ESTIMATING THE EQUILIBRIUM REAL EXCHANGE RATE FOR BRAZIL: 1984-2000

Carlos E. Merlin[1]
Marcelo S. Portugal[2]

Abstract

The present article aims at contributing towards the debate over exchange rate misalignment in Brazil, with special regard to the period after 1994. Therefore, we present an equilibrium exchange rate calculation for Brazilian economy for the 1984-2000 period. We use a model based on Montiel (1999), adequate for developing economies, and estimated by means of quarterly data. The estimates are made from long-run coefficients for a cointegrating model, in which variables are transformed by Hodrick-Prescott filter so that we can extract their permanent values. The results indicate that the evolution of fundamentals gave rise to a tendency towards the reduction of exchange rate misalignment after 1994. In addition, the estimated coefficient of error correction was compatible with the exchange rate behavior after the exchange market liberalization in January 1999.

Key words: Equilibrium Real Exchange; Exchange Rate Misalignment; Exchange Rate Policy.
JEL classification: F31.

1 Introduction

The beginning of the 1990's was marked by trade openness and by the reduced control over capital markets in several developing countries, including Brazil. Given the scenario of greater freedom of trade shared by several countries, exchange rate evolution has become one of the most relevant economic issues.

In general, the determination of real and financial flows in the world economy is related to the certainty economic agents can deal with, considering the current and estimated positions of currency values. The difficulty in predicting exchange rate dynamics originated a varied number of monetary arrangements more than a century ago to control exchange rate oscillations. Among these systems, we have the gold standard, Bretton Woods and, more recently, the development of unified monetary systems by economic blocs, according to the theory of optimal currency areas proposed by Mundell (1961).

The tendency towards the accumulation of external liabilities and the volatility of the terms of trade after Bretton Woods system gave rise to new types of exchange rate systems, which derive from fixed rate regimes vis-à-vis a currency (or basket of currencies) considered to be relevant to the international relationships of the countries involved. In developing economies, some more radical exchange rate regimes, such as unilateral fixed parity, crawling peg, exchange bands, or the currency board, were adopted in order to turn the exchange rate into an anchor, thus averting inflationary pressures and offering increased credibility to economic policies. However, if we disregard the success of price stabilization (most of it in the short run), these regimes have adverse effects, such as the accumulation of external liabilities, competitive traps (overvalued exchange rate) and speculative attacks, which resulted from the belief that administered rates would not allow for a correction in order to achieve the level of consistent macroeconomic equilibrium. The equilibrium real exchange rate (ERER) is inserted into this context.

ERER calculation is a measure that helps the economic policy to avoid problems with highly expensive adjustments. According to Black (1994), the misalignment between the real exchange

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[1] Economist at Pólo RS – Development Agency and Assistant Professor of Economics at Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS).
[2] Professor of Economics at Federal University of Rio Grande do Sul (UFRGS) and associated researcher of CNPq Special thanks to Patrícia U. Palermo (CNPq), Amanda Pimenta Carlos (CNPq), and Gustavo Russomanno (FAPERGS) for their research assistantship.

rate and its equilibrium level may create macroeconomic problems that affect internal variables (absorption, employment, competitiveness, and inflation, generating protectionism) and imply high costs of protection against speculative attacks.

It is also important to emphasize that the estimation of the ERER is not always the only goal to be attained. There is a great diversity of objectives for which such estimation works as a tool, such as inflation target models (in which it serves as an anchor for future exchange rate values), models for economic growth, other models for assessing the consistency of domestic economic policy or as a competition proxy. Therefore, there is a wide scope of objectives besides the one proposed here: contributing towards the debate on the evolution of exchange rate misalignment in Brazil throughout the last few years. The present study does not intend to propose an ultimate argument on Brazilian ERER, but rather, it aims at contributing to a discussion that has been gaining much momentum worldwide.

The assessment of the Brazilian case in this study was based on the model of Montiel (1999), since this model was flexible enough to incorporate the fundamentals we considered to be essential for this type of study.

2 Theoretical Models and Empirical Evidence: a brief review

Nurkse (1945) was the first to define the ERER, assuming that this is the rate that provides external equilibrium in terms of the balance of payments without the need for artificial controls over trade flows under full employment. Williamson (1994) presents adaptations to this concept, incorporating capital control effects by external restriction, and also those effects generated by the fundamentals of developed and developing economies. For him, the equilibrium rate based on these fundamentals is associated with the existing levels of output, capital flow and the market rate itself. On the other hand, Bayoumi *et al.* (1994) define the ERER as the real exchange rate consistent with a desirable set of macroeconomic objectives. Stein (1994) suggests that the equilibrium exchange rate is determined by the market rate that would prevail if speculative and cyclic factors were eliminated, given a natural rate of unemployment. Edwards (1994) and Elbadawi (1994) define it as the equilibrium rate that responds to exogenous factors when political economy variables follow sustainable paths.

Based upon the classic definition of Purchasing Power Parity (PPP), Black (1994) points out a greater consistency of a definition of ERER sufficiently flexible so as to incorporate the real factors that affect the external and internal positions of an economy. From this standpoint, a valid PPP for the long-run equilibrium should be variable over time in order to absorb the shocks on the terms of trade, cyclical and seasonal factors, and also those shocks that are determined exogenously. These shocks are considered as structural breaks instead of occasional movements in the fundamentals; therefore, they cannot be adjusted through a change in relative prices.

In general, the brief observation of empirical studies allows us to affirm that ERER estimation is subject to several theoretical and methodological approaches for the estimation and decomposition of the fundamentals. Among empirical analyses, a critical characteristic is the lack of consistency of the value estimated by alternative models and methods.

As the ERER is unobservable, but can be determined from the values of observable fundamentals, the specification of models always carries along the idea of long-run relationships. With respect to fundamentals, most studies recognize that there are short-run factors that do not allow them to keep their “desirable”, “sustainable” or “optimal” values.

Although the determination of the equilibrium values of these variables is highly relevant, most models and empirical studies express them normatively. “Desirable”, “sustainable” or “optimal” values of the fundamentals are subjective concepts even when specified by models based on utility maximization, profits or loss functions, etc, considering, for instance, the possible choices of policymakers and the weights attributed to each alternative. On the other hand, some models attempt to shift the values of the fundamentals from “sustainable” to endogenous, by establishing the highest possible number of relationships between variables. Others rely on the econometric analysis to set their “permanent” values”.

The results of any study on the ERER are therefore arguable. Nevertheless, it is important to say that the various theoretical models do not differ as to the relationships between variables, but the divergence lies in knowing which variables are relevant and which ones are determined endogenously and exogenously. On the other hand, the methodologies used for empirical analysis of models enhance the importance of the different characteristics of the fundamentals. These, combined with the fact that the involved concepts are set normatively, could produce different results even if applied to the same model.

The case of Brazil is not different. Melo (1998) presents a model for the so-called “virtual equilibrium” based on a partial equilibrium approach. She incorporates the distortion of international market prices via trade restrictions in order to estimate the equilibrium exchange rate for economic planning and analysis of project viability. She establishes therefore shadow prices that would come into effect in Brazil if such distortions were eliminated. In this sense, the equilibrium exchange rate is the nominal exchange, which, in the tradables sector, equals production (supply) and consumption (demand). By theoretical formulation, the estimation of this virtual rate also reflects the distortion of suboptimal economic policies on aggregate spending. The results indicate a virtual rate lower than that of free trade in the surplus years, which means that a smaller appreciation is required to achieve the desired trade balances. Finally, these estimates show that the exchange rate would have been continuously devalued throughout the period from 1975 to 1995, with a degree of misalignment between 3.67 and 9.85%.

Ades (1997) uses the GSDEEMER (Goldman Sachs Dynamic Equilibrium Emerging Markets Exchange Rates) method to calculate the long-run real exchange rate for a group of emerging economies. The theoretical model is based on a small and open economy whose real exchange rate movements are governed by fundamentals. Speculative and short-run factors, and transitory shocks to the fundamentals produce temporary misalignments in the ERER (in this case, the long-run real exchange rate). The estimated coefficients indicate that a greater degree of economic openness implies devaluation of long-run real exchange rate, but the other fundamentals have a contrary relationship, with negative elasticities in relation to the real exchange rate. This means that better terms of trade, higher levels of public investment, government spending, and real increases in the LIBOR rate cause real exchange appreciation. The estimated coefficient of error correction indicates a high speed of adjustment, with 50% of the deviation eliminated in a bit less than four months and 99% in a bit more than two years. The results concerning Brazil’s exchange rate situation up to the second quarter of 1997 indicate that the country had a real exchange rate quite close to its equilibrium level between mid-1992 and July 1994. However, with the implementation of the new currency, the Real, at that time, there was a quick appreciation of the real exchange rate, which was kept until the end of the study sample period.

Baumgarten (1996) estimates the ERER for Brazil based on the model of Elbadawi (1994), using the annual real exchange rate from 1964 to 1995, deflationed by three different domestic price indices: one called wholesale price index (IPA-DI) to obtain a measure of competitiveness of domestic goods; another one known as national consumer price index (INPC) to measure the relative prices between traded and nontraded goods; and also an intermediate measure, the general price index (IGP-DI). Although only the coefficient of government spending was significant in the estimation, all the estimated signs were in agreement with the theoretical model in the three cases. Specifically, positive variations of government spending, capital flow, and terms of trade tend to generate real appreciation of the long-run exchange rate. On the other hand, an increase in the degree of openness generates an expectation of depreciation. In a subsequent step, an error correction model (ECM) is estimated. The error correction term of this model indicates an initially quick adjustment of the exchange rate misalignment to the real exchange calculated by IPA-DI and by IGP-DI (0.95 and 0.92 years to correct 50% of the deviations, respectively). However, the elimination of 99.9% of the deviation would take 9.5 (IPA-DI) and 9.2 years (IGP-DI), showing that the shocks to the real exchange persist in the long-run. For the exchange rate deflationed by INPC, the estimated adjustment periods for deviations of 50 and 99.9% would be higher: respectively, 2.5 and 25 years. The results are a bit different in the 1990’s. The real appreciation of the exchange rate starting in 1989 had a higher persistence when assessed by the exchange rate deflationed by INPC, which lasted until 1993, while such appreciation assessed by IPA and IGP was observed only until 1990 and 1991, respectively.

Goldfajn and Valdés (1999) estimated the equilibrium rate for 93 countries based on monthly data obtained between 1960 and 1994. Their objective was to assess the sustainability of an exchange rate system, administered through exchange rate appreciation periods. The estimation of long-run coefficients was made using the cointegrating vector between the real exchange rate and the fundamentals. These were filtered by Hodrick and Prescott (1997) method for ERER calculation. The fundamentals studied were the terms of trade, degree of economic openness, government spending and external long-term interest rate, and are consistent with those estimated by Ades (1997).

Holanda (1999) presents an ERER estimation for Brazil between 1975 and 1998, using quarterly data based on the model introduced by Edwards (1994)[3]. Long-run movements of real exchange would be associated with permanent fundamentals changes and the short-run dynamics would be determined not only by temporary shocks, but also by deviations of monetary and fiscal policies from their sustainable levels. The coefficients estimated in the model were output gains, terms of trade, government spending, capital and exchange rate control, monetary policy, fiscal policy and nominal depreciation of the exchange rate, which compose the fundamentals. In the long-run, the coefficients had the expected sign; however, in the short run, the political economy proxies were not significant, but were kept because they did not affect ERER results, since the model assumes long-run neutrality for such variables. The estimated exchange rate devaluation presented the inverted sign of the theoretical model that, according to the author, may be a result of a high indexation of Brazilian economy in a great part of the sample. This means that the devaluation of the nominal exchange rate would have a greater immediate effect on inflation rates than on the nominal exchange rate, leading to a real net appreciation in some periods. The estimated ECM, differently from Ades (1997), showed a low adjustment speed. The results of the estimated ERER show that at the beginning of the 1990's the exchange rate would effectively be close to its equilibrium level; however, it showed a slight devaluation that would last until mid-1996. The implementation of the Real would enhance this devaluation, but exchange rate would enter a process of gradual restoration, even though it continued to be undervalued until the end of the sample (in 1998).

3 The Theoretical Model

The theoretical model used to assess Brazil's ERER will be that developed by Montiel (1999), whose theoretical concept is widely used to estimate equilibrium exchange rates of developing economies due to its capacity of incorporating different characteristics in its analytical structure. Next, the model will be briefly outlined, only reinforcing the fundamental relationships between fundamental variables and the ERER.

The hypotheses of the model refer to a small and open country that is unable to affect world economy prices. Thus, the international interest rate is given. Other important prices, such as the terms of trade, can only be marginally affected and are irrelevant to other countries if domestic economy is large in any of the several tradables markets. In conformity with the long-run relationship, the prices are flexible and lead the economy towards equilibrium.

The real exchange rate is the relative price determined by the ratio between the prices of traded (T) and nontraded (NT) goods, expressed in domestic currency, according to equation (1).

$$R = \frac{E \cdot P_T^f}{P_{NT}}, \tag{1}$$

where R is the real exchange rate and E is the nominal exchange rate, defined as the price in

[3] Holanda (1999) also estimates the ERER by the PPP and by the method of Bayoumi *et al.* (1994), which were left out for space reasons.

domestic currency of a unit of foreign currency. The prices of T goods (P^f_T) are internationally defined and expressed in foreign currency and the prices of NT goods (P_{NT}) are set in domestic economy and expressed in Brazilian currency. This way, an increase in R represents a devaluation of the Brazilian currency, where T goods become relatively more expensive than NT goods.

The condition of internal balance can be summarized by the elimination of excess supply and demand of NT goods and, consequently, in the job market, according to equation (2).

$$y_{NT}(R) = c_{NT} + g_{NT} = (1-\theta)\cdot R \cdot c + g_{NT}\,, \tag{2}$$

where c is the total private spending and θ is the participation of T goods in total spending, with y_{NT} equivalent to the supply of NT goods under full employment. Baffes, Elbadawi and O'Connell (1999) use $y_{NT}(R, \xi)$, with ξ representing a measure of biased productivity shocks in favor of T[4] goods, that is, $\partial y_{NT}/\partial\xi > 0$, when the prices are given. From now on, this characteristic will be incorporated into the analysis, without greater implications for the analytical structure. As previously observed, we should also consider that $\partial y_{NT}/\partial R < 0$.

Using (2), together with the productivity parameter ξ, it is possible to implicitly find the real exchange rate that restores the internal balance, expressed in equation (3).

$$R = R(c, g_{NT}, \xi) \tag{3}$$

The reduction of private spending from an initially balanced situation implies exchange rate depreciation. This occurs because the excess supply of domestic goods that has to be eliminated by a change in the relative prices, promoted by the exchange rate, generates the substitution of spending that favors the demand for domestic goods. An increase in the biased productivity of T goods, in its turn, causes a fall in their prices when compared to NT goods. Similarly, a smaller public spending on NT goods would have the same effect.

The external balance is determined by a measure of the excessive spending in relation to the consolidated budget restriction of private and public agents. This balance can be expressed in the form of accumulated external debt liabilities, which reflect the current account flow. This calculation of the balance of payments represents a savings measure in relation to aggregate spending, that is, if domestic agents expend more resources than the national income allows, we will have a current account deficit. Therefore, the external reserves are being used to supply the lack of internal reserves.

So, it is possible to express the level of external balance of the economy in a steady-state equilibrium, considering the flow of payments in relation to the maintenance of an external debt stock, through equation (4).

$$\pi_W \cdot f^* = y_T(R,\xi) + (\rho + \pi_W)\cdot f^* - \{\tau^*[h(\rho + \pi_W + \varepsilon)] + \theta\}\cdot c - g_T \tag{4}$$

Equation (4) is the long-term condition for current account balances implying the maintenance of a constant real external debt stock. The amount of external debt correction by world inflation ($\pi_W \cdot f^*$) should be equal to the current account balance. The country's supply of exports is given by the domestic output of T goods (y_T) and the demand for imports depends on the levels of public (g_T) and private spending on these goods (term in c). Hypothetically, all transactions costs (τ)[5] are related to the private spending on T goods, representing the outflow of domestic resources combined with imports. On top of that, such costs positively rely on the time preference rate (ρ), world inflation (π_W) and on the exchange rate devaluation (ε). The flow of payments of the debt service must be such that the interest rate on the debt should equal the time preference rate[6], thus preventing explosive trajectories for the stock of debt.

Therefore, the implications for the ERER related to external economy are associated with the

[4] According to Balassa-Samuelson effect.

[5] In the equation, (*) represents the steady-state values of the variables.

[6] The correction of the debt by inflation would be canceled by the equivalent current account balance. Thus, we observe in the steady-state equilibrium that $\dot{f} = 0$.

variation in the output of T goods necessary for restoring the equilibrium. Negative shocks to the current account balance (or to the financing of these accounts), for example, an increase in spending, would cause exchange rate devaluation by enhancing output (and supply) of T goods and by discouraging the demand for imports. Also, an improvement in trade competitiveness alongside an increase in output (ξ) will induce exchange rate appreciation, which is necessary to realign the relative prices in the manufacturing sectors. This way, the demand for goods would be reduced and the external balance of the economy would be restored. Thus, when we consider the elimination of domestic and external excess demand and supply presented by equations (3) and (4), we reach a macroeconomic equilibrium, in which output and domestic spending are on the same level and there is no debt accumulation.

The implementation of terms of trade (TOT) in the theoretical model is relatively simple. TOTs are defined as the ratio between the price of exports and the price of imports. As far as the internal balance of the economy is concerned, the real wages among sectors will be determined not only by the real exchange rate, but also by the terms of trade. However, the allocation of manpower among sectors will undergo significant change, and T goods should be divided into exportable (y_X) and importable (y_M). This occurs because TOTs affect the incentives to the production of these goods in a different fashion. An improvement in the terms of trade stimulates the output of goods in the first group, but discourages it in the second group and in the sector of NT goods. The new internal balance is then defined by:

$$y_{NT} = y_{NT}\{L_{NT}[w(R,\xi,\phi)\cdot R]\} \quad \Rightarrow \quad y_{NT}(R,\xi,\phi) = c_{NT} + g_{NT}, \tag{5}$$

where TOTs are represented by ϕ. The condition of external balance is then represented by equation (6), in which g_M indicates government spending on importable goods.

$$\pi_W \cdot f^* = \phi \cdot y_X(R,\xi,\phi) + y_M(R,\xi,\phi) + (\rho + \pi_W)\cdot f^* - \{\tau^*[\bullet] + \theta\}\cdot c - g_M \tag{6}$$

Similarly, it is possible to include the trade policy (η) in the analytical structure if it is defined as the ratio between the average of the net import and export tariffs[7]. The effects are similar to those of TOTs, with a specific difference in terms of control. While TOTs result mainly from market forces (price setting), the trade policy is designed by the government. Nevertheless, this last variable may assume different forms of a mere imposition of tariff rates or subsidies, such as physical restrictions (quotas) or regulation (nontariff barriers). To determine the ERER, it is interesting to consider these forms separately, according to equation (7) below.

$$ERER = erer\left[\overset{-}{g_{NT}}, \overset{+}{g_T}, \overset{+}{r\cdot f^*}, \overset{+}{\tau^*}, \overset{-}{\xi}, \overset{-}{\phi}, \overset{-}{\eta}\right] \tag{7}$$

This equation defines the ERER that will be estimated next. The signs on top of the variables denote the partial derivative of the equilibrium exchange rate. Following the previously observed relationships, we note that the appreciations of the ERER are associated with the increase in government spending on NT goods and on output gains (positive bias in favor of T goods). On the other hand, the ERER depreciations would be a result of increased public spending on T goods, higher transactions costs and increased payment of debt service (given $f^*<0$). The least protectionist trade policy (reduction of subsidies or tariffs) ends up causing the depreciation of the ERER, since the economy tends to generate trade deficits. An improvement of TOTs tends to create an ambiguous result. The best price received from exports causes an increase in the domestic income in terms of importable goods (income effect), which has the tendency to generate an ERER appreciation in order to shift the demand towards the external sector and restore the equilibrium level of the domestic market. However, the replacement of domestic goods with foreign goods (substitution effect) causes ERER depreciation so as to restore the trade balance. The empirical regularity, however, shows that the second effect will unlikely be strong enough to reverse the first

[7] We should consider that the mean rates are expressed differently: the import tariffs are positive ($1+t_m$), whereas the export subsidy is regarded here as a negative tariff ($1-t_x$). This justifies the placement of the latter in the denominator of the definition, so as to make the analysis comparable to that of TOT.

one, which is shown in equation (7). In the case of trade policy, the increase of subsidies will not likely generate ambiguity, since it must be compensated for an increase in taxes, maintaining the domestic aggregate income rate at a constant level.

4 Econometric Methodology and Data Used[8]

To extract the long-run relationships between the real exchange rate and the fundamentals, we will use the cointegration analysis. The methodologies developed by Engle and Granger (1987) and Johansen (1988) will be employed. The variables used as proxies for those presented in the theoretical model are shown next. The data were expressed in logs so as to directly estimate the elasticity of the real exchange rate in relation to the fundamentals. The fundamentals series were filtered by Hodrick-Prescott (HP) method, in order to indicate the permanent values of the variables for the ERER calculation.

The real exchange rate index was calculated using the deflation of the nominal exchange rate for the Real vis-à-vis the dollar (R$/US$) by the General Price Index (IGP-DI) and by the external inflation measured by the Producer Price Index (PPI), Bureau of Labor Statistics. A fixed-base index was used in 2000/IV=100, for this variable and all other fundamentals variables. The index of the degree of openness was calculated using the relative evolution of the Brazilian current of trade (exports plus imports, in US$ as of 2000/IV, deflationed by the PPI) in relation to the real rate of Brazilian GDP. Government spending was measured in R$ millions on a cash basis, and was deflationed by the IGP-DI for 2000/IV. The series for the payment of international interests (current account balance), in US$, was deflationed by the PPI for the values of 2000/IV. Given the high variability of flow between the quarters, we decided to use the mean of the two last observations. The biased productivity of T goods was calculated using the wholesale price index (IPA-DI) in relation to the consumer price index (IPC-DI). We tried to obtain estimates through the number of people employed in relation to the physical output, but the series referred only to the state of São Paulo. We opted for the structuralist hypothesis presented in Frisch (1983). In the end, the terms of trade were calculated using the price indices of exports and imports calculated by Funcex in its external trade bulletin, reflecting the ratio between the prices received from goods domestically produced outside the country and the prices paid by Brazilians for externally produced goods.

As to the political economy proxies used for the calculation of short-run dynamics, the domestic and external interest rate differential was obtained through the monthly distribution of annual rates of Over/Selic (Brazil) and of three-month T-Bill (United States) – which are two short-term rates. The series was obtained by dividing the Selic by the T-Bill rate, and the differential was expressed in % p.m. The monetary multiplier was directly obtained from the Brazilian Central Bank, which controls currency supply and the amount of obligatory bank deposits. Variations were calculated by the subtraction of the value of the variables in "t" for the value in "t-1".

The extraction of the "permanent" value for the series was made by Hodrick-Prescott (HP) filter, which is a smoothing method that became popular in macroeconomics after its use in Hodrick and Prescott (1997). Its main feature is the simple algorithm used for the extraction of long-run trends for univariate time series, functioning as a restricted linear filter, obtained from the minimization of the function $\sum_{t=1}^{T}(y_t - s_t)^2 + \lambda \sum_{t=2}^{T-1}((s_{t+1} - s_t) - (s_t - s_{t-1}))^2$.

This equation generates a series s_t, which is derived from y_t with the minimization of the variance of y around s. In addition, there is a parameter λ (penalty parameter) that restricts the second difference of s. This λ is the variable for controlling the smoothing of the estimated s_t series. If, for instance, $\lambda \to \infty$, s_t will converge to a linear trend.

[8] The data can be obtained through the Internet at: www.bcb.gov.br, www.fgv.br, www.bls.gov, www.ipeadata.gov.br and www.federalreserve.gov.

5 Empirical Results

The variables used in the model estimation to calculate the equilibrium real exchange rate are: level of real exchange rate deflationed by the general price index (L_EREAL), level of evolution of degree of Brazilian economic openness (LGA), level of government spending (LGGOV), amount of international interests paid on current account balances (LPAGJUROS), relative productivity level calculated from the price differential between nontraded and traded goods (LPRODUTIV) and level of Brazilian terms of trade (LTOT).

Two political economy variables were introduced to estimate the short-run dynamics through an error correction model (ECM): variation of the domestic and international interest rate differential (ΔDIFJUROS) and the variation of the monetary multiplier (ΔMULTMON). We opted to use the variation of these variables from one quarter to another, as we believe the signaling of economic policy in the short run is more important for the agents than the moments that immediately precede the current period. The long-term trend, that is, if the interest rate differential or the monetary multiplier is low or high, is already incorporated into the other fundamentals by means of indirect effects. Therefore, it is important to observe, regardless of this level, if the government is tightening or loosening its policy in comparison to the previous moment.

In this section, we present the estimation results for the model outlined in section 3. Equation (7) is explicitly written as shown in equation (10) so that the methods developed by Johansen and Engle & Granger are used.

$$\Delta L\_REAL_t = \alpha(\beta' F_{t-1} - L\_REAL_{t-1}) + \gamma_1' \Delta F_t + \gamma_2' X_t + \delta + \varepsilon_t, \qquad (10)$$

where

$$F_t = (1, Dummy89\_92_t, LGA_t, LGGOV_t, LPAGJUROS_t, LPRODUTIV_T, LTOT_t)'$$

$$X_t = [1, \Delta DIFJUROS_t, \Delta MULTMON_t]'.$$

Vectors F_t and X_t respectively represent the fundamentals and exogenous variables (economic policy). Dummy89_92 variable, which is an intercept variable, was introduced for the better performance of the estimated equation. The introduction of this dummy variable occurs in a moment characterized by two important facts. Firstly, the succession of economic plans between 1986 (Cruzado Plan) and 1991 (2nd Collor Plan), which caused the real exchange rate to shift away from its fundamentals, given the heterodox burden of exchange rate and price control during this period and the paradoxical rise of hyperinflation, in addition to the misalignment of these fundamentals in relation to their historical trends. Secondly, the economy is commercially and financially open, promoting the liberalization of trade and external capital flows[9].

In order that equation (10) can correctly specify the model to be estimated, all the involved variables have to be stationary. Table 1 summarizes the results of unit root tests for the variables series. We can observe that the fundamentals series had to be differentiated once to become a stationary variable

The set of variables was then tested for the presence of cointegrating vectors, that is, combinations between fundamentals that resulted in a long-run equilibrium relationship. The results can be seen in Table 1 and they indicate the existence of a cointegrating vector with a 5% significance level[10].

After establishing the existence of cointegration between variables, the next step is to estimate the model for obtaining the short- and long-run coefficients, in addition to the error correction parameter. The results obtained from the estimation of equation (10) are shown in Tables 4 and 5.

The equation was estimated by both Johansen and Engle-Granger methods. Table 3 shows the results of the cointegrating vector estimated for each case: Johansen (1) estimated with linear deterministic trend in the data and Johansen (2) as a specification similar to that of Engle-Granger,

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[9] Bonomo and Terra (1998) analyze the factors exposed here, pp. 16-17.

[10] The test also presents a significant value for the statistics calculated for at least six cointegrating vectors. However, given the non-significance of previous values, the result was ignored.

without linear deterministic trend.

Variable	ADF τ_μ		ADF τ_t		ADF τ		PP τ_μ	PP τ_t	PP τ	Order of integration
L_EREAL	-1.27	(0)	-2.17	(2)	-0.72	(0)	-1.35	-1.94	-0.68	I(1)
LGA	-2.01	(2)	-2.17	(2)	-0.41	(2)	-2.32	-2.36	-0.35	I(1)
LGGOV	-1.48	(1)	-2.91	(1)	0.81	(1)	-2.68	-5.22	0.97	I(1)
LPAGJUROS	-2.40	(0)	-2.45	(0)	0.45	(2)	-2.32	-2.38	0.61	I(1)
LPRODUTIV	-1.26	(1)	-0.79	(1)	1.78	(1)	-1.14	-0.70	1.23	I(1)
LTOT	-1.76	(0)	-3.21	(0)	0.22	(1)	-1.66	-3.20	0.16	I(1)
Δ DIFJUROS	-8.63*	(1)	-9.56*	(0)	-8.69	(1)	-10.03*	-10.01*	-10.11*	I(0)
Δ MULTMON	-9.64*	(1)	-9.60*	(1)	-14.59*	(0)	-16.72*	-16.66*	-16.63*	I(0)
Δ E_REAL	-8.14*	(0)	-8.10*	(0)	-8.16*	(0)	-8.13*	-8.08*	-8.15*	I(0)
Δ LGA	-8.48*	(2)	-8.75*	(2)	-8.51*	(2)	-11.80*	-11.99*	-11.87*	I(0)
Δ LGGOV	-8.03*	(2)	-8.09*	(2)	-15.75*	(0)	-18.10*	-18.12*	-17.85*	I(0)
Δ LPAGJUROS	-9.59*	(0)	-9.53*	(0)	-9.63*	(0)	-9.77*	-9.69*	-9.80*	I(0)
Δ LPRODUTIV	-6.61*	(0)	-4.09*	(2)	-3.95*	(2)	-6.59*	-6.63*	-6.48*	I(0)
Δ LTOT	-10.48*	(0)	-10.43*	(0)	-10.54*	(0)	-10.53*	-10.47*	-10.58*	I(0)

NOTE.: the numbers between parentheses indicate the number of lags included in the regression. (**) and (*) respectively denote a 5% and 1% significance level. The number of lags was based on adjusted F, R^2 statistics and Schwarz criterion.

TABLE 1 – Results of the unit root, Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests and the order of integration of the variables in the model .

Test assumption: Linear deterministic trend in the data
Series: L_EREAL DUMMY89_92 LGA LGGOV LPAGJUROS LPRODIGP LTOT
Exogenous series: D(DIFJUROS) D(MULTMON)
Lags interval: 1 to 1

Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypothesized No. of CE(s)
0.465831	134.5819	124.24	133.57	None **
0.374302	91.94299	94.15	103.18	At most 1
0.268681	60.05865	68.52	76.07	At most 2
0.187242	38.78111	47.21	54.46	At most 3
0.165768	24.68322	29.68	35.65	At most 4
0.111495	12.35863	15.41	20.04	At most 5
0.061553	4.319991	3.76	6.65	At most 6 *

*(**) denotes rejection of the hypothesis at 5%(1%) significance level
L.R. test indicates 1 cointegrating equation(s) at 5% significance level

NOTE.: The econometric EViews software shows critical values for the test of cointegration, disregarding exogenous variables.

TABLE 2 – Johansen maximum likelihood method

The best specification in each method and data set was chosen using Akaike and Schwarz criteria, sum of squared residuals (SSR) and standard error, in addition to R^2, all of which are shown in Table 3.

The calculation and analysis of the equilibrium real exchange rate will be made using the estimated elasticities. To do that, we chose the result of Johansen (1), since it employs the maximum likelihood method, which is asymptotically optimal for obtaining the cointegrating vector coefficients. Furthermore, by looking at Figure 1, we can observe the good long-run adjustment of this relationship to the real exchange rate series.

The coefficients of the equilibrium relationship presented the expected signs, with no exception, according to equation (7). It is possible to observe that, in the long run, greater degrees of openness, higher government spending, output gains and improvement of terms of trade are compatible with the appreciation of real exchange rate so that the internal and external balance of the economy is maintained. Likewise, the higher amount of spending on the payment of international interests produces real exchange rate devaluation in order to restore the equilibrium.

Fundamentals	Long-run coefficients (Cointegration)					
	Johansen (1)		Engle and Granger		Johansen(2)	
	Value	t-Student	Value	t-Student	Value	t-Student
Dummy89_92	-0.22	-7.67	-0.26	-9.34	-0.28	-11.10
LGA	-0.80	-6.73	-0.27	-2.58	-0.14	-1.19
Dummy_LGA	-	-	0.02	1.88	0.04	4.30
LGGOV	-0.36	-5.78	-0.12	-2.88	-0.40	-7.26
LPAGJUROS	0.37	6.48	0.40	7.89	0.59	10.26
LPRODUTIV	-1.50	-4.90	-2.08	-8.33	-2.17	-8.67
LTOT	-0.02	-0.11	-0.33	-2.32	0.25	1.57
Constant	15.10	-	15.62	15.98	13.04	-
R^2 =	0.32		0.95		0.28	
SSR. =	0.34		0.36		0.36	
Standard error eq. =	0.08		0.08		0.08	
Log likelihood =	83.75		81.48		82.14	
Akaike AIC =	84.08		-2.16		82.47	
Schwarz SC =	84.44		-1.90		82.83	

NOTE.: Estimation by Engle-Granger method - F = 167.2672; Durbin-Watson = 1.572886

TABLE 3 – Long-run coefficients for ERER in Brazil obtained by Engle & Granger and Johansen methods. Dependent variable: real exchange rate.

Except for the terms of trade, the other coefficients are statistically significant. However, we decided to maintain this variable for it appears in the theoretical model and, on the other hand, for its impact is rather small (a 10% improvement in the terms of trade would originate an appreciation of 0.19% in the exchange rate), with no significant distortion of the results. The empirical evidence suggests that the income effect generated by variations in external trade prices is quite close to the substitution effect, surpassing it by a small margin.

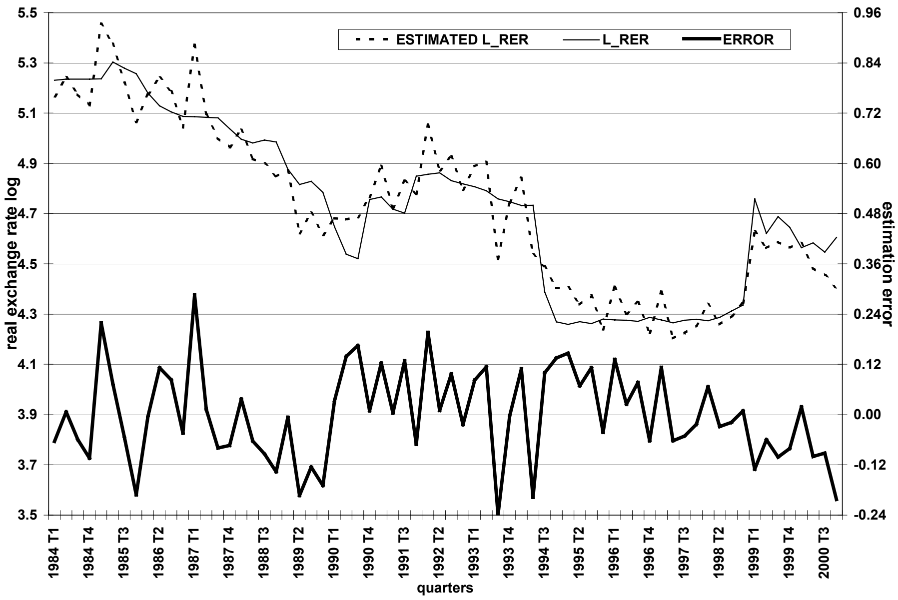

FIGURE 1 – Exchange rate (in logarithm): original series, series estimated by Johansen (1) method and estimation error.

Figure 1 shows a graph comparing the values of real exchange rate and the values estimated through the cointegration coefficient vector, and also shows the estimation error. We can observe that there are moments in which the estimated series shifts away from the exchange rate in relation to the original one, and we also perceive a constant oscillation of the estimated series. This, however, is not a problem, since theoretical construction gives long-run coefficients the role of normatively relating the fundamentals to the exchange rate in the long-run. Therefore, the estimation is made so as to clearly show the equilibrium relationship that underlies the fundamentals. In this study, we do not aim at achieving the perfect adjustment of the estimated series in relation to the original one.

As the meaning of the signs obtained from the estimation was already discussed, now we should comment on the magnitude of the coefficients we found. The exchange rate responds to approximately 80.2% of the variation in the degree of openness in the long-run, in the opposite direction. This means that if the Brazilian economy is 10% more open in relation to a previous period, the gross result will be a nearly 8% depreciation of the equilibrium real exchange rate necessary to restore the internal and external balance. This elasticity is high and is probably affected by the fact that the degree of economic openness in Brazil is more largely influenced by the increment of imports other than exports. This partly explains the tendency towards the devaluation of the real exchange rate in comparison with the ERER in the period subsequent to the beginning of the trade liberalization process (up to the implementation of Real), thus producing a strong antitrade bias on the Brazilian economy.

Government spending showed a negative relationship with long-run real exchange rate at a proportion of a 10% increase equivalent to approximately 3.6% of the equilibrium real exchange rate depreciation. The point is that in an increasingly open economy as is the case of Brazil, the income multiplier effect tends to put pressure on imports more quickly than on the output, thus deteriorating the trade balance and failing to push the level of employment to a higher level. The necessary correction of the trade balance would be related to devaluation, given the elasticity of government spending, which is estimated at 0.36.

The payment of interests has a contrary effect to that of government spending, since it reduces domestic income and therefore has a positive multiplier effect on the trade balance, usually improving it and calling for ERER appreciation. The similar magnitude, albeit inverse, suggests that the multiplier effects are quite similar when combined with the elasticity of Brazilian foreign trade, calling for proportionally similar depreciations/appreciations.

The exchange rate showed greater long-run sensitivity to productivity (biased in favor of T goods) among all fundamentals. This result suggests a strong influence of Balassa-Samuelson effect on the Brazilian real exchange rate. The magnitude of this coefficient is also suitable for the coincidence that the periods in which there were the greatest output gains are the same periods in which there was continued real overvaluation of the Brazilian currency.

Another important result regards the inclusion of a dummy variable. The estimation and analysis of the graph show how important the inclusion of this variable is. The tests carried out previously show that the use of the dummy variable improves the cointegrating relationship expressed in Table 3.

The results of the estimates taken as alternatives (EG and Johansen (2)) can be seen in Figure 2. By comparing their results with those obtained from the estimation chosen for the equilibrium real exchange rate calculation in the next section, it is possible to make some observations.

Looking at the EG estimation, we observe that: a) there was a greater change in the magnitude of the coefficients of government spending, output, and terms of trade, but all signs conform to the theoretical prediction; b) LGA variable was only significant with the introduction of a dummy variable (Dummy_LGA), used in a long time period (1985-I to 1994-II), which corrected the problems with the degree of openness in the estimation; in addition, the coefficient calculated for such dummy variable was approximately 0.0166 (the net effect of the degree of openness on this period is therefore approximately –0.249, still in agreement with the theoretical prediction); c) the terms of trade variable was significant at 5%; d) Durbin-Watson statistics is not conclusive about the fact that residuals are not correlated; however, the ADF[11] tests allow us to affirm that the

[11] The results can be obtained from the authors, along with Granger causality tests between real exchange rate and fundamentals,

observed combination is stationary.

a) Engle and Granger. b) Johansen (2).

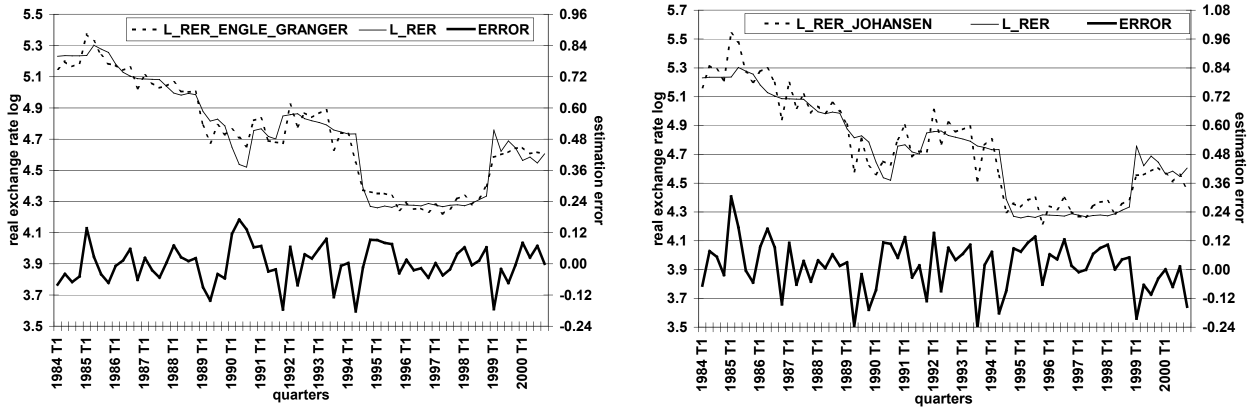

FIGURE 2 – Exchange rate (in logs): original series, series estimated by Engle-Granger and Johansen (2) methods and estimation error.

The results of Johansen(2), which uses the same specification of the EG estimation, show that the adjustment was not so good. In fact, the estimated series tends to vary more than the original one. The observations pertinent to this estimation may be summarized as: a) the degree of openness had a lower coefficient than that of the EG estimation, presenting a low t statistics, contrary to its dummy variable, which was significant in spite of its lower magnitude; b) the coefficients of payment of interests and of output were slightly greater than Johansen(1) estimation; c) the terms of trade showed inverted sign compared to the last two estimations, and the statistical significance of the coefficient stayed low (the positive sign may be theoretically accepted, being interpreted as the substitution effect dominating the income effect of an improvement in the long-run terms of trade).

The coefficients that rule the short-run dynamics are shown in Table 4. Among these, the coefficients of the political economy variables confirm what was already expected from them. The negative sign of the domestic and international interest rate differential is compatible with the uncovered interest parity, given the higher stability of international rates. In moments of appreciated real exchange rate in relation to its equilibrium level, it is necessary to increase the domestic interest rate in order to offset the expectations of loss of foreign capital invested in the country, resulting from the greater probability of devaluation. Such variable is important for the model, as it balances the monetary and exchange markets[12], considering market expectations, in addition to introducing a component of sustainability of capital flows (the lower the interest differential, the greater the possibility of having sustainable capital inflows).

The positive relationship between the real exchange rate and the variations in the monetary multiplier suggests that, in periods of tighter restrictions to the multiplication of monetary supply, usually associated with inflation control, part of the pressure regarding exchange rate increase can be withdrawn.

Finally, we should observe that the coefficient of adjustment estimated in Johansen (1) is represented in terms of the speed necessary to restore the equilibrium of the long-run relationship. In Table 5, we can observe it from two different points of view. We can observe that three quarters (nine months) are required so that 3/4 of the initial exchange rate misalignment can be eliminated. If we compare this with some other results, there is some similarity with the results obtained by Ades (1997), indicating that approximately four months are necessary to eliminate 50% of misalignment and that 99% of misalignment would only be eliminated after two years. On the other hand, Baumgarten (1996) and Holanda (1999) show a much slower speed of adjustment. Baumgarten

necessary for validating the estimation, according to Campbell and Perron (1991).

[12] According to Krugman and Obstfeld (1999), chapter XVI.

shows that a 50% elimination would take approximately 11 months[13] and that a 99% elimination would take a little bit longer than nine years, while the coefficient found by Holanda is –0.114, approximately 2.5 times less than the one obtained from the estimation in the present study. These different results may be attributed to the different proxies for the fundamentals that were used by each author; however, the discussion about which proxy is more appropriate to be used as fundamental goes beyond the aims of this study.

Fundamentals	**Short-run coefficients (Error correction model)**					
	Johansen (1)		**Engle &Granger**		**Johansen(2)**	
	Value	**t-Student**	**Value**	**t-Student**	**Value**	**t-Student**
ECM (adj.coef.)	-0.371	2.73	-0.589	4.67	-0.254	1.75
Δ E_REAL	-0.002	-0.02	-	-	0.068	0.47
Dummy89_92	-0.020	-0.33	-0.115	-2.40	0.024	0.40
Δ LGA	-0.020	-0.19	-0.119	-1.51	0.066	0.69
Δ Dummy_LGA	-	-	0.037	3.18	-0.009	-0.57
Δ LGGOV	-0.069	-1.37	-0.033	-0.95	-0.031	-0.63
Δ LPAGJUROS	-0.079	-0.90	0.273	3.79	-0.038	-0.37
Δ LPRODUTIV	0.932	1.14	-1.021	-1.63	0.460	0.59
Δ LTOT	0.145	0.92	-0.341	-2.60	0.221	1.35
Constant	0.008	0.82	-	-	-	-
Δ DIFJUROS	-0.004	-3.47	-0.0003	-0.30	-0.004	-3.46
Δ MULTMON	0.018	0.47	0.036	1.18	0.024	0.62
R^2 =	0.32		0.52		0.28	
SSR =	0.34		0.24		0.36	
Standard error eq. =	0.08		0.06		0.079	
Log likelihood =	83.75		95.72		82.14	
Akaike AIC =	84.08		-2.52		82.47	
Schwarz SC =	84.44		-2.19		82.83	

NOTE: the estimation test statistics are the same shown in Table 3 in the case of relationships estimated by Johansen, since this method calculates the coefficients in a single step.

TABLE 4 – Short-run coefficients for the correction of Brazilian ERER miscalculation, of the cointegrating vector.

a) calculation of the number of quarters necessary to eliminate a given % of misalignment

% corrected	t value (no. of quarters)
50	1.50
75	2.99
80	3.47
85	4.10
90	4.97
95	6.47
99	9.94

b) calculation of misalignment % eliminated every semester

quarters	α value (% corrected)
1	37.08
2	60.41
3	75.09
4	84.32
5	90.14
6	93.79
7	96.09
8	97.54
9	98.45
10	99.03

NOTE: the t and α values are calculated from $(1-\alpha)=(1-\beta)^t$.

TABLE 5 – Speed of adjustment of the real exchange rate to fundamentals calculated using the adjustment coefficient of 0.37077 (Table 3).

The terms of error correction estimated in EG and Johansen(2) showed greater differences

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[13] According to the real exchange rate calculated by IPA-DI and IPC-DI.

when compared to Johansen(1) estimation. As shown in the graph (Figure 3), the adjustment speed obtained by EG is much higher than that obtained by others. On the other hand, Johansen(2) produced a result that shows that approximately 20% of the initial misalignment would not be eliminated after 5.5 quarters. After one quarter, for instance, Johansen(2) presents a correction of only 25%, while EG and Johansen(1) would respectively eliminate approximately 60% and 37%.

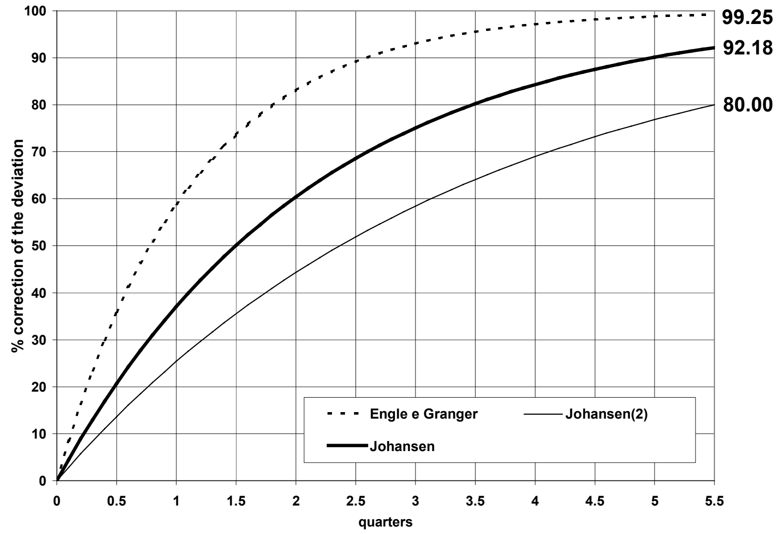

FIGURE 3 – Speed of adjustment of the real exchange rate to its level of equilibrium according to alternative estimations.

The results presented here show that the model estimated with the fundamental's proxies suggested in this study produce relatively robust results. As previously reported, there are problems associated with the terms of trade. However, most long-run relationships are preserved.

6 Measurement of the Equilibrium Real Exchange Rate for Brazil

To calculate the equilibrium real exchange rate, the fundamentals series were smoothed by Hodrick-Prescott (HP) filter, so as to control stochastic cycles and trends. Thus, we tried to obtain values close to the permanent fundamentals values. We therefore eliminate temporary values that shift the real exchange rate away from its equilibrium value. There are also other factors that produce misalignments, such as the influence of the economic policy over the exchange rate and prices, among others.

The decomposition of the fundamentals between permanent and temporary values was tested via ARIMA, according to Baumgarten (1996). Nevertheless, the resulting series closely mimicked the behavior of the original series, originating a very unstable ERER series, in addition to showing a tendency towards slight misalignments in periods of remarkable disequilibrium (for example, when the Real Plan was implemented).

The ERER calculation is made from the combination of estimated long-run coefficients ($\hat{\beta}'$), shown in the first row of Table 3,[14] and the fundamentals series filtered by HP ($\widetilde{F}_t$), according to equation (11).

$$L\_ERER_t = \hat{\beta}'\widetilde{F}_t \qquad (11)$$

After calculating the ERER index, we calculate the misalignment or appreciation of the real

[14] The ERER was also calculated using the coefficients of alternative estimations represented by EG and Johansen (2). The results were quite similar, except for two periods. Johansen(2) presented appreciated exchange rate almost throughout the period prior to 1989. In the moment after exchange rate liberalization, EG estimation showed equilibrium at the end of 2000 compared with under-valued positions of the two Johansen estimations. On the whole, there were some changes in magnitude, but the sign of the mis-alignment was the same for the three alternatives during most of the period. The results can be obtained from the authors.

exchange rate index in terms of equilibrium value using equation (12).

$$APPRECIATION(\%)_t = \left[\frac{EREAL_t - ERER_t}{ERER_t}\right] \times 100\,, \qquad (12)$$

where $EREAL_t$ is the real exchange rate index and *ERER* is the equilibrium real exchange rate. If $EREAL_t > ERER_t$, then the expression is positive and there is a real appreciation of the exchange rate. Otherwise, we observe a real devaluation of the exchange rate in terms of equilibrium level. The results obtained from the coefficients presented in Table 3 are shown in Figure 4.

Initially, by observing the ERER behavior in terms of the real exchange rate throughout the 1980's, we can briefly bring some interesting issues into discussion. First of all, we perceive that exchange rate misalignments in the 1980's tended to be weaker than those found in the 1990's. A more closed economic environment relegated the real exchange rate to a secondary role. Economic agents gave little importance to the nominal exchange rate, which served to informal indexation of the Brazilian economy, independently of the countless number of controls over trade, capitals and prices that were imposed at that time. Thus, the exchange rate was only relevant to the export sectors. Price stabilization in some periods originated supply shocks to the domestic output capacity[15], exerting no pressure on the exchange market for not restoring the demand for dollars in imports as an alternative to the domestic supply of goods.

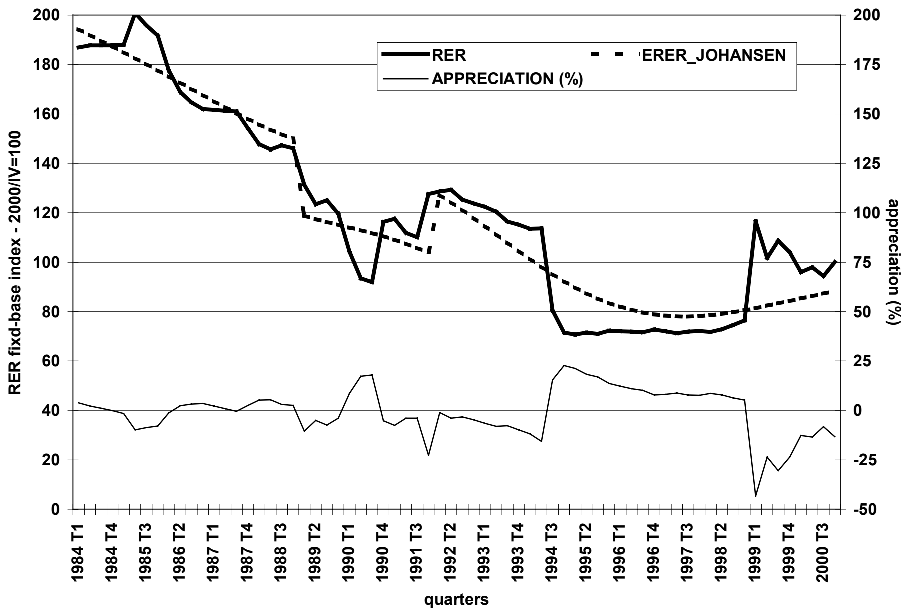

FIGURE 4 – Estimated Equilibrium Real Exchange Rate, real exchange rate (indices) and appreciation (in %) estimated by Johansen procedure. Brazil: 1984-2000.

In 1984 indexation scenario, with a stable real exchange rate, the fundamentals that control the ERER already showed the real currency appreciation, which, to be corrected, was submitted to minidevaluations in the following year. However, the inflexibility of the fundamentals at that time was already bringing the real exchange rate to a lower level, albeit at a slow pace. Even with a continuous appreciation trend during that decade, the high trade balances achieved by Brazil were more a consequence of imports control than of an exports dynamics.

The real appreciation provided by the Cruzado Plan in 1986, although it was low for the open economy standards, was significant for that period of time, when there was a strong dependence upon trade balances. Even with the high indexation of Brazilian economy at the end of the price

[15] The Cruzado Plan (1986) is important in this sense. With the increase in internal demand stimulated by frozen prices, the products quickly "vanished" from supermarket shelves and the cattle "disappeared" from the fields. People would stand in line to buy a car, which induced a black market premium over the price of products. In fact, this was a disguised price increase.

control period, there was a lag in nominal devaluations attached to price rises, thus maintaining real appreciation. In 1987, the government decided to stop paying external debt interests.

The year of 1989 was atypical: exchange rates, prices, and wages were frozen at the beginning of the year. That stabilized the real exchange rate, bringing it down to a level lower than that of the ERER in a moment when the economy was starting off a process of commercial and financial openness. The relative exchange market liberalization (dual exchange rate system) allowed for the gradual convergence of the exchange rate to its equilibrium level. However, that did not last long. Another economic plan (the Collor Plan) was announced in March 1990, once again deviating the exchange rate from the ERER[16].

Between 1993 and June 1994, given the strategy of total and instant indexation of the economy that preceded the Real Plan, exchange rate devaluation was restored.

The immediate real exchange rate appreciation that took place right after currency change from Cruzeiro Real to Real, in the second semester of 1994, was exacerbated by economic openness, reaching nearly 23% by the end of that year. At that time, the demand repressed by the previous high inflation rate was offset by imports, compelling the country's manufacturing sector to adopt a competitive adjustment approach, thus increasing the output of the tradables sector by approximately 25% more than the levels observed in the mid-1980's.

Actually, during the period that followed the Real Plan, the behavior of the fundamentals allowed the convergence of the ERER to the real exchange rate that resulted from the nominal administration through exchange bands. In addition to the enhanced degree of openness and stepped-up production (output), other fundamentals contributed to that up to the third quarter of 1997: reduced payment of interest rates (which would increase again later), improvement of the terms of trade (favored by shocks such as the worldwide oil price reduction) and a more predictable path for government spending, which still kept an unsustainable increase.

In spite of the gradual elimination of exchange rate misalignment in the exchange band regime, when overvaluation had already been reduced to 5.14% (practically the fourth part of the peak observed at the end of 1994), the successive international crises in the last few years[17] ended up reversing market expectations of Brazilian exchange rate. According to Holanda (1999), the exchange rate devaluation at the beginning of 1999 was not recommended in light of exchange rate adjustment. The same author pointed out that the real exchange rate appreciation in the second quarter of 1998 was 15%, that is, a level higher than the 7.89% rate observed in the present study. However, the market itself forced the Central Bank to devalue the exchange rate because of expectations generated by nonfundamental factors, regardless of the degree of exchange rate appreciation.

In the period subsequent to the exchange rate devaluation as of January 1999, we can clearly observe the overshooting of the exchange rate in real terms, which became evident in an environment of great emphasis on exchange market liberalization. The initial devaluation reached 43.25% in the first quarter of that year before following a path of convergence towards the ERER. At the end of 2000, the real exchange rate showed an undervaluation of 13.36%, with a downward trend[18]. This accelerated convergence between real exchange and equilibrium exchange is in conformity with the coefficient of error correction obtained from the estimation, which indicates that in eight quarters the misalignment residual should reach a bit less than 7% of its initial value. According to the estimated ERER, the residual underestimations (which still have to be corrected) would be approximately 18 and 30% for the third and fourth quarters of 2000, respectively. Another important factor for the quick elimination of this excessive devaluation was the devaluation of the ERER itself, produced by some significant changes in some fundamentals, which had been designed since the middle of 1998.

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[16] These results are in agreement with those observed by Cardoso (2000).

[17] Mexico (1994/5), Southeast Asia (1997) and Russia (1998).

[18] The irregular path of real exchange depreciation is a common overshooting phenomenon in the presence of floating exchange rate. The third quarter of 2000, for example, showed a devaluation rate lower than the last one, amounting to 8.15%.

The increased payment of international interest rates suggested a "structural" devaluation of the exchange rate, since the trade balance did not immediately respond to the nominal devaluation dictated by the market. Therefore, the capacity of currency supply was impaired. The concomitant worsening of the terms of trade of Brazilian economy (worldwide oil price increase and the price reduction of primary goods) also prevented the restoration of positive balances in world trade, calling for the generation of more reais for each exported dollar, that is, a permanent increase in the exchange rate. Similarly, the reduction in the degree of economic openness shows that there was not enough export dynamics in such a way that, by adding the effective reduction of imports, the trade balance could be stimulated.

The sudden reduction of the productivity is associated with the restoration of prices in the tradables sector. Also, the stabilization of the rate of unemployment, which had accelerated in 1998 (Figure 5), allowed reversing the expectations and boosting domestic spending. The depreciation of the ERER would then be associated with the necessity for compensation in the tradables sector, so as to make the external market more attractive than the domestic one. So, we turn back to the problem with fall of international prices and rising prices in the domestic market.

On the other hand, the excessive expansion of government spending averted a higher devaluation of the ERER. The increased demand by public spending required that imports be maintained so that a shortfall in the domestic supply of goods could be obviated. This would cause the equilibrium value of the real exchange rate to move downward.

Figure 5 shows the behavior of the unemployment rate, which is the most important component, along with inflation, of the internal balance. The comparison between the observed rate of unemployment and NAIRU (non-accelerating inflation rate of unemployment), which, just like the ERER is a latent variable, contributes important suggestions for the results of the present study. The NAIRU series was calculated by Tejada and Portugal (2002) and adapted to show the interval of one standard deviation around the estimated series, regarded as a band in which unemployment is considered to be in equilibrium. This way, we observe that the rise of inflation in the first half of the 1980's, which was not so strong as those detected between 1987 and 1994, is also in keeping with the exchange rate misalignment. Once again, we perceive the importance of the low degree of economic openness at that time, which did not allow the rise of inflation to bring on structural unemployment. As the economy gained higher economic and financial liberalization, NAIRU reached higher proportions in relation to the observed rate of unemployment, just like the deviations between the real exchange rate and the ERER.

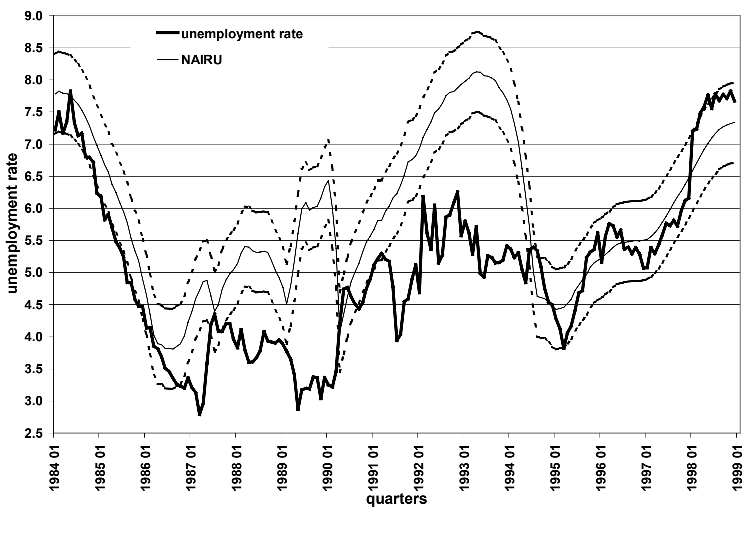
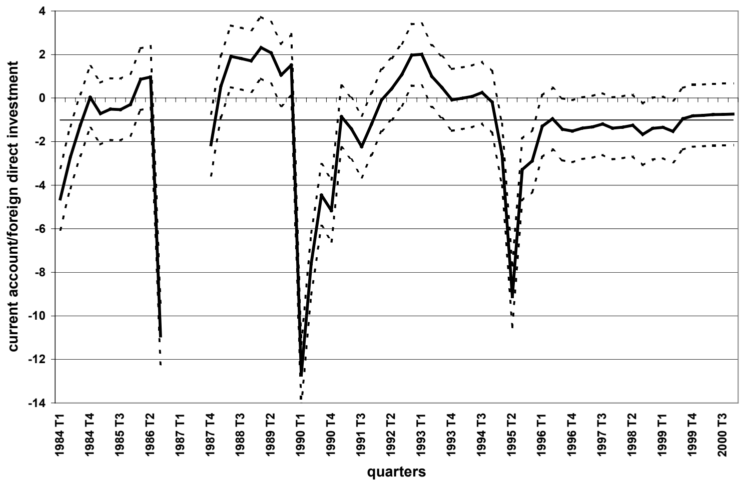


FIGURE 5 –Rate of Unemployment and NAIRU. Brazil (1984-1998).
SOURCE: adapted from Tejada and Portugal (2002).

We should underscore that some tests performed by Tejada and Portugal (2002) confirm that the fundamentals of the Brazilian economy suggested that some important variables, including the real exchange rate, were not in actual disequilibrium in the period before the exchange rate collapse, as pointed out by Holanda (1999) and the present study.

Figure 6 shows a criterion for the assessment of the sustainability of current account deficits, confronting them with the amount of direct capital inflows. The index is constructed such that the sustainable relationship is equivalent to -1 (implying current account deficits equivalent to the net capital inflow through direct foreign investment); in this case, the interval of one standard deviation should also be considered. The more negative the index was, the less direct investments would finance current account deficits. Again, we have the stabilization of the index with a value that is quite close to an equilibrium from the middle of 1996 onwards, after the implementation of the Real Plan. These factors regarding unemployment and external financing justify the convergence between the real exchange and the ERER in that time period; however, they should be further investigated.



NOTE.: the period between 1986/IV and 1987/III is not shown in the graph so that the graph scale is not twisted. The values that are not shown are 44.05 (86/IV), 60.70 (87/I), 157.04 (87/II) and -29.31 (87/IV).

FIGURE 6 – Relationship between current account balance and direct investment as a measure of Brazilian external balance (1984-2000).

SOURCE: Ipeadata.

Undoubtedly, there was convergence between the NAIRU and the observed rate of unemployment during this period. In this aspect, the data suggest internal balance of the economy. This, however, does not represent the whole, since the economy presented low growth rates, a fact that goes against the requirements of internal balance. It is therefore difficult to safely establish the internal balance of the period under study here.

With regard to the external balance, we opted for using the direct investment, since this capital flow is less volatile than the others, and is more conclusive about the sustainability of the current account balance. Even though this flow continued to increase[19] in the years after exchange rate oscillation, there is a great possibility that a large part of it will decrease in the medium-run unless a substantial economic growth takes place.

This apparent lack of internal and external sustainability of Brazilian economy justifies the non-normalization of the unobserved series (ERER) in the periods of sustainable equilibrium of the series, which contrasts with the suggestion made by Elbadawi (1994) and Baumgarten (1996). Even if the series is normalized, this would have to be applied to the period between 1996-1998, in which there is a consensus on the exchange rate disequilibrium. In spite of this, some simulations were

[19] According to the Brazilian Central Bank: US$ 26 billion (1998), US$ 26.9 billion (1999) and US$ 30.5 billion (2000).

carried out, but no *ad hoc* attempt resulted in misalignments that could be better interpreted than the ones presented here.

7 Conclusion

The aim of this study was to marginally contribute to the discussion about the exchange rate misalignment in Brazil. The excessive influence of the economic policy over variables was a common event throughout the 1984-2000 period. Perhaps 1999 and 2000 were the years in which economic freedom was more present. However, the excessive control over some periods in opposition to the total lack of control over some others greatly interferes with the relationship between the real exchange rate and its fundamentals. Even before estimating any long-run relationship, it was clear that we would not be able to establish reliable periods of sustainable internal and external balance simultaneously for Brazil within the proposed time period. The major results are concerned with three important observations:

a) Economic and financial openness substantially affected the deviations of the real exchange rate from its equilibrium level, since in an open economy the effects of foreign currency on demand and supply may be enhanced by the encouragement of external flow of capital or goods.

b) The speed of adjustment was similar to that obtained by Ades (1997) and a lot higher than those estimated by Baumgarten (1996) and Holanda (1999). The convergence between the real exchange rate and the ERER during the exchange rate oscillation period (two years) partially corroborates the hypothesis of a quicker error correction when market forces are less influenced by heterodox economic policies.

c)The Real Plan was implemented at a favorable time for Brazil as far as the fundamentals that control its economy are concerned. Even with increased control over the nominal exchange rate after a great appreciation following the implementation of the Real Plan, especially until the middle of 1997, the fundamentals presented a behavior that made the ERER converge towards the real exchange rate, thus reducing appreciation at the end of 1998 to the fourth part of that observed at the end of 1994.

Therefore, the results presented here underscore the important role of the market in determining an exchange rate that is close to its equilibrium level. These results also support the belief that the exchange rate devaluation as of January 1999 stemmed from a herd behavior, induced by adverse expectations created by non-fundamental factors: a typical second-generation exchange rate crisis.

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