DISCUSSION PAPERS

THE LONG-TERM "OPTIMAL" REAL EXCHANGE RATE AND THE CURRENCY OVERVALUATION TREND IN OPEN EMERGING ECONOMIES: THE CASE OF BRAZIL

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Contents

List of tables

List of figures

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André Nassif, * *Carmem Feijó* ** *and Eliane Araújo* ***

Abstract

We present a Structuralist-Keynesian theoretical approach on the determinants of the real exchange rate (RER) for open emerging economies. Instead of macroeconomic fundamentals, the long-term trend of the real exchange rate level is better determined not only by structural forces and long-term economic policies, but also by both short-term macroeconomic policies and their indirect effects on other short-term economic variables. In our theoretical model, the actual real exchange rate is broken down into long-term structural and short-term components, both of which may be responsible for deviations of that actual variable from its long-term trend level. We also propose an original concept of a long-term "optimal" real exchange rate for open emerging economies. The econometric models for the Brazilian economy in the 1999–2011 period show that, among the structural variables, the GDP per capita and the terms of trade had the largest estimated coefficients correlated with the long-term trend of the RER in Brazil. As to our variables influenced by the short-term economic policies, the short-term interest rate differential and the stock of international reserves reveal the largest estimated coefficients correlated with the long-term trend of our explained variable. The econometric results show two basic conclusions: first, the Brazilian currency was persistently overvalued throughout almost all of the period under analysis; and second, the long-term "optimal" real exchange rate was reached in 2004. According to our estimation, in April 2011, the real overvaluation of the Brazilian currency in relation to the long-term "optimal" level was around 80 per cent. These findings lead us to suggest in the conclusion that a mix of policy instruments should have been used in order to reverse the overvaluation trend of the Brazilian real exchange rate, including a target for reaching the "optimal" real exchange rate in the medium and the long-run.

I. INTRODUCTION

One of the most controversial topics in recent economic literature concerns the determinants of the real exchange rate (RER). At least two alternative theories dispute arguments on how to establish the long-term RER: the more traditional theory of purchasing power parity (PPP) and Williamson's (1983) alternative concept of the real exchange rate denoted by the fundamental equilibrium exchange rate (FEER). Nonetheless, in spite of the lack of theoretical consensus on how to determine the real exchange rate, empirical literature has shown that exchange rate overvaluation has negative effects on long-term

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economic growth (Razin and Collins, 1999; Dollar and Kraay, 2003; Prasad, Rajan and Subramanian, 2006; Gala, 2008). Rodrik (2008) and Berg and Miao (2010) went further and showed empirical evidence that not only does overvaluation damage growth, but also that undervaluation benefits growth. Also, Williamson (2008) suggests that "the very best policy (in terms of maximizing growth) appears to be a *small* undervaluation" (p. 14, italics from the original) and concludes: "The evidence that overvaluation hurts development is now sufficiently strong to merit being reflected in policy, including delay to capital account liberalization where it appears likely to threaten overvaluation" (p. 24).

Yet, one of the main implications of the Mundell-Fleming model is that small economies under a floating exchange rate regime and free capital mobility face greater volatility in their nominal exchange rates. Indeed, since nominal exchange rates are highly volatile over short periods and nominal prices are rigid, there is evidence that nominal and real exchange rates are correlated almost one to one in the short-term (Flood and Rose, 1995). As Aizenman, Chinn and Ito (2010) show, emerging Asian countries have been relatively successful in reducing the high volatility of their nominal exchange rate by purchasing large amounts of international reserves. However, the room to manoeuvre in this area is very limited in Brazil because, due to continuing high interest rates, the cost of sterilizing the monetary impact of purchasing international reserves by the Central Bank has negative impacts on gross public debt.

The Brazilian currency, in particular, has shown a trend of real overvaluation since inflation was controlled in the mid-1990s. After 2004, this trend became stronger, and it has intensified since the aftermath of the 2008 international financial crisis, given the increase in capital flows from advanced economies into fast growing emerging economies. This trend has only been interrupted by either internal or external shocks. In this sense, the foreign scenario of increased capital volatility in a financially integrated world exacerbates the trilemma of economic policy for Brazilian policy-makers, that is to say, the difficulty of balancing the competing objectives of economic policy: price stability, exchange rate stability and free capital mobility.

To shed some light on how to reach the mix of policies that would allow for an improvement in policy space in emerging economies, our aim in this paper is to present a Structuralist-Keynesian approach in which the real exchange rate, instead of being explained by macroeconomic fundamentals linked basically to market forces, is better explained by not only long-term structural forces like market competition but also short-term economic policies. We also present an econometric model that captures the main explanatory variables of the real exchange rate in Brazil in the 2000s. In our empirical model, which covers the 1999–2011 period and uses monthly data in the econometric implementation, the policy space can be inferred from the importance that each group of variables – either those linked to the structural functioning of the economy, or those related to short-term economic policies – has in explaining the real exchange rate.

We also introduce an original concept of long-term "optimal" real exchange rate. As far as we know, this concept has not been raised before in international economics. This new theoretical concept is used to refer not to a long-term equilibrium real exchange rate as disseminated by the conventional theoretical literature on the subject (such as PPP theory, for instance), but rather to a long-term reference real exchange rate which is able to reallocate the productive resources towards the sectors with the highest productivity and, considering everything else equal, directs the economy as a whole towards technological and economic catching-up in the long run. In accordance to the empirical evidence on the relationship between the real exchange rate and growth for open emerging economies, the long-term "optimal" level for the RER must incorporate a small undervaluation. We will argue ahead that the "optimal" level might (and should) be, at least partially, targeted.

The remainder of the paper is organized as follows: section II analyses the economic policy dilemmas that policy-makers in emerging economies have to face to avoid large real exchange rate deviations from their long-term "optimal" level in an economy with a floating exchange rate regime and free capital mobility. Section III briefly discusses the theory of the determination of a real exchange rate and

proposes a Structuralist-Keynesian theoretical model that better explains the determinants that cause the actual real exchange rate to deviate from its long-term "optimal" level in open emerging economies, like Brazil. Section IV presents the econometric evidence for Brazil in the 2000s. Section V draws the main conclusions and discusses some policy implications for Brazil.

II. FLOATING EXCHANGE RATES REGIME AND FREE CAPITAL MOVEMENTS: ECONOMIC POLICY DILEMMAS FOR EMERGING ECONOMIES

In open financially integrated economies, the exchange rate plays a fundamental role in macroeconomic policy as its level and volatility affect not only inflation, but also the balance of payments, investment decisions and economic growth. Economic literature on growth suggests that, unless the so called Harrod-Balassa-Samuelson effect is considered, continuous real overvaluation of the exchange rate does not favour economic growth. Given this assumption, this section provides analytical arguments to further investigate which mix of short-term economic policies could favour growth strategies with exchange rate stability. Our theoretical concern is directed to emerging economies that face greater difficulty in the macroeconomic adjustment of the exchange rate, given their higher vulnerability to the external movement of capital flows.

A. The "impossible trinity" and issues for emerging economies

Nowadays, most emerging countries adopt a floating exchange rate regime. The theoretical literature suggests that, under a system of flexible exchange rates, both the autonomy of monetary policy and low volatility of interest rates could be assured, because this policy instrument could not be used to stabilize the exchange rate. In practical terms, however, given the great financial integration among economies, monetary autonomy is not observed (Greenville, 1998). In addition, the recent international experience has shown that emerging countries actually intervene in their foreign exchange market in order to offset violent movements in the exchange rate, configuring an intermediary floating exchange rate regime. Actually, central banks interfere in the foreign exchange market every time they choose to reach a macroeconomic goal. The success of such interventions in reducing exchange rate volatility or eliminating the misalignment (especially overvaluation) can be evaluated according to the policy space that monetary authorities have to implement counter-cyclical measures aimed at increasing output and employment while reducing external vulnerability. This space is reduced when short-term economic policy has to be used to restore the equilibrium of the balance of payments (Ocampo and Vos, 2006).

By discussing how some emerging Asian countries have tried to reduce high volatility of their nominal exchange rate, Aizenman et al. (2010: 2) argue that "a country may simultaneously choose any two, but not all, of the following three goals: monetary independence, exchange rate stability and financial integration. This argument, if valid, is supposed to constrain policy makers by forcing them to choose only two out of the three policy choices." In this sense, they present the trilemma of economic policy that implies the choice of a mix of possibilities among different degrees of autonomy of monetary policy, foreign exchange intervention and capital mobility. However, Aizenman et al. showed sound econometric evidence that, since the Asian crisis of 1997, most Asian countries (except China), even without giving up a floating exchange rate regime and freedom of capital movements, have been very successful in by-passing the "impossible trinity" through an aggressive policy of accumulation of international reserves. In other words, rather than a dirty floating exchange rate regime like most Latin American countries (including Brazil), the Asian countries have, in practical terms, an administered floating exchange rate regime.

The logic of the Mundell-Fleming model states that the choice of the exchange rate regime has implications on how domestic prices and the balance of payments are kept in equilibrium. However, Mundell (1960) had already observed that, since the internal stability of a model with a floating exchange rate and capital mobility depends on the manipulation of the interest rate, this latter instrument affects the stability of

domestic prices in an indirect way. The change in the interest rate aimed at controlling aggregate demand affects, first, the short-term capital flow, which in turn affects, albeit with some time lag, the exchange rate which, in turn again, is adjusted to restore the equilibrium in the market of goods and services as well as the balance of payments. In this way, in economies that are open to free capital movements, the transmission mechanism of the monetary policy operates through the exchange rate.[1] This occurs because the sensitivity of the adjustment in the market of goods and services is inferior to the sensitivity of the changes in the capital movements to the interest rate.

Moreover, since many emerging economies are characterized by some specificities such as non-convertible currencies, high volatility in the capital flows as well as recurring and persistent current account deficits, their operation of a floating exchange rate regime is often associated with high volatility in the nominal exchange rate, which leads to systematic interventions in the foreign exchange market. These interventions can be justified as a defensive measure to respond to the greater sensitivity that emerging economies have when it comes to external shocks and does not necessarily mean a "fear of floating", as Calvo and Reinhart (2002) argued.[2]

In fact, particularly in the case of Brazil, the "fear-of-floating" argument seems to be misleading when it comes to explaining the large positive difference between domestic and external interest rates. As Silva and Vernengo (2009) argue, since the inflation rate target regime was introduced in Brazil in 1999, Brazil's Central Bank has managed the monetary policy in a very conservative way.[3] In practical terms, its only goal has been to keep inflation rates low and very close to target. The authors conclude that, in the case of Brazil, rather than a "fear-of-floating" behaviour, Brazil's Central Bank has presented a "fear-of-inflating" behaviour, meaning that this assumption would better explain the very high short-term interest rate differential.

Given the considerations above, two stylized facts that narrow the policy space of economic authorities in emerging countries can be formulated:

1. *Unstable expectations in relation to the exchange rate contribute to exchange rate appreciation in emerging economies*

The uncovered interest rate parity ($i = i^* + e^e$) determines that the domestic interest rate, *i,* is equal to the international rate, i^*, plus the expectation of exchange rate depreciation, e^e. This latter variable, in turn, is affected by many factors, especially by the country's risk premium. Thus, when the country's risk premium increases, the domestic currency is expected to depreciate ($e^e > 0$).[4] This means, on the one hand, if high instability in the foreign exchange market is observed, the threat of depreciation puts pressure on the domestic interest rate to keep domestic assets attractive. This suggests a positive correlation between the short-term interest rate differential and the nominal (and real) exchange rate.

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[1] For specific transmission channels of monetary policy in emerging economies, see Bhattacharya et al. (2011). They found strong evidence that the exchange rate is the main transmission channel for monetary policy in India.

[2] Consistent with the uncovered interest rate hypothesis, this would suggest a positive correlation between expectations of exchange rate depreciation and an increase in the domestic interest rate, in the assumption that the international interest rate remains unchanged.

[3] As an example of the conservative manner in which Brazil's Central Bank manages the monetary policy, after the outburst of the global financial crisis in September 2008, Brazil's basic interest rate (*SELIC*) was maintained at 13.75 per cent p.a. until January 2009, even taking into account the recessionary environment in Brazil. See Nassif (2010) for a comparative analysis between India and Brazil about this issue.

[4] The uncovered interest rate parity can also be expressed as i = i* + e^e + CR, where CR is the country's risk premium (Rivera-Batiz and Rivera-Batiz, 1994). This expression makes it clearer that the final impact of an unexpected increase in the country's risk premium (e.g., following an external shock) is, through its effect on the expectations for domestic currency depreciation, to augment the domestic interest rate.

On the other hand, as soon as the foreign exchange market is stabilized again, an appreciation of the exchange rate is expected in response to the manipulation of the domestic interest rate by the central bank to avoid currency depreciation. The systematic increase in the short-term interest rate differential represents an additional incentive to sustain the exceeding flows of foreign short-term capital, especially those of a speculative nature. In practical terms, according to this stylized fact, since foreign investors tend to bet on the appreciation trend of currencies in emerging economies in the near future, the use of these currencies for carry-trade strategies implies that the uncovered interest rate parity is explicitly violated in the short term. That is to say, instead of reflecting expectations of depreciation, this fact reveals that the higher the interest rate differential, the greater the expectation that the domestic currency will continue to appreciate. So, in this case, the effect of an increase in the interest rate differential on exchange rate appreciation occurs with some time lag due to the attractiveness of large short-term capital inflows. This tendency will only be interrupted by sudden stops.[5] The trend in favour of over-valuating the real exchange rate has also been pointed out by Obstfeld (2008). According to the author, taking into account the short-term nominal price rigidities, another collateral effect of the floating exchange rate regime with free capital mobility in emerging economies is that changes in worldwide demand for assets or domestic products are quickly translated into an overvaluation of the real exchange rate.

2. *Excess of international liquidity pushes foreign capital towards open emerging economies and deteriorates gross public debt*

When international liquidity is plentiful and the inflow of foreign capital exceeds the necessity to finance balance of payments equilibrium, foreign reserves will increase. This increase, given the interest rates differential, implies financial loss for the country, on one hand, and an increase in the gross public debt, on the other, that is equal to the part of the reserve that has been sterilized. This means policy-makers face a trade-off between purchasing international reserves to avoid a large real overvaluation of their currency and, since they have to sterilize the monetary impacts of that policy, absorbing this extra burden on gross public debt. The foreign reserve accumulation policy could also aim at building a net safety to prevent negative consequences in capital inflows in the long-term. Nonetheless, this policy has a clear negative impact on domestic fiscal policy. Also, it should be noted that the increase in the gross public debt has a negative effect on the country's risk premium. In this case, the assumption is that a higher gross public debt/GDP ratio increases expectations of exchange rate depreciation, which in turn puts pressure on the domestic interest rate.

III. THEORETICAL DETERMINANTS OF THE REAL EXCHANGE RATE: STRUCTURAL AND SHORT-TERM VARIABLES

At least two theories compete to offer the most convincing hypothesis that explains both the determinants of the real exchange rate equilibrium in the long-term and the causes of deviations of this trend in the very short term: the theories of purchasing power parity (PPP), and the fundamental equilibrium exchange rate (FEER). The PPP theory, which defines the real exchange rate as the relative price of a common basket of goods traded between two countries converted into the same *numeraire*, predicts that in an ideal world without any nominal price rigidity, transport costs, trade barriers or other short-term disturbance, that ratio should be equal to 1. Since the hypothesis under the absolute version of the PPP theory is difficult to hold, the relative version of the PPP theory is more accepted, and it can be defined as (all variables in logarithms):

$$RER = e - (p - p^*) \tag{1}$$

where: *RER* is the real exchange rate;

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[5] On the use of the Brazilian currency (the *real*) in carry-trade strategies over the last few years, see Kaltenbrunner (2010).

> e is the nominal exchange rate (defined as the domestic currency price of foreign currency);
> p and p^* are the domestic and foreign price levels, respectively.

This definition implies that a fall in both nominal and real exchange rates is an appreciation. In a study on the PPP theory, Taylor and Taylor (2004) showed that there is now (more than in the past) sound evidence that the PPP remains valid in the long run. However, they also stressed that empirical studies have shown a strong reversion of the real exchange rate equilibrium over time. Therefore, for an econometric study not to show a biased result, it is important to incorporate variables that can capture structural changes in the economy, such as the so-called Harrod-Balassa-Samuelson effect and the terms of trade.

The former refers to a tendency of a country that shows higher changes in productivity of tradable goods compared with non-tradable ones relative to the world economy to have higher price levels, that is to say, a real exchange rate appreciation. As Obstfeld and Rogoff (1996) concluded "the famous prediction of the Harrod-Balassa-Samuelson proposition is that price levels tend to rise (that is, the real exchange rate over time tends to appreciate) with country per capita income".

The terms of trade (ToT) is another important variable associated with changes in the long-term structural behaviour of the real exchange rate. According to Baffes et al. (1999: 413) "an improvement in the terms of trade increases national income measured in imported goods; this exerts a pure spending effect that raises the demand for all goods and appreciates the real exchange rate".[6] Edwards (1989) comments that most authors are used to establishing a negative relationship between the ToT and the real exchange rate. He also agrees that an improvement in the terms of trade, by augmenting the real income, results, in fact, in an increasing of the demand for non-tradable goods and, therefore, in a real exchange rate appreciation. However, Edwards (1989: 38) emphasizes that "a problem with this view is that the income effect is only part of the story (…) and both income and substitution effects, as well as intertemporal ramifications, should be analysed". In other words, if the net income effect of an improvement of the ToT on the RER is positive, there will be a real exchange rate appreciation. This tends to be the immediate effect of the improvement in the ToT on the RER. However, after some time, the initial increase of the real income provoked by favourable ToT might be followed by replacement of the non-tradable goods for tradable ones. If this is the case, the substitution effect will prevail on the income effect and, given the increase of the relative prices of tradable goods, the impact on the RER will be depreciation. In other words, the expected effect of the ToT on the RER is ambiguous.

The FEER theory, on the other hand, was proposed by Williamson (1983) to connect either the medium or the long-term equilibrium real exchange rate (the so-called *fundamental* one) with the current economic policy. It should be considered that both PPP and FEER theories were developed within the mainstream framework of the determination of the real exchange rate. In both approaches, the role of economic fundamentals is essential for explaining the movements of the real exchange rate in the long run. However, the forces that deviate the real exchange rate from its "fundamental" long-term equilibrium are explained by either very short-term price rigidity or monetary and real shocks, or any other market disturbances.

Although a heterodox approach is not discussed in international economics textbooks, there has been some effort to propose an alternative theoretical framework in both Structuralist and Keynesian literature. In the first line of research, Bresser-Pereira (2010) proposes a Structuralist approach to explain that in a

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[6] For a formal treatment, see Obstfeld and Rogoff (1996).

world with floating exchange rate regimes and high freedom of capital movements, currencies of emerging economies have a chronic tendency to overvalue rather than undervalue.[7]

Bresser-Pereira (2010) classifies his approach as Structuralist because this tendency to overvalue is driven by one (or both) of the following two structural forces:

(i) the Dutch disease, which makes countries rich in natural resources to chronically overvalue their currencies in real terms; and

(ii) the attractive power with which countries scarce in capital absorb large amounts of short-term capital inflows.

The author does not reject the existence of an equilibrium real exchange rate, but, different from the mainstream approach where there is only one equilibrium real exchange rate, Bresser-Pereira's hypothesis opens room for the existence of two equilibrium real exchange rates: "an industrial equilibrium" exchange rate which could move the economy towards the international technological frontier and a trajectory of faster economic development, and, in the case of those countries which suffer from the Dutch disease, "a current equilibrium", that is, an exchange rate that tends to overvalue as it deviates the economy from the technological path consistent with economic development (Bresser-Pereira, 2010: chapter 4). As long as the real exchange rate appreciation movement persists, both structural forces and inconsistent short-term economic policies end up driving the economy to generate increasing current account deficits that will only be adjusted by a balance of payments crisis and a disruptive overshooting of the nominal and real exchange rate.

In normative terms, Bresser-Pereira and Gala (2010: 25) argue that while for "the conventional wisdom, exchange rate policy must be flexible in such a way that monetary authorities should have neither a goal nor a policy for the exchange rate", for the Structuralist view in a world relatively open to capital flows, "although the exchange rate regime must be flexible, the Central Bank should (and must) pursue the so-called industrial equilibrium exchange rate".

Another alternative view on the determination of the real exchange rate behaviour is offered by the Keynesian literature. Considering that there is no economic forces strong enough to guarantee that an economy will move towards equilibrium positions in the long- term (the long-term is the sum of a sequence of short-term events), the Keynesian theory rejects the distinction between long-term and short-term equilibrium exchange rates.[8] Following this, even knowing that the Keynesian literature on the theme is very scarce, Kaltenbrunner (2008) argues that, instead of market forces driven by fundamentals, real exchange rates are essentially explained by short-term capital flows.

As a matter of fact, Keynes (1923) had already recognized that short-term capital flows are one of the main transmission channels of interest rates differential between countries and exchange rate movements. However, rather than believing that this relationship would be based on the traditional uncovered interest rate parity, Keynes emphasized the role of the agents' forecast confidence (Harvey, 2006). As Harvey (2006: 397) states:

> ... the uncovered interest rate parity deviation is a forecast, and forecasts are never certain. In general, the more confidence agents have in their predictions, the more funds they are willing to commit in

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[7] In an e-mail sent to one of the authors of this paper, Professor Bresser-Pereira argued that the term "misalignment" is misleading when referring to the actual level of the real exchange rates of these economies, for the general tendency is to overvalue. In other words, "misalignment" would be a shadow term for overvaluation. As will be shown ahead, instead of "misalignment", we will use the expression "deviation of the actual real exchange rate from its long-term trend level" and will also estimate, in turn, the long-term "optimal" real exchange rate for the Brazilian economy.

[8] This does not mean that the Keynesian approach rejects the existence of an "optimal" real exchange rate, but that this indicator is essentially determined and influenced by economic policies.

speculation. The more realistic way to incorporate this into this model would be to make capital flows (for a given uncovered interest rate parity deviation) go from a trickle to a strong flow as forecast confidence increased.

Similar to both Structuralist and Keynesian literature on the theme, we propose a model that rejects the long-term variables determined by "fundamental" forces as required by the PPP and FEER theories. In our Structuralist-Keynesian theoretical framework, we consider two groups of variables: the first expresses long-term structural forces; and the second represents a set of variables directly or indirectly influenced by short-term economic policies. Differently from the conventional theoretical approaches, in the Structuralist-Keynesian model proposed here, not only the long-term trend of the real exchange rate, but also the deviations of the actual real exchange rate from an "optimal" level are jointly explained by long-term structural forces and short-term economic policies.[9] Moreover, we reject the conventional wisdom of the existence of automatic forces driving the real exchange rate either towards a long-term equilibrium (such as the PPP approach) or even a long-term "optimal" level (as inherent in our framework). By supporting this argument, our model is expressed as:

$$RER_t = g_t(structlt_t) + m(st_t) \tag{2}$$

where RER_t is the actual real exchange rate and the variables that comprise the function g are interpreted as representing the long-term structural forces denoted by $structlt_t$ which are better driven by both market competition and long-term economic policies,[10] and the component m incorporates the set of short-term variables st_t that are directly and indirectly influenced by short-term macroeconomic policies. In fact, both structural and short-term economic policies may be responsible for not only driving the long-term real exchange rate towards its "optimal" trend, but also (depending on the specificity of the structural force and the quality of the short-term economic policy) directing that indicator to a "suboptimal" level. The main policy implication of our model is that, like most Asian countries, policy-makers could (and should) target, at least partially, the real exchange rate in such a way that it could be driven towards a long-term "optimal" level.

When the theoretical model is expressed in econometric specifications (section IV), we cannot only capture the main determinants of the recent actual real overvaluation of the Brazilian currency, but also evaluate the policy space of short-term economic policies, according to the explanatory power of the m variables. Despite the fact that our model does not capture important characteristics related to the workings of foreign exchange markets, such as the dynamic changes and the forward-looking behaviour, its simplicity is attractive enough to provide a useful and comprehensive empirical implementation.

IV. REAL EXCHANGE RATE OVERVALUATION: EMPIRICAL EVIDENCE FOR BRAZIL IN THE 2000s

The Brazilian currency has presented a trend towards overvaluation of its real exchange rate ever since inflation became controlled in the mid-1990s. The phase of the floating exchange rate regime (from January 1999 on), which was followed by the adoption of an inflation targeting regime, did not bring stability to the real exchange rate. After 2004, the trend towards real appreciation of the Brazilian currency, the real, became for the majority of the time a dominant pattern until the eruption of the international

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[9] See Razin (1996) and Razin and Collins (1999) for a conventional theoretical and empirical formulation.

[10] By long-term economic policies, we mean those government measures which are introduced with the objective of accelerating structural change and economic development, such as industrial and technological policies, trade policies and so on. In this sense, although it is hard to reject that the productivity change is one of the most important structural forces behind the long-term real exchange rate, we must stress that the evolution of productivity is in itself strongly influenced by those kinds of the above-mentioned long-term economic policies.

financial crisis in September 2008. After a sharp depreciation during the aftermath of the financial crisis, the appreciation trend of the Brazilian real has intensified again.

Figure 1 shows the evolution of the real exchange rate from February 1999 to February 2011. Considering the standard deviations of the real exchange rate, figure 1 shows three distinct phases related to the trajectory of the RER. The first phase (standard deviation of 6.7) begins in the months immediately after the change in the Brazilian exchange rate regime. After a sharp depreciation of the real exchange rate at the end of 1998, the introduction of a floating exchange rate regime in early 1999 was followed by a relatively stable evolution in 2000.

Figure 1

ACTUAL REAL EFFECTIVE EXCHANGE RATE, BRAZIL, FEBRUARY 1999–FEBRUARY 2011

(Monthly data, 2000 average real exchange rate = 100)
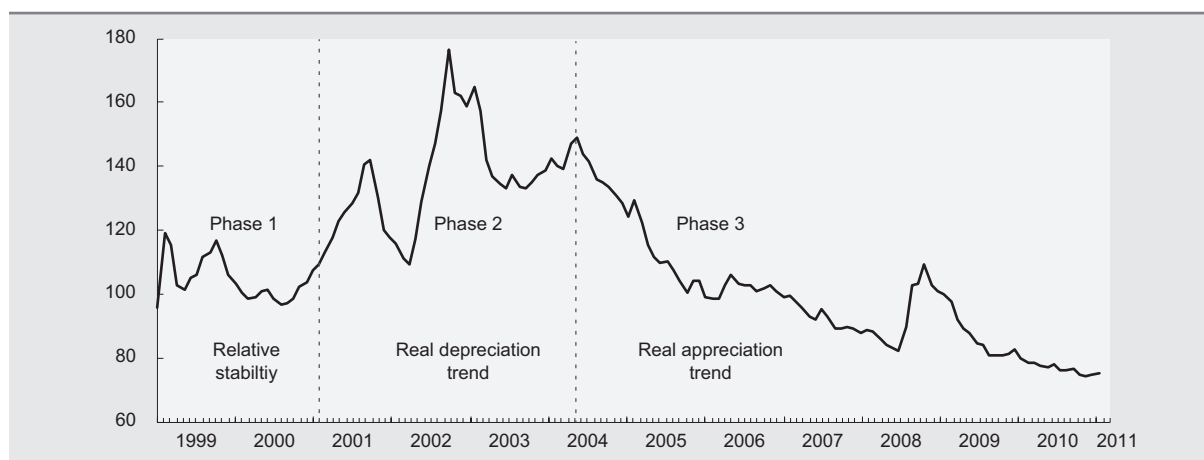
Source: Brazil's Central Bank.

After this short period of relative stability, the second phase (standard deviation of 16.8) was marked by the negative expectations of the presidential election of a candidate (Luiz Inácio Lula da Silva), who was at the time adversely evaluated by markets in Brazil. The Brazilian currency, in this second phase, showed a trend towards depreciation in real terms until mid-2004.

Throughout the third phase (standard deviation of 18.0), from June 2004 onwards, the real exchange rate showed an appreciation trend, except for the second half of 2008, when the international financial crisis triggered a brief movement of depreciation of the Brazilian currency. In this phase, the Brazilian economy was characterized by greater dynamism. In fact, the expansion of world trade, mainly after 2004, favoured the country's terms of trade, allowing the growth and real appreciation of its currency to occur simultaneously.[11] In addition, in absence of capital controls, the excess inflow of external capital forced the Brazilian real to appreciate.

A. Econometric implementation

Our theoretical framework presented in equation (2) will be translated into the following econometric specification (equation 3):

[11] Real GDP grew at 5.7 per cent in 2004; 3.2 per cent in 2005; 4.0 per cent in 2006; 6.1 per cent in 2007; and 5.1 per cent in 2008.

$$\ln RER_t = c_0 + \alpha_1 \ln Y_t + \alpha_2 \ln ToT_t + \alpha_3 \ln CA_t + $$
$$+ \beta_1 (\ln IDIFER)_t + \beta_2 (\ln IDIFER)_{t-1} + \beta_3 \ln STKF_t + \beta_4 \ln IR_t + \beta_5 \ln CR_t + \varepsilon_t \qquad (3)$$

Following analogous procedures of empirical literature on the real exchange rate determination, we chose the most appropriate candidates to represent the variables associated with the structural changes in the real exchange rate in the long run (variables with the α coefficients on the right hand of equation (3)) and those directly or indirectly associated with the short-term policies (variables with the ß coefficients on the right side of equation (3)).

The variables of the model (see data source in annex 1) are specified in logarithms as follows: *RER* is the actual real effective exchange rate; *Y* is the Brazilian real GDP per capita expressed in US dollars; *ToT* is the terms of trade; *STKF* is the net short-term capital flow expressed as a ratio of GDP;[12] *CA* is the current account balance expressed as a ratio of GDP; *IDIFER* is the differential of short-term domestic (*SELIC* basic rate) and international (*US Fed Funds*) interest rates; $IDIFER_{t-1}$ is the previous variable lagged one period; *IR* is the stock of Brazilian international reserves expressed as a ratio of GDP; *CR* is Brazil's risk premium; ε_t is a random error variable, which is also assumed to contribute to deviating the actual real exchange rate from its long-term trend level; and the subscript *t* is the time reference (in our econometric modelling, it refers to one month).[13]

The variables chosen to represent the structural conditions to determine the real exchange rate are largely used in the empirical literature (Helmers, 1988, Edwards, 1988, Rodrik, 2008). And the short-term variables chosen are considered to be the most important for an open emerging economy according to the specific discussion in section III.[14]

Following the basic econometric procedures, we investigated the potential non-stationarity of the variables and the potential endogeneity of the chosen explanatory variables. As for non-stationarity, we implemented the Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) unit root tests.[15] Except for the STKF, all other variables are non-stationary in levels (with a trend and intercept), but stationary in first differences, i.e., the series are I (1) at 5 per cent significance level. For this reason, and others which we will further discuss ahead, we removed the STKF variable from the model. Following Baffes et al. (1999), we consider that, since the econometric model is represented by a single equation, the most appropriate methodologies to estimate the determinants of the real exchange rate are the ordinary least squares (OLS) and the error correction model (ECM).

Before applying the cointegration test, it is important to stress that ECM models are generally applied to non-stationary series which have a cointegration relationship. As supported by Campbell and Perron (1991), in reaching a cointegrated process between non-stationary series, the addition of a stationary variable in the ECM will not cause significant changes in the statistical robustness of the regression. However, when we included the stationary variable STKF in our econometric implementation, the model did not show a good fit. As we already discussed in section III, since one of the main transmission channels from the interest rate differential to the real exchange rate is through the short-term capital flow, the removal of

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[12] We computed the foreign investment for portfolio and other short-term foreign investments (mainly suppliers' credit and short-term loans) as short-term capital flows.

[13] Following Bogdanski, Tombini and Werlang (2000: 17), all variables with negative values (CA and STKF) were transformed adding a positive number in order to apply logarithms in the following procedures: CA = 1 + CA; and STKF = 2 + STKF.

[14] These short-term variables can also be found dispersed throughout conventional empirical models. See, for instance, Meese and Rogoff (1983), Edwards (1988), Calvo, Leiderman and Reinhart (1993), among others.

[15] Results are described in annex 2.

this variable does not damage the consistency of the model. Therefore, by removing the variable STKF from the econometric model, equation (3) is re-expressed by the following equation:

$$\ln RER_t = c_0 + \alpha_1 \ln Y_t + \alpha_2 \ln ToT_t + \alpha_3 \ln CA_t +$$
$$+ \beta_1 (\ln IDIFER)_t + \beta_2 (\ln IDIFER)_{t-1} + \beta_3 \ln IR_t + \beta_4 \ln CR_t + \varepsilon_t$$

(4)

Having now established that the variables of equation (4) are non-stationary and possess the same order of integration I (1), we are able to apply the cointegration test so as to verify whether a linear combination of these variables is stationary. Following Engle and Granger (1987), if a unit root test reveals the residuals are stationary, i.e., I (0), we can conclude not only that all variables of our single equation are cointegrated in levels, but also that the estimated coefficients by ordinary least square (OLS) are consistent (Hamilton, 1994: 857; Greene, 1997: 856–857). The ADF and PP tests prove we can reject the null hypothesis of unit root in the residuals. So, according to Granger (1981) and Engle and Granger's (1987) procedure, since the residuals are stationary, the real exchange rate and its structural long-term and short-term determinants are cointegrated.

To deal with the potential endogeneity issues of our explanatory variables, we followed two methodologies. First, by applying Engle, Hendry and Richard's (1983) weak exogeneity test, the variables GDP per capita, international reserves and the terms of trade were revealed to be endogenous. A traditional way of addressing the potential for the endogeneity bias is to use instrumental variables that are able to correct the estimates through the use of exogenous variables, or instruments. Therefore, we also run the model in two stages least squares (2SLS).

Second, as Baffes et al. (1999) argue, even the relevant exogeneity tests proposed by Engle, Hendry and Richard (1983) might not be able to completely solve endogeneity problems when the marginal distribution of the explanatory variables shifts. Following this argument, in a model where more than one variable is endogenous, the Johansen (1988) cointegration procedure can be complementary for solving the endogeneity bias, since it treats all the variables in the estimation process as endogenous and tries to simultaneously determine the equilibrium relationship among them. Assuming that all the variables are I(1), the Johansen procedure, which considers all the I(1) variables as if they were endogenous and related to a vector-autoregressive structural model (VAR), uses the maximum likelihood estimation for the VAR model and derives a set of cointegration vectors. The number of cointegration vectors is determined by trace and eigenvalue tests (table 1).[16]

Table 1

JOHANSEN TEST OF COINTEGRATION RANK

	Trace statistics			Max-Eigen statistics		
	Eigenvalues	Critical values	Prob. 5 per cent	Eigenvalues	Critical values	Prob. 5 per cent
None	177.5079	139.2753	0.0001	72.27859	49.58633	0.0001
At most 1	105.2293	107.3466	0.0683	40.66017	43.41977	0.0970
At most 2	64.5691	79.34145	0.3807	27.48926	37.16359	0.4124

Note: 4 lags, with a trend and intercept.

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[16] See Enders (1995) and Hamilton (1994). The null hypothesis that there is a lack of cointegration relationship is rejected at 5 per cent significance level, both for trace and maximum eigenvalue test statistics. This means that there is strong evidence to support the existence of a cointegration vector which represents the long-term relationship among the variables of our model.

Table 2

ESTIMATED MODEL FOR BRAZIL
DEPENDENT VARIABLE: REAL EXCHANGE RATE

Variable	Description of the variables	OLS coefficient (t-statistics between brackets)	2SLS coefficient (t-statistics between brackets)	ECM coefficient (t-statistics between brackets)
C	Constant	6.766*** [11.610]	2.659** [1.964]	4.463***
lnGDP	Log of the real GDP per capita	-0.356*** [-6.771]	-0.505*** [-11.588]	-0.505*** [-9.458]
lnTOT	Log of the terms of trade	-0.239* [-1.744]	0.290* [1.732]	0.568* [1.582]
lnCA	Log of the current account balance/ GDP	0.129*** [8.17]	0.227*** [13.988]	0.230*** [12.636]
Ln(IDIFER)	Log of the short-term interest rate differential	0.121*** [3.266]	- -	- -
Ln(IDIFER)t-1	Log of the lagged short-term interest rate differential	-0.129*** [-3.693]	-0.104*** [-3.641]	-0.161*** [-4.236]
lnIR	Log of the stock of international reserves/GDP	0.115*** [4.088]	0.109** [2.538]	0.139*** [5.511]
lnCR	Log of the Brazil's risk premium	0.065*** [2.231]	0.194*** [3.453]	0.072*** [2.815]

Note: *** Significant at 1 per cent level; ** Significant at 5 per cent level; * Significant at 10 per cent level.

Notes on OLS model: R-squared: 0.88745; Adjusted R-squared: 0.88169; Durbin-Watson: 1.633; F-statistics: 153.319; Prob (F-statistics): 0.0000; Number of observations: 145 after adjustments.

Notes on 2SLS model: R-squared: 0.8259; Adjusted R-squared: 0.8178; Durbin-Watson: 1.6106; F-statistics: 110.661; Prob (F-statistics): 0.0000; Number of observations: 145 after adjustments; Instrument list: LOGTOT(-1); LOGIR(-1); LOGIDIFER(-2); LOGGDP(-1); LOGCR(-1); LOGCA(-1); LOGTOT(-8); LOGTOT(-9).

Notes on ECM model: 4 lags; Number of observations: 141 after adjustments.

Table 2 presents the results of our estimation in OLS, 2SLS and ECM according to the econometric model specified in equation (4).

Among the structural variables, all the three models revealed that the largest estimated coefficients were the GDP per capita and the terms of trade, respectively.[17] The real GDP per capita, with a negative sign, supports the Harrod-Balassa-Samuelson effect. However, the high coefficient estimated for this variable should be cautiously analysed. In fact, far from reflecting an expressive growth in either labour productivity or even total factor productivity (TFP) in Brazil, the growth of the real GDP per capita in the last decade (especially in the last few years) resulted from a set of well succeeded social policies which led to a significant improvement in income distribution.[18] So, rather than expressing an increase in productivity,

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[17] Among the structural variables, the terms of trade showed the largest estimated coefficient in the ECM model.

[18] If we take into account the total factor productivity (TFP), an indicator of aggregate efficiency, the annual average growth was less than 0.5 per cent between 2002 and 2009 (against 4 per cent in China and 2.6 per cent in India, see *The Economist*, 18 November 2009).

which has been stagnant in the 2000s, it expresses an improvement in the income distribution due to a set of social policies (e.g., the Family Assistance Programme – *Bolsa Familia*, among others).

In the OLS model the terms of trade *ToT* presented a negative sign, so an improvement of 10 per cent in the terms of trade appreciates the long-term trend of the real exchange rate by 2.39 per cent. However, when this variable is considered with one or more lagged ones both in the 2SLS and ECM models, the medium-term impact is to depreciate the Brazilian currency. So this seems to confirm the ambiguous effects of the terms of trade on the real exchange rate, as supported by Edwards (1989) and already discussed in section III.

The expected sign of the current account balance to GDP ratio (*CA*) is also ambiguous. On the one hand, *ceteris paribus*, the more a country shows current account surplus, the more appreciated its currency will be in real terms. On the other hand, we could also argue that large current account surpluses, by being associated with large domestic savings in the long run, tend to increase the incentives of the demand for foreign exchange for purchasing external assets and, furthermore, to depreciate the long-term real exchange rate. Then, if this is the case, we could expect a positive sign for the current account to GDP ratio. In fact, although the estimated sign for the Brazilian case has been positive, it is necessary to stress that, on average, Brazil presented large net capital inflows during the period under analysis. This suggests that Brazil's current account balance seems to be strongly associated with a depreciated currency in real terms, though we cannot draw any conclusion on the causality relationship between the former variable and the Brazilian real exchange rate behaviour.

Among the short-term economic policy variables, the short-term interest rate differential and the international reserves showed the largest estimated coefficient. Though the country-risk premium has presented a high estimated coefficient in the 2SLS model, it presented low estimated ones in both OLS and ECM models. Nonetheless, the estimated positive coefficient of the country-risk premium implies that a higher coefficient of this variable is associated with an undervalued currency in real terms, as suggested by the theoretical literature.

As supported by the analysis in section II, the very short-term impact of the interest rate differential might reflect a "fear of inflating", given the context of the current inflation targeting regime in Brazil. So, we should expect a positive sign in the interest rate differential, as shown in the OLS model. At the same time, the increase in the country's risk premium is reinforced every time the Brazilian economy faces either an internal or external shock, which, by indicating or eventually provoking a sudden stop in capital flows, compels Brazil's Central Bank to maintain the short-term interest rate differential at a high level.

On the other hand, the incorporation of the lagged short-term interest rate differential into the econometric model is based on the assumption that the short-term interest rate differential impacts the real exchange rate with some time lag through its effects on net short-term capital inflows, as discussed in section II. An increase of 10 per cent in the short-term interest rate differential tends to appreciate the Brazilian currency to a minimum of 1.0 per cent (2SLS model) and a maximum of 1.6 per cent (ECM model) in real terms.

The stock of international reserves as a ratio of GDP is, along with the interest rate differential, one of the largest to correlate with the real exchange rate. It is necessary to stress, though, that the relationship between this variable and the real exchange rate is ambiguous. On the one hand, by reducing the country's risk premium, the larger the stock of international reserves, the lower the expectation for real exchange rate depreciation, considering everything else equal. If this is the case, the expected sign should be negative. On the other hand, a larger stock of international reserves also reflects the central bank's strategy of accumulating foreign reserves as an attempt to either target a long-term "optimal" real exchange rate (like most Asian countries) or avoid a large real exchange rate overvaluation (a defensive strategy). In both cases, the expected sign should be positive, although the defensive strategy seems to be the case of Brazil in the period under analysis.

B. The long-term trend and the long-term "optimal" real exchange rate in Brazil

Since we were able to identify two relevant groups of variables in the determination of the Brazilian real exchange rate, our next step is to take the regressors of these variables to estimate the long-term trend of the real exchange rate. This result is then compared with the actual real exchange rate *RER* to construct an index that allows us to evaluate the trend of real exchange rate overvaluation in Brazil.

In practice, the variables of the model are likely to include both transitory and permanent components. Thus, a strategy towards the estimation of the long-term trend of the real exchange rate can be based on the econometric decomposition of the variables into a transitory and a permanent component. The long-term estimated real exchange rate *(RÊR)* depends only on the permanent component, which reflects the long-term trend of the series. As suggested by Edwards (1989) and Alberola (2003), this paper uses the Hodrick-Prescott (HP) filter technique to estimate the long-term trend of the series and, furthermore, to obtain the permanent values for the set of our long-term and short-term explanatory variables. Therefore, the long-term estimated real exchange rate is obtained by multiplying the values of the permanent component of both structural and short-term explanatory variables by the vector of the estimated coefficients of the regression model.

Figure 2 jointly shows the actual (RER) and long-term estimated real exchange rates RÊR (this latter by OLS, 2SLS and ECM models). As figure 2 reveals, the episodes that produced strong and damaging depreciations happened exclusively in response to either internal or external shocks (such as in early 1999, due to the speculative attack which forced the adoption of a floating exchange rate regime in Brazil; in the first semester of 2001 in virtue of the severe electric energy crisis – the apagão crisis; in the second semester of 2002, due to the negative expectations of the upcoming presidential elections; and in the aftermath of the September 2008 financial crisis).

Figure 2

ACTUAL AND LONG-TERM ESTIMATED REAL EXCHANGE RATES IN BRAZIL, FEBRUARY 1999–FEBRUARY 2011

(In logarithms)
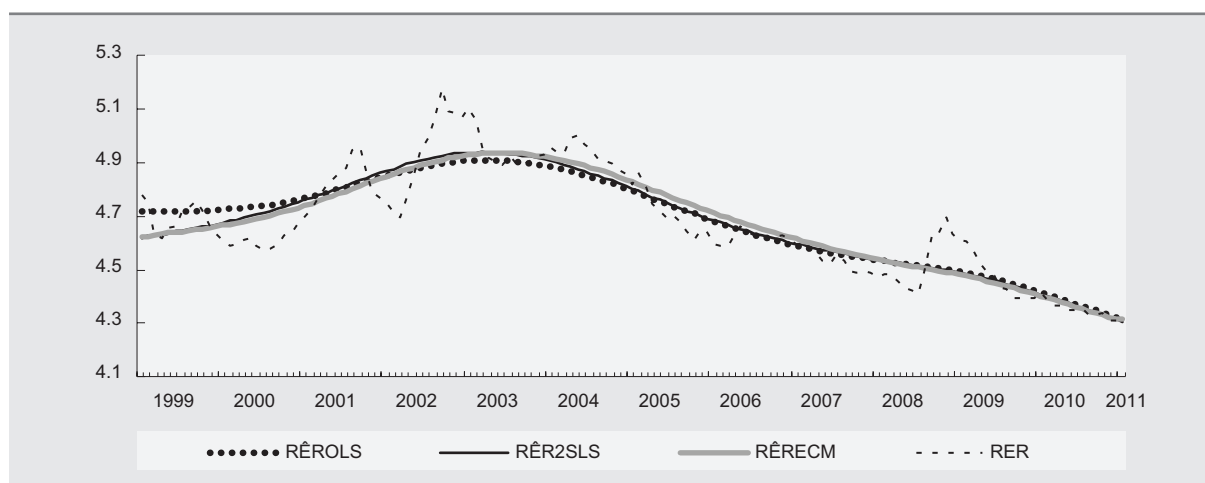
Source: Estimated by authors according to the described methodology.

Figure 2 also highlights three additional points: first, since the general trend of both actual and long-term estimated real exchange rate is similar, the results support the robustness of our models to capture the long-term trend of the real exchange rate in Brazil throughout the period; second, the very close results of the estimations by OLS, 2SLS and ECM demonstrate that both the explanatory variables and the methodologies chosen to estimate the determinants of the long-term trend of the Brazilian real exchange

rate overvaluation are appropriate; and third, there has been a chronic tendency of the long-term real exchange rate in Brazil to overvalue and be directed towards a "suboptimal" level. This overvaluation trend could have only been considered "healthy" if it was explained by a significant increase in either Brazilian labour productivity or TFP, which, as already mentioned, has not been the case throughout the period under analysis.

Given these specificities, one could speculate what the level of the long-term "optimal" real exchange rate should be, that is, the one that could prevent the current process of Brazilian early deindustrialization and, hence, not damage economic development. One attempt to estimate this level could be to consider, coherently with our previous concept of long-term "optimal" RER, a shorter period, when, roughly speaking, the economy had shown sound macroeconomic indicators (on average) and, at the same time, a small estimated real undervaluation. By comparing the actual real exchange rate (RER) with the long-term estimated real exchange rate (RÊR) in the three models, we can calculate both overvaluation and undervaluation of the RER related to the long-term estimated trend. Figure 3 shows that the actual real exchange rate kept a small undervaluation related to its long-term estimated trend only in 1999, 2001 and between mid-2003 and mid-2005.[19]

Figure 3

LEVEL OF UNDERVALUATION OR OVERVALUATION OF THE ACTUAL REAL EXCHANGE RATE RELATED TO THE LONG-TERM ESTIMATED TREND, FEBRUARY 1999–FEBRUARY 2011
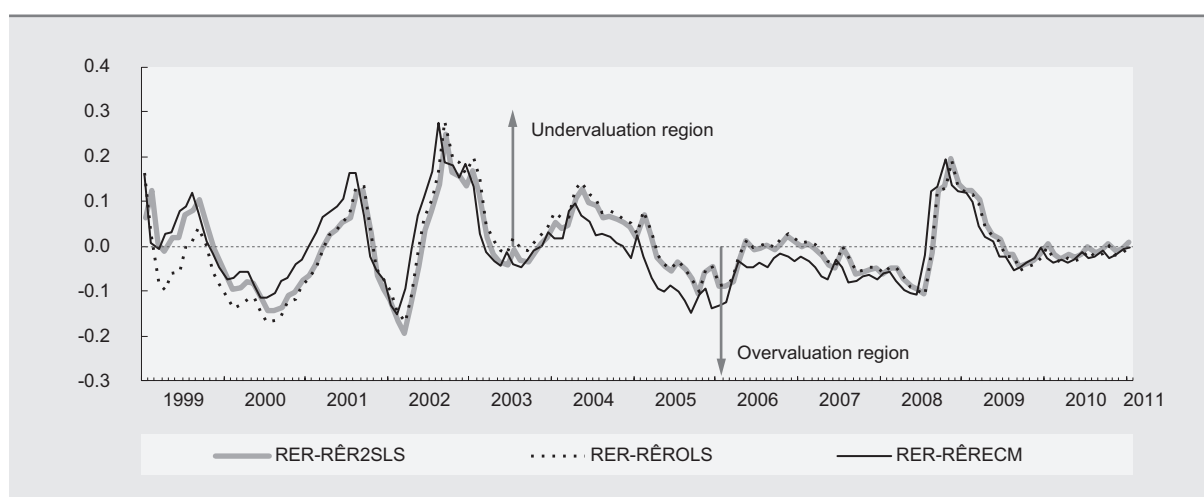
Source: Estimated by authors according to the described methodology.
    Note: Undervaluation and overvaluation are calculated by the difference between the actual RER and the estimated long-term trend of the RER (RÊR). If this result is above zero, there is an undervaluation; if it is less than zero, there is an overvaluation.

However, the period from mid-2003 to mid-2005 was the only one during which the Brazilian economy combined sound macroeconomic indicators with a small estimated real exchange rate undervaluation.[20] So, considering only this period, the average index of the long-term estimated real exchange rate was 129.55 (OLS: 126.47; 2SLS: 129.53; and ECM: 132.66). To illustrate, comparing this level with the index of the real exchange rate observed in April 2011 (72.57 on average), the Brazilian real exchange

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[19] Note that as the actual RER related to the long-term trend was excessively undervalued from mid-2002 to early 2003 as well as in the immediate aftermath of the September 2008 financial crisis, these periods are not in accordance with the requirement of a small undervaluation according to our concept of long-term "optimal" real exchange rate.

[20] We investigated ten macroeconomic indicators, such as GDP growth, consumer inflation, international reserves/GDP, current account balance/GDP, external debt/GDP, among others. All data from Brazil's Central Bank.

rate showed a real overvaluation of around 78 per cent related to its long-term "optimal" level (the steps for estimating the long-term "optimal" real exchange rate are in annex 3).

By looking at the mid-2003 and mid-2005 period's results we can assume that Brazil reached its long-term "optimal" real exchange rate in 2004. This assumption is supported by two statistical evidences: first, in 2004 the Brazilian economy showed good performance expressed by macroeconomic indicators, such as a real GDP growth of 5.7 per cent, a current account surplus of 1.6 per cent of GDP and an external debt to export ratio of only 2.3 per cent, among others; and second, we realized that the estimated real undervaluation of the Brazilian currency was around 6 per cent (on average) in 2004 (OLS: 8 per cent 2SLS: 6 per cent; and ECM: 4 per cent).[21] This level is consistent with the empirical literature's conclusion according to which a small real undervaluation is the best policy for assuring economic development (Rodrik, 2008; Williamson, 2008). By following the same procedures as described above, in April 2011 the Brazilian actual real exchange rate showed a real overvaluation of around 80 per cent in relation to its long-term "optimal" level.[22] To give an idea of this, in April 2011, the average nominal exchange rate should have been around 2.90 Brazilian *reais* per dollar (against an observed nominal rate of 1.59 Brazilian *reais* per dollar) to achieve the 2004 "optimal" level (average of the year).

V. CONCLUDING REMARKS AND ECONOMIC POLICY IMPLICATIONS

In the recent experience of a floating exchange rate regime with relatively high capital movements in Brazil, policy-makers clearly face the challenges imposed by the trilemma of economic policy. So, finding out how to overcome the "impossible trinity", that is to say, how to choose two out of three competing policy goals – monetary independence, exchange rate stability and high external financial integration – should still be on the agenda of the Brazilian economic policy. In practical terms, it is not an exaggeration to say that Brazilian policy-makers, by having pursued monetary independence to assure price stability and high external financial integration as priority goals for economic policy in the last decade, have tolerated the high volatility and a large overvaluation trend of the real exchange rate. This trend is supported by our econometric equation that allowed us to estimate the real exchange rate throughout the 2000s, combining structural long-term variables and short-term economic policy variables.

Aizenman et al. (2010) showed econometric evidence that, since the 1997 financial crisis, Asian emerging market economies have been successful in dampening the negative impacts of large short-term net capital flows on the real exchange rate overvaluation through massive accumulation of international reserves. The authors suggest that "policy makers in a more open economy would prefer to pursue greater exchange rate stability" (p. ii). Nevertheless, in the case of Brazil, since our econometric results reveal that the actual real exchange rate was significantly overvalued in April 2011 (around 80 per cent) in relation to its long-term "optimal" level, it is not recommended to introduce policy instruments too quickly to correct this high level of overvaluation. Needless to say, taking into account that the terms of trade will likely be favourable to Brazil in the next few years, if the high interest rate differential in Brazil is not reduced, it is likely that the trend of overvaluation will continue. Actually, in such a context, the high interest rate differential reinforces the tendency to overvalue the Brazilian currency. Since Brazilian policy makers are facing difficulty in their economic policy choices, the most appropriate macroeconomic policy is to implement a mix of policy instruments which should prevent the strong trend of overvaluation while

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[21]   By looking at figure 1, one could question the choice of the year 2004 – see the controversy that followed the publication of our results released in the two articles in the Brazilian newspaper Valor Econômico (2011), arguing that the Brazilian actual real exchange rate was excessively undervalued. And, in fact, it was. However, since this conclusion is based only on the actual RER, for empirical purposes, the correct index for estimating either the undervaluation or overvaluation is that one which compares the actual RER with the long-term estimated RER. So, the correct procedure is to look at figure 3, instead of figure 1.

[22]   This should be taken as a preliminary exercise, as the explained variable, the actual real effective exchange rate, is based on a basket of currencies and not on the United States dollar.

preserving price stability. This challenge demands policy makers to assume a target for the "optimal" level of the real exchange rate in the medium and the long-run. This goal is more or less in line with the UNCTAD's recent proposal of using the "real effective exchange rate (REER) as a simple and viable system for averting exchange rate misalignment and the prevention of carry trade based on currencies" (UNCTAD, 2011: 1).[23]

First of all, the policy space for avoiding the real exchange overvaluation through accumulation of international reserves is much more limited in Brazil than in Asian emerging market economies, because, by virtue of maintaining high Brazilian interest rates, this strategy has adverse effects on the gross public debt. However, our econometric exercise showed that the estimated coefficient of the stock of international reserves had a positive sign and was statistically significant. This means that, even taking into account that this strategy can increase the gross public debt, this economic policy mechanism has been somewhat influential in mitigating the real exchange rate's trend of overvaluation and has contributed to offsetting high volatility. So, as long as policy-makers are able to manage the impact of interventions on the spot and forward foreign exchange markets on the growth of gross public debt, Brazilian monetary authorities should continue to pursue the strategy of accumulating international reserves.

Secondly, the terms of trade figured in the OLS model as one of the main structural factors responsible for the overvaluation trend of the Brazilian currency in the long run. Since this result is explained in turn by the recent behaviour of the high relative prices of agricultural products and manufactured commodities in global markets, the basic policy implication is that Brazilian authorities should neutralize the threat of the so-called Dutch disease by implementing industrial and technological policies with the goal of reallocating resources and promoting structural change towards sectors that are technologically more sophisticated. In this sense, a strong ally of industrial and technological policies is the commitment to keep the real exchange rate slightly undervalued in real terms in the long run, say around 5 per cent.

Thirdly, since the short-term interest rate differential in Brazil has figured as one of the highest in the capitalist world, Brazilian monetary authorities should enlarge the policy space for bringing the domestic interest rates to levels closer to international standards, and so contributing to the undervaluation of the domestic currency. One could argue that this possibility is very limited in Brazil, as the main concern of the inflation target regime is price stability. However, this goal is not incompatible with the effort to reduce domestic interest rates. There are academic studies suggesting that the design of the inflation target regime in Brazil could be modified in order to give monetary authorities more room to reduce the SELIC basic interest rate. One of the recommendations is to manage the inflation target through a calendar year of 18 months (see, among others, Oreiro et al., 2009; and Squeff et al., 2009).

Fourthly, we also agree that fiscal policy responsibility, through which the growth of current government expenditures in real terms is lower than the increase of the real GDP, could contribute not only to supporting a drop in Brazilian policy interest rates (the highest in capitalist world in current days – August, 2011), but also to augmenting the public investment to GDP ratio in Brazil.[24] It is necessary to remark, however, that, without some change in the conservative way with which the Brazilian inflation targeting regime has been managed since it was introduced in 1999, fiscal policy responsibility *per se* is not sufficient for reducing high interest rates in Brazil. It is important to recognize that there have been small changes in the way Brazil's Central Bank manipulates the monetary policy under the inflation target regime. After September 2008, Brazil's Central Bank has been adding other instruments and strategies, besides

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[23] According to the UNCTAD's proposal, the most appropriate observed indicator for estimating the misalignment of the REER is the unit labour cost (that is, the premium of nominal wages over total productivity of the economy) rather than consumer price indices. So, policy-makers should target the "equilibrium" real exchange rate by realigning nominal exchange rates to the domestic cost level. For details, see UNCTAD, 2011.

[24] The total investment of the central government as a proportion of Brazilian GDP was only 1.3 per cent in 2010, a very low rate for a country with poor physical and social infrastructure.

the management of the *SELIC* rate, such as compulsory reserve requirements, capital requirements to strengthen bank balance sheets and the apparent and undeclared acknowledgement of the challenges and high costs associated with reaching the current inflation target (4.5 per cent for 2011) in a single calendar year. The doubt is whether or not these changes will be maintained.

Finally, Brazilian policy-makers should not discard the use of more effective mechanisms for capital control as suitable mechanisms for economic policy. Taking into account that international interest rates might be maintained at a very low level in the near future, due to the stagnant environment in the world economy, the high short-term interest rate differential will continue to contribute to the appreciation of the Brazilian currency in real terms. Even conservative voices have upheld that some sort of protection against speculative short-term capital inflows should be established by emerging economies to avoid exchange rate overvaluation. A recent International Monetary Fund Staff Position Note (see Ostry et al., 2010, among others) concluded that "capital controls are a legitimate part of the toolkit to manage capital inflows in certain circumstances" (p.15).[25] In fact, when a first draft of this paper was concluded in May 2010, almost no capital control measures had been adopted by the Brazilian authorities, although the overvaluation trend of the Brazilian currency had been continuing since 2004. As this trend deepened in 2010, a set of measures of capital control – until then a forbidden topic among Brazilian economic policy-makers – have been introduced up to July 2011, most of them involving financial tax on short-term capital inflows directed to bond purchases and transactions tax on future markets (especially on the currency derivatives market).

The main issue is that these governmental measures (including the mix of the above suggested macroeconomic policies) should have been implemented in mid-2009, when the real exchange rate began to show a sustained trend of appreciation again – once having overcome the strong depreciation that follow the September 2008 financial crisis – and not in ad hoc small doses as has ocurred from early 2010 on. Currently (August 2011), as the current account deficits have increased dramatically from 2009 to 2011, the imposition of radical measures of capital control (e.g. quantitative constraints against capital inflows) is much harder to implement, given the need of large amounts of external savings to finance the current account deficits. In other words, it is much more difficult to find an organized exit from a potential exchange rate crisis when the country's external financial vulnerability has dramatically increased.[26]

To conclude, there are at least two reasons the strong real exchange overvaluation should have been avoided: first, as has been strongly supported by the empirical literature, a large and continued overvaluation in the short-term can damage long-term economic growth; and second, as stressed by Dornbusch (1988) a long time ago, although a floating exchange regime can provide for the correction of overvaluation in the medium term, the aftermath of a correction by free-market forces is far from being a "first best" solution since it can lead to severe macroeconomic instability and requires high adjustment costs: balance-of-payments crises, inflation, high interest rates and real GDP reduction.

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[25] For a detailed country study on short and medium run capital control experiences, see BIS, 2008.

[26] Between 2009 to June 2011 (yearly basis), the current account deficits have increased from US$24 billion (1.5 per cent of GDP) to US$49 billion (2.2 per cent of GDP). Although Brazil's Central Bank statistics account for large amounts of foreign direct investment, most of these have been related to intrafirm lendings.

Annex 1

DESCRIPTION OF THE DATA SOURCE

Actual real effective exchange rate – estimated by Brazil's Central Bank (http://www.bcb.gov.br).

Brazilian GDP per capita expressed in US dollars – estimated by Brazil's Central Bank based on statistics on monthly real GDP in R$ Brazilian Real (series No. 4383) and transformed into United States Dollar according to IPEAdata series of exchange rates. Population estimated by the Brazilian Institute of Geography and Statistics (IBGE) (http://www.bcb.gov.br).

Terms of trade – estimated by FUNCEX- FUNCEX12_TTR12 (http://www.funcex.com.br).

Current Account Balance – Balance of Payments, Brazil's Central Bank (http://www.bcb.gov.br).

GDP in current United States dollar – Brazil's Central Bank (series no. 4; http://www.bcb.gov.br).

Short-term interest rate differential – difference between Brazil's Central Bank monthly interest rate series for SELIC (BCB Boletim/M.Finan. – BM_T JOVER12 – http://www.bcb.gov.br) and the US FED FUNDS monthly interest rate (IFS/IMF – IFS12_TJFFEUA12).

Net short-term capital flow – Balance of Payments, Brazil's Central Bank (http://www.bcb.gov.br).

Stock of international reserves – Brazil's Central Bank (series no. 3546; http://www.bcb.gov.br).

Brazil's risk premium (EMBI Brazil sovereign foreign currency) – Standard&Poors monthly series.

Annex 2

Table A.1

UNITY ROOT TESTS IN THE RESIDUALS

Tests	t-statistics	Critical values: 1 per cent		
		1 per cent	*5 per cent*	*10 per cent*
ADF	-4.524946	-2.58195	-1.943175	-1.615168
PP	-7.393642	-2.58112	-1.943058	-1.615241

Note: The ADF and PP tests were applied to residuals without either the constant or trend.

Annex 2 (concluded)

Table A.2

AUGMENTED DICKEY-FULLER TEST (ADF): IN LEVELS AND FIRST DIFFERENCES

Variable	lags	t-statistics	Critical values		
			1 per cent	5 per cent	10 per cent
RER	1	-1.756	-4.024	-3.442	-3.146
GDP	2	-2.511	-4.024	-3.442	-3.146
TOT	1	-1.006	-4.024	-3.442	-3.146
CA	5	-1.2267	-4.024	-3.442	-3.146
IDIFER	3	-2.897	-4.024	-3.442	-3.146
STKF	0	**-11.733**	-4.024	-3.442	-3.146
IR	0	-2.545	-4.024	-3.442	-3.146
CR	3	-2.243	-4.024	-3.442	-3.146
			Critical values		
	lags	t-statistics	1 per cent	5 per cent	10 per cent
RER	0	-9.999	-4.024	-3.442	-3.146
GDP	1	-9.857	-4.024	-3.442	-3.146
TOT	0	-15.695	-4.024	-3.442	-3.146
CA	4	-11.327	-4.024	-3.442	-3.146
IDIFER	2	-5.804	-4.024	-3.442	-3.146
STKF	3	-10.675	-4.024	-3.442	-3.146
IR	0	-12.859	-4.024	-3.442	-3.146
CR	0	-11.605	-4.024	-3.442	-3.146

Note: With a trend and intercept, except STKF with only an intercept.

Table A.3

PHILLIPS-PERRON TEST (PP): IN LEVELS AND FIRST DIFFERENCES

Variable	lags	t-statistics	Critical values		
			1 per cent	5 per cent	10 per cent
RER	4	-2.33	-4.022	-3.443	-3.145
GDP	8	-2.238	-4.022	-3.443	-3.145
TOT	5	-2.109	-4.022	-3.443	-3.145
CA	8	-2.779	-4.022	-3.443	-3.145
IDIFER	0	-3.016	-4.022	-3.443	-3.145
STKF	4	**-12.097**	-4.022	-3.443	-3.145
IR	0	-2.545	-4.022	-3.443	-3.145
CR	2	-2.376	-4.022	-3.443	-3.145
			Critical values		
	lags	t-statistics	1 per cent	5 per cent	10 per cent
RER	0	-9.714	-4.022	-3.443	-3.145
GDP	2	-10.066	-4.022	-3.443	-3.145
TOT	0	-15.695	-4.022	-3.443	-3.145
CA	18	-49.772	-4.022	-3.443	-3.145
IDIFER	5	-19.074	-4.022	-3.443	-3.145
STKF	28	-55.767	-4.022	-3.443	-3.145
IR	3	-12.876	-4.022	-3.443	-3.145
CR	0	-11.615	-4.022	-3.443	-3.145

Note: With a trend and intercept, except STKF with only an intercept.

Annex 3

**STEPS FOR THE ESTIMATION OF THE LONG-TERM
"OPTIMAL" REAL EXCHANGE RATE**

1. In the first step, we chose a shorter period during which the Brazilian economy showed good macroeconomic indicators, such as real GDP growth, current-account surplus to GDP, external debt to export ratio, among others. According to data from Brazil's Central Bank and the International Monetary Fund, this shorter period occurred from July 2003 to June 2005.

2. In the second step, we obtained the long-term "optimal" real exchange rate by multiplying the vector of the estimated coefficients of the regression model by the permanent components of the explanatory variables from July 2003 to June 2005.

3. Finally, after calculating an arithmetic average of the previous values, as all series are in logarithmic terms, we used the anti-logarithmic function to find the index of the real exchange rate.

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