IMF Working Paper

External Adjustment and Equilibrium
Exchange Rate in Brazil

Claudio Paiva

WP/06/221

IMF Working Paper

IMF Institute

External Adjustment and Equilibrium Exchange Rate in Brazil

Prepared by Claudio Paiva[1]

Authorized for distribution by Enrica Detragiache

October 2006

Abstract

This paper investigates the factors behind the significant improvement in Brazil's external accounts and wide fluctuations of the real exchange rate since the floating of the *real* in 1999. Particular attention is devoted to the strong appreciation of the *real* from 2003–05. Econometric estimates of of behavioral equilibrium exchange rate (BEER) model for Brazil show that most of this appreciation was an equilibrium response to improved economic fundamentals.

Contents   Page

I. INTRODUCTION

The Brazilian *real* (BRL) appreciated by approximately 40 percent in real effective terms between January 2003 and December 2005, reaching its strongest valuation since the collapse of the exchange rate peg in 1999 (Figure 1). At the same time, Brazil also experienced a significant improvement in its external accounts, with a surge in exports leading the way to record trade surpluses in recent years. From a saving-investment perspective, the external adjustment and current account surpluses registered in 2003–05 reflected a strong increase in the national saving rate, notably that of the private sector.

Figure 1. Brazil: The Real Effective Exchange Rate (REER), Jan 1994–Dec 2005
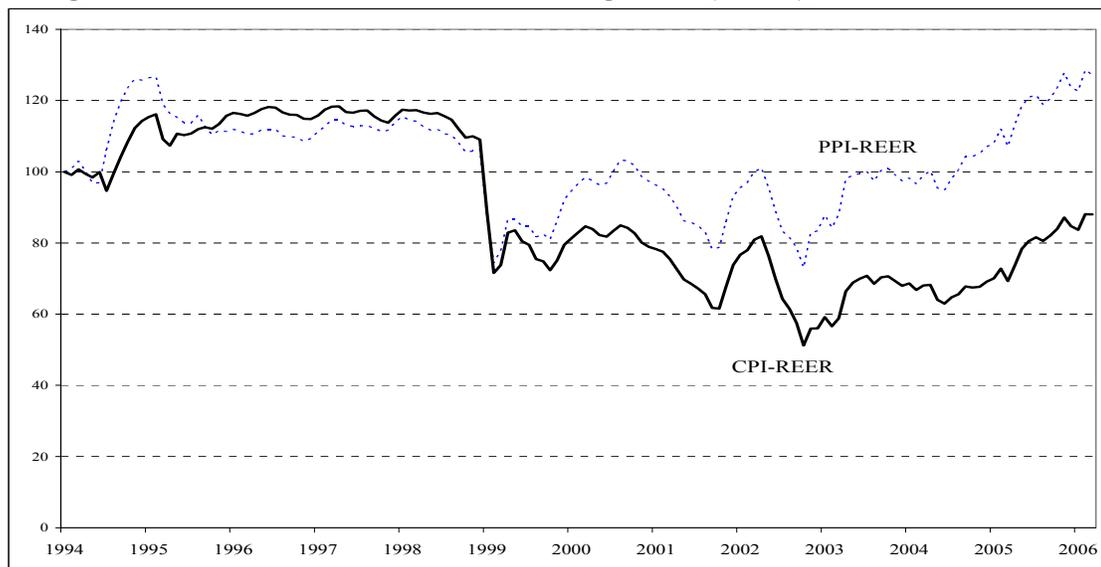
Source: Brazilian Institute of Applied Economic Research (IPEA) database.
Note: CPI = consumer price index; PPI = producer price index.

The wide exchange rate fluctuations and the current account reversal over the last several years call for a closer examination of Brazil's external performance. What are the main forces driving the real effective exchange rate in Brazil? Was there an "overshooting" in the appreciation recorded between 2003 and 2005? Why did the current account balance react so modestly to the floating and ensuing depreciation of the BRL until finally booming in 2003–05? This paper looks at the current account reversal in Brazil from both the trade and saving-investment perspectives. Various economic indicators are brought together to link the emergence of current account surpluses to improved economic fundamentals and positive structural changes that seem to also justify most of the currency appreciation during 2003–05.

In order to formalize and further investigate the hypothesis that the strengthening of the BRL over 2003–05 can be explained by the favorable evolution of some key economic fundamentals, the paper provides empirical estimates of a behavioral equilibrium exchange rate (BEER) model for Brazil making use of a methodology applied, among others, by

MacDonald and Clark (1998) for the United States, Japan, and Germany and by Maeso-Fernandez, Osbat, and Schnatz (2001) for the euro. In short, the BEER methodology consists of (1) econometrically estimating a vector error-correction model for the real effective exchange rate and its potential determinants (fundamentals), and (2) using the cointegrating vector(s) to infer the equilibrium path of the real exchange rate. More specifically, the exchange rate is considered to be in equilibrium if it matches the prediction of the estimated cointegrating vector(s) given the actual values of fundamentals. The estimates for Brazil confirm that a set of key economic fundamentals widely used in the BEER empirical literature succeed in explaining most of the appreciation of the BRL over 2003–05, i.e., this appreciation can be regarded as an "equilibrium phenomenon."

The remainder of the paper is organized as follows. The next section presents various indicators that characterize and explain the significant improvement in Brazil's external accounts since the floating of the BRL in 1999. These indicators show that competitiveness gains were widespread and effectively supported by the combination of a floating exchange rate regime with prudent macroeconomic policies, allowing Brazil to take advantage of a favorable external environment. Nonetheless, they also suggest that the expansion of export activities may have started to moderate as a result of the recent REER appreciation.

The third section of the paper discusses empirical estimates of BEER models for Brazil that suggest that (1) most of the BRL appreciation between 2003 and 2005 was an equilibrium response to improved fundamentals, and (2) the real exchange rate was broadly in line with its estimated equilibrium value in 2005. In addition, the BEER model estimates help in understanding some of the main factors driving exchange rate dynamics in Brazil in recent years, notably the role of the terms of trade, productivity, and debt indicators. These results are revisited and summarized in the final section, the paper's concluding remarks.

II. THE EXTERNAL ADJUSTMENT

Brazil's external accounts improved significantly since the abandonment of the exchange rate peg in January 1999, with the current account shifting from a deficit of about 4¼ percent of GDP in 1998 to a surplus of 1¾ percent of GDP in 2005 (Figure 2). After an initial deterioration that was mainly associated with valuation adjustments to a large stock of external liabilities, Brazil's net foreign asset position also began to strengthen in recent years, benefiting from the emergence of sizeable trade surpluses, lower debt ratios, and improved financing conditions.

On the trade side, the current account reversal is explained mainly by the growth of exports, since import values also reached record levels even as the trade and current account surpluses were materializing (Figure 3). Exports responded rapidly to the floating and ensuing depreciation of the BRL, with the twelve-month growth of export volumes rising sharply from the second half of 1999 and remaining in positive territory for the remainder of the sample period (Figure 4). This growth rate has been highly volatile nonetheless. The initial

expansion that followed the floating of the exchange rate started losing momentum at the end of 2000 with the emergence of capacity constraints in manufacturing, and subsequently decelerated further due to a domestic electricity shortage and the aggravation of the Argentine crisis. This deceleration occurred despite an additional depreciation of the REER in the period. Notwithstanding these difficulties, Brazil's export market shares recovered slightly during 1999-2001 (Figure 5).[2]

Figure 2. Brazil: Current Account Balance and Net Foreign Assets, 1994–2005
(As a percentage of GDP)
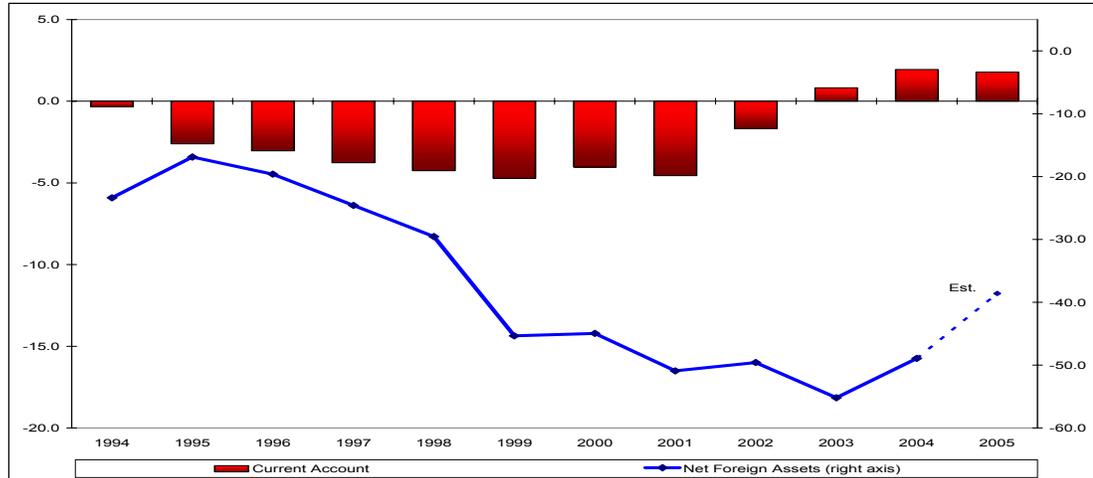
Source: Brazilian Institute of Applied Economics; Lane and Milesi-Ferretti (2006); and author's estimation

Figure 3. Brazil: Exports, Imports, and the Trade Balance, 1994–2005
(In billions of U.S. dollars)
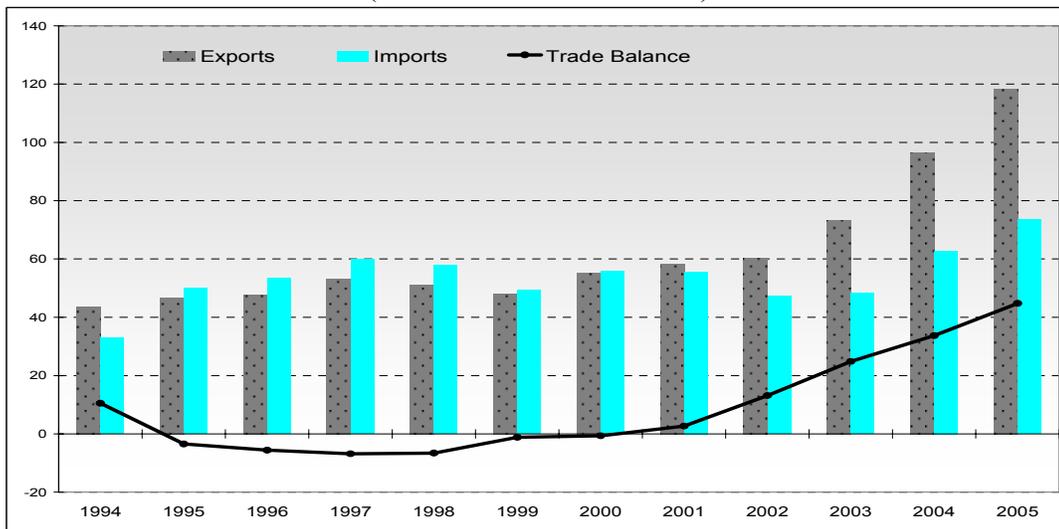
Source: Brazilian Institute of Applied Economics

---

[2] Export market shares are calculated as the 4-quarter average growth of export volumes divided by the 4-quarter average growth of import volumes in Brazil's main trading partners according to IMF, *World Economic Outlook* data.

Figure 4. Brazil: 12-month Growth of Export Volumes and Export Prices, 1994–2006
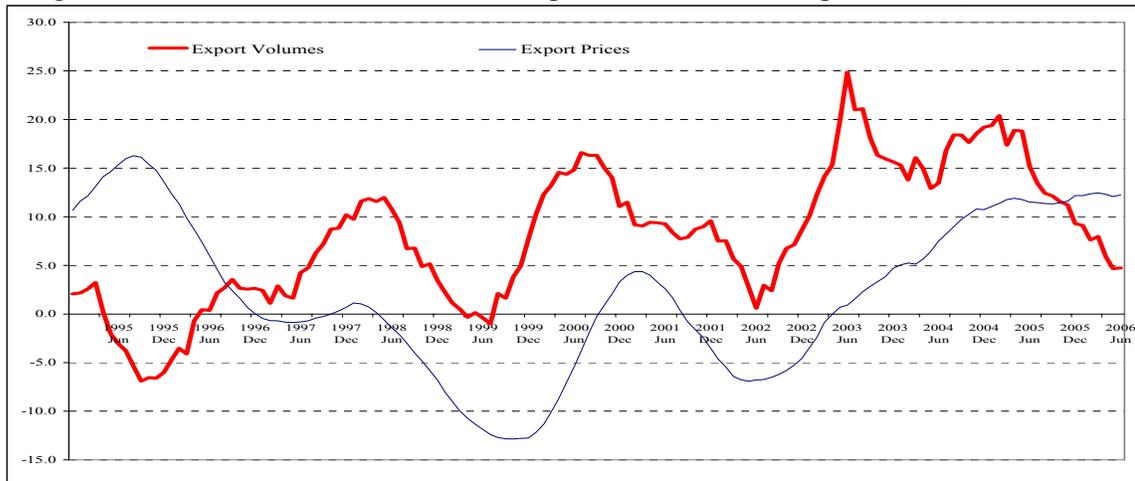
Source: Brazilian Institute of Applied Economics

Figure 5. Brazil: Export Market Share (index number), 1994:4–2006:1
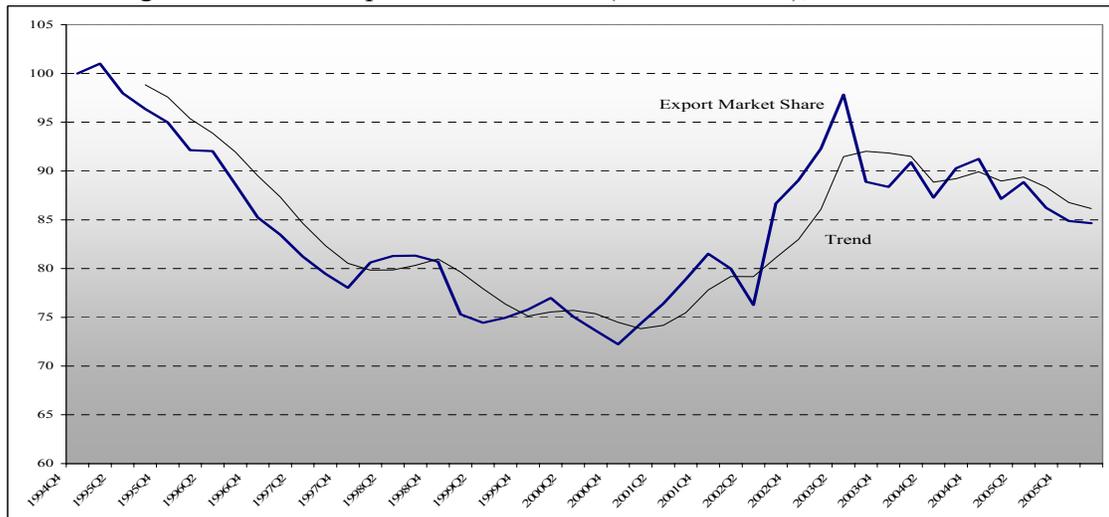
Source: IMF, *World Economic Outlook;* and author's calculations

The second spurt of export growth started in the latter half of 2002, triggered by a sharp REER depreciation associated with electoral uncertainty and large capital outflows. This renewed dynamism in export growth was amplified and later sustained by a buoyant global economy and rising export prices, as double-digit export volume growth rates were observed concomitantly with a steady appreciation of the REER during 2003–05. Brazil's productive sector was well-positioned to take advantage of the favorable international environment, thanks in part to the expansion in manufacturing productive capacity that followed the adoption of the floating exchange rate regime (Figure 6).[3]

---

[3] Installed productive capacity was estimated using the series for the level of production and capacity utilization compiled by the Brazil's National Confederation of Industries (CNI). Although the national accounts data do not show a significant increase in investment rates, it does show an increase in the share of machinery and equipment in total investment expenditure.

Figure 6. Brazil: Installed Capacity in Manufacturing, (index number), 1994–2005
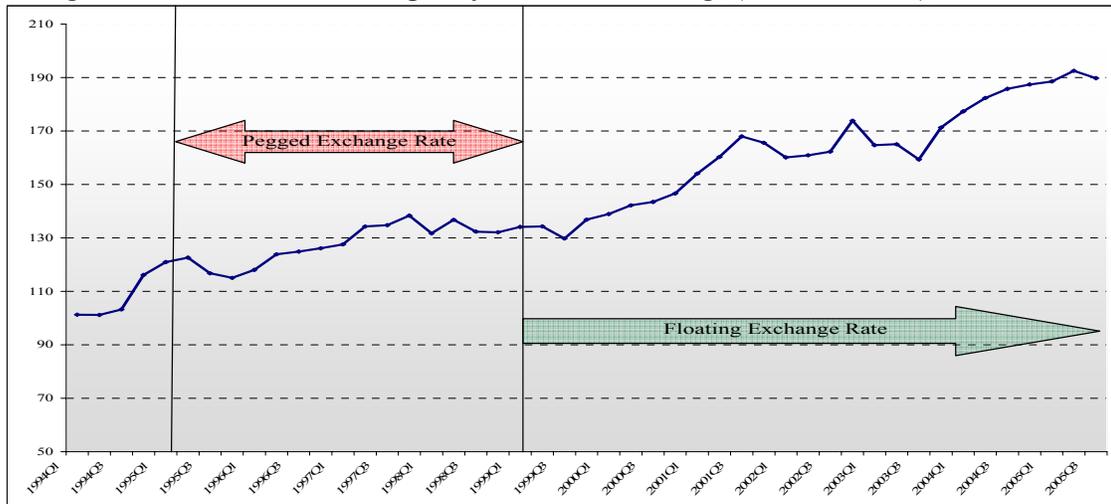
Source: National Confederation of Industries (CNI) and author's calculations

From a saving-investment perspective, the improvement in the current account reflected mostly an increase in the saving ratio, as national saving as a percentage of GDP averaged 21½ percent during 2003–05, compared to about 17 percent in 1998 (Figure 7). Both the private and public sectors contributed to this rise in the national saving ratio: private saving reached an average of almost 25 percent of GDP in 2003–05, compared to less than 22 percent in 1998, whereas public saving improved by about 1½ percentage point of GDP in the same period comparison (Figure 8).

Figure 7. Brazil: Saving, Investment, and the Current Account (% of GDP), 1994–2005
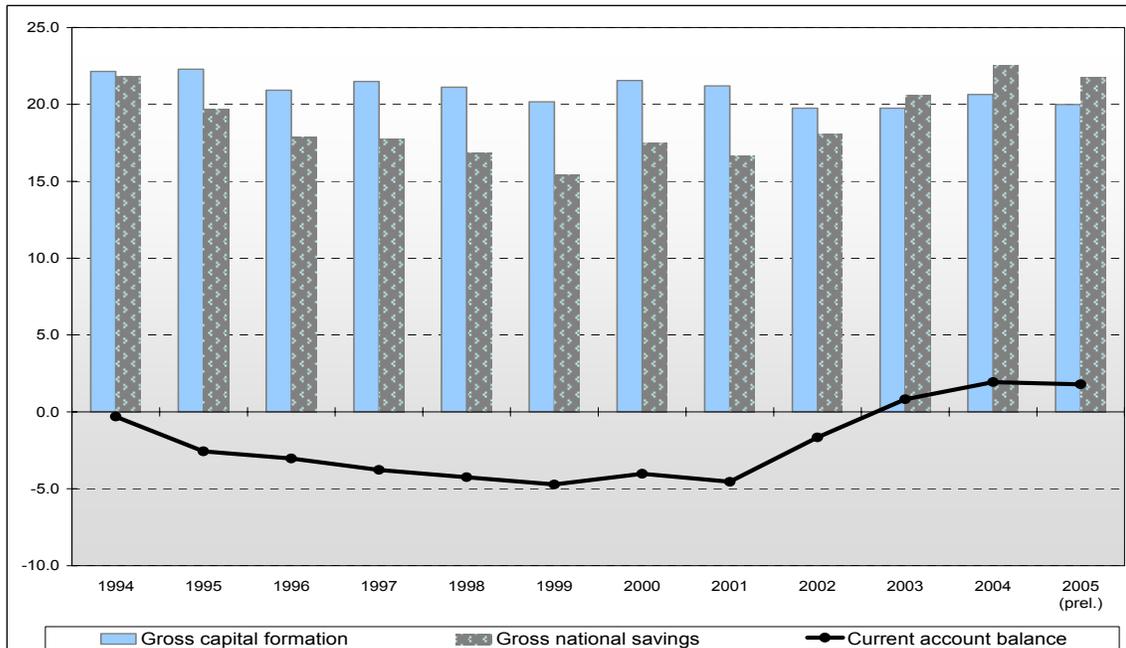
Source: IMF, *World Economic Outlook*.

Figure 8. Brazil: National, Private, and Public Saving (% of GDP), 1994–2005
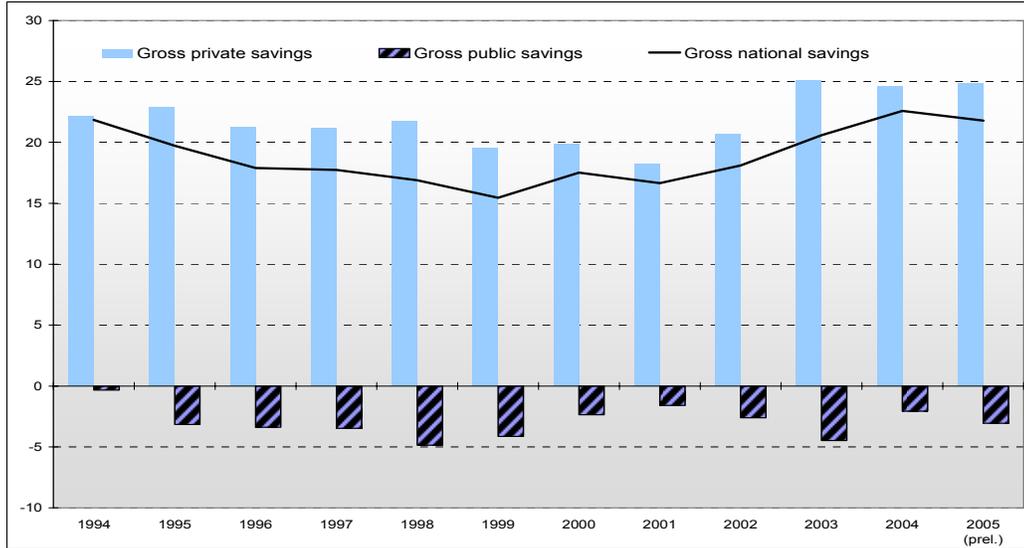
Source: IMF, *World Economic Outlook.*

The large trade surpluses recorded after 2003 combined with prudent macroeconomic policies and a favorable external environment to restore investor confidence and increase the inflows of foreign currency. The exchange rate appreciated and debt indicators improved, with the ratios of public and external debt to GDP and of short term debt to reserves declining significantly (Figure 9). The composition of domestic public debt also improved with the elimination of all dollar-indexed debt, further contributing to a sharp reduction in the country risk (Figure 10).

Figure 9. Brazil: Debt Indicators, 1995–2006
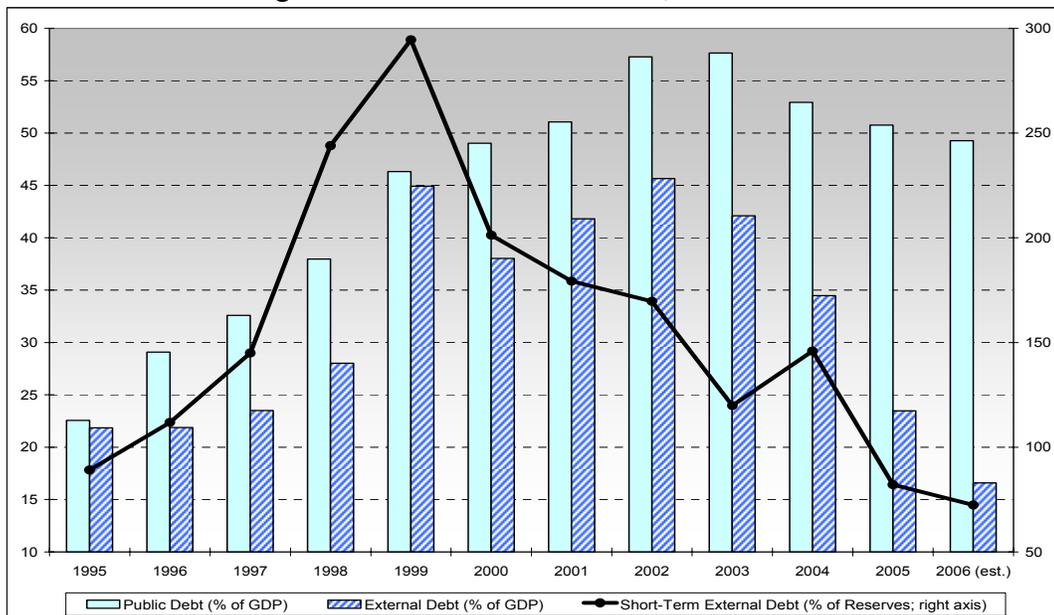
Source: Brazilian Institute of Applied Economics; IMF, *World Economic Outlook.*

Figure 10. Brazil EMBI and Overall EMBI, 2002:1–2006:5
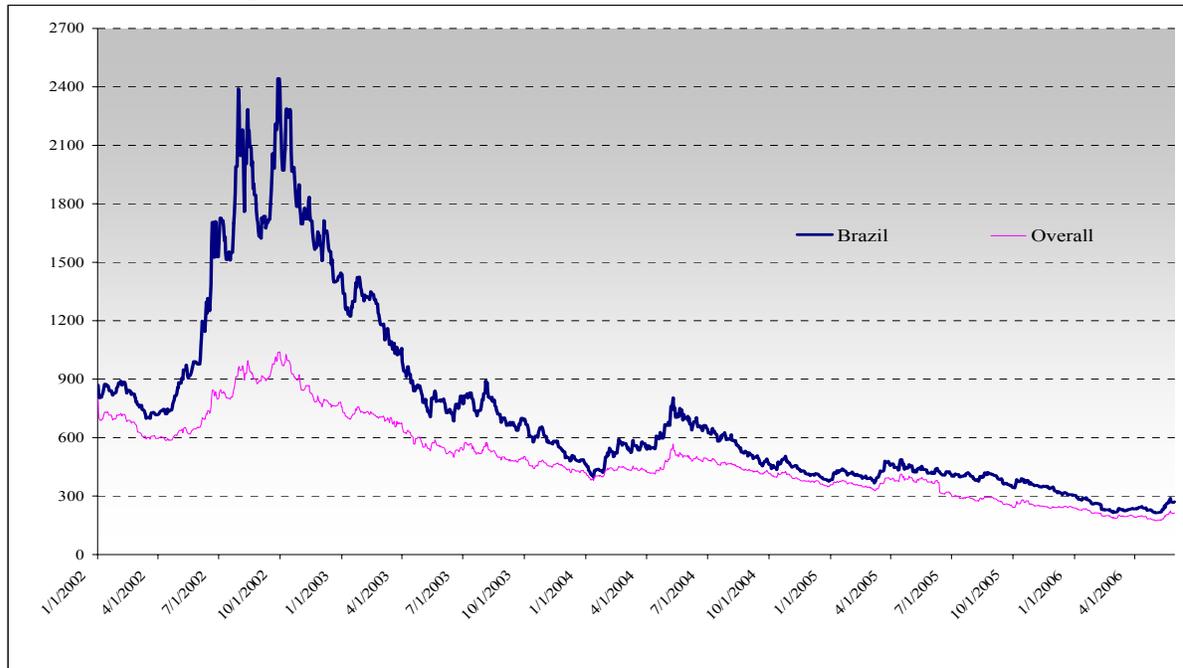
Source: JPMorgan.

The picture that thus emerges from Brazil's external position is one in which a reduced debt burden and improved financing conditions signal that a lower trade surplus may still be compatible with the maintenance of external sustainability. Combined with the rise in export prices and the terms of trade, the increase in the national saving rate and in the manufacturing productive capacity, this lower surplus requirement suggest that external equilibrium can be sustained with a more appreciated exchange rate, i.e., that there has been an equilibrium appreciation in Brazil's exchange rate. Nonetheless, the magnitude of this equilibrium appreciation is not easily quantified, and therefore the recent strengthening of the nominal exchange has been seen with caution by market analysts, policy makers, and important sectors of the business community, especially given the increase in Brazil's manufacturing unit labor costs relative to its trading partners, the sharp deceleration of export volume growth, and the decline in export market shares observed since 2005 (Figures 4, 5, and 11).[4] Further appreciation of the BRL was avoided when the Brazilian Central Bank made several large purchases of foreign exchange in the market during 2005 and 2006 in order to strengthen its foreign reserve position.

In an attempt to confirm the occurrence and estimate the magnitude of the recent appreciation of the equilibrium exchange rate of the BRL, the next section presents and discusses some econometric estimates of a BEER model for Brazil. The analysis also contributes to the debate by identifying some of the main factors driving exchange rate dynamics in Brazil and their relative importance in explaining the recent strengthening of the BRL.

---

[4] The increase in Brazil's unit labor costs in 2005 was associated with both an increase in average real wages and a decline in average productivity in the manufacturing sector.

Figure 11. Relative Unit Labor Costs, Brazil and Main Partners, 1994–2005
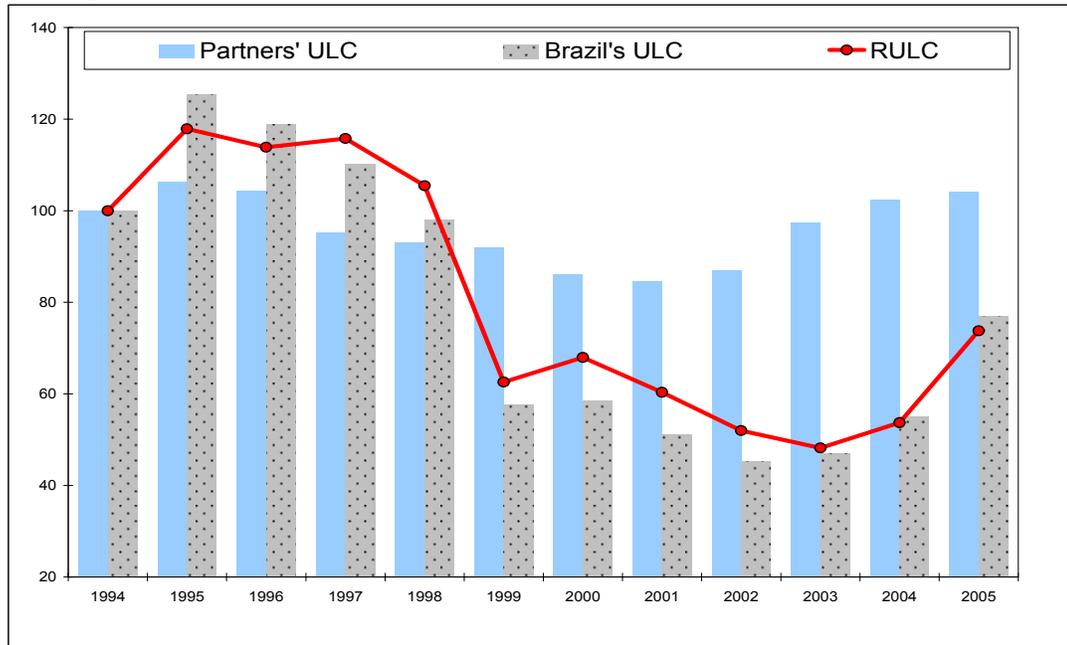
Source: Brazilian Institute of Applied Economics; IMF, *World Economic Outlook*; and author's calculations

III. THE EQUILIBRIUM EXCHANGE RATE IN BRAZIL

This section presents an empirical analysis of Brazil's real effective exchange rate dynamics based on the approach known in the literature as the Behavioral Equilibrium Exchange Rate (BEER). In short, the BEER consists in econometrically estimating the real effective exchange rate as a function of the actual values of the relevant explanatory variables or fundamentals. Hence, the concept of "equilibrium" embedded in the BEER is mostly of a statistical nature, in the sense that the exchange rate is considered to be in equilibrium if it matches the prediction of the econometric model given the actual values of fundamentals. This is in contrast to methodologies that aim at determining an "equilibrium" level of the exchange rate in which the notion of equilibrium implies the simultaneous achievement of full employment of domestic factors, broad price stability, and external sustainability, thus in fact requiring explanatory variables to be valued at "sustainable" levels.[5]

MacDonald and Clark (1998) apply the BEER methodology and show that movements in the real effective exchange rate (REER) indexes of the United States, Japan, and Germany in the period 1960–96 are largely explained by fundamentals such as the terms of trade, the relative prices of tradables and nontradables, the net foreign asset positions, domestic and international real interest rate differentials, and the relative stocks of government debt. These authors consider the equilibrium level of the exchange rate to be the one implied by the estimated cointegrating relationship and the actual values of the fundamentals. Maeso-Fernandez, Osbat, and Schnatz (2001) use a similar methodology and set of fundamentals to

---

[5] More details on the BEER and other methodologies to estimate equilibrium exchange rates can be found in MacDonald and Stein (1999), Isard and Faruqee (1998), and Williamson (1994).

model the REER of the euro area during 1975–98. Other recent work applying BEER principles include Egert (2005), Komarek and Melecky (2005), and Zalduendo (2006).

A. The Variables: Motivation and Definition

Following MacDonald and Clark (1998), Brazil's equilibrium exchange rate dynamics are expected to be driven by fundamentals as follows:[6]

$$REER = f(\overset{+}{NTT}; \overset{+}{TOT}; \overset{+}{RINTDIFF}; \overset{+}{NFA}; \overset{-}{RELDEBT})$$

- The relative price of nontradables to tradables (NTT) is supposed to have a direct impact on the equilibrium exchange rate for two main reasons. First, it may capture the Balassa-Samuelson effect as faster productivity growth in the tradables sector would lead to lower price of tradables relative to nontradables and this improved competitiveness would be balanced by an appreciation of the real exchange rate.[7] In addition, this variable could also capture changes in consumer preferences, as a shift in consumer demand away from tradables and toward nontradables would also make tradable goods relatively cheaper and allow for an equilibrium appreciation of the exchange rate. The productivity channel is expected to dominate movements in the variable, however, especially in countries that are undergoing a "catch up" process relative to more developed trading partners. The variable is measured here as the ratio of the (less tradable-intensive) consumer price index to the (more tradable-intensive) producer price index in Brazil divided by a similar, trade-weighted ratio for Brazil's main trading partners.[8]

- The terms of trade (TOT) are expected to have a direct impact on the equilibrium exchange rate, as a deterioration of a country's terms of trade would require a depreciation of the country's currency in order to compensate the negative impact on the external accounts. This effect is captured here through a variable defined as Brazil's

---

[6] For additional details on the theoretical model underpinning this set of explanatory variables, see MacDonald and Clark (1998) as well as Faruqee (1995).

[7] A possible drawback of using this variable as a proxy for relative productivity differentials is in the event of tax-driven relative price changes and the varying composition of price indexes over time and across countries. Despite these potential imperfections, this variable remains widely used to assess competitiveness and exchange rate dynamics. See, for instance, Kakkar and Ogaki (1999) and Chinn (1999).

[8] The country weights used in this section are those in the IMF's calculation of Brazil's REER. Some criticism has been made about the inclusion of this variable among the fundamentals explaining REER dynamics on grounds that the NTT would be an equivalent measure of the (price-deflated) real exchange rate. However, the NTT series in our sample has shown a strong, upward trend during the sample period, with the average in the 1990s being about 50 percent higher than the average in the 1970s, whereas the average REER rose by only 16 percent in the same period. The NTT calculated for Brazil therefore seems to be broadly reflecting productivity trends and the country's productivity "catching up" process as hypothesized by the model.

terms of trade (the ratio of export to import prices) divided by a similar, trade-weighted measure for Brazil's main trading partners.

- Real interest rate differentials (RINTDIFF) are also expected to have a direct effect on the equilibrium exchange rate to satisfy the uncovered interest parity condition. Hence, other things equal, an increase in Brazil's real interest rate vis-à-vis international interest rates should lead to an appreciation of the Brazilian currency. International real interest rates are also measured as a trade-weighted average of real interest rates in Brazil's main partners. The interest rates used are the money market rate or similar short-term rates, as comparable long-term rates are not available for Brazil during most of the sample period.

- The net foreign assets position (NFA) is also expected to have a direct impact on a country's equilibrium exchange rate: higher foreign borrowing and/or inflows of foreign direct investment worsens a country's NFA position and thus require a weaker currency to generate an improvement in the primary current account that will help cover the higher debt service and profit remittances associated with those inflows.[9] This variable may also capture, indirectly, a country's trade competitiveness, to the extent that the current account balance approximates the change in the net foreign asset position in the absence of valuation adjustments. It is measured as a ratio to GDP.

- The relative stock of public domestic debt (RELDEBT) may have a negative impact on the equilibrium exchange rate to the extent that it increases the country's risk premium. Thus, the rising indebtedness of the Brazilian government compared to foreign governments would render Brazilian assets riskier and lead to an equilibrium depreciation of the Brazilian currency for a given real interest rate differential.[10] This variable is constructed as the general government net debt to GDP ratio in Brazil divided by the weighted average of similar debt statistics in partner countries.

B. The Data

The dataset used in the estimation comprises annual data for the period 1970–2004. Data sources are as follows: the real effective exchange rate (REER) is calculated by the IMF; the series NTT, TOT, RINTDIFF, and RELDEBT were calculated using data obtained from the IMF's World Economic Outlook (WEO) and International Financial Statistics (IFS), and

---

[9] Notice that FDI inflows may also indirectly stimulate an equilibrium appreciation of the exchange rate by promoting economic efficiency and raising the productivity of tradable goods; in addition, privatization-related inflows or FDI in public utilities may also contribute to reduce the public sector debt, reducing risk and leading to a stronger equilibrium exchange rate.

[10] Fiscal policy could also affect the (equilibrium) exchange rate through its impact on national savings and the composition of aggregate demand. Nonetheless, these effects are accounted for by the net foreign assets position and the relative price of tradables to nontradables, leaving the risk factor as the plausible effect captured by this variable.

from the Brazilian Institute of Applied Economics (IPEA); data on Brazil's NFA were taken
from Lane and Milesi-Ferretti (2006).

Augmented Dickey-Fuller Unit Root Tests were performed on the series involved in the
estimation of Brazil's BEER. The lag length in each test was determined based on the
Schwarz information criteria and a maximum of 8 lags. Results are summarized in Table 1.
All series appear to be nonstationary in levels but stationary in first-difference, i.e., all series
are integrated of first order, I(1). Only the series RINTDIFF showed a test statistics with a p-
value below 0.10, which implies that the hypothesis of no unit root would be rejected at
10 percent significance. Nonetheless, a visual inspection of the autocorrelogram of the series
reinforces the idea that the series be treated as I(1) for empirical modeling. [11] Moreover, the
changing economic structure and macroeconomic instability observed in Brazil during the
sample period (including bouts of hyperinflation, heterodox stabilization plans, trade and
capital account liberalization, currency crises, and sharp fluctuations in real GDP growth)
makes it intuitively less likely that Brazil's real interest rate differential relative to its mostly
industrialized partners would be stationary. To be sure, some models will be estimated
treating the variable as stationary.

Table 1. Stationarity Tests: ADF Statistics

Variable	Level	First Difference	Variable	Level	First Difference
REER	-1.82	-4.80 **	RINTDIFF	-2.93*	-5.72 **
NTT	-1.31	-5.57 **	NFA	-1.47	-4.69 **
TOT	-2.50	-4.96 **	RELDEBT	-1.87	-5.20 **

** denotes significance at the 5-percent significance level

* denotes significance at the 10-percent significance level

C. Empirical Modeling

Having established that the REER and its main determinants are likely to be integrated of
first order, econometric modeling was carried out according to cointegration methodologies
suggested in Johansen (1995). It is assumed that the dynamics of the six variables described
above can be modeled through a Vector Error-Correction (VEC) specification of the form:

$$\Delta Y_t = \Psi Y_{t-1} + \sum_{i=1}^{k} \Phi_i \Delta Y_{t-i} + \delta + \varepsilon_t$$

---

[11] MacDonald and Clark (1998) and Maeso-Fernandez, Osbat, and Schnatz (2001) have also reported finding
"border line" test statistics for some measures of interest rate differentials but treating the series as I(1).

where

$Y_t^{'}$ = [REER$_t$, NTT$_t$, TOT$_t$, RINTDIFF$_t$, NFA$_t$, RELDEBT$_t$]
Ψ is a (6 x 6) matrix of coefficients
Φ is a (6 x k) matrix of short-run coefficients
δ is a (6 x 1) vector of constants and
ε_t is a (6 x 1) vector of white noise residuals
and k denotes the order of the VAR associated with this specification

Under the condition that Ψ has reduced rank (0 < r < 6), Ψ can be decomposed into a (6 x r) matrix of cointegrating vectors β and another (6 x r) matrix A of adjustment coefficients. In this case, β can be interpreted as providing the long-term, equilibrium relationships among the variables while the adjustment coefficients in A can be interpreted as capturing the importance of past deviations from this equilibrium for the system dynamics (i.e., A indicates how fast the system adjusts to disequilibrium). The Johansen test consists basically of estimating the Ψ matrix for the unrestricted VAR and testing whether restrictions associated with the reduced rank of Ψ can be rejected.

The search for appropriate VEC specifications followed standard model selection procedures and the main results are summarized in Table 2. All models reported showed satisfactory results when tested for autocorrelation, heteroskedasticity, and normality of residuals. These test statistics, as well as the models' estimated short-run coefficients and intercepts are omitted from the table for simplicity. The estimated long-run, cointegrating vector coefficients were used to track and analyze the movements of Brazil's behavioral equilibrium exchange rate (BEER). Their values are plotted against the actual REER in Figure 12. It is clear from the various graphs that the trends in the real exchange rate in Brazil have been traced relatively well by the set of economic fundamentals considered.[12] When 2005 official data for individual partner countries were not available for the year as a whole, they were estimated by extrapolating the trends observed up to the most recent data point (including data for the initial quarters of 2005, when available).

Models I and II included all six endogenous variables, and Schwarz information criteria recommended the addition of one lag of the differenced variables in the respective error-correction formulations. The difference between the two specifications is the addition of a dummy variable that singles out the years in which stabilization plans were introduced in Brazil (1986, 1987, 1989, 1990, 1991, 1994) and tries to account for the impact of an abrupt decline in the inflation rate and other sharp fluctuations in the model fundamentals. All coefficient estimates in the cointegrating equation have the expected signs, plausible magnitudes, and are highly significant. Despite the relatively short sample size, the large t-ratios obtained reflect very small standard errors of the coefficient estimates and help

---

[12] The wide discrepancies between actual and estimated values observed around 1990 and 1994 should be viewed with caution as they may reflect distortions in the measurement of some of the variables entering the estimation caused by the very high inflation observed in the period as well as the stabilization strategies and currency reforms implemented.

increase confidence in the model. As argued by Campos and Ericsson (1999), a short sample size can be compensated by a large variance per observation of the regressors to yield efficient coefficient estimates.

Table 2. VEC Models for the Real Effective Exchange Rate

	I	II	III	IV
REER	1.00	1.00	1.00	1.00
TOT	-1.49 [-9.0]	-1.41 [-8.2]	-1.73 [-9.3]	-1.91 [-8.8]
NTT	-0.46 [-5.9]	-0.44 [-5.7]	-0.39 [-4.6]	-0.45 [-4.4]
RINTDIFF	-0.23 [-9.9]	-0.22 [-9.4]		
RELDEBT	0.39 [11.3]	0.35 [10.1]	0.38 [9.8]	0.35 [8.2]
NFA	-0.78 [-6.8]	-0. 79 [-6.5]	-1.09 [-8.7]	-1.20 [-8.7]
α	-0.46 [-1.9]	-0.54 [-2.1]	-0.70 [-4.8]	-0.67 [-4.0]
Exogenous variables	None	Het. dummy	RINTDIFF Het. dummy	RINTDIFF Varinfl
Cointegration test: Trace Statistics				
H_0: r = 0	107.6**	108.1**	96.1**	86.7**
H_0: r ≤ 1	67.9	68.2	41.5	40.5
Cointegration Test: Max Eigenvalue Statistic				
H_0: r = 0	39.9*	39.9*	54.5**	46.4**
H_0: r ≤ 1	29.3	30.8	19.5	18.9
ΔBEER 2003 →2005	23%	23%	29%	31%

** denotes significance at the 5-percent significance level; * denotes significance at the 10-percent level

The adjustment coefficients (α) in the dynamic real exchange rate equations were estimated at -0.46 and -0.54, respectively, indicating that real exchange rate deviations from equilibrium are corrected relatively fast.[13] Cointegration tests based on trace statistics

---

[13] This speed of adjustment is broadly in line with that estimated by MacDonald and Clark (1998) for the US dollar and by Maeso-Fernandez, Osbat, and Schnatz (2001) for the euro.

adjusted for the small sample size and allowing for the existence of intercepts in the potential cointegrating equations suggested the existence of a single cointegrating relation among the variables in both model specifications.[14] Adjusted maximum eigenvalue statistics reinforced the hypothesis of one cointegrating relation.

Figure 12. Actual and Equilibrium Real Effective Exchange Rate, 1970–2005
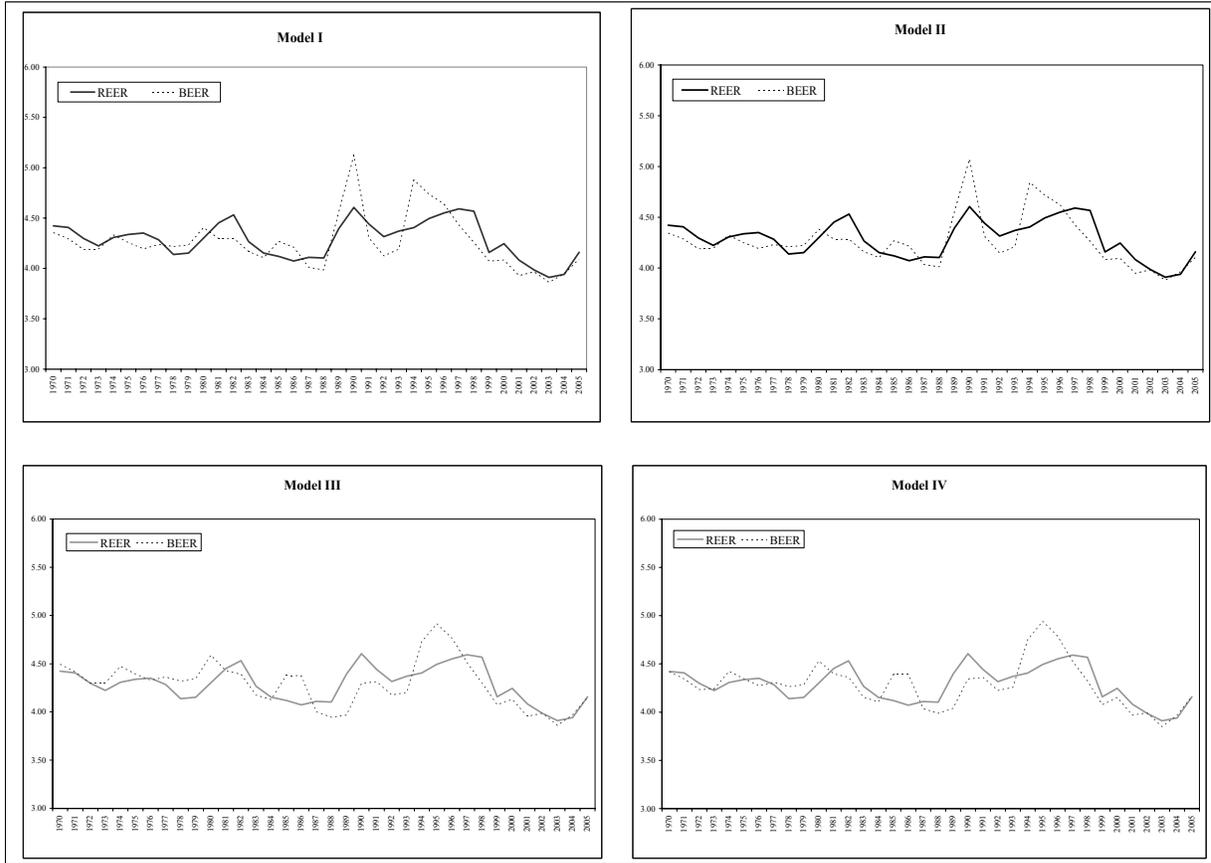
Models I and II exhibit good performances in tracking movements in the Brazilian real effective exchange rate (Figure 12). More specifically, both models suggest that most of the 25 percent appreciation of the REER observed between 2003 and 2005 was an equilibrium phenomenon: the cointegrating vector estimates in these models and the actual value of

---

[14] The test statistics reported were adjusted for the small sample size as recommended in Reimers (1992) by multiplying the original values by a factor of $(T- nk)/T$, where T is the number of observations, n is the number of variables, and k is the number of lags in the system. Notice that, as appropriate, the adjustment factor converges to 1 as the sample size increases for a given model specification with n variables and k lags. The unadjusted test statistics suggested the existence of two cointegrating vectors. However, this second hypothesized cointegrating vector probably corresponded to the real interest differential variable (rintdiff), which was found to be border-line stationary in the tests described above. This possibility was confirmed by estimating the VEC system imposing two cointegrating relations with the second vector constrained to include only the rintdiff variable. The constraints were accepted and the first cointegrating vector yielded coefficient estimates that are very similar to the ones obtained under the hypothesis of a single cointegrating vector.

fundamentals imply in a BEER appreciation of about 23 percent during the same period. Although point estimates indicate that the BEER was below the actual REER in 2005, they still fall within reasonable confidence intervals for the estimation, thus supporting the conclusion that the exchange rate was broadly in line with fundamentals in 2005.

Model III represents a more substantial change from the previous specifications in that it treats the interest differential as an exogenous variable, therefore taking it out of the cointegrating vector and including it only among the short-term coefficients. This formulation addresses the possibility that the RINTDIFF variable is indeed stationary, as suggested by the unit root tests reported above, and also responds to Wald tests that indicated the series may be considered weakly exogenous relative to the other variables in the system. Both the trace and maximum eigenvalue statistics suggest the existence of a single cointegrating relation among the five remaining endogenous variables. The estimated coefficients on these variables continued to have the expected signs and reached high levels of significance. The more pronounced changes occurred in the estimated coefficients on the terms of trade and net foreign assets, implying in a stronger positive impact of these external fundamentals on the real effective exchange rate. The coefficient on the error-correction term is also higher in absolute terms, and more significant. The short-run coefficient on the interest rate differential has the expected positive sign and is statistically significant. The estimated cointegrating vector and the evolution of the explanatory variables suggest that the equilibrium in Brazil appreciated by about 29 percent during 2003–05, thus implying that the actual appreciation of the BRL in the period was fully justified by improved economic fundamentals. The point estimate of the BEER obtained through this model continues to imply that the real was broadly aligned with fundamentals in 2005.

Model IV maintains the interest rate differential among the exogenous variables but replaces the heterodox plan dummy with a measure of intra-year inflation variance (VARINFL). This variable was calculated as the variance of monthly inflation each year. It traces the stabilization plans well since these plans were associated with sudden (and often temporary) reductions in monthly inflation rates. The advantage of this variable is that it is continuous and reflects the different impact of the various heterodox stabilization plans. Unit root tests indicated that VARINFL is stationary. The t-ratios on the coefficients in the cointegrating vector are lower than in the previous specification, which would increase the uncertainty surrounding this model's estimates. The equilibrium appreciation implied by this model is the highest among all models presented here, at 31 percent. However, the model yields an estimated BEER that corresponds exactly to the observed real exchange rate in 2005.

What do these models say about the relative importance of the different fundamentals in driving the 2003–05 real appreciation of the Brazilian currency? Table 3 presents the breakdown of the changes in the BEER by economic fundamental as implied in each of the four models presented. Notice that the order of importance of the fundamentals remains the same regardless of the model specification. The main factor explaining the real exchange rate appreciation between 2003 and 2005 was Brazil's stronger net foreign assets position, whose ratio to GDP is estimated to have risen by about 15 percentage points and thus contributed with about 60 percent of the estimated movement in the BEER in the period. The improvement in Brazil's terms of trade relative to its partners (TOT) combined with the estimated high elasticity of the exchange rate to this variable to generate about 40 percent of

the estimated BEER appreciation. Moving to the other extreme, the only downward pressure exerted on the equilibrium exchange rate stemmed from the increase in the relative ratio of tradable to nontradable prices, which may be associated to a decline in Brazil's relative productivity of the tradables sector vis-à-vis its main partners mentioned in the previous section.

The relatively small contribution from the interest rate differential reflects the small absolute value of its coefficient in the cointegrating equation, which was expected since Brazil's external financial account remained relatively closed to private flows for most of the sample period while high real interest rates were recorded in association with super-inflation and various stabilization attempts. Moreover, according to the model underlying these estimates, the recent impact of interest rate differentials should be analyzed in conjunction with the risk factor captured by the relative public debt ratio: the strengthening of the real in 2003–05 can therefore be interpreted as owing less to an increase in interest differentials per se and more to a decline in the risk associated with investments that earn this differential.

While the improvement in the external assets position may be partially attributed to fiscal restraint and the associated reduction in the public debt to GDP ratio, this lower debt ratio also had a direct impact on the strengthening of the Brazilian currency in recent years. Namely, the fall in RELDEBT responded for up to 10 percent (on average) of the estimated BEER appreciation between 2003 and 2005. Recalling that this variable was introduced to proxy the risk of investing in Brazil, it can be argued that it has underestimated the equilibrium appreciation experienced in the period, since risk is likely to have declined not only because the *level* of debt was reduced (in relation to GDP and in comparison to other countries) but also because the *composition* of this debt was improved, especially with the virtual elimination of dollar-indexed bonds. In fact, as also shown in the previous section, the "Brazil risk" measured by the EMBI reached record lows in 2005.

Table 3. Relative Contribution of Fundamentals to the BEER Appreciation, 2003–05

Model	ΔBEER 2003 → 2005	Relative Contributions of Fundamentals (in percent of total BEER appreciation)				
		TOT	NTT	RINTDIFF	RELDEBT	NFA
I	23%	42	-15	6	10	57
II	23%	41	-14	5	9	59
III	29%	39	-10		8	63
IV	25%	40	-11		7	64

Model estimates also have some interesting implications for the period covering the second half of the 1990s, when Brazil adopted an exchange rate peg as part of its successful stabilization program but subsequently was forced to float under heavy speculative attacks and capital outflows. First, the depreciation that followed the collapse of the exchange rate peg in 1999 brought the REER very close to its estimated equilibrium level (Figure 12).

Moreover, the estimates also indicate that the equilibrium rate had been driven lower by the fast-rising domestic public debt to GDP ratio and the deteriorating net foreign assets position, thus placing the BRL under pressure. Although touted at the time as evidence that foreign investors had confidence in the Brazilian economy and that the peg was therefore sustainable, large capital inflows (and rising current account deficits) generated about US$110 billion in additional foreign liabilities between 1994–98. Servicing these liabilities would eventually require an improvement in the primary current account that called for a real exchange rate depreciation, an underlying change that is captured by the BEER estimated for the period and may have eventually contributed to the collapse of the peg in 1999.

IV. CONCLUDING REMARKS

Brazil's external current account has improved markedly since the floating of the exchange rate in 1999. Trade performance has benefited from the initial depreciation of the REER, the resumption of investment in the manufacturing sector and, more recently, from the acceleration of global economic activity and significant gains in export prices. From a saving-investment perspective, the external adjustment was supported mainly by higher saving rates, notably that of the private sector. All these elements contributed to explain the emergence of record trade and current account surpluses amidst a sharp appreciation of the REER during 2003–05, suggesting that most of this appreciation was an equilibrium response to improved economic conditions at home and abroad.

In addition to the reversal of the current account, the first seven years under the floating exchange rate regime were also marked by wide exchange rate fluctuations. In order to further investigate the main factors driving movements in Brazil's REER and, specifically, whether the 2003–05 appreciation was an equilibrium response to improved fundamentals, this paper provided estimates of behavioral equilibrium exchange rate models for Brazil using data for 1970–2004. Model estimates and preliminary data for 2005 suggest that most of the appreciation of the BRL observed during 2003–05 was indeed driven by fundamentals, notably the strengthening of the net foreign assets position and more favorable terms of trade.

Model estimates also illustrate the positive impact of stronger fiscal accounts. Besides indirectly supporting the increase in net foreign assets, the relative fiscal discipline also contributed to the equilibrium strengthening of the currency through a reduction in the risk associated with investing in Brazilian assets. In fact, the reduction in risk seems to have played a bigger role in the currency appreciation than the real interest rate differential per se: Brazilian assets attracted more investments not only because real interest rate differentials increased with the decline of inflation but mainly because the same return was associated with a lower risk according to the underlying model and estimated coefficients. Finally, because the models' point estimates for the equilibrium real exchange rate index fall within reasonable confidence intervals, the econometric exercise also supports the conclusion that the BRL was broadly aligned with fundamentals in 2005.

REFERENCES

Campos, J., and N. Ericsson, 1999, "Constructive Data Mining: Modeling Consumers' Expenditure in Venezuela," *Econometrics Journal*, Vol. 2, pp. 226–40.

Chinn, M.C., 1999, "Productivity, Government Spending, and the Real Exchange Rate: Evidence for OECD Countries," in *Equilibrium Exchange Rates,* ed. by R. MacDonald and J.L. Stein (Boston: Kluwer Academic Publishers).

Clark, P., and R. MacDonald, 1998, "Exchange Rate and Economic Fundamentals: A Methodology Comparison of BEERs and FEERs," IMF Working Paper 98/67 (Washington: International Monetary Fund).

Egert, B., 2005, "Equilibrium Exchange Rates in South Eastern Europe, Russia, Ukraine and Turkey: Healthy or (Dutch) Diseased?" *Economic Systems*, Vol. 29, pp. 205–41.

Faruqee, H., 1995, "Long-Run Determinants of the Real Exchange Rate: a Stock-Flow Equilibrium Approach," *Staff Papers*, International Monetary Fund, Vol. 42, pp. 80–107.

Isard, P., and H. Faruqee, eds., 1998, *Exchange Rate Assessment: Extensions of the Macroeconomic Balance Approach*, IMF Occasional Paper No. 167 (Washington: International Monetary Fund).

Kakkar, V., and M. Ogaki, 1999, "Real Exchange Rates and Nontradables: A Relative Price Approach," *Journal of Empirical Finance*, Vol. 6, pp. 193–215.

Komarek, L., and M. Melecky, 2005, "The Behavioural Equilibrium Exchange Rate of the Czech Koruna," Czech National Bank Working Paper 05/2005.

Lane, P.R., and G.M. Milesi-Ferretti, 2006, "The External Wealth of Nations Mark II: Revised and Extended Estimates of Foreign Assets and Liabilities, 1970–2004," IMF Working Paper 06/69 (Washington: International Monetary Fund).

Lipschitz, L., and D. McDonald, 1991, "Real Exchange Rates and Competitiveness: A Clarification of Concepts, and Some Measurements for Europe," IMF Working Paper 91/25 (Washington: International Monetary Fund).

MacDonald, R., and J. L. Stein, eds., 1999, *Equilibrium Exchange Rates* (Boston: Kluwer Academic Publishers).

Maeso-Fernandez, F., C. Osbat, and B. Schnatz, 2001, "Determinants of the Euro Real Effective Exchange Rate: A BEER/PEER Approach," European Central Bank Working Paper No. 85.

Reimers, H.E., 1992, "Comparison of Tests for Multivariate Cointegration," *Statistical Papers*, Vol. 33, pp. 335–59.

Williamson, J., ed., 1994, *Estimating Equilibrium Exchange Rates* (Washington: Institute for International Economics).

Zalduendo, J., 2006, "Determinants of Venezuela's Equilibrium Exchange Rate," IMF Working Paper 06/74 (Washington: International Monetary Fund).