks in time series that could indicate that a change in the base year is needed. As a result, the choice of a base year may be subjective; and reasonable alternatives should be considered when they are available.

For the Côte d’Ivoire examples shown in the graphs in this section, the RER was nonstationary, as explained in Chapter 10, and 1985 was chosen as the base or equilibrium year for analytical purposes. This was the most recent year before the devaluation year of 1994, in which both the terms of trade and capital flows were at broadly sustainable levels and there was reasonable growth and low inflation. This choice, however,

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4. The standard procedure is to select the RER for the base year as its equilibrium value. However, because of lags in the effects of the RER on the economy, one could also argue that the RER for the preceding year or a three-year moving average centered on the preceding year would be a more accurate estimate of the rate that actually generated the base-year equilibrium.
has elements of both unsustainability and undesirability. The situation in 1985 was unsustainable in that the debt service burden was too heavy for the long term and the terms of trade were more favorable than their historical trend. It was also undesirable in that the investment level was too low to support the desired long-term growth rate and trade policy was too restrictive to promote accelerated export and productivity growth. Hence, even in 1985 the actual RER was probably overvalued relative to the equilibrium RER in normative terms and even somewhat overvalued in positive terms. Furthermore, as a result of the sharp decline in the terms of trade in subsequent years, the equilibrium RER probably depreciated in the 1986–93 period rather than remaining constant at the 1985 base-year level as assumed in the PPP-based analysis.

The effect that choosing different base years can have on PPP-based analysis is illustrated in figure 7.1. In the long debate over the overvaluation of the CFA franc, most of those arguing for a devaluation chose 1985 as the best available base year. This choice indicated that on the eve of the devaluation in 1993 Côte d’Ivoire’s actual real effective exchange rate (REER) had appreciated by 37 percent relative to the equilibrium base year. In contrast, some of those arguing for maintaining the existing parity chose 1980 as a base year, a choice which showed that Côte d’Ivoire’s actual REER in 1993 was close to its base-year level. Note, in addition, that the use of either year as a base assumes that the equilibrium RER remained constant at the level of that year. If, however, as discussed in the preceding paragraph, the sustainable values of the terms of trade or other fundamentals in fact deteriorated after the base year, the equilibrium RER would depreciate. The use of either base year would thus give an underestimate of the misalignment.

Means for Short Base Periods

For sustainability of predetermined variables, theoretically it would be desirable to have an equilibrium period, rather than just a single equilibrium year, so that the predetermined variables have time to approach their steady-state values. In addition, in practice all of the fundamentals will not necessarily be at sustainable levels in precisely the same year. One way of dealing with these problems is to use the average value of the RER over a short equilibrium period as a base. However, the utility of this alternative empirically depends very much on the situation in the particular country concerned. In some circumstances, particularly when an appropriate choice of base year is not obvious or when a country has a market-determined exchange rate that fluctuates significantly year to year, a mean for a short time period may be a more representative indicator of the equilibrium value of the RER than a single base-year estimate. In other cases, equilibrium periods may be limited to little
more than a year or two by the volatility of the terms of trade, capital flows, or other fundamentals. In Côte d’Ivoire, for example, the longest period in the 1980s that might reasonably have been used as a base was 1985–86. If this two-year period had been used as a base together with a one-year lag in the RER, the results would have been similar to those from using 1985 because the average RER for 1984–85 was almost equal to that in 1985. However, when, as in this case, some exogenous or policy variables diverge in the same direction from sustainable levels for the entire period, the mean value of the RER for the period may not reflect the sustainable values of these variables any better than does the RER for a single year.

**Long-Period Mean and Trend PPP Estimates of the Equilibrium RER**

One way of dealing with fluctuations in the fundamentals during the sample period is to estimate their sustainable values on the basis of their sample means or, in the trend-stationary case, as their trend values within the sample. In effect, this procedure amounts to estimating the LRER as the sample mean or the trend value of the RER within the sample, rather than as the particular value of the RER in a specified base year. Hence,
instead of trying to identify a particular year or short span of years in which the RER is believed to be at its equilibrium level, one tries to identify the long-term trend value toward which the actual RER tends. Thus, the LRER could be estimated as being the mean value of the RER over a long period of time or as evolving along a deterministic or stochastic trend. Justification for both procedures can be found in the literature.

However, as discussed in the survey of empirical research on PPP in Chapter 5, the evidence supporting relative PPP is not that strong; and, hence, some care is needed in using this procedure. For example, according to Clark and others (1994): “Empirical evidence suggests that PPP-based indicators may be useful to explain long-run movements in exchange rates among industrial countries, but less so to explain movements of these exchange rates in the short run, or of exchange rates between industrial and developing countries, either in the long or the short run.” Hence, before deciding whether to use a long-period mean or a trend as a base for a particular developing country, time-series data for its RER should be analyzed to determine, if possible, whether its RER has been stationary for the sample period as illustrated for Côte d’Ivoire and Burkina Faso in Chapter 10 on the single-equation methodology. Unfortunately, sometimes the short time period for which RER data are available and the weak power of unit-root tests will make it impossible to determine whether the RER is stationary or nonstationary for the sample period. Both possibilities should then be considered.

Means for Long Time Periods.

The long-run referred to in the above citation for which relative PPP has been found to hold for a few industrial countries is in fact very long—specifically, periods of 70 to 100 years, over which both nominal and real shocks to the external RER may prove transitory. In addition, ultra-long-term relative PPP has been shown to hold only for a small group of industrial countries with fairly similar income levels. The long-term behavior of RERs between developing and industrial countries at quite different income levels, which is our primary interest here, could be equally different. If a sufficiently long data series is available for a particular developing country, the equilibrium value of the RER in the very long term could be determined as its mean; and RER misalignment could be measured accordingly. However, data for 70 to 100 years are only rarely available for developing countries. Data for even 20 to 30 years are hard to come by for many low-income and transition economies. Since PPP theory permits extended periods of misalignment during which the actual RER diverges from its long-term equilibrium value and empirical studies of PPP have found substantial volatility in RERs and
only very slow convergence toward the mean, the significance of a mean for anything other than a very long period is not clear. Despite the weakness of the theoretical and empirical support for PPP, it is entirely possible that, as in the Burkina Faso case in Chapter 10, the RER for a particular country will be stationary for a given sample period. In this case, the mean value of the RER for the sample period will be the best estimate of its equilibrium value. However, when available time-series data are long enough neither for determining with any accuracy whether the RER for a particular country is stationary or nonstationary nor for computing a meaningful long-term mean, a base-year estimate of the equilibrium RER is likely to be preferable.

**Trend Estimates of the Equilibrium RER**

As discussed in the chapter on the two-good internal RER and the survey of empirical research, the Balassa-Samuelson effect provides theoretical justification for observing persistent long-term trends in the equilibrium RER. Countries experiencing significantly higher or lower productivity growth than their trading partners should show a statistically significant long-term trend appreciation or depreciation in their external RER. Demand factors (for example, a high-income elasticity of demand for services and other nontraded goods) or long-term trends in other fundamentals (for example, a sustained deterioration in the terms of trade) can also generate trends in the RER. In samples for which the RER is nonstationary, such trends are more meaningful measures of the equilibrium RER than the mean; and misalignment should be measured relative to the trend value of the RER rather than relative to its mean. Such time trends can be either deterministic or stochastic. Figure 7.2 shows the time trends in the RER for Côte d’Ivoire and compares these to the mean and 1985 base-year values of the equilibrium RER. Since empirically it is very hard to distinguish between deterministic and stochastic time trends with short noisy time-series data, deterministic trends have been used in figure 7.2 for simplicity.

**Interpretation of PPP-Based Analyses**

Five points concerning the interpretation of analyses based on relative PPP are worth noting: (a) the alternative of measuring competitiveness only in terms of goods that are internationally traded, (b) the relationship between the expenditure-PPP external RER and the internal RER, (c) the effects of structural breaks in the RER series, (d) statistical indicators of misalignment from multicountry studies, and (e) measures of misalignment based on data for standardized baskets of goods from the International Comparison Programme (ICP).
Figure 7.2 Côte d’Ivoire: The REER—Actual Values, Average Values, and Time Trends, 1967–85 and 1986–93 (1985=100)

Note: The time trend value was computed as an OLS regression of the logarithm of the REER and a time trend. The annual growth rate is 0.3 percent in 1967–85 and 1.0 percent in 1986–93. The REER was computed using CPIs, adjusted country weights, and weighted average official and parallel exchange rates. An upward movement of the REER is an appreciation.

Source: Computed from World Bank data.

Competitiveness in Internationally Traded Goods: An Alternative Approach

The base-year and trend approaches for measuring RER misalignment were originally developed for use with the expenditure-PPP version of external RER. However, they can be used equally well with the external RER for traded goods since relative PPP can be applied to traded goods as an interpretation of the law of one price. As discussed in the chapter on the external RER, it can, in fact, be quite reasonably argued that the entire foregoing analysis should be in terms of the external RER for traded goods rather than the expenditure-PPP version using CPIs.

Theoretically, somewhat different behavior should be expected in the prices of homogeneous and differentiated traded goods, with the external RER for homogeneous traded goods obeying relative PPP more closely than the RER for differentiated traded goods.5 Unfortunately,

5. Although the theoretical basis for expecting relative PPP to hold for internationally traded goods is stronger than for all goods (both traded and nontraded), Isard and Faruquee (1998) note that the hypothesis that the relative price of traded
data on the relative prices of internationally traded goods are only available for recent years for industrial countries and often not available at all for developing countries. Because of the shortage of data, relatively little empirical research has been done for industrial countries, and even less research for developing countries, on whether relative PPP holds for traded goods.

When the required data are available, it is useful to examine the behavior of the external RERs for both homogeneous and differentiated traded goods. Unfortunately, only limited data are available for the prices of traded goods in Côte d’Ivoire. Since these data have already been presented in figures 2.12 and 2.13 in Chapter 2 on the external RER and the application of the techniques presented above to traded goods is straightforward, the external RER for traded goods is not shown here.

Relationship to the Internal RER

Because of the Belassa-Samuelson effect and highly income-elastic demand for nontraded goods, all countries in which productivity grows faster in the traded-goods sector than in the nontraded-goods sector, the common experience, should experience a sustained trend appreciation in the equilibrium internal RER. This pattern is in fact what has been observed in studies of the internal RER in industrial countries. De Gregorio, Giovannini, and Wolf (1994), for example, find that for 14 industrial countries the internal RER appreciated almost uniformly at an average rate of more than 1 percent per year in the period 1970–85. Furthermore, as explained in earlier chapters, it is entirely possible and consistent for the external RER for all goods, the external RER for traded goods, and the internal RERs to follow different trends. The typical pattern for a country experiencing more rapid productivity growth than its trading partners is a rapidly appreciating internal RER, a more slowly
appreciating external RER for all goods, and a constant or depreciating external RER for traded goods. The internal RER is, in addition, generally more useful than the external RER in assessing the magnitude of real shocks.

Although relative PPP is not directly applicable to the internal RERs, analytically it is still useful to know how the internal RERs have behaved both relative to trend and to their values in the last equilibrium (base) year. Figures 7.3 and 7.4 thus look separately at the internal RERs for imports and exports for Côte d’Ivoire. Figure 7.3 indicates that the internal RER for imports behaved in a similar fashion to the expenditure-PPP external RER, jumping upward by 20 percent during 1985–86 because of the appreciation of the nominal effective exchange rate (NEER) and then remaining relatively stable until the 1994 devaluation. As figure 7.4 shows, the export sector was more severely affected than the import competing sector. Because of the sustained decline in the prices of its major export commodities (primarily coffee and cocoa) and devaluations by competing developing-country exporters, Côte d’Ivoire’s internal RER for exports appreciated strongly throughout the entire period, rising by almost 80 percent during 1986–93, four times the appreciation in the RER for imports.

**Structural Breaks**

Large external shocks and major regime shifts can cause structural breaks in the RER data for developing countries and create significant problems in interpreting these. Such structural breaks can cause nonstationarity in the RER and lead to significant shifts in means, trends, and base years.

The data for Côte d’Ivoire provide a good example of the possible effects of structural breaks. The combination of the large drop in Côte d’Ivoire’s terms of trade after 1985 and the strong appreciation in its NEER shown in figure 7.5 caused a marked change in the external environment that the country faced, and its RER was nonstationary as discussed in Chapter 10. Since figure 7.5 shows that the NEER and the terms of trade behaved in significantly different ways in the periods 1967–85 and 1986–93, figures 7.2–7.4 take 1985 as the dividing point between two different time periods and give the means and time trend values separately for the 1967–85 and the 1986–93 periods. During 1967–85, the average value of the expenditure-PPP external RER was 10 percent more appreciated than the 1985 base-year level but showed little trend movement over the period. In the 1986–93 period, in contrast, the external RER appreciated strongly and was, on average, nearly 30 percent more appreciated than in the 1985 base year.
Figure 7.3 Côte d’Ivoire: The REER and the Internal RER for Imports—Actual Values, Average Values, and Time Trends, 1970–85 and 1986–93 (1985=100)

Note: The time trend value was computed as an OLS regression of the logarithm of the RER and a time trend. The annual growth rate is 0.4 percent in 1970–85 and –0.5 percent in 1986–93. The REER was computed using CPIs, adjusted country weights, and weighted average official and parallel exchange rates. An upward movement is an appreciation.

Source: Computed from World Bank data.
Figure 7.4 Côte d’Ivoire: The REER and the Internal RER for Exports—Actual Values, Average Values, and Time Trends, 1970–85 and 1986–93 (1985=100)

Note: The time trend value was computed as an OLS regression of the logarithm of the RER and a time trend. The annual growth rate is 3.1 percent in 1970–85 and 7.9 percent in 1986–93. The REER was computed using CPIs, adjusted country weights, and weighted average official and parallel exchange rates. An upward movement is an appreciation.

Source: Computed from World Bank data.
Statistical Indicators of RER Misalignment

Because of the availability of CPIs for calculating the expenditure-PPP version of the RER in most developing countries and the relative ease of computing PPP-based measures of misalignment, these measures have been used in numerous multicountry econometric studies. These studies have noted some empirical regularities that are useful in assessing RER misalignment in individual countries. Since selection of appropriate base years requires detailed knowledge of individual countries and can be criticized as subjective, most large multicountry studies have measured misalignment of the RER relative to its long-term mean or trend value; and hence their insights apply to misalignment measured in this way. In Chapter 12, for example, in analyzing parallel market exchange rates for a sample of 24 developing countries, Ghei and Kamin use a simple relative PPP-based measure for the equilibrium unified RER—the average of the official real exchange over long periods of time during which a country’s exchange markets were unified.

Large appreciations of the actual RER relative to its trend value, which are easily detectable in a PPP-based analysis, are often warning signs of serious exchange rate misalignment and potential currency crises. For

Figure 7.5 Côte d’Ivoire: The Real Effective Exchange Rate (REER), the NEER, and the Terms of Trade, 1970–95 (1985=100)

Note: An upward movement is an appreciation of the REER.
Source: Computed from World Bank data.
example, Milesi-Ferretti and Razin (1996, 1998) use the degree of appreciation of the RER relative to its 25-year average (median) as a benchmark for assessing the sustainability of current account deficits and find that even this crude measure of misalignment is a useful predictor of currency crises. Kaminsky, Lizondo, and Reinhart (1997) find that substantial appreciation of the RER above its trend value is a warning sign of a future devaluation and that the 10 percent of RER observations that are the farthest from the trend are accurate leading indicators of a currency crisis within the next 24 months. Similarly, Goldfajn and Valdes (1996, 1997) analyze a large set of RER appreciations for 93 countries from 1960 to 1994 and find that for large real appreciations of 15 percent to 35 percent relative to trend the probability of a subsequent devaluation ranged from 68 percent for real appreciations of 15 percent or more to 100 percent for appreciations exceeding 35 percent. Hence, even if there is some uncertainty about the precise level of the equilibrium RER, large appreciations in a short period of time are a warning sign of misalignment. Finally, volatility of the real exchange rate, which is readily measurable, implies that the RER spends more time farther away from its equilibrium level. Volatility is, as noted in Chapter 11 on the effect of the RER on trade flows, a deterrent to export growth; and, as Razin and Collins (1997) have observed, volatility has served in effect as a reasonable proxy for misalignment in some multicountry studies.

**Measures of Misalignment Based on International Comparison Program Data**

Equilibrium exchange rates can be based on absolute as well as relative PPP. As explained in the chapter on the external RER, measurement of absolute PPP requires the use of standardized baskets of goods. For example, the “Big Mac Index” is a simple one-good absolute-PPP exchange rate, which The Economist uses as an informal indicator of the equilibrium nominal exchange rate. It is simply the ratio of the domestic-currency price of a Big Mac in the home country to its price in the numeraire country.\(^6\) However, data for more comprehensive measures of absolute PPP have been hard to come by.

Because relative-PPP-based measures of misalignment have various theoretical shortcomings and estimating equilibrium exchange rates using the more sophisticated methodologies discussed later in this vol-

\(^6\) See The Economist (1995, August 26) and (1996, April 27). In a lighter vein, Cumby (1996) analyzes data for 14 countries for the “Big Mac Index” and finds that their exchange rates converge to “Big Mac parity” twice as fast as to relative PPP.
volume is quite time-consuming, researchers have long sought a methodology simple enough to use in measuring misalignment for panel data for a large number of countries. Until recently, the lack of price data for representative standardized baskets of goods had inhibited the empirical use of absolute PPP for this purpose. Hence, as the Summers-Heston data for standardized baskets of goods has become available for 90 or so countries from the International Comparison Programme (ICP) described in appendix A to Chapter 2, some researchers have utilized these to develop alternative simplified procedures for estimating equilibrium exchange rates.

Aggregate ICP exchange rates have themselves occasionally been used to analyze trade distortions and exchange rate misalignment. Nominal exchange rates for developing countries derived from the ICP data are generally lower (less appreciated) than nominal market exchange rates with the U.S. dollar because of the Balassa-Samuelson effect discussed in Chapters 3, 5, and 6. Figure 7.6, which compares the aggregate ICP dollar exchange rate for GDP for Côte d’Ivoire with the official rate, illustrates this point. The magnitude of the differences between aggregate ICP exchange rates and nominal exchange rates also tends to vary inversely with per capita income.

A predictable tendency in the ICP data for the relative price levels of countries to vary positively with their relative income levels as a result of the Balassa-Samuelson effect has been exploited by a number of researchers to derive estimates of the equilibrium RER. Dollar (1992) regresses the relative price levels of the standardized baskets of goods from the ICP data on relative per capita GDP. This regression gives him a norm that he considers as the equilibrium relationship between the free trade RER and per capita income. Deviations from this norm give a measure of the combined effects of trade and exchange rate policy on outward orientation. Bosworth, Collins, and Chen (1996) employ a procedure similar to Dollar’s to derive a measure of exchange rate misalignment that they then use in analyzing the factors affecting growth in an 88-country sample. Razin and Collins (1997) use data on the relative international price of the standardized basket of consumption goods and services in different countries as a measure of the real exchange rate. This measure is then regressed on the fundamental variables determining the RER using panel data, and the fitted values are used as an estimate of the equilibrium RER.

7. See, for example, Rogoff (1996) for data and regression results documenting these stylized facts.
Such statistical analyses of ICP exchange rates may give broad indications of misalignment suitable for use in general multicountry studies and provide country-specific information that is useful in particular cases. However, more research is needed on the relationship between these general measures of misalignment and those from the methodologies discussed elsewhere in this volume before basing policy recommendations for individual countries on ICP exchange rates.

**Conclusion: Advantages and Limitations of the Relative-PPP-Based Approach**

The relative-PPP-based approach set out above has a number of practical advantages in estimating the equilibrium RER in low-income developing countries. Its data requirements are limited. The methodology is both straightforward and transparent. With simple computer spreadsheets it is easy to run extensive sensitivity analyses of the results assuming different base years or means. A number of multicountry statistical analyses of misalignment are also available for comparative purposes. These are significant practical advantages for balance-of-payments management in a developing country in which data and professional manpower may both be limited. Relative-PPP-based measures of mis-
alignment can also be quite useful in high-inflation countries where shocks to the external RER are primarily nominal ones. Thus, for example, the implementation of real exchange rate targeting has often relied on simple relative-PPP-based rules.8

The PPP-based approach does have some major limitations, however. In developing countries, lack of data on the prices of internationally traded goods usually forces one to use the external RER for all goods (computed with CPIs) rather than the theoretically preferable external RER for traded goods. The PPP-based analysis also relies on relatively simple base-year or mean-trend estimates of the equilibrium RER. If there are structural breaks in the time-series data for the RER or permanent changes in the fundamentals and hence in the equilibrium RER, base-period or mean estimates of misalignment may no longer be relevant, and PPP analysis is of little help in determining the new equilibrium RER. Moreover, real exchange rates can be quite volatile—and convergence to the mean, if it occurs at all, is typically quite slow. Hence, the RER may diverge from a PPP-based equilibrium for long periods, and it may be of little practical use for policy purposes.

However, all of the other methodologies for measuring misalignment, including the trade-equations approach discussed below, are much more time-consuming to implement than the relative-PPP-based approaches. Thus the relative-PPP-based approaches are often the only feasible methodologies for multicountry studies in which the amount of time that can be devoted to individual country cases is limited. For the same reason, PPP-based analysis is also widely used for making initial diagnoses of individual countries and for identifying hypotheses for analysis using more sophisticated techniques. A comparison of the movements of the fundamentals with movements of the RER since the last equilibrium may also be useful for detecting cases of possible misalignment. The PPP-based methodology thus provides a starting point—it may be used alone, when nothing else is available, or as a reference point when more sophisticated methodologies are also used.

The Trade-Equations Approach: Establishing the Quantitative Relationship between the RER and the Resource Balance

The second of the established operational methodologies for measuring exchange rate misalignment is the trade-equations approach. The
The quantitative relationship between the RER and the resource balance established in task (a) is then used to calculate the appreciation or depreciation in the initial RER required to move the resource balance from its adjusted level in the initial year to its target level, everything else remaining the same. The estimated long-run equilibrium RER is the one that corresponds to the target or equilibrium resource balance. The following section of this chapter discusses task (a). Tasks (b) and (c) are taken up in the subsequent two sections.

Because of the different structures of industrial and low-income developing economies and the greater availability of data in the former, trade is usually modeled in somewhat different fashions for the two groups. In industrial countries, trade equations based on the Mundell-Fleming production structure, the subject of the first part of this section, are usually used. In developing countries, in contrast, a trade-elasticities approach based on a three-good production structure, the subject of the last part of this section, is often employed.

**The Mundell-Fleming Framework—Industrial Countries**

The general analytical framework used in the trade-equations methodology in industrial countries usually employs equations 7.1 through 7.3:

\[(7.1) \quad \log M = \epsilon_M \log RER + \eta_M \log Y_D + f(Z_M)\]

\[(7.2) \quad \log X = \epsilon_X \log RER + \eta_X \log Y_F + g(Z_X)\]

\[(7.3) \quad \Delta RB = \Delta X - \Delta M\]

where \(M\) and \(X\) are the quantities of imports and exports, \(Y_D\) and \(Y_F\) are
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domestic and foreign real income, $Z_M$ and $Z_X$ are vectors of whatever predetermined or exogenous variables (for example, lagged values of the RER, the terms of trade, commercial policy) are relevant in a particular case, and the resource balance ($RB$) is expressed in real terms. The two trade equations are usually estimated econometrically to obtain values for $e_M$ and $e_X$, the price elasticities of import and export demand, and for $\eta_M$ and $\eta_X$, the income elasticities of import and export demand.

To solve the above system of three equations, domestic and foreign income are determined exogenously by setting them at full employment or some other desired level. The change in the resource balance is also set exogenously as the difference between the target and the adjusted resource balances, which are determined separately in tasks (b) and (c). One is thus left with three variables—$M$, $X$, and RER—to be determined endogenously; and the three equations are solved for these.

A number of general points about the application of the trade-equations approach to industrial economies are worth noting. First, the analytical framework used for industrial countries is usually based on the Mundell-Fleming production structure. In this framework, complete specialization of both the domestic and foreign economies in producing one composite good (their own GDPs) makes export supply functions perfectly elastic, while the domestic and foreign goods are taken to be imperfect substitutes in demand. Export and import quantities are thus demand-determined. The RER exerts its effect on the trade balance through the price elasticities of domestic demand for imports and of foreign demand for exports. Second, since industrial-country trade models focus primarily on competitiveness in the domestic and foreign markets for differentiated traded goods, the traded-goods version of the external RER (computed using relative wholesale prices or unit labor costs in the traded-goods sector) is commonly used in equations 7.2 and 7.3. Third, the estimated equilibrium exchange rates for large industrial countries like the G-7 that account for large shares of world trade need to be mutually consistent since one country’s economy can have important income and relative price effects on the others’, a fact that considerably complicates the estimation of equilibrium exchange rates for large industrial economies. Fourth, if the RER is quite volatile and subject to large random fluctuations, these could be reflected either in similar volatility in the resource balance or in significant statistical noise in the empirical relationship between the RER and the resource balance, either of which could complicate empirical analysis and policy making.9

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Both the International Monetary Fund (IMF) and the Institute for International Economics (IIE) employ the trade-equations approach for estimating equilibrium exchange rates for the G-7 countries. Major papers by Wren-Lewis and Driver (1998) for the IIE and Isard and Faruqee (1998) for the IMF documenting their approaches have been published within the last year. Since both of these papers have already been reviewed in the survey of empirical research in Chapter 5, they are not discussed further here. The reader is referred, instead, to the previous survey for a review of the papers and to the papers themselves for detailed presentations of industrial-country applications of the trade-equations methodology.

**The Three-Good Framework—Developing Countries**

**The General Analytical Framework**

An alternative analytical framework is usually adopted for small developing countries whose production structures are less flexible and whose exports are dominated by undifferentiated primary products. For these countries, imports could still reasonably be modeled by equation 7.1, in which the demand for imports depends upon the domestic price and income elasticities of demand. However, equation 7.2 for exports is more problematic in a developing-country context. For a small open developing economy that accounts for a tiny fraction of world trade, it is more appropriate to consider export demand as being infinitely price-elastic and to drop foreign income from the export equation but to allow for a finite elasticity of export supply.\(^1\) Then the quantity of exports is determined by the elasticity of export supply. Hence, export supply elasticities are conventionally employed in modeling developing countries rather than export demand elasticities used in equation 7.2.

For example, Wren-Lewis and Driver (1998) follow the Mundell-Fleming tradition of modeling trade in industrial countries in terms of differentiated products that are imperfect substitutes. They estimate price elasticities of demand for exports ranging from \(-0.23\) for Canada to \(-1.36\) for Japan, with a median of \(-0.96\). In contrast, the empirical evidence on RERs and trade flows in developing countries cited by Ghei and Pritchett in Chapter 11 suggests that the standard assumption of an infinite price elasticity of demand for developing-country exports is reasonable. Conversely, Wren-Lewis and Driver assume an infinite price elasticity of export supply for the G-7 countries rather than supply

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1. Conceptually, this approach also implies supposing that the home country produces at least one other type of good besides the exportable good and, hence, requires adopting a three-good framework.
elasticities in the 1.0–2.0 range suggested for developing countries by Ghei and Pritchett.

The differences in approach to modeling trade in industrial and developing economies also lead to differences in view about the relevance of the Marshall-Lerner condition. This condition for a real depreciation to improve the resource balance measured in domestic currency terms, starting from a zero balance, requires that the sum of the absolute values of the price elasticities of demand for imports and exports exceed unity.\(^1\) The Marshall-Lerner condition is satisfied for industrial countries by the average values of the price elasticities of demand for imports (–0.9) from Ghei and Pritchett and of the demand for exports (–1.0) from Wren-Lewis and Driver (1998). Although the Marshall-Lerner condition would also be satisfied by the representative values of demand elasticities for developing countries, it is not directly applicable to them for two reasons. First, the condition assumes an infinite price elasticity of export supply, whereas the empirical evidence suggests a supply elasticity of 1.0 to 2.0 for developing countries. Second, many developing countries are capital importers and start from a resource deficit rather than from the balanced position assumed in deriving the simplest version of the Marshall-Lerner condition.

Because trade models of developing countries focus on domestic resource allocation incentives, the internal RER rather than the external RER for traded goods is usually the appropriate RER measure for them. The use of the internal RER also has the advantage that the effects of changes in some fundamentals on the equilibrium RER that are difficult to handle in the Mundell-Fleming framework can easily be handled in a three-good framework with importables, exportables, and domestic goods. Because of its assumed production structure, the Mundell-Fleming framework cannot distinguish between the terms of trade and the RER. Thus, it cannot be used to analyze the impact of changes in the terms of trade and commercial policy whereas these can be readily incorporated in a three-good framework.

Finally, for analyzing small economies it is not necessary to determine a set of mutually consistent multicountry RERs as is done in modeling the G-7 economies. Rather, a simpler partial-equilibrium approach that ignores the impact of a developing country’s RER and trade flows on the rest of the world can be used. Because of the relative ease with which it can be implemented and the availability of estimated elasticities from the large amount of empirical work on trade reviewed in

\(^{11}\) The resource balance measured in foreign-currency terms will almost always improve for reasons explained in footnote 40 in Chapter 11 on trade flows and the RER.
Chapter 11, the trade-elasticities approach has been widely used in operational applications in developing countries. This chapter and the subsequent one on the DLR model give two examples of trade-elasticity methodologies. Both chapters utilize three-good frameworks with exports, imports, and domestic goods and constant-elasticities assumptions. In this chapter, the relationship between the three goods is in terms of constant price elasticities of the supply of exports and of the demand for imports. The DLR model also assumes constant elasticities—but in this case they are elasticities of transformation in production between exports and domestic goods and of substitution in consumption between imports and domestic goods.\footnote{12}

\textit{A Specific Three-Good Methodology}

The remainder of this section presents a specific trade-elasticities methodology that is suitable for use in low-income countries in which only limited data are available. The relationship between the resource balance, trade elasticities, and the internal RER is set in an explicit three-good framework. This formulation allows for different RERs for imports and exports and facilitates the analysis of the relative price effects of changes in the terms of trade and commercial policy.\footnote{13} Essentially, the approach involves using the definitions of the price elasticities of demand for imports and the supply of exports to replace the trade equations 7.1 and 7.2 above for imports and exports.\footnote{14} The procedure for calculating the equilibrium RER is otherwise the same as that set out above for the trade-equations approach.

Appendix A gives the detailed derivation of the basic RER, trade-elasticities, resource balance equation in a three-good framework. As shown there, the RER for imports \((RERM)\) may be expressed as in equation 7.4:

\begin{equation}
\frac{\Delta RERM}{RERM} = \frac{\Delta RB - \sigma_x \cdot X \left( \frac{\Delta ITT}{ITT} \right)}{\sigma_x \cdot X - \epsilon_{MX} \cdot M}
\end{equation}

\footnote{12. The elasticities of transformation and substitution are ratios of relative changes in the quantities of two goods rather than—as in the case of standard trade elasticities—the ratio of the relative change in the quantity of a single good to the change in its own relative price. Although these elasticities can be derived from each other mathematically, their values will generally differ.}

\footnote{13. This formulation requires the assumption that the elasticities of export supply and import demand are the same for changes in relative prices as for changes in the real exchange rate. This assumption is quite natural when using separate internal RERs for exports below but less so when using the PPP external RER.}

\footnote{14. Alternatively, a trade equation similar to equation 7.1 could also be used to express imports as a function of \(RERM\) and real income with the trade-elasticities formula being used for \(RERX\).}
where \( \sigma_x \) is the price elasticity of export supply; \( \epsilon_x \) is, as above, the price elasticity of import demand; and the change in the resource balance is measured in real terms. The internal terms of trade, \( ITT \), is defined as the domestic price of exports relative to the domestic price of imports—that is, \( P_X / P_M \). If the law of one price holds, \( ITT \) is determined exogenously by the foreign prices of imports and exports \( (P_M^F \) and \( P_X^F) \) and the home country's average trade taxes on them \( (t_M \) and \( t_X) \) as shown in equation 7.5:

\[
(7.5) \quad ITT = \frac{P_X^M}{P_M^M} = \frac{P_X^M (1-t_X)}{P_M^M (1+t_M)} = \frac{P_X^M (1-t_X)}{P_M^M (1+t_M)}.
\]

The RER for exports \( (RER_X) \) is given by equation 7.6:

\[
(7.6) \quad RER_X = RERM \cdot ITT.
\]

Equation 7.3 for the change in the resource balance remains as stated above.

The system now contains four equations (numbers 7.3, 7.4, 7.5, and 7.6) and four endogeneous variables \( (M, X, RERM, \) and \( RER_X) \). It contains only the parameters, \( \sigma_x \) and \( \epsilon_x \); initial values of \( X, M, \) and \( ITT \); and two exogenously determined variables, \( \Delta RB \) and \( \Delta ITT \). The determination of the change in the internal terms of trade, \( \Delta ITT \), from equation 7.5 is straightforward. Exogenous projected values are used for the external prices of exports and imports, \( P_X^M \) and \( P_M^M \). Average trade taxes on exports, \( t_X \), and imports, \( t_M \), are policy variables, for which assumed values are used for future years.15

The other exogenous variable on the right-hand side of equation 7.5 is the targeted or required change in the resource balance, \( \Delta RB \). Adjusting the initial resource balance for cyclical, exogenous, and policy changes and determining the sustainable or target resource balance are similar in the Mundell-Fleming and three-good frameworks. These two tasks, however, are considerably more complicated than determining \( \Delta ITT \) and are discussed separately in the following two sections of this chapter.

Once the adjusted and target resource balances have been determined, the trade-elasticity relationships are used in place of the trade equations employed in industrial countries to calculate the change in the RER needed to move it from its actual level to its equilibrium level. Thus, the computed values of \( \Delta ITT \) and \( \Delta RB \) are plugged into the right-hand side of equation 7.4 to calculate the change in the RER for imports necessary

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15. See the section below on adjusting the initial resource balance for a further discussion of projecting the terms of trade and trade taxes.
to achieve the required change in the resource balance. The RER for exports can then be computed using equation 7.6. After the RERs for imports and exports have been calculated, the supply response to the change in the RER (that is, the corresponding changes in the volume of imports and exports) can also be computed using the equations in appendix A.

Note, however, that equations 7.4 and 7.6 only permit determining relative prices, not nominal ones. The definitions of the internal RERs, in fact, contain two endogenous variables, the nominal exchange rate, \( E_{d,e} \), and the price of domestic goods, \( P_{d} \), as well as the exogenously determined prices of exports or imports. In order to determine separate values for these two endogenous variables, either the nominal exchange rate or the domestic-currency price of domestic goods needs to be exogenously specified as a nominal anchor for domestic prices.

The accuracy of the equilibrium RER calculated using the trade-elasticities methodology depends upon that of the elasticity estimates used. Econometrically estimating country-specific elasticities can be both a time-consuming and problematic process in developing countries with inadequate data. However, a considerable amount of empirical work has been done on trade elasticities for a wide range of countries and products; and one of the advantages of the trade-elasticities methodology is that empirical estimation of the elasticities is not necessary in cases where data or time constraints do not permit it. Chapter 11 on trade flows and the RER summarizes the results of this empirical work and gives a good idea of what are reasonable values to assume for import and export elasticities in developing countries.

Three additional points concerning the parameters in the relationship between the internal RER, trade elasticities, and the resource balance merit further explanation and possible modification in particular applications, namely: (a) the empirical trade-elasticity estimates to be used in equation 7.4; (b) the numeraires used in measuring the elasticities and the RER; and (c) the problem of price-inelastic export demand. These are discussed in appendix A.

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16. These two endogenous variables may be compressed into one variable (the price of domestic goods expressed in foreign-currency terms) by multiplying them together to arrive at an alternative single measure of the internal RER that is used by some authors. See, for example, the related concept of the equilibrium GDP deflator in the DLR constant elasticity model in the next chapter.

17. For a further discussion of the nominal anchor problem and a methodology for calculating consistent nominal and relative prices, see Chapter 13 on devaluations and inflation.
Determining the Target Resource Balance

Establishing a reliable quantitative relationship between the real exchange rate and the resource balance is only the first of the three major analytical tasks involved in implementing the trade-equations methodology. The second and third tasks are to determine a reasonable target for the resource balance and to adjust the initial resource balance so that it provides a satisfactory basis from which to calculate the change in the resource balance required to achieve its target level. Since the approach that one takes to adjusting the initial resource balance depends, among other things, upon how the target resource balance is determined, this section first examines the alternative methods for determining the target resource balance. The next section then considers the problem of making appropriate adjustments in the initial resource balance.

Determining an appropriate target for the resource or current account balance is an analytical step that is common to the trade-equations methodologies as a group and is also encountered when using macroeconomic models and the single-equation methodology for estimating the equilibrium RER. The trade-equations methodologies employed for industrial countries by the IMF and the IIE in the studies by Isard and Faruqee (1998) and Wren-Lewis and Driver (1998) cited earlier established target current account balances in order to calculate the equilibrium RER required to achieve these. Similarly, for developing countries, the DLR constant-elasticities model in the next chapter relies on establishing target resource balances.

The analytical problem of determining an appropriate target for the resource balance is not, however, limited just to the trade-equations methodologies. As discussed in the survey of empirical research in Chapter 5, some analysts (such as Williamson 1994 and Bayoumi and others 1994) who use large macroeconomic models must also determine target current account balances. Similarly, the reduced-form single-equation methodology set out in Chapter 10 uses a target resource balance in order to estimate the equilibrium RER in in-sample counterfactual simulations and in forward-looking out-of-sample policy applications. Hence, much of the discussion here and in the next section is relevant both to the trade-equations methodologies as a group and to a number of other methodologies for estimating the equilibrium RER.

The simplest approach to targeting is to aim at returning to the situation existing in a base year that is deemed to be satisfactory. In this case, one must chose, as in the relative-PPP-based analysis discussed earlier, an appropriate base year in which the resource or current account balance is believed to have been an equilibrium or desirable level. This approach is illustrated by Devarajan for his constant-elasticities
model in the next chapter. However, the usefulness of the base-year approach in a specific application depends upon having a fairly recent base year that constitutes a reasonably satisfactory equilibrium in both positive and normative terms. Since, for the reasons explained earlier, appropriate base years are often not available, alternative methods for establishing appropriate targets for the resource balance are usually needed.

This section reviews the two basic alternative ways of determining targets for the resource or current account balance—the saving-investment balance and the sustainable capital flows approaches. It then examines the cases of aid-dependent, fully and partially creditworthy developing countries.

**The National Accounts Identity and Alternative Approaches to Targeting**

The basic national accounting identities (equations 7.7 and 7.8) relate GDP \(Y\), consumption \(C\), saving \(S\), investment \(I\), and exports, imports, and the resource balance. They require that the resource balance equals the saving-investment balance:

\[
(7.7) \quad Y = C + S = C + I + X - M = C + I + RB
\]

\[
(7.8) \quad S - I = X - M = RB
\]

where \(S\) and \(I\) are defined to include both private and public saving and investment and the identities hold in both nominal and real terms. Thus, exports, imports, and the resource balance can potentially be affected by changes in \(Y\), \(C\), \(I\), or \(S\) as well as by the movements in relative prices discussed in the previous section.\(^{18}\)

The resource balance is also the mirror image of the net resource transfers needed to finance it. The standard balance-of-payments accounting identities require that the resource balance equal the net resource transfer between the home country and abroad, plus the change in reserves, (with the opposite sign) as shown in equation 7.9:

\[
RB = S_p + S_c - I_c - I_p = S_p - I_p + FB
\]

where \(FB\) is the fiscal balance. See, for example, Knight and Scacciavillani (1998).
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(7.9)  \( RB = -(NFI + NT + NCF + \Delta RES) = -(NRT + \Delta RES) \)

where \( NFI \) is net factor income payments or receipts (including interest on debt), \( NT \) is net transfers, \( NCF \) is net capital flows, \( \Delta RES \) is the change in external reserves, and \( NRT \) is the net resource transfer.

Hence, a target resource balance can be determined either by using projections of the savings-investment balance in equation 7.8 or projections of sustainable net resource transfer and a targeted change in reserves in equation 7.9. In either case, the equilibrium RER is the one that corresponds to the target resource balance. A three- to five-year time horizon is usually adopted for targeting in order to allow adequate time for the medium-term effects of changes in the RER to work through the economy as discussed in Chapter 11 on the relationship between trade flows and the RER.

Whether using the saving-investment balance or the sustainable capital flows approach in deriving a resource balance target, the trade-equations methodology employs a partial-equilibrium recursive approach in the analysis. That is, the saving-investment balance or sustainable capital flows determine the target resource balance, which then determines the target (equilibrium) RER. Any feedback effects from the RER to saving-investment and capital flows are not explicitly taken into account in the methodology.

In operational applications, one also has to decide whether the resource or the current account balance is the appropriate target. The resource and current account balances are related through the balance of payments accounting identities shown in equation 7.10:

(7.10)  \( CAB = RB + NFI + NT = -(NCF + \Delta RES) = \Delta NFA \)

where \( CAB \) is the current account balance and \( NFA \) is an economy’s net stock of foreign assets broadly defined. While the resource and current account balances are related, they differ in their treatment of net

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19. Note that in both cases projections in real terms are needed since the change in the resource balance in equation 7.3 is measured in real terms.
20. See Wren-Lewis (1992) for a discussion of the implications of such recursiveness. Ideally, it would be desirable to have a full macroeconomic model to capture all the interactions and the net effects of the changes in prices and expenditures in a full general equilibrium setting such as in the macroeconomic model discussed in Chapter 9. However, as noted there, the full general-equilibrium approach is much more difficult to implement in operational applications.
21. Defined here to include the change in external reserves.
factor income and net transfers.\textsuperscript{22} A current account balance of zero implies no change in a country’s net foreign assets or liabilities, whereas a zero resource balance implies that a debtor country is borrowing to finance interest payments and its indebtedness is therefore increasing.

Whether the resource or current account balance is the appropriate variable to target depends upon the nature of the financial flows to a particular country and the approach taken to modeling these. Typically, the resource balance approach, which in effect treats interest payments as an item to be financed, is used for noncreditworthy developing countries in which an equilibrium is specified in terms of a sustainable level of capital flows. By contrast, the current account balance is usually used with the equilibrium debt stock approach. In this approach, interest payments are generally determined by the stock of the debt and an assumed interest rate, and are treated as an item to be paid on a current basis. This relationship may be written in a stylized form (abstracting from other factor service payments and transfers) as equation 7.11:

\[
CAB = RB - rD = \Delta D
\]

where \(D\) is the debt stock, \(r\) is the average interest rate paid on the debt, and \(\Delta D\) is the change in the debt stock. This approach is often used for creditworthy countries to allow for feedback between interest payments and the debt stock.

The Saving-Investment Balance Approach

For creditworthy industrial countries, current practice is to project the saving-investment balance to determine a target resource balance through the national accounts identity (equation 7.8). These countries typically have full access to capital markets, and both the public and private sectors usually borrow almost entirely from private sources. The standard assumption for such countries is that capital markets will provide whatever financing is required for a sustainable current account deficit. Even for these countries, however, after projecting the saving-investment balance separately, analysts typically use the rules of thumb

\textsuperscript{22} Note that saving measure in the saving-investment balance in equation 7.8 is domestic saving, that is, GDP minus total consumption. If total saving (domestic saving plus \(NFI\) plus \(NT\)) is used, \(S - I\) will equal the current account balance rather than the resource balance. Hence, when choosing whether to target the resource or current account balance, one needs to work with the corresponding saving measure.
discussed in the capital flows section below to verify that the correspond-
ing current account deficit is in fact sustainable.

The analytical procedures used in determining the target current ac-
count balance have evolved in the 1990s from ad hoc adjustments to
trend current account balances taking into account theories of saving
and investment to more systematic econometrically based projections
of the saving-investment balance. For example, in using macroeconomic
models to estimate equilibrium RERs for the G-7 countries in 1994,
Williamson (1994) examined past current account balances in terms of
(a) an analysis of investment needs based on the relative availability
and growth rate of labor and other complementary factors of produc-
tion and (b) a demographic life-cycle analysis of saving in order to de-
termine whether the balances reflected rational economic behavior or
misguided government policies. In cases in which the current account
reflected inappropriate policies, he adjusted the balances to more ap-
propriate levels as suggested by the saving and investment theories.
These current account balances were then used as targets in the macro-
economic models to compute the equilibrium RER. Similarly, to com-
pare the use of dynamic trade equations and the IMF’s MULTIMOD
model for calculating equilibrium REERs, Bayoumi and others (1994)
simply assumed that all of the G-7 countries needed to aim at current
account surpluses of 1 percent of GDP. A few years later when provid-
ing target current account deficits for the G-7 as inputs for Wren-Lewis’s
and Driver’s (1998) estimates of the LRER using the trade-equations
methodology, Williamson and Mahar (1998) draw on available macro-
economic projections of saving and investment from the OECD to de-
termine target saving-investment and current account balances for the
G-7 countries. Subsequently, in the IMF study by Isard and Faruqee
(1998), a more systematic approach is adopted for the G-7 countries. In
that study, each country’s saving-investment balance is modeled
econometrically as depending on its relative per capita income, relative
dependency ratio, fiscal position, the gap between its actual and poten-
tial output levels, and the level of world interest rates.

Similar procedures may be used for determining current account tar-
gets for creditworthy developing countries. In cases in which reliable
macroeconomic projections are not available, one often has to make ad
hoc projections of the saving-investment balance. Thus, Williamson and
Mahar (1998) utilize the results of recent econometric studies of the de-
terminants of saving in developing countries to project private saving
on the basis of relative per capita GDP, changes in the growth rate of real
GDP, the dependency ratio, government saving, and changes in current
account balances. Government saving is projected separately on the ba-
sis of changes in real GDP growth per capita and in current account
balances. Williamson and Mahar project investment using incremental capital output ratios (ICORs). The resulting saving-investment balance and interest payments on the country’s debt determine the target current account balance.

One stylized fact worth noting in this regard is the relationship between changes in the fiscal deficit and the resource balance. A reduction in the current fiscal deficit, an increase in public saving, will tend (assuming Ricardian equivalence does not hold and the increase in public saving is not matched by an offsetting reduction in private saving) to reduce the resource deficit. One way of allowing for this effect is to use the rule of thumb that 50 percent of the net change in the structural fiscal deficit will be reflected in the external resource balance and the other 50 percent in the crowding out or in of domestic private-sector activity. A ratio of about 50 percent has been observed in a wide range of open economies and is a reasonable standard for judging the effects of fiscal changes in economies with fully employed resources.23

In cases in which country-specific targets for the saving-investment balance are available separately, or can be developed, these may be utilized in the analysis. Some countries have macroeconomic plans or multiyear programs, such as those reflected in Policy Framework Papers (PFPs), which set out saving-investment and current account targets that can be used in estimating LRERs. The World Bank’s revised minimum-standard model (RMSM–X) can also be used to establish a target for the saving-investment balance (World Bank, 1997a). In this model, a target level of investment is determined from an assumed medium-term ICOR, a target ratio of investment to GDP, or a combination of the two. The determination of a target saving rate is more problematic, in part because the effects of government policies on private sector saving are quite difficult to predict. Saving is thus usually calculated as a residual in the projection process. Numerous iterations of the projections are made until the analyst arrives at a scenario that is consistent both with the projected behavior of other variables and his judgment about the likely behavior of saving in the country concerned.

23. See, for example, Williamson (1994, p. 198), who writes: “The stylized fact to have emerged from the econometric modeling of recent years is that about half of the counterpart to a lower fiscal deficit is to be found in a lower current account deficit . . . .” Faruque and Debelle (1998) confirm this finding in a study of data for 21 industrial countries. Note that this finding applies to the structural fiscal deficit: when there are substantial unemployed resources and an increase in the fiscal deficit leads primarily to increased demand for and output of nontraded goods, the effect of a change in the fiscal deficit on the resource balance will be limited.
Sustainable Capital Flows Approaches

The definition of the long-run equilibrium RER requires that the current account or resource balance be at a level that can be financed by sustainable financial flows. As discussed in the survey of empirical research in Chapter 5, there are two approaches to determining what constitutes sustainable financial flows: a flow approach and a stock approach. The flow approach examines the level and composition of capital and other financial flows to determine a sustainable medium-term trend or pattern of flows. The stock approach takes a longer-term view, deriving sustainable flows from a sustainable debt level. The flow approach is the simpler of the two and is widely used, particularly for noncreditworthy countries. The stock approach is used primarily for creditworthy countries with full access to capital markets. However, in practice the distinction between the stock and flow approaches is often blurred as analysts utilizing the flow approach usually check to ensure that the projected flows are consistent with realistic debt levels.24

With the medium-term flow approach, the simpler target resource balance is often used, with interest payments netted against other financial flows in determining the projected net resource transfer as noted above. With the longer-term stock approach, in contrast, the current account balance—with interest payments determined by the level of the debt and an assumed interest rate—is used to allow for feedback between interest payments and the debt stock via equation 7.11 above.

Different developing countries have different mixes of public and private flows, and the choice of methodologies for projecting financial flows usually depends upon whether a country’s capital flows come primarily from the public or the private sector. At the limit, there are two polar ways of establishing sustainable capital flows: one for noncreditworthy countries that must rely entirely on public aid flows and the other for creditworthy countries that borrow entirely on private market terms. The simpler case of aid-dependent countries is discussed first.

Noncreditworthy Aid-Dependent Countries

For aid-dependent countries, sustainability of the resource balance is essentially a question of aid availability—that is, the amount of aid available

24. Another consideration in determining sustainable capital flows is to ensure consistency between the assumptions about capital flows and those about policy targets (such as investment and saving rates) used to determine the adjusted resource balance.
to a country on a sustained basis determines the resource deficit that can be financed. Thus, for these countries, the analysis normally starts by projecting the sustainable net resource transfer and a target external reserve level in order to determine the target resource balance from the balance-of-payments identity (equation 7.9). The internal saving-investment balance (equation 7.8) is assumed to adjust to the external balance. An implicit assumption under this approach is that aid flows are on appropriately concessional terms so that they pose no debt-servicing problem. Hence, the country should draw on the aid to the extent that it is available. For example, in the counterfactual simulations in Chapter 10, the target resource balance for Burkina Faso was determined primarily by an estimate of the sustainable level of concessional aid flows likely to be available to the country in the long term.

In aid-dependent low-income countries, private capital flows are often such a small part of total net resource transfer that the overall result is relatively independent of the accuracy of the projections of private flows. In these circumstances, the projection procedure for private flows is often simply to make a reasonable assumption about the level of private capital flows that is consistent with the projected behavior of investment. Alternatively, private capital flows may be subject to government controls, in which case they are, in effect, a policy-constrained variable that can be limited to desired levels.

Different analytical techniques are sometimes used in backward- and forward-looking analyses of financial flows in aid-dependent countries. Historical analyses often use the same statistical techniques employed for determining sustainable values of other exogenous variables, namely: moving averages or procedures for decomposing changes in financial flows into permanent and transitory components. These techniques are illustrated in the backward-looking analysis of misalignment in Burkina Faso and Côte d’Ivoire in Chapter 10. Such statistical techniques can also be used for forward-looking analysis of financial flows by assuming a continuation of trend or a return to base-year levels. Alternatively, independent projections can be made of financial flows. Independent projections are employed in determining the adjustment, \( \lambda \), to the base-year resource balance in the DLR constant-elasticities methodology in Chapter 8 and in making the counterfactual simulations for the single-equation methodology in Chapter 10.

**Creditworthy and Partially Creditworthy Countries**

The other polar extreme in analyzing capital flows is that of creditworthy countries with full access to private markets. Operational applications in creditworthy industrial countries originally started with ad hoc
estimates of sustainable capital flows. But, as discussed above, recent analyses have increasingly adopted the saving-investment balance approach. However, even creditworthy industrial countries face long-term borrowing constraints and cannot indefinitely finance excessive current account deficits. Large current account deficits can lead to a rapid buildup in debt and debt service obligations. Unless the initial deficit is eliminated spontaneously (for example, because an adverse terms-of-trade shock proves temporary), policy actions will be needed to reverse the initial current account deficit, including possibly an eventual depreciation of the RER. If capital markets do not perceive the required policy actions as likely, sources of financing may dry up. Lenders’ concerns about creditworthiness and debt-servicing capacity thus set limits on the maximum level of sustainable borrowing. Hence, even if the analysis starts by projecting the saving-investment balance, one still needs to check that this balance can in fact be financed on a sustained basis. Moreover, for countries already having high debt levels, the analysis can often simply start with the question of what is a sustainable level of borrowing because that may be the effective constraint on the current account deficit as larger saving-investment deficits cannot be financed.

Creditworthiness Indicators. Standard creditworthiness analysis typically utilizes a maximum sustainable debt to GDP or debt to export ratio. When this limit on borrowing has been reached, the growth rate of nominal debt is subsequently limited to that of nominal GDP or nominal exports so that the debt to GDP or debt to export ratio stabilizes. Williamson (1994) and Williamson and Mahar (1998) follow this approach, noting that common rules of thumb for dangerous levels of debt are 40 percent of GDP and 200 percent of exports. Similarly, the World Bank’s debt reduction initiative for highly indebted poor countries (HIPC) sets a limit of 200 percent to 250 percent for the ratio of the net

26. See Cuddington (1997) for a derivation of the accounting formulas for the equilibrium deficit that will yield a constant debt to GDP ratio. Cuddington also describes the more sophisticated present-value constraint approach and notes the difficulties in implementing it empirically. A problem with both approaches is that temporary large deficits are financeable only if there will be a future turnaround in them and lenders believe that such a turnaround is likely. Neither approach addresses the problem of what causes such turnarounds.
27. A debt to GDP ratio of 40 percent is equivalent to a debt to export ratio of 200 percent when exports account for 20 percent of GDP. Williamson and Mahar (1998, p. 87) argue that “in some sense, the debt/GDP ratio may be considered the more fundamental long-term criterion, in as much as adjustment policies can transform domestic output into exports should the need arise.”
present value of the public and publicly guaranteed foreign debt to exports.\textsuperscript{28} Assuming a 3 percent world inflation rate and 5 percent growth rate of real GDP, Williamson and Mahar estimate that a current account deficit of 2–3 percent of GDP is consistent with these rules of thumb. Sustained growth rates of real GDP of 7–8 percent would permit somewhat higher sustained current account deficits of 3–4 percent of GDP. A persistent current account deficit of 5 percent or more of GDP has, in contrast, traditionally been viewed as a warning sign of unsustainable policies, particularly if it reflects a consumption boom or is financed by building up short-term debt or drawing down external reserves.\textsuperscript{29}

In reality, many developing countries are partially creditworthy, borrowing on both concessional and quasi-commercial terms, and fall in between the two extremes of aid dependency and full market access. In such cases, one first assumes the utilization of available aid flows. Remaining debt-servicing capacity then sets a limit on the amount of commercial borrowing that can be undertaken. Total capital flows are determined as the sum of aid flows and commercial borrowings.\textsuperscript{30}

\textbf{The Composition of Capital Flows.} A similar type of creditworthiness analysis can be carried out for the public sector separately and used to establish limits for public-sector borrowing.\textsuperscript{31} Creditworthy countries,

\textsuperscript{28} The following two additional criteria are also considered: a ratio of external debt service to exports within the range of 20–25 percent and, “for very open economies with a heavy fiscal debt burden despite strong efforts to generate fiscal revenue, a net present value of the debt to export ratio below 200\% and a net present value of the debt to fiscal revenue ratio no higher than 280\%.”

\textsuperscript{29} See, for example, Milesi-Ferretti and Razin (1996).

\textsuperscript{30} Alternatively, a limit on the current account deficit may be based on an assessment of the total interest payments that an economy can bear over the long term considering its income level and growth prospects. This approach was used for projecting external capital flows for Côte d’Ivoire and for the counterfactual simulations in Chapter 10. The target resource balance for Côte d’Ivoire was based on the assessment that its debt burden at the time of the devaluation in 1994 was unsustainable. The basic assumptions at the time were that 4 percent of GDP was the maximum amount that Côte d’Ivoire could pay in interest on its outstanding debt given its income level and growth prospects and that the outstanding debt would eventually be restructured or canceled as necessary to reduce it to a sustainable level reflecting this assumption. To cover interest charges of 4 percent of GDP, other net factor service payments, and private transfer outflows (workers’ remittances, primarily to Burkina Faso), a target resource balance of 6 percent of GDP was established as explained in appendix C to Chapter 10.

\textsuperscript{31} This approach is followed in the Maastricht Treaty, which sets a limit on total public-sector borrowings of 60 percent of GDP as one of its fiscal convergence criteria for prospective European Monetary Union members.
however, also usually have large private-private capital flows, which increasingly are overshadowing private-public flows. Although the consequences of a private sector default may be somewhat different from one by the public sector, private sector borrowing still creates future debt service obligations with balance of payments implications just as public sector borrowing does.

Data on private capital flows are often inadequate. Improved data on these flows, particularly short-term ones, may in many cases be essential for sustainability analysis. Private capital flows are notoriously difficult to predict in any case, and determining “sustainable” levels of these may be one of the most hazardous steps in estimating the equilibrium RER empirically. Because of the size and volatility of private capital flows in some countries, estimating the equilibrium RER in these cases may essentially be a problem of determining what constitutes a sustainable level of private flows.

Public borrowing from private capital markets is under direct government control and is thus a policy variable. For countries with controls on private capital flows, these too may be subject to policy limits. However, liberalization of the capital account may both appreciate the RER by encouraging larger capital inflows and increase the volatility of these flows. In the absence of direct controls on private capital flows, government influence over private-private flows is an indirect one through monetary, fiscal, exchange rate, and financial-sector policies. Hence, if an aggregate target for debt is to serve as a basis for exchange rate policy, the government must manage its macroeconomic policies to stay within this limit.

Because of the volatility of private capital flows, the composition of these flows and the maturity structure of a country’s external debt, as well as the overall level of debt relative to GDP, are concerns in analyzing creditworthiness. As Bacchetta and van Wincoop (1998) note, private outflows have been relatively stable, most of the volatility has been associated with changes in inflows, and the story of net flows has largely been that of variations in inflows.

Short-term debt is, in particular, subject to rollover risk if credit market conditions change because of such factors as increases in interest rates in industrial countries or contagion effects from a financial crisis in a neighboring country. In view of the role of excessive levels of short-term borrowing in the Mexican and East Asian currency crisis, credit markets have started to monitor the ratio of short-term foreign debt to

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external reserves, typically looking for a ratio below 1.0 to ensure that short-term debt can be repaid in the event of a crisis. Therefore, in determining sustainable debt levels, at the least, assumptions about the reliance on short-term debt need to be consistent with the target for external reserves. Elbadawi and Soto (1994, 1995) in the papers reviewed in the research survey in Chapter 5, go even farther: they exclude short-term debt altogether when determining sustainable long-term flows.

Liquid private portfolio investment can also be quite volatile and may be subject to bubble effects. However, although private direct investment flows have to be serviced, they tend to be long-term in nature and have been the most stable component of private flows to developing countries. Hence, Williamson and Mahar (1998) suggest counting only 50 percent of private direct investment against the debt limit but counting a higher percentage of portfolio investment.

Current Account Sustainability. The above analytical techniques and assumptions about sustainable debt and current account limits are commonly used and do provide a starting point for the analysis. However, they are somewhat arbitrary. A given current account deficit may be financeable in some circumstances but not in others, a fact that complicates the determination of a sustainable level of capital flows. Concern about the arbitrariness of the traditional rules of thumb and the need for a better understanding of the volatility of capital flows and exchange rate crises has led to some recent research on the sustainability of current account deficits. Milesi-Ferretti and Razin (1996, 1998) find that current account deficits significantly larger than 5 percent of GDP can be financed for extended periods if a country has ample investment opportunities and markets are confident that external resources are being productively used. Nevertheless, at some point a country that has been running a large current account deficit and amassing a large external debt must reach a turning point where the resource balance shifts from deficit to surplus in order to pay the interest on this debt. Moreover, even smaller current account deficits of significantly less than 5 percent of GDP can be unfinanceable if markets view a country’s policies as inconsistent and do not believe that they will lead to an eventual turnaround in its balance of payments position. Milesi-Ferretti and Razin conclude that in assessing the sustainability of current account deficits, a number of factors, rather than a single indicator, need to be considered, in particular: “A 5% or so current account deficit becomes worrisome when a

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33. If data on short-term debt are inadequate, as was the case in some of the East Asian countries, improved data are likely to be needed for effective exchange rate management.
nation’s export sector is small, debt service is large, savings are low, the financial sector is dominated by banks with weak regulatory oversight, and equity financing is small.”

**Adjusting the Initial Resource Balance**

After establishing a quantitative relationship between the RER and the resource balance and determining the target resource balance, the remaining analytical task in the trade-equations methodology is to adjust the resource balance for the initial year for cyclical, exogenous, and policy changes (for example, lagged effects of changes in the RER, a return to full employment, exogenous movements in the terms of trade, changes in the fiscal deficit) so that it provides an appropriate basis for computing the change required in the RER to move the resource balance to its target level. This analytical task is often referred to as detecting the structural or “underlying” current account balance.34

There are several ways of handling the problem of how to adjust the initial resource balance, ranging from fairly simple to quite complex. This section both discusses general approaches to the problem and sets down some simple analytical procedures that can be used to adjust the initial-year resource balance in low-income developing countries with limited data. It first sets out the relationship between the adjusted and the target resource balances. The section then discusses positive adjustments for changes in cyclical, predetermined, and exogenous variables and subsequently considers normative adjustments for policy actions and targets.

**The Adjusted Resource Balance**

The trade-equations methodology can be used in either of two ways to determine the relationship between the actual and equilibrium RER: (a) to estimate the change in the equilibrium RER required to move from one long-run equilibrium to another or (b) to estimate the change in the actual RER in any given initial year required to move from the initial situation to long-run equilibrium. As noted in the previous section, the simplest, although often not very satisfactory, procedure is to start with a base year in which the resource balance and RER are believed to be at their equilibrium levels. Equations 7.4 to 7.6 are then used to determine the change in the equilibrium RER since the base year is needed to offset the changes in the resource balance that have been caused by movements in the fundamental variables that affect it.

The trade-equations methodology does not, however, require starting with a base year for which the actual and equilibrium RERs are assumed to be equal. The alternative, and more common, approach is to work with data for almost any recent initial year and adjust these data as discussed below to take into account deviations from trend, spontaneous exogenous changes, and policy measures. This procedure permits establishing an adjusted initial resource balance from which one can determine the real appreciation or depreciation required to attain a targeted resource balance and move the RER from its initial level to its equilibrium level.

Because of the absence of satisfactory base years, in most cases it is desirable to work with an adjusted resource balance. The adjustment to the initial resource balance to take into account factors other than the appreciation-depreciation of the RER needed to achieve a particular target resource balance can be expressed algebraically as in equation 7.12:

\[
(7.12) \quad \Delta R_{B_0} = R_{B_a} - R_{B_0}
\]

where \( R_{B_0} \) is the initial- or reference-year resource balance in real terms, \( \Delta R_{B_0} \) is the change in the resource balance, and \( R_{B_a} \) is the adjusted or underlying resource balance. The change in the adjusted resource balance (\( \Delta R_{B_a} \)) required to achieve the target resource balance (\( R_{B}^* \)) can similarly be expressed as in equation 7.13:

\[
(7.13) \quad \Delta R_{B_a} = R_{B}^* - R_{B_a}.
\]

The total required change in the resource balance (\( \Delta R_{B} \)) is the sum of the adjustments to the initial resource balance and the desired change in the adjusted resource balance as shown in equation 7.14:

\[
(7.14) \quad \Delta R_{B} = \Delta R_{B_0} + \Delta R_{B_a} = R_{B}^* - R_{B_0}.
\]

In most cases one is, in fact, interested in separating the total required change in the initial resource balance into \( \Delta R_{B_0} \) and \( \Delta R_{B_a} \) as different policy actions (or nonactions) are needed to achieve these. In some cases (for example, to allow for lagged effects of changes in the RER), it may also be desirable to use an adjusted RER for the initial year, \( R_{ER_a} \), rather than the actual RER in the initial year, \( R_{ER_0} \)\(^{35}\).

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35. See the discussion of the components of misalignment in Chapter 5. Clark and MacDonald (1998) refer to the change in the RER required to move from \( R_{ER_0} \) to \( R_{ER} \) as “current misalignment” and that which is required to move from \( R_{ER} \) to the LRER as “total misalignment.” In the same vein, the difference between \( R_{ER} \) and the LRER could be referred to as structural misalignment.
Two types of factors other than the RER may affect the initial resource balance: (a) positive changes in predetermined, cyclical, and exogenous variables; and (b) normative policy actions and targets. The procedure for estimating the effects of these two groups of changes on the initial resource balance in order to determine $\Delta R_{B}$ are discussed below. As explained there, in some cases the adjustment procedure will depend upon whether the target resource balance, $R_{B}^{*}$, has been determined through the saving-investment balance or the sustainable capital flows approach.

**Positive Adjustments for Changes in Predetermined, Cyclical, and Exogenous Variables**

To arrive at the underlying current account deficit in industrial countries, the IMF uses trade equations to adjust imports and exports in the initial year for the lagged effects of changes in the RER in the preceding two years and for the gaps between current and full employment output at home and abroad. Wren-Lewis and Driver (1998) follow a similar procedure, using the fitted values of imports and exports from their trade equations and full employment output in calculating the adjusted resource balance for the initial year. For developing countries, additional adjustments in the initial resource balance may be needed to allow for exogenous shocks to import and export quantities and for significant movements in the terms of trade. Positive adjustments for these factors are discussed below, the effects of quantity changes first and then those of relative price movements.

**Quantity Changes**

**Underutilized Productive Capacity or Return to Trend Growth Rate of GDP.**

The trade-equations methodology may be used equally well for economies that are on the production frontier with fully employed resources and for those that are inside it. When, as in the CFA zone prior to the 1994 devaluation, the RER has been overvalued for a significant period and nominal wages and prices in the nontradable sector are sticky downwards, internal relative prices change at best very slowly. As a result, resources may not shift quickly enough from the production of nontradables to tradables. In such cases, a country may experience a significant recession or a period of below-trend GDP growth. Imports may then be depressed below their full employment level through cyclical income effects. In these cases, a return either to full utilization of the existing capital stock or to the trend level of GDP growth may lead to a cyclical increase in the demand for imports as expanding production

and incomes lead to higher absorption and imports and a deterioration of the resource balance. However, there may also be cases where absorption is excessive, inflation is accelerating, the economy is overheated, and the current account deficit is too large, requiring a reduction in GDP, and imports, in the initial year from their actual levels to trend.

The standard procedure for determining output gaps in industrial countries is to estimate a production function for GDP and calculate the output gap as the difference between output given by the production function and actual output. In developing countries, the data necessary for estimating production functions are often not available; and simpler approaches have to be used. Typically, the size of the gap between potential and actual GDP is estimated from an analysis of trend growth rates and deviations from them. When the required data are available, the trend analysis can be supplemented by examining capacity utilization and unemployment figures. Once the estimated GDP gap has been determined, it is multiplied by an estimated or assumed income elasticity of demand for imports to calculate the additional imports needed to allow for a return to full employment. Appendix B summarizes representative estimates of income elasticities of demand for imports that may be used for this purpose when country-specific estimates are not available.

Exogenous Quantity Changes. In addition to cyclical income effects, the initial resource balance may also be affected by exogenous variations in export or import quantities that are not caused by changes in incomes or the RER. Such exogenous changes in quantities may reflect corrections for unusual circumstances or deviations from trend in the initial year (for example, higher-than-normal food imports because of a drought or lower-than-normal exports because of a strike or civil unrest). Alternatively, they may take account of projected new developments that would occur without any change in the RER—such as additional exports from completion of an investment already in progress in a major mining project, or adoption of improved agricultural technology. Such projected changes in import and export volumes are added to the initial-year val-

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37. The above formulation assumes that it is not profitable to shift resources to the production of tradable goods without a depreciation of the internal RER so that the excess capacity is in the nontradable sector. If output in the export sector is demand-rather than supply-constrained and there is excess capacity in this sector, then a return to full employment or trend growth levels of GDP could also lead to an expansion of exports that could offset part or all of the increased demand for imports.

38. See, for example, Demasi (1997).

39. If investment is also cyclically depressed, an additional allowance should be made for its recovery as discussed below.
ues to determine the adjusted resource balance. In the Burkina Faso example in Chapter 10, new zinc exports of 2.6 percent of GDP and additional imports of 0.9 percent of GDP were projected as the result of the completion of a mining project that was already being implemented before the 1994 devaluation and would have started production any case.

Changes in Relative Prices
Lagged Effects of Changes in the RER. As discussed in Chapter 11 on the effects of the RER on trade flows, on average it takes approximately three years for all the effects of changes in the RER to work their way through an economy. The trade equations used by Isard and Faruqee (1998) thus model imports and exports as functions of the RER in the current and preceding two years, with average weights of 0.6, 0.25, and 0.15 assigned to the RERs in these years. The underlying current account deficit is then calculated assuming that the RER remains at its current level indefinitely. When trade-elasticity equations 7.4 through 7.6 are used, a simpler adjustment may be made when appropriate, that is: imports and exports in the initial year can be assumed to reflect the weighted average of the RER in the current and preceding two years, with whatever adjustments to Isard’s and Faruqee’s weights are merited in light of country-specific data. The resulting three-year weighted average RER is then used as the base for calculating its equilibrium level.40

Projected External (International) Prices. Although recently a great deal of attention has been focused on the volatility of capital flows, fluctuations in the terms of trade can—as in the case of the devaluation of the CFA francs—be equally or more important concerns for commodity-exporting low-income countries with limited access to private capital markets. Hence, for developing countries with highly variable terms of trade, determining sustainable values for the exogenous external prices of their imports and exports is a key step in the estimation of the equilibrium RER.41 The central analytical problem is to distinguish between temporary and permanent (or sustained) changes in what are often quite volatile export prices. Different approaches to this problem are usually taken in historical and forward-looking analyses. In historical analyses,

40. Using this procedure for the internal RERs also takes into account changes in the terms of trade and commercial policy in the preceding two years since these are reflected in the internal RER.

41. Fluctuations in the terms of trade are normally much less of a concern for industrial countries that export a range of manufactured products. Isard and Faruqee (1998, p. 38) note that for most of these countries, variations in the terms of trade have typically been a temporary phenomenon.
moving averages of the annual values or econometric techniques for decomposing changes into permanent and transitory components are usually used in order to reduce the random fluctuations in what are normally quite volatile annual data. These techniques are illustrated in Chapter 10 for the single-equation reduced-form methodology.

Forward-looking analysis may also assume that external prices continue to follow historical trends and simply extrapolate these trends into the future. Alternatively, they may employ available projections of international prices of primary commodities and manufactured goods such as those regularly produced by the World Bank. In this case, the changes in the real (inflation-adjusted) prices of exports and imports are multiplied by the corresponding price elasticities of supply and demand to calculate the adjustment to the initial resource balance.

Adjustments for Policy Actions and Targets

The above adjustments to the initial resource balance for changes in cyclical, predetermined, and exogenous variables are all positive ones needed to estimate the underlying or structural resource balance. In addition, the initial resource balance may need to be adjusted for the effects of policy actions and targets other than changes in the RER. As explained in the discussion of conceptual issues in Chapter 5, numerous different assumptions about policy actions and targets can be made when estimating the equilibrium RER; and these will generally lead to somewhat different estimates of the LRER. These assumptions may be classified broadly into two groups: (a) positive assumptions specifying the policies that one thinks are likely to be implemented and (b) normative assumptions specifying the policies that one thinks should be implemented.42 The principal policies that need to be taken into account in a developing-country context are those affecting trade and the import intensity of absorption.

Trade Taxes

Developing countries often undertake devaluations, at least in part, to permit dismantling of protective barriers against competition. Hence, devaluations are commonly accompanied by reforms, often extensive, in trade policy; and the effects of these on the initial resource balance need to be taken into account. Equation 7.5 above contains the average trade taxes on imports and exports, \( t_M \) and \( t_X \). These should be broad

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42. In addition, in considering the effects of a devaluation and alternatives to it, it may also be helpful analytically to distinguish between the effects on the initial resource balance of those policy measures that could be implemented without a devaluation and those that would require a devaluation.
measures of the average trade taxes (net of subsidies) on imports and exports. In principle, \( t_m \) and \( t_X \) should also include the tariff equivalent of nontariff barriers, differential domestic taxes on traded goods, profits of marketing boards, and effects of administered pricing schemes, although quantifying these effects empirically may be difficult. Since the structure of protection in developing countries is often highly differentiated with a wide dispersion of effective trade tax rates, it is sometimes possible to achieve a general leveling of incentives (particularly through the elimination of exemptions and non-tariff barriers) while maintaining or even increasing revenues from trade taxes. In such cases, historical changes in average trade tax rates may give a vague or even a misleading idea of the changes in the incentives facing key subsectors; and ad hoc adjustments, based on whatever data are available in a particular case, may be needed.

As in the case of exogenous external prices, different approaches are usually utilized for historical and forward-looking analyses of changes in commercial policy. Accurate historical measures of commercial policy are hard to come by.\(^{43}\) Hence, changes in openness to trade are sometimes used as a proxy for changes in commercial policy as in Chapter 10, in which alternative empirical measures of trade openness are examined. Forward-looking analyses, on the other hand, typically start by making an ad hoc estimate of the average tariff rates in the initial or base year and an assumption about how this rate will change as a result of future policies. The effects on the initial resource balance are then calculated using equations 7.4 to 7.6.

**Policies Affecting the Import Intensity of Absorption**

In a particular country application, the previous trend rate of GDP growth may be satisfactory; and the policy objective associated with the equilibrium RER may simply be a return to this growth rate. Or, the previous trend rate of GDP growth may have been too low; and the equilibrium RER may need to be estimated assuming an acceleration in growth. In the former case, the adjustment to the initial resource balance for a return to trend growth described in the previous subsection will be sufficient. If, however, an acceleration of the growth rate is desired, a higher level of investment will generally be required.\(^{44}\)

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43. See Pritchett (1996). Pritchett finds that there is no reliable robust measure of commercial policy orientation that can be used in cross-country regression analyses and suggests that the issue may be too complex and opaque to be analyzed with a single standardized measure.

44. This subsection discusses the effects of an increase in the growth rate of GDP whereas the preceding subsection on the GDP gap discusses the effects of a one-time increase in the level of GDP. In empirical applications, care needs to be taken to ensure consistency in the treatment of these effects.
Since the target resource balance (and hence the $S - I$ balance) is determined independently by the level of sustainable capital flows, a higher investment rate will require increased saving. An additional important consequence of higher investment for present purposes, however, is that the resulting change in the composition of absorption may have implications for the equilibrium level of the real exchange rate. Because investment tends to be relatively more import-intensive than consumption in most low-income countries, even an equal increase in the levels of investment and saving may tend to raise the import intensity of expenditure. Consequently, for a given resource balance (and thus for a given $S - I$ balance), the higher the level of investment, the more depreciated the RER may need to be to offset the greater ex ante import intensity of absorption.\footnote{An important assumption underlying the above approach is that public and private saving behavior have little direct impact on exports. Low-income countries typically do not consume a significant share of their export production, which usually consists largely of export crops (for example, coffee, cocoa, cotton), mineral products (for example, phosphates, petroleum), or nontraditional products (for example, horticulture, garments) produced for foreign markets. (Another type of export on which saving behavior would have little direct effect is the exportable surplus of a basic consumption good, such as rice, with a low-income elasticity of demand.) Hence, the effects of changes in saving and consumption fall primarily on imports and domestic goods.} In the Côte d’Ivoire case, for example, the import intensity of investment was estimated at 0.6 and that of consumption at 0.3 so that a balanced increase in investment and saving would, other things being equal, require an increase in imports. Hence, to offset the resulting tendency for the composition of expenditure to become more import intensive because of increased investment, a depreciation of the RER would be required.

The initial resource balance can be adjusted to allow in a rough way for the differential effects on imports of projected increases in the levels of investment and saving. This adjustment is computed by multiplying the projected increase in investment, as a share of GDP, from its initial level by the import intensity of investment and then subtracting from this product the projected increase in saving from its initial level multiplied by the import intensity of consumption.\footnote{The import intensities of both private and public consumption and investment may also differ, with private investment being relatively more equipment (import) intensive and public investment being relatively more construction (nontraded good) intensive, making it desirable to split investment and saving into their public and private sector components. However, in practice the data on the import intensities in the public and private sectors are often so sketchy that, as in the Côte d’Ivoire case, it is difficult to quantify these differences.}
Significant compositional effects requiring an adjustment in the initial resource balance can also arise from projected changes in the composition of government expenditures. For a given fiscal deficit, a shift in government expenditure between traded and nontraded goods will tend to affect the resource balance. As discussed in Chapter 6 on the theory of the equilibrium RER, switching government expenditures from domestic (nontraded) goods to imports will tend in the first instance to widen the resource deficit. When the switching of government expenditure between traded and nontraded goods is important in a specific case, a rough adjustment can be made, similar to that made for a balanced increase in investment and saving, using whatever data are available on the import intensities of the categories of expenditure involved. Because data decomposing government expenditures into those on traded and nontraded goods are often not available, in practice data for government investment and consumption expenditures (particularly wages) are often used as proxies for these.

Limitations of the Adjustment Procedures

The recursive approach used in the trade-equations methodology does not explicitly allow for feedback from the RER to the variables that determine the target resource balance. Investment and saving behavior, both public and private, may, however, be affected by changes in the RER. As discussed in appendix B of Chapter 2 on the external RER, a depreciation of the RER (an increase in competitiveness) will tend to raise returns to capital and thereby increase both investment and saving. A depreciation of the RER may also have important effects on government revenues—particularly if the government is highly dependent on trade taxes—and on the real value of nominal government expenditures.

47. For a further discussion and empirical evidence, see Khan and Lizondo (1987) and Lane and Perotti (1996).

48. Likewise, changes in government revenues may also have somewhat different effects on imports from changes in government expenditures. In this case the adjustment to the initial resource balance for equal changes in government revenues and expenditures would be computed by multiplying the change in government expenditure by the average import intensity of the expenditures involved and subtracting from this product the increase in government revenues multiplied by the import intensity of private consumption (assuming that the increased taxes fall on private consumption).

49. Isard and Faruqee (1998) hypothesize that the determinants of the saving-investment balance in the G-7 countries are independent of the RER and, hence, do not make some of adjustments to the initial resource balance discussed above. See Chapter 5, Figure 5.1, and the discussion of it on pp. 244–246.
Alternative monetary and fiscal policies for closing an output gap may have differing implications for the RER. Movements in the RER and in investment, saving, and fiscal variables can also affect lenders’ perceptions of a country’s creditworthiness and hence the level of sustainable capital flows. Ad hoc adjustments can be made for some of these effects, as discussed above, when they are important in particular cases and the required data are available. For other effects, it may not be possible to make adjustments in a specific case. Moreover, a devaluation and accompanying policy measures need to be designed to adjust both the external resource balance \((X - M)\) and the saving-investment gap \((S - I)\) in equation 7.8 in a consistent way to achieve the targeted resource balance. While rough adjustments can be made in specific cases for some of the more important interactions, theoretically it would be desirable to have a full general-equilibrium framework that takes into account all of the important feedbacks in a fully consistent manner.

**Conclusion: Advantages and Limitations of the Trade-Equations Methodology**

The trade equations–elasticities methodology set out above has a number of practical advantages in estimating the equilibrium RER in low-income developing countries. First, its data requirements are limited. One needs only GDP, CPI, and balance of payments statistics for the home country. Reasonable estimates of the price elasticities of export supply and import demand needed for the methodology are also readily available even if trade elasticities have not previously been estimated for the particular country concerned. Second, the methodology is reasonably straightforward and transparent. With simple computer spreadsheets it is easy to run extensive sensitivity analyses of the results from the methodology assuming different parameter estimates and structural changes, projections of exogenous variables, policy targets, and so forth. Minimal data requirements, readily available parameter estimates, and transparency are significant practical advantages at the time of a balance of payments crisis in a developing country in which data, time, and professional manpower are all likely to be limited. Third, in cases of shifts in the fundamentals, the trade equations–elasticities methodology can provide a measure of the new equilibrium RER that cannot be

50. The trade-equations methodology also does not explicitly take into account such short-term factors as speculative stocking and destocking and the relationship between the seasonality of the cropping cycle and the timing of RER movements. It does not consider possible expansionary or contractionary monetary effects on real balances, either. Again, it is sometimes possible to make ad hoc adjustments for these effects in cases in which they are important.
estimated using the simpler relative-PPP-based approach. The methodology is thus a useful base-line approach that may be used by itself, when nothing else is available, or as a cross-check when other methodologies are also used.

However, the trade-equations methodology does have some significant limitations. First, the errors involved in the parameter estimates could be substantial and suggest large confidence intervals around the estimated LRER. The methodology is, in principle, valid only for marginal changes. Large nonmarginal changes caused by major RER realignments may lead to structural changes affecting the parameters.\footnote{For example, the elasticities or the various import ratios used in computing the adjustments in the target resource balance may change.} Although sensitivity analyses can be readily made for alternative parameter estimates and changes in these as illustrated in the next chapter, outcomes of large changes in the RER are often hard to predict.

Second, the three-good framework utilized in the developing-country version of the methodology assumes that the law of one price holds for internationally traded goods. If the law of one price does not hold or holds only loosely, the relationship between domestic and foreign prices will be much looser, and the internal RERs for exports and imports may change less or more slowly than assumed.

Third, the trade-equations methodology employs a recursive partial-equilibrium approach. Given required changes in the resource balance, it determines new equilibrium values for the RER, imports, and exports but not for other important macroeconomic variables that may also change simultaneously. Nor does it explicitly allow for feedback from the RER to the factors (for example, saving, investment, capital flows) determining the target resource balance. While rough adjustments are possible for some of the more important income and feedback effects, one would be more confident of the results if they were determined in a complete general-equilibrium framework that takes into account all important interactions in a fully consistent manner.

Fourth, the methodology is one of comparative statics. It projects long-term changes but not the dynamic time path of the adjustment process, although by repeated applications of the methodology, year by year, it is also possible to generate a time series for the equilibrium RER as illustrated with the DLR constant-elasticities model in the next chapter. The volatility of exchange rates implies that the RER may diverge from its equilibrium value for significant time periods and the path by which it converges to this value may in some cases have significant policy implications (for example, for the level of debt or the length of the adjustment period).
Finally, forward-looking analyses of the LRER using the trade-equations methodology require projections of the fundamental variables determining the LRER. If some important fundamentals such as the terms of trade or private capital flows are completely unpredictable or subject to repeated shocks to their “permanent” values, the LRER will also be unpredictable or volatile.

How accurate then are estimates of misalignment from the trade equations–elasticities methodology likely to be? Little research has been done on this question. The methodology was not fully articulated until 1994–98. Before that, it was applied in different forms as it evolved and was typically used, often in informal unpublished internal analyses, for operational purposes without systematically looking back years later to see how accurate the results were. Isard and Faruqee (1998) present a historical analysis of what the methodology would have revealed about the major exchange rate misalignments of the 1980s and 1990s in industrial countries if it had been used then in its present form and find that, if applied ex ante, it could have identified these misalignments. In the absence of formal statistical measures of accuracy, they suggest, based on the IMF’s experience, a 10–15 percent confidence interval for industrial countries.52 That is, estimated misalignments of 10 percent or less are probably not significant given all of the uncertainties involved. Misalignments of 15 percent or more are likely to merit further careful investigation, and the significance of misalignments between 10 percent and 15 percent can only be judged in light of country-specific knowledge of the factors likely to affect their accuracy.53 This rule of thumb also seems reasonable for developing countries until further experience provides better guidance.

52. See also Kramer (1996) for a more formal statistical analysis of a case study for the Canadian dollar.
53. For a further discussion of the interpretation of apparent misalignment, see Isard and Faruqee (1998), pp. 1–3 and 16–17.
Appendix A

The RER, Trade-Elasticities, Resource Balance Relationship in a Three-Good Framework

This appendix derives the relationship between the resource balance, trade elasticities, and the internal RER in a three-good framework with exports, imports, and domestic goods.54 This formulation allows for different RERs for imports and exports and facilitates more explicit treatment of the relative price effects of changes in the terms of trade and commercial policy than does the expenditure-PPP external RER. Both formulations require the assumption that the elasticities of export supply and import demand are the same for changes in relative prices as for changes in the real exchange rate. This assumption is quite natural when using separate internal RERs for exports and imports but less so if the PPP external RER is used. The approach developed below uses the definitions of the price elasticities of imports and exports to calculate the equilibrium RER from a target value for a sustainable resource balance and estimates of the home country’s import and export elasticities.

Derivation of the Basic RER, Trade-Elasticities, Resource Balance Equation

The Definition of Trade Elasticities

The price elasticity of export supply, \( \sigma_{x} \), is defined as shown in equation 7.A.1:

54. For earlier discussions of the trade-elasticities methodology see E. Bacha and L.Taylor (1971) and A. Kreuger and others (1988).
The Definition of the Internal RERs

In the above three-good framework, the internal RER is the domestic price of exports or imports relative to the price of domestic (nontraded) goods. The internal RERs for exports, $RER_X$, and for imports, $RERM$, are defined as shown in equation 7.A.3:

$$ (7.A.3) \quad RER_X = \frac{P_{Xd}}{P_{Dd}} \quad \text{and} \quad RERM = \frac{P_{Md}}{P_{Dd}}. $$

If the home country is a price taker in international trade, its exports and imports are subject to the law of one price. The domestic prices of
exports, $P_{Xd}$, and imports, $P_{Md}$, are then determined by their international (border) prices and trade taxes as shown in equations 7.A.4 and 7.A.5:

\begin{align}
  (7.A.4) & \quad P_{Xd} = P_{Xf} (1 - t_X) \cdot E_{dc} \\
  (7.A.5) & \quad P_{Md} = P_{Mf} (1 + t_M) \cdot E_{dc}.
\end{align}

$P_{Xf}$ and $P_{Mf}$ are the foreign-currency border prices of exports and imports, $t_X$ and $t_M$ are the average trade taxes on exports and imports, and $E_{dc}$ is the nominal exchange rate in domestic-currency terms. The definitions of the internal RERs may then be written as in equations 7.A.6 and 7.A.7:

\begin{align}
  (7.A.6) & \quad RERX = \frac{P_{Xd}}{P_{Md}} = \frac{P_{Xf} (1 - t_X) \cdot E_{dc}}{P_{Mf} (1 + t_M) \cdot E_{dc}} \\
  (7.A.7) & \quad RERM = \frac{P_{Md}}{P_{Xd}} = \frac{P_{Mf} (1 + t_M) \cdot E_{dc}}{P_{Xf} (1 - t_X) \cdot E_{dc}}.
\end{align}

The trade elasticities may be expressed in terms of the RERs for exports and imports by substituting the definitions of the internal RERs from equations 7.A.3 into equations 7.A.1 and 7.A.2 as shown in equations 7.A.8 and 7.A.9:

\begin{align}
  (7.A.8) & \quad \sigma_X = \frac{\Delta X}{X} \cdot \frac{ARERX}{RERX} \\
  (7.A.9) & \quad \epsilon_M = \frac{\Delta M}{M} \cdot \frac{ARERM}{RERM}.
\end{align}

The Resource Balance

The resource balance and its first difference measured in real terms are given in equation 7.A.10:

\begin{align}
  (7.A.10) & \quad RB = X - M \quad \text{and} \quad \Delta RB = \Delta X - \Delta M.
\end{align}

Expressions for $\Delta X$ and $\Delta M$ in terms of the internal RERs and trade elasticities may be derived by rearranging equations 7.A.8 and 7.A.9 to obtain equations 7.A.11 and 7.A.12:
Subtracting equation 7.A.11 from 7.A.12 yields equation 7.A.13 for the change in the resource balance, $\Delta RB$:

$$\Delta RB = \Delta X - \Delta M = \sigma_X \cdot X \cdot \frac{\Delta \text{RER}_X}{\text{RER}_X} - \varepsilon_M \cdot M \cdot \frac{\Delta \text{RER}_M}{\text{RER}_M}$$

### Solution for the Internal RERs

**The Relationship between the Internal RERs for Imports and Exports**

In order to solve equation 7.A.13 for either $\text{RER}_X$ or $\text{RER}_M$, we need an expression for the relationship between them. Dividing the definition of $\text{RER}_X$ by that for $\text{RER}_M$ (equation 7.A.3) gives equations 7.A.14 and 7.A.15:

$$\text{RER}_X = \frac{\text{RER}_M}{\text{RER}_X}$$

$$\text{RER}_X = \frac{\text{RER}_M}{\text{RER}_X} \cdot \frac{\text{ITT}}{\text{RER}_X}$$

where the internal terms of trade, ITT, are defined as the domestic price of exports relative to the domestic price of imports, that is: $\frac{P_{Xd}}{P_{Md}}$. Note, for future reference, that the numeraire, $P_{Dd}$, cancels out in equation 7.A.14 (see page 351).

Substituting for $P_{Xd}$ and $P_{Md}$ from equations 7.A.4 and 7.A.5 yields equation 7.A.16:

$$\text{ITT} = \frac{P_{Xd}}{P_{Md}} = \frac{P_{Xd}(1-t_x)}{P_{Md}(1+t_M)} \cdot \frac{E}{1-E} = \frac{P_{Xd}(1-t_x)}{P_{Md}(1+t_M)},$$

Since all of the variables on the right-hand side of equation 7.A.16 are exogenously determined if the law of one price holds, so are the internal terms of trade, ITT. Hence, $\text{RER}_X$ can be calculated from $\text{RER}_M$ and the exogenously determined internal terms of trade using equations 7.A.15 and 7.A.16.
The Internal RERs

By substituting for from equation 7.A.15 in equation 7.A.13 and rearranging the terms, equation 7.A.17 for the internal RER for imports can be obtained:

\[
\Delta \text{RERM} = \frac{\Delta R - \sigma_X \cdot X \left( \frac{\Delta ITT}{ITT} \right)}{\sigma_X \cdot X - \epsilon_M \cdot M}.
\]

The above system contains four equations (numbers A.10, A.15, A.16, and A.17) and four endogenous variables \((M, X, \text{RERM}, \text{RERX})\). It also contains the parameters \(\sigma_X \) and \(\epsilon_M\); initial values of \(X, M, \text{and ITT}\); and the exogenously determined variables \(\Delta R\) and \(\Delta ITT\). The determination of the change in the internal terms of trade, \(\Delta ITT\), from equation 7.A.16 is straightforward. Exogenous projected values are used for the external prices of exports and imports, \(P_{Xf}\) and \(P_{Mf}\). Average trade taxes on exports, \(t_X\), and imports, \(t_M\), are policy variables.

The other exogenous variable on the right-hand side of equation 7.A.17 is the targeted or required change in the resource balance, \(\Delta RB\). Determination of both the adjustments to the initial resource balance for cyclical, exogenous, and policy changes and determination of the sustainable or target resource balance is similar in the trade-equations and the trade-elasticities approaches. This process is considerably more complicated than calculating \(\Delta ITT\) and is discussed separately in the sections of the text on the adjusted and target resource balances.

Once the adjusted and target resource balances have determined, as in the trade-equations approach, the trade-elasticity relationships are used to calculate the change in the RER needed to move it from its actual level to its equilibrium level. Thus, the computed values of \(\Delta ITT\) and \(\Delta RB\) are plugged into the right-hand side of equation 7.A.17 to calculate the change in the RER for imports necessary to achieve the required change in the resource balance. The RER for exports can then be computed using equation 7.A.15. After the RERs for imports and exports have been calculated, the supply response to the change in the RER (that is, the corresponding changes in the volume of imports and exports) can also be computed using equations 7.A.8 and 7.A.9.

Note, however, that equations 7.A.15 and 7.A.17 only permit determining relative prices, not nominal ones. The definitions of the internal RERS, in fact, contain two endogenous variables, the nominal exchange rate, \(E_{Xf}\), and the price of domestic goods, \(P_{Mf}\), as well as the exogenously set prices of exports or imports. In order to determine separate values

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55. These two endogenous variables may be compressed into one variable (the price of domestic goods expressed in foreign-currency terms) by multiplying
for these two endogenous variables, either the nominal exchange rate or the domestic-currency price of domestic goods needs to be exogenously determined as a nominal anchor for domestic prices.\textsuperscript{56}

**Parameter Estimates**

Three points concerning the parameters in the relationship between the internal RER, trade elasticities, and the change in the resource balance merit further explanation and possible modification in particular applications. These are (a) the empirical trade-elasticity estimates to be used in equation 7.17; (b) the numeraire used in measuring the elasticities and the RER; and (c) the problem of inelastic export demand. Each of these is discussed in turn below.

**Trade-Elasticities Estimates**

The accuracy of the equilibrium RER calculated using the trade-elasticities methodology depends upon that of the elasticity estimates used. Econometrically estimating country-specific elasticities can be both a time-consuming and problematic process in developing countries with inadequate data. However, a considerable amount of empirical work has been done on trade elasticities for a wide range of countries and products. Chapter 11 by Ghei and Pritchett on trade flows and elasticities summarizes the results of this empirical work and gives a good idea of what are reasonable values to assume for import and export elasticities.

The elasticity estimates used in equation 7.A.17 may either be aggregate elasticities for imports and exports or a weighted average of the commodity-specific elasticities for major product groups.\textsuperscript{57} The definition of trade elasticities (equations 7.A.1 and 7.A.2) and the law of one price (equations 7.A.4 and 7.A.5) used in deriving equation 7.A.17 implicitly assume that there is no import compression through exchange.

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\textsuperscript{56} For a further discussion of the nominal anchor problem and a methodology for calculating consistent nominal and relative prices, see Chapter 13 on devaluations and inflation.

\textsuperscript{57} Nonfactor service receipts and payments should be treated as imports and exports in order to allow for the possibility that they may change in response to a change in the RER. In some cases, it may also be desirable to treat some factor service flows and private transfers as “imports” and “exports” and allow for a non-zero price elasticity for these. The elasticities of different product groups should be weighted by the ratios of imports or exports of these to GDP to determine the aggregate import and export elasticities.
controls or nontariff barriers and no smuggling of either exports or imports. Hence, the quantities of imports and exports are determined entirely by foreign prices, trade taxes, and the market or official exchange rate. If one or more of the foregoing distortions are present, the average tax rate on imports and exports needs to be adjusted to allow for these as discussed below.

The Numeraire for the Trade Elasticities and the RER

In the formulas for import and export price elasticities (equations 7.A.1 and 7.A.2) relative prices are expressed in terms of the price of domestic goods. Relative prices are, however, more often expressed in terms of the aggregate price level, \( P_{Gd} \). Because of the ready availability of data for aggregate price indexes, the common practice when estimating elasticities empirically is, in fact, to express import and export prices relative to the aggregate price level rather than to the price of domestic goods.

The relationship between the aggregate price level and the prices of imports, exports, and domestic goods are given by equations 7.A.18 and 7.A.19:

\[
(7.A.18) \quad P_{GDP} = P_{xd}^{\tau_x} \cdot P_{DM}^{1-\tau_x}
\]
\[
(7.A.19) \quad P_{GDA} = P_{Md}^{\tau_m} \cdot P_{DM}^{1-\tau_m}
\]

where \( P_{GDP} \) is the deflator for GDP, \( P_{GDA} \) is the deflator for gross domestic absorption, \( \tau_x \) is the share of value added in exporting in GDP, and \( \tau_m \) is the share of imports of final goods in absorption. If, as often happens, the prices of traded goods vary more than those of domestic goods, elasticities with respect to the aggregate price level, which includes traded goods, will be higher than with respect to the price of domestic goods.

Fortunately, however, as long as the elasticities for imports and exports and the RER are expressed relative to the same numeraire, equation 7.A.17 can be used for any numeraire as the numeraire cancels out in its derivation as noted above. Hence, standard elasticity estimates expressed relative to the general price level may be used as long as the same numeraire (for example, the deflator for GDP or GDA or the CPI) is used for estimating the elasticities for both imports and exports. However, in this case the RER will also be expressed relative to the general price level rather than to the price of domestic goods. If the equilibrium RER

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58. The composition of the numeraire must also not change during the period for which the elasticities are measured empirically. That is, \( \tau_x \) and \( \tau_m \) must be constant.
expressed relative to the general price level is calculated using equation 7.A.17, then equations 7.A.18 and 7.A.19, which relate the price of domestic goods to the general price level, may subsequently be used to calculate the RER expressed relative to the price of domestic goods as discussed in Chapter 13 on devaluations and inflation.

The Elasticity of Foreign Exchange Supply

The above formulations assume that the home country’s imports and exports are small relative to the world markets for these goods and services and that it is a price taker for both imports and exports. Hence, it faces infinitely elastic import supply and export demand curves. However, if the home country’s exports of a particular commodity represent a large share of world exports and foreign demand for them is not highly price elastic, the quantity of the home country’s exports will affect the price at which they can be sold. Whenever the absolute value of the price elasticity of demand for a particular country’s exports of a given product is less than infinite but greater than unity, the elasticity of foreign exchange earnings will be less than the elasticity of export supply, although still positive. In this case, the elasticity of the supply of exports, $\varepsilon_j$, should be replaced in equation 7.A.17 by the elasticity of the supply of foreign exchange, $\sigma_p$, given by equation 7.A.20:

$$\sigma_j = \frac{\sigma_s (-\varepsilon_j - 1)}{\sigma_s - \varepsilon_j} \quad \varepsilon_j < 0$$

where $\varepsilon_j$ is the price elasticity of foreign demand for the home country’s exports and $\sigma_s$ is the price elasticity of export supply. $\varepsilon_j$ is equal to the price elasticity of demand in the world market for the commodity concerned divided by the home country’s share of the world market.

Consider, for example, the case of exports of cocoa and coffee from the entire CFA zone at the time of the devaluation of the CFA franc in 1994. Together these accounted for 24 percent of total CFA zone exports, and the zone’s cocoa exports were a large enough share of the world market (36 percent) that inelastic demand was a reasonable policy concern.

Since the price elasticity of world demand for cocoa was estimated at –0.35, an increase in the quantity of cocoa exported by the CFA countries would lower the world price and total revenues from cocoa sales. Using the rule of thumb (from Chapter 11 on trade flows and the RER) that the elasticity of demand for an individual country’s exports is the world elasticity divided by the country’s market share, the price elasticity of demand for cocoa exports from the CFA countries was approximately –1.0 (that is, (–.35)/(.36)). Using the estimated long-term supply elasticity for the CFA countries’ cocoa exports of 1.0 from Ghei and
Pritchett, the estimated elasticity of foreign exchange earnings from equation 7.A.20 is 0.

By contrast, for coffee, the estimated price elasticity of world demand was higher (–0.5 for coffee vs. –0.35 for cocoa); and the CFA zone’s market share was much lower (8 percent for coffee vs. 36 percent for cocoa). Hence, the price elasticity of demand for its coffee exports, although not infinite, was much larger (–6.2 = (–0.5)/(–.08)) than for cocoa. Consequently, the elasticity of foreign exchange earnings from equation 7.A.20 was only slightly lower (0.6) than the estimated long-term elasticity of export supply for coffee (0.8).
Appendix B

Representative Estimates of
the Income Elasticity of
Demand for Imports

Empirically, import demand functions are usually estimated as log linear functions of the relative price of imports and real income. Recent studies (see table 7.B.1) have found that on average, income elasticities of import demand are somewhat higher in industrial countries than in developing countries, another possible reflection of the difference in import structure discussed earlier. As with price elasticities, income elasticities are lower in the short run than in the long run.

As Wren-Lewis and Driver (1998) point out, differences in income elasticities can, other things being equal, lead to changes in equilibrium RERs. They note, for example, that even if the trend growth rates of GDP in the United States and Japan are the same, U.S. imports will grow more rapidly than Japanese imports because the income elasticity of import demand in the United States is 2.0 compared to 1.2 in Japan. More rapid growth of imports will put pressure on the U.S. equilibrium RER to depreciate over time relative to Japan’s. Similarly, a low-income elasticity will create pressure on a country’s equilibrium RER to appreciate over time relative to its trading partners’. However, it is important to bear in mind that, as discussed elsewhere in Parts II and III of this volume, the income elasticity of import demand is only one of many factors determining intertemporal movements in the equilibrium RER.

Table 7.B.1. Estimated Income Elasticity of Import Demand

<table>
<thead>
<tr>
<th>Study</th>
<th>Average Income Elasticity</th>
<th>Number of Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Industrial Countries</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bayoumi and Faruqee (1998)</td>
<td>1.50</td>
<td>—</td>
</tr>
<tr>
<td>Wren-Lewis and Driver (1998)</td>
<td>1.82</td>
<td>7</td>
</tr>
<tr>
<td>Senhadji (1997)</td>
<td>1.67</td>
<td>19</td>
</tr>
<tr>
<td>Reinhart (1995)</td>
<td>2.05</td>
<td>—</td>
</tr>
<tr>
<td><strong>Developing Countries</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Senhadji (1997)</td>
<td>1.25</td>
<td>48</td>
</tr>
<tr>
<td>Reinhart (1995)</td>
<td>1.22</td>
<td>—</td>
</tr>
</tbody>
</table>

*Source: Studies cited in table.*
Appendix C

Formulas for Exchange Rate Appreciation, Depreciation, and Misalignment in Domestic- and Foreign-Currency Terms

A presentational question involved in measuring exchange rate misalignment empirically is whether to express the required appreciation or depreciation in domestic- or foreign-currency terms. Although each of these may be calculated from the other, the two expressions are not equal and may differ substantially in the case of large misalignments.

Exchange rates may be expressed in either domestic-currency ($E_d$) or foreign-currency terms ($E_f$), where these are the reciprocals of each other, as shown in equation 7.C.1:

\[ E_d = \frac{1}{E_f}. \]

Thus, for example, an exchange rate for the CFA franc in domestic-currency terms of CFA 50 = FF 1.0 is equivalent to an exchange rate in foreign-currency terms of FF 0.02 = CFA 1.0. Similarly, a depreciation from 50 CFA francs per French franc to 75 CFA francs per French franc (or FF 0.0133 = CFA 1) represents a depreciation of 50 percent in domestic-currency terms and 33 percent in foreign-currency terms.

Equations 7.C.2 and 7.C.3 give the formulas for converting a given percentage depreciation ($d_f$) or appreciation ($a_f$) in foreign-currency terms into the corresponding depreciation ($d_d$) or appreciation expressed in domestic-currency terms:

\[ d_d = 1 - \frac{1}{1 + d_f}, \quad \text{and} \quad d_d = 1 - \frac{1}{1 - d_f}. \]
Note that depreciation and appreciation are expressed relative to the actual exchange rate. Hence, an appreciation (depreciation) of \( x \) percent followed by a depreciation (appreciation) of \( x \) percent would not return the exchange rate to its original level. An appreciation of \( X_a \) percent requires a depreciation of \( X_d/(1+X_a) \) to return to the original level of the exchange rate. Similarly, a depreciation of \( X_d \) would require an offsetting appreciation of \( X_a/(1-X_d) \). For example, an appreciation of 20 percent (a movement of the exchange rate index from 100 to 120 in foreign-currency terms, appreciation of 20/100=20 percent) requires a depreciation of 16.7 percent to return to the original level (movement of the index from 120 back to 100, depreciation of 20/120=16.7 percent).

Exchange rate misalignment itself may be expressed relative to the actual or the equilibrium value of the RER. Theoretically, misalignment, \( MA \), is usually expressed as the percentage divergence of the actual rate from its equilibrium value and is calculated as shown in equation 7.C.4:

\[
(7.\text{C}.4) \quad MA = \left( \frac{ARER}{ERER} - 1 \right) \cdot 100
\]

where \( ARER \) is the actual RER and \( ERER \) is the equilibrium RER. Empirically, however, the actual RER is usually known; but the equilibrium RER, the numeraire in the above formulation, is uncertain. Hence, empirically it is often clearer to use the known actual RER as the numeraire and indicate the estimated depreciation or appreciation required, \( RD \), to bring the actual RER to the equilibrium level as shown in equation 7.C.5:

\[
(7.\text{C}.5) \quad RD = \left( \frac{ERER}{ARER} - 1 \right) \cdot 100 .
\]

As explained in the chapters in Part I of this book, different RER measures may diverge because of fluctuations in the terms of trade, differential productivity growth in the traded and nontraded sectors, changes in trade taxes, differences in the behavior of the prices of standardized and differentiated products, parallel markets, and unrecorded trade. Furthermore, as the actual value of the RER may vary with the concept employed, so too may its equilibrium value and the resulting estimate

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60. See, for example, Clark and MacDonald (1998), p. 30.
of misalignment. Hence, it is important that misalignment be calculated using the same measures for both the equilibrium and the actual RERs. Given the relationship between the internal and external RERs set out in Part I, the equilibrium value of either the internal or the external RER should, in principle, also determine the equilibrium value of the other. However, because of the theoretical and empirical limitations of the various methodologies, it is desirable to look separately at the behavior of the internal and external RERs, estimate the misalignment in both of them, and then cross-check the results, utilizing the relationships discussed in Part I of this volume.