The Equilibrium Exchange Rate: Alternative Concepts and Their Applications in IMF Surveillance

Introduction

1. This background document surveys major recent approaches to modeling an equilibrium exchange rate,[1] and reviews how IMF economists applied these approaches in their exchange rate surveillance during 2000–05. Although there are a number of approaches to modeling exchange rate determination, most notably including monetary and portfolio balance models,[2] the focus here is on recent empirical models that are designed to assess the level of exchange rates relative to some equilibrium value. For the purpose of this review, the term *equilibrium exchange rate* is used to refer to the exchange rate that is consistent with a given set of fundamentals over the medium to long term. The concept of equilibrium exchange rate thus presupposes a stable long-term relationship between exchange rates and a set of fundamentals.[3]

2. At the outset, it should be noted that no consensus exists in the literature on the "correct" concept of equilibrium exchange rate and that, depending on which concept is used, estimates of the equilibrium level for a given set of fundamentals can vary widely. One way to make sense out of the divergence of approaches suggested in the literature is to think of each concept as corresponding to a particular policy question one is interested in addressing. No single model is expected to answer all relevant policy questions. In view of this, the Policy Development and Review Department's 2005 Surveillance Guidance Note suggests that IMF staff should apply "a broad range of indicators and other analytical tools" to make "a forthright assessment of the exchange rate level."

Alternative Approaches to Modeling the Equilibrium Exchange Rate

3. Broadly speaking, two classes of empirical exchange rate models have been used in empirical work that relates the equilibrium real exchange rate to a set of economic fundamentals: (1) models that are based on the notion of internal and external balance; and (2) models based on the estimation of a reduced-form equilibrium real exchange rate regression. In what follows, as an example of the first class of models, we review the fundamental equilibrium exchange rate (FEER) model and its close variant, the desired equilibrium exchange rate (DEER) model; and as an example of the second class of models, the behavioral equilibrium exchange rate (BEER) and its close variant, the permanent equilibrium exchange rate (PEER) model. We also review the natural real exchange rate (NATREX) model separately. Although the NATREX is often indistinguishable from the BEER when applied in empirical work, in terms of the selection of explanatory variables, it has a longer-term orientation; it also imposes a particular theoretical structure to interpret the empirical results.

The fundamental equilibrium exchange rate (FEER)

4. The FEER is defined to be the exchange rate that is consistent with both internal and external balance simultaneously (see Williamson, 1994, for details). Internal balance is reached when the economy in question is at the full-employment level of output at stable prices, while external balance is characterized as a balance of payments position sustainable over a medium-term horizon. Because it is difficult to identify the level of potential output, it is often assumed that the adjustment process assures internal balance when external balance is achieved. Then, the FEER is found by a two-step procedure: (1) identifying the components of the current account balance as a function of the real effective exchange rate; and (2) solving for the equilib-

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[1]For a similar review of the literature, see Driver and Westaway (2004).

[2]For a survey of other approaches to exchange rate determination that are not reviewed here, see Frankel and Rose (1995).

[3]Although the ability of economic fundamentals to forecast exchange rates over the short term has proven to be rather poor (see Meese and Rogoff, 1983), recent research points to limited evidence that exchange rates are linked with permanent movements in the fundamentals (Engel and West, 2005; also Mark, 1995).

rium real effective exchange rate by imposing macro-economic balance.

5. As an illustration of the FEER approach, let us decompose the current account (*CA*) into two components: the net trade balance (*ntb*) and returns to net foreign assets (*nfa*), where *ntb* is a function of the real effective exchange rate (q^{REER}) and the outputs of the domestic and foreign economies (y_d and y_f); and *nfa* is also influenced by the real effective exchange rate (because an accumulation of net foreign liabilities would have to be financed). It will be necessary under these assumptions for the currency to depreciate in order to improve the trade balance and the net foreign asset position. Assuming full employment, we have:

$$CA = ntb + nfa = f(q^{REER}, \bar{y}_d, \bar{y}_f), \qquad (1)$$

where $\bar{y}_d$ and $\bar{y}_f$ are the full employment outputs of the respective economies. On the capital flow side, most applications of the FEER assume that the equilibrium capital account over the medium term, denoted as $\overline{KA}$, is exogenously determined (Williamson, 1994; Bayoumi and others, 1994). Then, by imposing external balance ($CA = -\overline{KA}$), we obtain the equilibrium real exchange rate (q^{FEER}) as:

$$q^{FEER} = f(\overline{KA}; \bar{y}_d; \bar{y}_f). \qquad (2)$$

6. Additional factors can easily be accommodated in this framework. For example, the FEER can incorporate the impact of a potential difference in productivity growth between the two economies. This is the well-known Balassa-Samuelson effect. In this case, it becomes similar to the so-called adjusted purchasing-power-parity (PPP) approach (which adjusts the simple PPP approach for changes in the relative price of traded and nontraded goods, commodity terms of trade, or net foreign asset position). The key point is that, unlike the simple PPP approach, the FEER approach allows the equilibrium exchange rate to move as fundamentals change.

An extension of the FEER: the desired equilibrium exchange rate (DEER)

7. As an alternative to external balance, we can consider a current account target set by policymakers as part of overall macroeconomic policy. Then, we have a variant of the FEER called the DEER. The DEER makes explicit the normative nature of the assumptions underlying macroeconomic balance, particularly external balance. As a close variant, the calculation of the DEER methodically follows that of the FEER, except that the estimates of the DEER are driven by the preference of policymakers regarding internal and external balance.

8. Bayoumi and others (1994), for instance, estimated the DEERs of major currencies for 1970, assuming that the targeted current account surplus was equal to 1 percent of GDP.[4] The authors viewed the DEER as consistent with (and necessary for achieving) the "desired" positions of internal and external balance over the medium term, which they claimed was "in the range of four to six years" during which output was expected to return to its potential and changes in competitiveness to be reflected in trade volumes. As in the case of the FEER, different assumptions are used to generate different estimates of the DEER for policy simulation purposes.

The behavioral equilibrium exchange rate (BEER)

9. The BEER approach decomposes the variables that determine the real exchange rate into long-term economic fundamentals (Z_t) and short-term real interest rate differentials. Unlike the FEER approach, it does not consider macroeconomic balance and therefore uses the current values (rather than full employment values) of economic fundamentals in defining the equilibrium real exchange rate. The key elements of the BEER approach are: (1) a set of long-term economic fundamentals (which could include the terms of trade, net foreign assets, relative government debt, productivity, and the like); and (2) uncovered interest rate parity (UIP), which is assumed to determine the short-term (cyclical) behavior of the exchange rate.

10. To see how the model works, let us express UIP as follows:

$$E_t(e_{t+1}) - e_t = i_t - i_t^*, \qquad (3)$$

where $E_t(e_{t+1})$ denotes the expected value formed in period *t* of the nominal exchange rate in period *t*+1; e_t is the nominal exchange rate in period *t*, defined in terms of domestic currency per unit of foreign currency; and i_t and i_t^* refer to the domestic and foreign nominal interest rates, respectively. By subtracting the expected inflation differential from both sides, equation (3) can be rearranged to yield the observed real exchange rate (q_t) as a function of the expected real exchange rate $E_t(q_{t+1})$ and the current real interest rate differential ($T_t - r_t^*$). Assuming that the unobservable expected real exchange rate $E_t(q_{t+1})$ is determined solely by long-run economic fundamentals (Z_t), one can then estimate the BEER (q_t^{BEER}) by making use of its functional relation-

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[4]The authors selected the current account balance equal to 1 percent of GDP as the target because it was the stated objective of the U.S. administration during the Smithsonian discussions leading to a realignment of the central rates for major currencies in 1971.

ship to the vector of the chosen fundamentals and the real interest rate differential:

$$q_t^{BEER} = f(Z_t, r_t - r_t^*). \qquad (4)$$

11. Several studies have applied the BEER approach in recent years, including Clark and MacDonald (1998); Koen and others (2001); Detken and others (2002); and Maeso-Fernandez, Osbat, and Schnatz (2002). Clark and MacDonald (1998), for example, used three variables as long-run economic fundamentals (Z_t): the terms of trade, the relative price of nontraded to traded goods (which captures the Balassa-Samuelson effect), and the balance of net foreign assets. These authors, however, modified UIP by adding a risk premium, which they assumed to be time-varying depending on the ratio of domestic to foreign government debt. Because the BEER uses the current values of economic fundamentals (without making a distinction between short-term and long-term equilibrium values), any identified exchange rate misalignment is often referred to as the *current* misalignment.

An extension of the BEER: the permanent equilibrium exchange rate (PEER)

12. A major weakness of the BEER is that it does not distinguish between the long-term and short-term values of economic fundamentals. An extension of the BEER that is based on the consideration of the long-run "sustainable" levels of economic fundamentals is called the PEER. Decomposing the real exchange rate into temporary and permanent components is a critical step in the PEER approach. The techniques introduced by Beveridge and Nelson (1981), Clarida and Gali (1994), Stock and Watson (1988), and Gonzalo and Granger (1995) are some of the tools that are frequently used in the PEER approach to make the decomposition. Under the PEER approach, the difference between the current real exchange rate and the estimated equilibrium real exchange rate is referred to as the *total* misalignment.

13. Comparing the BEER and the PEER in the context of estimating the real equilibrium effective exchange rate of the euro[5] for 1975–98, Maeso-Fernandez, Osbat, and Schnatz (2002) found that the PEER was smoother and less volatile than the BEER. Both the BEER and PEER approaches indicated that the euro was close to the equilibrium value in the 1970s and during the first half of the 1990s, but that it was undervalued in the first half of the 1980s. In contrast, Clark and MacDonald (2000), in estimating the equilibrium real effective exchange rates of the U.S. dollar, the Canadian dollar,

and the U.K. pound, observed that the BEER and the PEER moved closely, implying that the temporary component was very small. These examples suggest that the BEER and PEER deviate from each other substantially only when economic fundamentals display considerable short-term variability.

The natural real exchange rate (NATREX)

14. The NATREX is defined as the exchange rate that would prevail if speculative and cyclical factors were removed while unemployment was at its natural rate (Stein, 1994; Allen, 1995). As a distinguishing feature, the NATREX approach explicitly considers exchange rate dynamics. In particular, it postulates that the real exchange rate, observed at time t, consists of the following three components:

$$q_t(k_t, F_t, \varepsilon_t : Z_t) = \{(q_t(k_t, F_t, \varepsilon_t : Z_t) - q(k_t, F_t : Z_t))\} \\ + \{q(k_t, F_t : Z_t) - q^*(Z_t)\} + \{q^*(Z_t)\}, \quad (5)$$

where k is the stock of capital, F is the stock of external debt, ε is a random error (which is assumed to capture speculative forces), and Z is a vector of fundamentals. The first term on the right-hand side represents the deviation of the current (short-term) exchange rate from the medium-term value; the second term denotes the deviation of the medium-term real exchange rate from the long-term equilibrium value; the last term is the long-term equilibrium exchange rate that is determined solely by economic fundamentals, which are defined as productivity and time preference (or "social thrift") at home and abroad.

15. The NATREX corresponds to the medium-term real exchange rate, given by $q = q(k_t, F_t : Z_t)$. Unlike the short-term rate, it is independent of speculative factors; it is, however, specific to the given stocks of capital and debt. In contrast, the long-term real exchange rate is represented by $q^* = q^*(Z_t)$. This is the rate that materializes when the stock of capital and the stock of debt converge to their steady-state values consistent with the prevailing economic fundamentals. The fundamentals are the only exogenous variables in the long run.[6] The fundamentals, however, may not be stationary. They can also change, thus affecting not only the levels of desired investment, saving, and the current account, but also the trajectory of the NATREX by bringing about changes in capital formation, the rate of debt accumulation, and the interest rate.

16. In considering the determination of the medium-term real exchange rate, the NATREX approach pays particular attention to investment, saving, long-term

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[5]The "synthetic" euro was computed as a geometric weighted average of the EMU currencies.

[6]In a large economy, the only exogenous variables are shocks to productivity and time preference. In a small economy, however, there are additional exogenous variables, including the terms of trade and the world interest rate.

capital flows, and the resulting changes in the stocks of real physical capital, wealth, and net debt to foreigners. In the hypothetical medium run, it is assumed that prices have adjusted, output has returned to its potential level, and desired national investment equals desired national saving, which depends on the stocks of capital, wealth, and debt. To the extent that these stocks change, the NATREX is a moving equilibrium. The architects of this approach claim that the NATREX is "an artificial construct" toward which the actual exchange rate tends to adjust. It is not observable, and it "never actually prevails" (Allen, 1995).

17. The empirical application of the NATREX approach is much simpler than the theory implies and, as stated earlier, is often indistinguishable from the BEER approach. The NATREX is estimated by identifying a long-run cointegrating relationship between the real exchange rate and a set of fundamentals (usually productivity and time preference), for which appropriate proxies are selected; an error correction term is included to capture the trajectory of the real exchange rate toward the NATREX. In actual estimation, no distinction is made between the medium run and the long run, because the fundamentals never obtain their steady-state values. The theory is then used to explain why the real exchange rate has moved in a certain way and to predict how it might yet change over time. For example, a medium-term appreciation of the real exchange rate might be consistent with a rise in government expenditure, which raises aggregate demand and worsens the current account position. The theory then suggests that a *depreciation* of the real exchange rate is needed to stabilize the balance of net foreign assets in the longer run.

Comparing Alternative Concepts of Equilibrium Exchange Rate

18. The major advantage of these equilibrium exchange rate models over the simple PPP framework is that they all relax the assumption of static equilibrium and allow the equilibrium exchange rate to change as economic fundamentals change. These frameworks have provided policymakers with a tool to assess the level of exchange rates in terms of specific policy objectives—such as internal or external balance. Each has its strengths and possible weaknesses.

19. A key policy question the FEER approach is designed to address concerns how much the domestic currency is misaligned relative to its medium-term equilibrium value consistent with external balance (e.g., Akram (2003) for the Norwegian krone). The FEER can also be calibrated to work under an explicitly multilateral setting. Coudert and Couharde (2005), for example, have investigated the possible misalignment of the Chinese renminbi and how its correction might impact the U.S. current account deficit.

20. The FEER approach, however, has some limitations. First, it does not specify how the exchange rate moves from the current level to the long-term equilibrium rate. In this context, Bayoumi and others (1994) and MacDonald (2000) noted the possibility that different equilibrium values might correspond to different dynamic adjustment paths, such that there is a "hysteresis" effect in the real exchange rate. For example, depreciation could improve the current account balance and net foreign asset position of a country in the short run but, given the country's medium-term capital accumulation, could imply a subsequent appreciation. Such exchange rate behavior may be dictated entirely by hysteresis and may not have much to do with the fundamentals specified by the FEER approach.

21. Second, another limitation of the FEER approach comes from its focus on the long run. Because the FEER approach removes speculative capital flows from the medium-term capital account, it is difficult to account for the impact of short-run changes in the interest parity condition on the dynamic path of adjustment toward the FEER. By its very nature, the FEER approach assumes that the interest rate remains at the long-run equilibrium level, implying severe restrictions on how monetary policy can be modeled.[7]

22. Finally, the long-run estimates are critically sensitive to how the trade elasticities are estimated (MacDonald, 2000; and Driver and Wren-Lewis, 1999). It is well known that most empirical studies estimate the trade elasticities to be very low (Goldstein and Khan, 1985), but use of such an elasticity estimate may in practice lead to an inaccurate projection of the FEER trajectory. The vulnerability of long-run estimates to trade elasticity estimates, however, is not specific to the FEER but is common to all empirical exchange rate models that are based on the notion of macroeconomic (or external) balance.

23. Unlike the FEER, the BEER (or PEER) and the NATREX take account of the impact of exchange rate changes over the adjustment path. The BEER attempts to capture the sources of changes in the capital account that may also affect the current account and the "behavior" of the exchange rate itself. This may be especially important for countries that are experiencing substantial variation in short-term fundamentals (for relatively stable economies operating in the neighborhood of internal and external balance, the BEER would converge toward the FEER). For this reason, policymakers in several developing countries have used the BEER to assess the appropriateness of

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[7]It is a complex task to make distinction between the structural and speculative components of capital flows. Standard approaches have relied on alternative econometric techniques to decompose a time-series variable into a temporary (or speculative) and permanent components.

exchange rate levels. In considering the cases of Estonia and Botswana, for example, the BEER methodology allowed Hinnosaar, Kaadu, and Uusküla (2005), and Iimi (2006), respectively, to analyze the dynamics of exchange rate behavior.

24. At the same time, the BEER approach relies critically on the assumption that the stable long-run relationship can be derived from historical data. This makes use of the BEER approach difficult for countries that have undergone substantial structural change or for which longer-term data are not available. The sensitivity of estimates to the choice of data is a common problem for all empirical equilibrium exchange rate models, but this problem may be more serious for the BEER approach because it is an entirely empirical model in which no structure (such as long-run macroeconomic balance) is imposed. As a result, in the presence of sustained misalignment, time-series techniques may yield misleading results. One possible way to get around this problem is to estimate equilibrium relationships within a cross-country panel framework, so as to incorporate a wider range of country experiences (though at the risk of making country-specific inferences more difficult). As another drawback, no theory guides the choice of fundamental variables in the BEER approach.

25. When a longer time horizon is involved, the question of dynamic exchange rate adjustment may be best addressed by the NATREX approach. As explained in the previous section, the NATREX model allows us to consider the determination of the real exchange rate in terms of short-term, medium-term, and long-term factors. The NATREX converges to a static long-term rate only when there are no changes in the stocks of capital and debt. It is for this reason that a number of recent studies have applied the NATREX approach to analyze the long-term implications of monetary and exchange rate policies in the context of crisis vulnerability in Asia or economic integration in Europe (e.g., see Rajan and Siregar (2002) for an analysis of the pre- and post-crisis misalignments of the Hong Kong dollar and the Singapore dollar;[8] and Stein (2002) on the impact of EU expansion on the equilibrium real exchange rate).[9]

26. While these equilibrium exchange rate models have been used to address a number of policy ques-

tions, none claims to be perfect. Given the particular orientation of each approach, it has increasingly become standard practice in the literature to use multiple methods and to interpret each result carefully by taking into consideration the structures and assumptions of each model as well as the country-specific circumstances. Those recent studies that have applied multiple approaches include Husted and MacDonald (1998 and 1999); Rajan and Siregar (2002); Rajan, Sen, and Siregar (2004); Lim (2000 and 2002); and Montiel (1997). These studies have used different combinations of the BEER, PEER, NATREX, and other methods to assess the misalignment of currencies against the U.S. dollar, the euro, or the yen.

The IMF's Approach to Exchange Rate Assessment: The CGER

27. In 1995, the Consultative Group on Exchange Rate Issues (CGER), an interdepartmental working group, was established within the IMF to strengthen its capacity to assess the current account positions and exchange rate levels of major countries.[10] Extending the notion of macroeconomic balance, the CGER approach added global consistency in an explicitly multilateral framework. More recently, the CGER added another pillar of exchange rate assessment, namely, a cross-country application of a reduced-form exchange rate equation, called the adjusted PPP approach.[11] Although this is similar to an application of the BEER model, the rest of this discussion continues to call it the adjusted PPP approach (in line with IMF terminology) in order to emphasize its multilateral orientation designed to ensure global consistency.[12] Although the CGER exercise is being extended to include a number of emerging market economies with updated methodologies,[13] this section discusses the CGER framework (and its estimates) as used during 2000–05.

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[8]Rajan and Siregar (2002) argue that the exchange rate regimes of Hong Kong SAR and Singapore performed equally well in the precrisis period but Singapore's more flexible exchange rate policy performed better than Hong Kong SAR's currency board in the postcrisis period. See Rajan, Sen, and Siregar (2004) for a similar analysis of Thailand.

[9]Other studies estimated the trajectory of the exchange rate from the medium-term to long-term equilibrium position in selected European countries (e.g., Crouhy-Veyrac and Saint Marc, 1995; Detken and Marin-Martinez, 2001; Federici and Gandolfo, 2002; and Detken and others, 2002).

[10]The original name was *Coordinating* Group on Exchange Rate Issues.

[11]Prior to 2003, the adjusted PPP approach used the deviations of real multilateral exchange rates from trend to estimate an equilibrium exchange rate. The approach now allows productivity differentials, net foreign assets, terms of trade changes, and the like. Although this is called the reduced-form equilibrium real exchange rate approach, we refer to it here as the adjusted PPP approach without distinguishing between the pre-2003 and post-2003 methodologies.
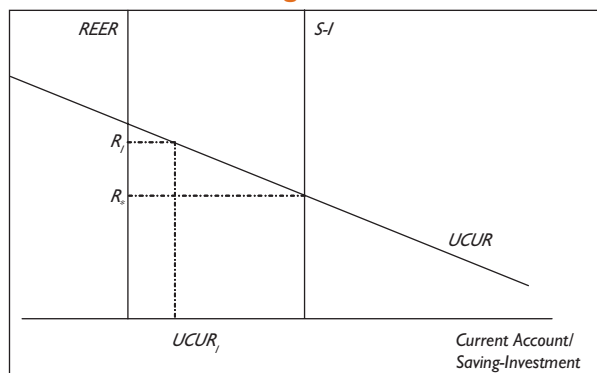
[12]The adjusted PPP approach has also been applied to single countries. In such cases, unlike most applications of the BEER approach, but similar to the CGER version, it uses the actual (as opposed to long-run) values of the explanatory variables, which generally do not go beyond the terms of trade, relative productivity, and net foreign assets.

[13]The extended CGER exercise consists of three complementary approaches: (1) macroeconomic balance; (2) equilibrium real exchange rate (or adjusted PPP); and (3) external sustainability. For details, see "Methodology for CGER Exchange Rate Assessments," SM/06/283, August 2006.

Figure A3.1. The Underlying Current Account Position and the Saving-Investment Balance

Source: Isard and others (2001).

The CGER framework

28. As one of the two pillars of the CGER exercise, the macroeconomic balance approach is based on the concept of equilibrium that is similar to that of the FEER, that is, the achievement of internal and external balance.[14] Internal balance means full employment with stable prices, while the notion of external balance relates to the link between the current account and the saving-investment balance, as follows:

$$S - I = CA = X - M. \qquad (6)$$

The key objective of the CGER macroeconomic balance model is to assess whether the outlook for the underlying current account ($UCUR$) position, captured by the net trade balance ($X-M$) at the prevailing exchange rate, is consistent with the "normal" or equilibrium saving-investment balance ($S-I$). If the current account position corresponds to the equilibrium saving-investment balance, the prevailing exchange rate is the "medium-term" equilibrium exchange rate. Otherwise, there is a possible misalignment of the currency.

29. This CGER framework can be depicted in a simple diagram (Figure A3.1). The $UCUR$ line slopes downward, indicating that the current account position improves when the domestic currency depreciates (captured by a lower real effective exchange rate level). The slope of $UCUR$ also reflects the degree of economic openness. Countries with a high ratio of exports and imports to GDP should have a relatively flat $UCUR$ line, indicating that a small percentage change in the real effective exchange rate can bring about a large change in the underlying current account position.

30. The medium-term saving-investment balance (S-I), on the other hand, is not a direct function of the real effective exchange rate. If the economy is at R_1, the underlying current account position is less than the saving-investment balance position. The real effective exchange rate then must depreciate to R^* in order to improve the current account position to the medium-term equilibrium level. In other words, given the current economic fundamentals, the prevailing real effective exchange rate is overvalued, and is expected to depreciate to R^*. In addition, driven by shocks to their fundamental variables, both the $UCUR$ line and the S-I line may shift to the right or the left.

The CGER estimation

31. Four steps are involved in calculating the medium-term misalignment of a currency. The first step is to estimate the *underlying* current account ($UCUR$) position that would emerge at the prevailing exchange rate if all countries were producing at their potential output levels and the lagged effects of past exchange rate changes had been fully realized. Here, we focus on the right-hand side of equation (6).

32. As an estimate of $UCUR$, the CGER uses forecasts obtained from the *World Economic Outlook* (*WEO*) exercise. For most countries, the *WEO* forecasts the underlying current account balances by assuming that the real exchange rate will remain unchanged and that the economy will be operating at potential output at the end of the five-year *WEO* horizon. The primary advantage of the *WEO* approach is that it incorporates the country-specific knowledge and judgments of the IMF's area department staff.

33. Once the underlying current account is obtained, the second step involves generating the "medium-term" equilibrium saving-investment balance or "norm." Two alternative estimating approaches are used. First, the saving-investment balance is regressed against a set of commonly considered fundamental determinants over a number of years. The fundamental determinants for industrial countries include fiscal balance, income per capita, output gap, and a demographic factor. For the developing economies, a more extensive set of fundamental variables is considered (see Chinn and Prasad, 2003). The estimated regression coefficients would yield the average medium-term equilibrium saving-investment balance. Second, as an alternative method, the "norm" saving-investment balance is obtained by estimating the current account balance required to maintain a constant ratio of net foreign liabilities to GDP.

34. The third step is to calculate how much the exchange rate would have to change, other things remaining unchanged, in order to equilibrate the underlying current account to the medium-term equilibrium

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[14]In highlighting the key features of the CGER macroeconomic balance approach, we rely on Isard and Faruqee (1998) and Isard and others (2001).

saving-investment balance. Incorporating the coefficient estimates from the first two steps, a globally consistent framework is used to calculate the required changes in the multilateral or bilateral exchange rate.

35. The last step involves comparing the results with those from the adjusted PPP approach which has also been applied multilaterally by using panel data. The staff then use subjective judgment to assess whether or not the currency is misaligned and the extent of misalignment when identified. Considerable uncertainty surrounds the estimates of the CGER or any other equilibrium exchange rate models. If there is a large discrepancy between the results obtained from the competing approaches, a range of values is provided for the potential deviation of the currency from the equilibrium level.

Features of the CGER approach

36. Undoubtedly, the single most important advantage of the CGER approach over other equilibrium exchange rate models in the literature is its explicitly multilateral character, which imposes global consistency. At the same time, the multilateral orientation comes with a cost, because it becomes more difficult to understand how a particular result is being generated. There is considerable uncertainty about the estimates generated from any equilibrium exchange rate model. But given the additional multilateral layer, uncertainty is likely greater in the CGER approach.

37. Some limitations of the CGER exercise are well known (Isard and others, 2001). First, the CGER exercise, unlike the NATREX model, is not explicit about the dynamics of exchange rate adjustment from the current value to the longer-term equilibrium. Second, the CGER exercise, given its global orientation, does not consider country-specific factors. The limitations are true of both the macroeconomic balance approach and the adjusted PPP approach, both of which rely on the cross-country estimates generated from panel data regression (which render the estimated relationship an average relationship across countries).[15]

38. Third, the CGER's macroeconomic balance model assumes that countries have unlimited access to international capital markets at a constant premium over the world interest rate, which may become a particularly serious problem in estimating a medium- to long-term equilibrium exchange rate for an emerging market economy. Fourth, the assumption that the "norm" saving-investment balance is independent of the current exchange rate is also restrictive, especially

for emerging market economies.[16] Fifth, the underlying model assumes that, for the purpose of estimating the size of possible misalignment, the real exchange rate is the only mechanism to bring about current account adjustment. This may create upward bias in the required real exchange rate change because other variables are likely to change in practice to facilitate the adjustment.

39. Isard and others (2001) noted that, as is typically the case with most applications of the FEER-type model, the estimates of the macroeconomic balance model are quite sensitive to small changes in the assumptions. This means that there is considerable uncertainty about the confidence with which one can assess the degree of misalignment of a currency. As the architects of this approach suggest, one would need to exercise judgment in coming to a particular assessment. This is true of all equilibrium exchange rate models, but the sensitivity associated with the CGER's macroeconomic model calls for caution, a point being addressed in part by the complementary use of two alternative methodologies by the exercise.

40. Given not only the limited sample size but also the nature of the exercise, it is not possible to conduct rigorous statistical tests of the CGER estimates.[17] The available evidence, however, suggests that the application of the CGER approach has sometimes yielded a widely divergent set of estimates. A look at the time-series of selected CGER results indicates that the range of estimates for a given currency for a given year can be large in terms of deviation from the equilibrium value, and that the range has increased sharply from around 2004 for most currencies (see Figure A3.2 for examples).[18] Moreover, it has occasionally been observed that the two methodologies can indicate misalignment in two opposite directions (e.g., one showing undervaluation, while the other indicating overvaluation) and that the CGER estimates

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[15]Use of common parameter estimates conceals the heterogeneity of different countries, which may be important in constructing the estimates of bilateral exchange rates.

[16]The cost of capital is highly influenced by expectations about the medium-term exchange rate, which in turn is also influenced by the current exchange rate.

[17]First, the CGER estimates are only available from 1997 for the United States and Japan and from 2000 for other industrial countries. Second, because the estimates have no explicit time dimension, there is no reasonable basis for comparing them with realized future values. In other words, it would not be possible to say whether a particular CGER estimate was right or wrong in the sense of predicting the actual future exchange rate, even if much longer time-series data were available.

[18]The limits indicated by a bar in the figure correspond to the estimates given by the macroeconomic balance and adjusted PPP approaches. The final CGER assessment, as stated by the Research Department, is indicated by (right and left) ticks in the figure, which are always within the overall limits. When the final judgment involves a point estimate (such as "around 10 percent") rather than a range, it is assumed that the implicit range is 5 percent (e.g., "between 7 percent and 12 percent"), subject to the restriction that an end of the range cannot exceed the overall limit.

Figure A3.2. Examples of CGER Estimates, 2000–06
(In terms of percentage deviation from medium-term equilibrium levels)
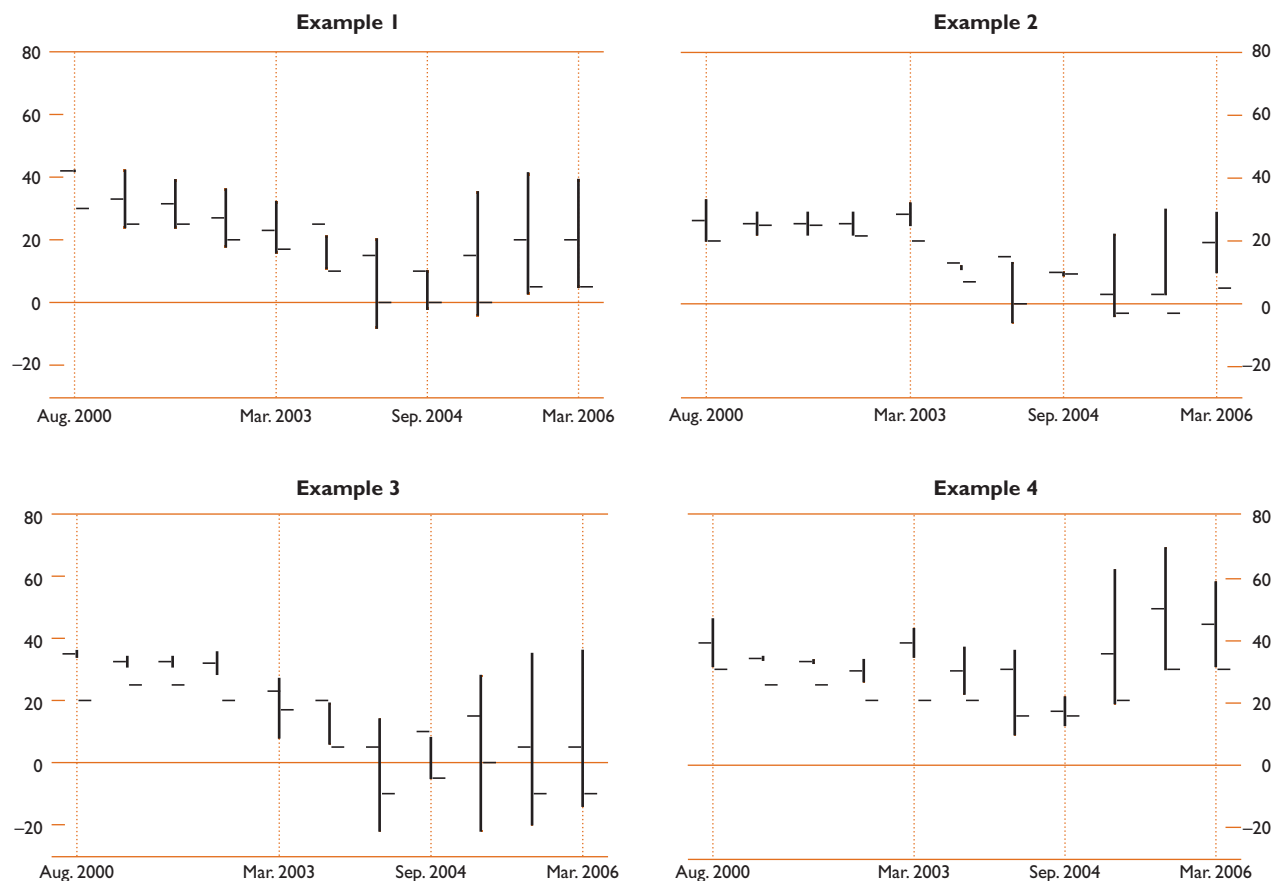
Note: The limits indicated by a vertical bar correspond to the CGER estimates produced by the two approaches for each year. Each bar has (left and right) ticks that correspond to the final CGER assessment.

even missed the direction of prospective exchange rate movements altogether.

41. The fact that the sets of CGER estimates have sometimes been widely divergent from each other (or even missed the prospective currency movement) does not by itself render them useless. After all, it is well known that exchange rates can deviate substantially from their long-term fundamental values in the short run. The CGER is not a forecasting exercise and does not claim to trace the short-term currency movements. Even so, these factors may explain the skepticism that exists among some IMF staff[19] and the (appropriate) judiciousness with which area department economists have applied the CGER estimates in their country work.

Equilibrium Models in IMF Surveillance: A Review of Country Reports, 2000–05

Exchange rate level assessments

42. The IEO's review of the two most recent Article IV consultation reports for all members through 2005,[20] supplemented by a screening of the remaining staff reports and accompanying selected issues papers for the period 2000–05,[21] indicates REER indices have been the main tool of exchange rate level assessment in IMF surveillance: REER charts were included in all Article IV reports reviewed and, in most cases, there was at least a brief commentary on the movements of

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[19]According to the IEO survey of IMF staff, about 30 percent of those who have worked on CGER-covered countries responded that they viewed the exercise as of little usefulness (though 40 percent considered it useful). For details, see Background Document 6 (Figure A6.26).

[20]See Background Document 4 for details.
[21]The cut-off date for staff documents was December 31, 2005. In the case of program countries, the relevant program documents were also reviewed.

Table A3.1. Use of Multiple Methods in the Assessment of Exchange Rate Levels by the IMF, 2000–05

| Year	Number of Methods			Number of Countries
	1	2	3	
2000	14	0	0	14
2001	15	2	0	17
2002	21	2	0	23
2003	12	6	0	18
2004	22	3	1	26
2005	16	7	2	25

Note: Based on staff papers and related documents *issued* between January 2000 and December 2005. The coverage thus differs slightly from the review of country documents presented in Background Document 4. See Annex A3.1 for details.

the REERs. Going beyond the REER charts, IMF staff provided additional exchange rate level analysis for up to 14 percent of the Fund membership in any given year since 2000 (see Table A3.1 and Figure A3.3). The documents covering the remaining countries did not explicitly use quantitative approaches to estimate the equilibrium exchange rate. A few of the documents, however, cited the findings of separate analyses, including the IMF's own working papers, central bank studies, and periodic reports of investment banks, in making exchange rate level assessments.[22]

43. Besides the ubiquitous REER charts, the most commonly applied tools were the simple PPP approach and the adjusted (or augmented) PPP approach; the latter was usually used as part of a CGER exercise. The estimates from the CGER approach were frequently reported, particularly in most discussions of the currencies of industrial countries, but also increasingly in the case of some emerging and developing countries. Among the equilibrium exchange rate models that were reviewed in the section "Alternative Approaches to Modeling the Equilibrium Exchange Rate" above, the BEER and its variants appear to be the most frequently employed by the IMF staff, particularly for the currencies of emerging market economies. A test of long-run cointegration between the real effective exchange rate and a selected set of fundamentals is usually carried out to estimate the equilibrium exchange rate and the degree of misalignment. In some cases, an error correction term is added to explain the short-term deviation of the exchange rate from its equilibrium value.

44. For example, IMF staff used a BEER model to assess the level of the Tanzania shilling in 2002 (supplemented by the PPP approach) as well as in 2004. The staff specified the BEER as a function of the terms of trade, productivity, government consumption, trade openness, and foreign capital flows and concluded that the shilling,

slightly overvalued at end-2001, gradually moved toward equilibrium and, by 2003, was broadly in line with the equilibrium level. For Madagascar in 2005, IMF staff used both FEER and BEER models. The staff specified the long-run FEER in terms of three fundamentals: productivity, net wealth, and the terms of trade, and considered that shocks to these fundamentals and the stance of monetary and fiscal policies determined the deviation of the actual real exchange rate from the FEER. In this framework, the BEER was estimated as the sum of the FEER and the deviation explained by the nonfundamental variables. Based on data for 1980–2003, the staff concluded that, at the end of 2004, the real effective exchange rate of the Malagasy franc was below both the FEER (by about 20 percent) and the BEER (by about 27 percent). For Hungary in 2004, the staff specified the equilibrium real exchange rate as a function of net

Figure A3.3. Methodologies Used in the IMF's Exchange Rate Level Assessment, 2000–05
(Total number)
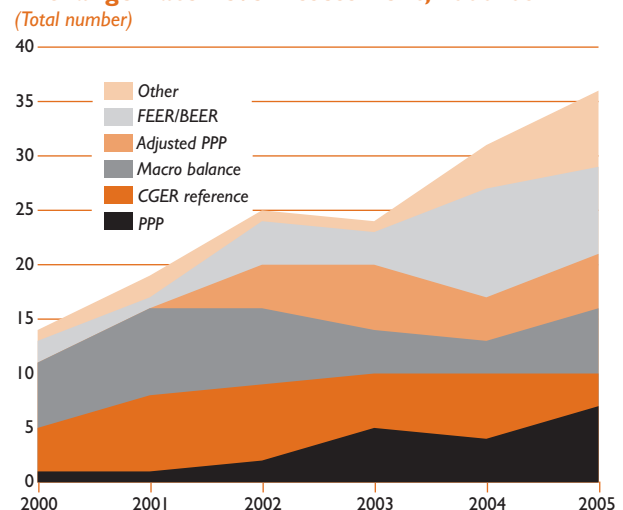
Note: See Annex A3.1 for details.

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[22]Examples include the 2005 Article IV consultations for Singapore and the Czech Republic.

foreign assets and industrial sector productivity,[23] and used this model to conclude that the Hungarian forint, undervalued in the second half of the 1990s, became overvalued in the early 2000s but returned to its equilibrium level in late 2003.[24]

45. Figure A3.3 indicates that, regardless of which methodology was used, use of quantitative models in the IMF's exchange rate surveillance has increased over the period. The increasing sophistication of exchange rate level assessments by the IMF staff has largely reflected the greater use of the PPP or adjusted PPP approach and the FEER/BEER methodologies. On the other hand, there has been little change in the frequency of references to CGER estimates or use of macroeconomic balance approaches (other than the FEER).[25] A closer look indicates that the use of multiple methods has increased somewhat over the years, though it remains rather limited in absolute terms (see Table A3.1).

The characteristics of the IMF's exchange rate level assessment

46. The IMF's country documents reviewed here differ widely in their quality, rigor, and comprehensiveness of analysis. In most cases, the IMF's exchange rate level assessment primarily attempts to identify evidence of improvement or deterioration in competitiveness on the basis of consumer-price-index-based REERs or, in a few cases, other REER indices (such as those adjusted for relative normalized unit labor costs). In a subset of these cases, the staff also attempt to establish how much, if any, the currency concerned is misaligned. In general, assessment is made in terms of a trade-weighted effective exchange rate. Only in rare cases is the level assessed in terms of a bilateral exchange rate against the U.S. dollar, the euro, or some other major currency.[26] With some notable exceptions,[27] country documents generally do not explain the causes of the misalignment when identified.

47. IMF staff, in using equilibrium exchange rate models, has selected a wide range of long-term economic fundamentals to determine the equilibrium exchange rate, often reflecting its understanding of the country-specific conditions. Among others, the following three factors have most frequently been selected in the construction of equilibrium exchange rate models.

- The Balassa-Samuelson effect, which has been found relevant in explaining exchange rate behavior in emerging market economies that are growing faster than their main trading partners.[28] Reliable data, however, are often not available.

- The terms of trade, which are often associated with supply-side shocks. A rise in the world prices for key export commodities, for example, has been found to improve the terms of trade and in turn appreciate the currency.[29]

- The role of wealth or access to international capital markets. Such factors have been found to influence the exchange rate, particularly in a highly indebted developing country.

In addition, the staff has selected such short-term factors as cyclical measures of monetary and fiscal policy and changes in net international reserves. Exchange rate regime and trade openness have extensively been considered as structural determinants.

48. When estimates from CGER or other macroeconomic balance applications are reported, the accompanying analysis tends to share the following characteristics:

(1) There is only a limited discussion of fundamental factors or specific policy issues.

(2) There is a trade-off between achieving global consistency and accounting for country-specific economic conditions.[30] For such countries as Canada, New Zealand, and Norway, the staff noted that failure to take account of key com-

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[23]Although the staff argued that the first variable is associated with "external equilibrium" (and the second with "internal equilibrium"), the model does not define the equilibrium exchange rate in terms of a sustainable balance of payments position. For this reason, we consider this specification to be a BEER/PEER model broadly defined, and not a FEER model. This judgment is reflected in Figure A3.3.

[24]In contrast, in 2005, the staff applied an entirely different approach (that does not fall under any of the equilibrium exchange rate models considered in the section "Alternative Approaches to Modeling the Equilibrium Exchange Rate") to the Slovak Republic, another transition economy in similar circumstances. Focusing on the role of productivity in real exchange rate determination, the staff concluded that, though the koruna's equilibrium rate would be expected to appreciate by about 3 percent a year (in line with expected productivity growth relative to the euro area), this could be mitigated somewhat by fiscal consolidation.

[25]It is often the case that staff, in reporting its estimates of equilibrium exchange rates, did not explicitly spell out the specification of the underlying models. When the staff refer real to the macroeconomic balance identity ($S - I = CA$)—equation (6) in the text—but without specifying a FEER-like framework, the underlying model was considered as a macroeconomic balance approach.

[26]For example, such assessment was made for the Eastern Caribbean Currency Union, the Gulf Cooperation Council, and the euro area.

[27]Such country cases include Argentina, Malaysia, Russia, and South Africa.

[28]In the case of industrial countries, the Balassa-Samuelson effect may not be as relevant. In the selected issues paper for the 2001 Article IV consultation with the United Kingdom, for example, staff found another relative productivity term (manufacturing productivity vis-à-vis trading partners) to be a significant determinant of the real exchange rate.

[29]Notably, staff have considered the impact of oil prices on Yemen and Russia, and the impact of other commodity prices on Argentina and Kenya.

[30]See, for example, the staff reports for the Article IV consultations with Canada, Indonesia, Mexico, New Zealand, and Switzerland.

modity price developments was a weakness of the CGER exercise.[31] For Mexico, the staff noted that the macroeconomic balance approach failed to take into account the impact of several structural reforms.

(3) Estimates are sensitive to key parameters, including trade elasticities and the saving-investment norm.[32] The documents for China and Egypt, for instance, show that the results from the macroeconomic balance approach critically depend on which methodology is used to estimate the medium-term saving-investment balance.[33]

49. Often the discussion of misalignment is disconnected from the empirical analysis presented in the same document. For example, the fundamental determinants used to estimate the equilibrium exchange rate may not form part of the discussion on misalignment. Several factors seem to contribute to this outcome:

- The exchange rate assessment is focused on identifying the degree of any misalignment.

- Data limitations and the resulting lack of confidence in the estimates obtained mean that any identified misalignment is therefore subject to considerable uncertainty.

- As noted before, the choice of some models (such as the CGER methodology) is not amenable to country-specific policy analysis.

As a result, the reported estimates serve only as a point of reference for policy discussions.

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[31]This may explain why only one reference to the CGER estimate is found in the staff reports for Article IV consultations with Norway over the sample period (in 2005).

[32]See, for example, the staff reports and selected issues papers for Article IV consultations with Brazil, China, Egypt, and Indonesia.

[33]In the case of China, for example, if the medium-term equilibrium saving-investment balance was estimated in terms of structural macroeconomic balance relationships (Chinn and Prasad, 2003), depreciation was found necessary to run a larger current account surplus. In contrast, if the equilibrium saving-investment balance was chosen so as to maintain the ratio of net foreign liabilities to GDP constant, appreciation of the currency was found necessary to reduce the current account surplus.

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Annex A3.1

Methodologies Used in IMF Exchange Rate Level Assessment, 2000–05

	Reference to CGER Estimates	Adjusted PPP	PPP	FEER	Other Macro Balance	BEER	Other Approaches	Reference to External Studies
Algeria		2004						
Australia	2000, 2003, 2004	2002			2005		2001	2002
Bangladesh			2001					
Benin						2004		
Brazil		2003			2003			
Bulgaria			2000, 2003					
Canada	2001, 2002	2004						2003
CEMAC			2005			2005		
China		2003–2005			2003–2005		2004	2005
Congo, Republic of			2002					
Costa Rica						2004		
Cyprus			2005		2000			2005
Czech Republic							2005x2	2004
Denmark	2002							
Dominican Republic		2003						
ECCU						2004		
Egypt		2002			2002			2002
Estonia			2003			2003		2004
Euro area	2000, 2001, 2003, 2004				2002			
Germany			2004	2004	2002			
Greece		2003			2003			
Guinea						2005		
Hong Kong SAR	2004							
Hungary					2003	2004		
Iceland					2001			
India					2000, 2001			
Indonesia					2001, 2002	2005		
Japan	2000, 2002–05							
Kazakhstan		2005						
Kenya						2004		
Korea					2001, 2002			
Latvia			2003, 2004			2003		2004
Lithuania			2003			2003		
Madagascar				2005	2002, 2005			
Malawi						2002		
Malaysia		2005			2000, 2001, 2005		2001, 2003, 2004	
Mali						2005		
Malta								2005
Mauritius					2005			
Mexico					2001			2002
Moldova			2005				2005x2	
Morocco			2005		2000		2005	
Mozambique						2000		
New Zealand	2001–2003				2005			2001
Norway	2005		2005					
Pakistan			2005					
Paraguay						2004		
Romania		2002						
Russia	2003	2005		2001				
São Tomé and Príncipe						2000		
Singapore				2000, 2001			2005	
Slovak Republic						2005		
South Africa					2002, 2005			
Spain	2001							

Annex A3.1 *(concluded)*

	Reference to CGER Estimates	Adjusted PPP	PPP	FEER	Other Macro Balance	BEER	Other Approaches	Reference to External Studies
Sri Lanka					2002			
Sweden		2004			2004			2003
Switzerland		2005		2004, 2005	2005			
Tanzania			2002			2002, 2004		
Thailand	2002							
Tonga					2000			
Tunisia		2002						
Turkey					2004		2002	2002
Uganda						2004		
Ukraine			2004				2004	2004
United Kingdom	2000–02, 2004–05					2001		2000, 2002
United States	2000, 2001–04		2003					
Uruguay		2005						
Venezuela, República Bolivariana de					2002			
Vietnam		2003						
WAEMU		2004						
Zambia							2004	
Zimbabwe						2000	2005	

Note: Based on IEO judgments (the cut-off date for the screening of staff documents was December 31, 2005); in some cases the IEO classification differs from that used by IMF area department staff.