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THE TREND OF THE REAL EXCHANGE RATE OVERVALUATION IN OPEN EMERGING ECONOMIES: THE CASE OF BRAZIL

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ABSTRACT

We present a Structuralist-Keynesian theoretical approach on the determining factors of the real exchange rate 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, and both of which may be responsible for deviations of that actual variable from its long-term trend level. The econometric model for the Brazilian economy in the 1999-2010 period shows that the terms of trade and the short-term interest rate differential are the most significant variables that explain the long-term trend of the real exchange rate overvaluation in Brazil. We also propose an index of overvaluation and an original definition of a long-term "optimal" real exchange rate for open emerging economies. 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. In January 2011, the average nominal exchange rate should be around 2.91 Brazilian *reais* per US dollar for reaching that "optimal" level, against an observed average nominal exchange rate of 1.67 Brazilian *reais* per US dollar. According to this estimation, in January 2011, the real overvaluation of the Brazilian currency in relation to the long-term ¨optimal¨ level was around 74 per cent. These findings lead us to suggest in the conclusion that a mix of policy instruments should be 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.

Key words: Real exchange rate, real overvaluation, economic policy dilemmas, Brazil

JEL: F30, F31, F39

1. Introduction

One of the most controversial topics in recent economic literature concerns the determining factors of the real exchange rate. At least two alternative theories dispute arguments on how to establish the long-term real exchange rate. On the one hand, the theory of purchasing power parity (PPP), which defines the real exchange rate between two countries as the relative price of a common basket of goods converted into the same *numeraire*, predicts that this ratio should be equal to 1 in the long run, in the absence of any short-term disturbance. On the other hand, Williamson (1983), in the mid-1980s, proposed an alternative concept of the real exchange rate denoted by the fundamental equilibrium exchange rate (FEER). The FEER is referred to as the real exchange rate that is consistent with a sustainable current account balance, while the economy is growing at its "natural" rate.

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 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. In a survey on theory and empirical evidence on exchange rate economics, 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 liberalisation where it appears likely to threaten overvaluation" (p. 24). By estimating the statistical relationship between the real exchange rate and growth in Brazil in the 1996-2009 period, Barbosa *et al*. (2010) reached a more moderate conclusion. Their results showed that, depending on the initial condition, both a real depreciation and a real appreciation can have a negative effect on growth. However, since they found that the best real exchange rate that corresponded to the highest growth in the period under analysis was 101.6, in practical terms, this means that the optimal real exchange rate is that which is consistent with a small real undervaluation, as suggested by Williamson (2008).

Yet, one of the main implications of the Mundell-Fleming model is that small economies under the 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, by virtue of 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 2003, 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. Actually, this trend has only been interrupted by either internal or external shocks, such as at the end of 1998 (a speculative attack against the unsustainable semi-fixed exchange rate regime with large capital mobility), in mid-2002 (because of negative market expectations concerning the possibility of a victory of a particular candidate to the Presidency of Brazil) and in the aftermath of the global crisis in September 2008. 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. Furthermore, we propose an econometric model that captures the main determining factors of the real exchange rate in Brazil in the 2000s. In our

econometric model, 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. Our empirical study, which covers the 1999-2010 period and uses monthly data in the econometric implementation, is useful not only to capture the main determining factors of the real exchange rate's trend of overvaluation, but also to guide our discussion on the mix of policies.

The remainder of the paper is organized as follows: Section 2 analyses the economic policy dilemmas that policy-makers in emerging economies have to face to avoid large real exchange rate deviations from its long-term "optimal" level in an economy with a floating exchange rate regime and free capital mobility. [1] Section 3 briefly discusses the theory of the determination of a real exchange rate and proposes a Structuralist-Keynesian theoretical model that better explains the determining factors that cause the actual real exchange rate to deviate from its long-term "optimal" level in emerging countries, like Brazil. Section 4 presents the econometric evidence for Brazil in the 2000s. Section 5 draws the main conclusions and discusses some policy implications for Brazil.

2. 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 Balassa-Samuelson effect is

[1] The term "optimal" level is used here 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, the economy as a whole is directed towards catching-up and economic development in the long run. We will argue ahead that the "optimal" level might (and should) be, at least partially, targeted.

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 open emerging economies – with a special look at the recent Brazilian experience – that face greater difficulty in the macroeconomic adjustment of the exchange rate, given their higher vulnerability to the external movement of capital flows. In a floating exchange rate regime, open emerging economies face special challenges in maintaining domestic and external equilibrium, which in many cases narrows their policy space. So, considering that the real exchange rate is a key variable that influences growth in the short and long run, and that its behaviour in the very short term is influenced by short-term economic policy measures, our aim in this section is to discuss stylized facts that narrow the policy space for emerging economies.

2.1 The "impossible trinity" and issues for emerging economies

Well documented in economic literature, the choice between alternative exchange rate regimes involves a trade-off between the advantages of a fixed exchange rate and a floating exchange rate regime. The former warrants the stability of the nominal exchange rate, an important condition for economies with a long tradition of high inflation. However, this benefit has a cost: the monetary policy's loss of autonomy. Also, international experience in the 1990s has shown that emerging countries that adopted an administered exchange rate regime and no capital control were vulnerable to speculative attacks on their currencies. These days, most of the emerging countries adopt a floating exchange rate regime.

In theoretical terms, by allowing for more autonomy in monetary policy, a floating exchange rate regime could be a solution for the 'impossible trinity'. According to this proposition, it is not possible to maintain a fixed exchange rate regime, free capital mobility and monetary policy autonomy and, at the same time, provide a consistent solution for economic policy. In a floating exchange rate regime, on the other hand, both the autonomy of monetary policy and low volatility of interest rates could be guaranteed, because this policy instrument could not be used to stabilize the exchange rate. In practical terms, however, given the great financial integration between the

economies, monetary autonomy is not observed (Grenville, 1998). Moreover, it should be added that 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.

The above considerations suggest that the central bank interferes in the foreign exchange market every time it chooses 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 equilibrium of the balance of payments (Ocampo and Vos, 2006).

Arguments put forward by Aizenman *et al.* (2010), discussing how some emerging Asian countries have tried to reduce high volatility of their nominal exchange rate, consider a modified version of the 'impossible trinity'. As stated by the authors, "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 (p.2)." 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. In a floating exchange rate regime, monetary authorities can

stabilize the domestic price level through monetary policy which should be efficient at guaranteeing domestic equilibrium. In this sense, the implementation of the monetary policy should be independent from other macroeconomic goals, as the floating exchange rate regime with capital mobility is responsible for maintaining the balance of payments in equilibrium. In an ideal world, with free capital mobility, it is assumed that a floating exchange rate regime can absorb exogenous shocks, without affecting the level of international reserves, and so making the country less vulnerable to exchange rate crises and speculative attacks.

However, Mundell (1960) had already observed that since the internal stability of the 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.[2] 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.

Notwithstanding, besides this asymmetry in the sensitivity of the adjustments, it should also be considered that emerging economies have specificities which might make the adjustment mechanism less efficient. These characteristics are: non-convertible currencies, high volatility in the capital flows as well as recurring and persistent current account deficits. Considering these characteristics, the operation of a floating exchange rate regime in emerging economies 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

[2] 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, a country relatively more open to short-term capital flows in current times.

external shocks and does not necessarily mean a "fear of floating", as Calvo and Reinhart (2002) argued.[3]

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.[4] 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.

Besides the 'fear of inflating", a "fear of depreciation" can also be added as an additional difficulty in administrating the economic policy trilemma in emerging economies. The "fear of depreciation" emerges because the process of foreign indebtedness in emerging economies involves a mismatch between the value of assets and obligations. As assets are, in general, denominated in the domestic currency, and obligations, in foreign currency, depreciation of the domestic currency could cause dramatic losses in debtors' stock of wealth in foreign currency. This sort of problem is known as the 'original sin' (Hausmann *et al.*, 2000). Because of this particularity, when external liquidity is plentiful, movements towards the overvaluation of a domestic currency have a positive effect on the balance sheet of indebted agents in a foreign currency, and the opposite effect is observed when international liquidity is scarce. The trend in favour of over-valuating the real exchange rate has 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

[3] 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.

[4] 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% p.a. until January 2009, even taking into account the recessionary environment in Brazil, the low inflation rate and the deflationary expectations stemming from said crisis. For a comparison between the different monetary and fiscal policy responses from Brazilian and Indian economic authorities to the immediate aftermath of the 2008 global crisis, see Nassif (2010).

or domestic products are quickly translated into an overvaluation of the real exchange rate.[5]

2.2 Stylized facts about real exchange rate volatility and the propensity for appreciation in emerging countries

We present below two stylized facts that narrow the policy space of economic authorities in emerging countries.

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. Then, when the country's risk premium increases, the domestic currency is expected to depreciate ($e^e > 0$).[6] On 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.

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

[5] According to Obstfeld (2008: 38), "with an open capital account, the possibility of undesired real currency appreciation—and indeed, depreciation—is inherent in the trilemma. Because appreciations are associated with distress in the manufacturing sector and with current account deficits, however, it is these, rather than depreciations, that generally worry policy makers the most".

[6] In some textbooks (e.g., Rivera-Batiz and Rivera-Batiz, 1994), when the country's risk premium is taken into account, the uncovered interest rate parity is expressed as $i = i^* + e^e + CR$, where CR is the country's risk premium. 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.

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. In fact, instead of reflecting expectations of depreciation, 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.[7]

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 necessary to finance balance of payments equilibrium, foreign reserves will increase. This increase, given the interest rate 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. Then, 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 safety net 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.

3. 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 determining factors of the real exchange rate equilibrium in the long

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

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 (denoted here as, country 1 and country 2) 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. Every time relative price level P1/P2 rises, we say that country 1 experienced a real exchange rate appreciation. This is the absolute version of the PPP theory, whose basic assumptions are that the goods that comprise the common basket are completely identical and that international prices are equalised by arbitrage. Since both assumptions are very difficult to sustain in the real world, the relative version of the PPP theory is more accepted, and it assures that the equilibrium real exchange rate can be maintained if the nominal exchange rate is adjusted by the differences in inflation rates in the countries considered over a given period. In this sense, the real exchange rate can be defined as (all variables are in logarithms):

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

where *RER* is the real exchange rate;
e is the nominal exchange rate (defined as the domestic currency price of foreign currency);
*p** and *p* are the foreign and domestic 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, except for countries facing very high inflation rates, even the relative PPP theory is not valid in the short term. However, according to the same authors, after the diversity of empirical work published from the 1990s onward, there is now (more than in the past) sound evidence that the PPP remains valid in the long run. They also remind us that this evidence became more convincing after econometric studies incorporated nominal rigidities into the models and showed the impact of both monetary shocks and short-term economic policy on the deviations of actual real exchange rates from their long-term trend.

However, Taylor and Taylor (2004) stressed that empirical studies have shown a strong reversion of the real exchange rate equilibrium over time. Then, 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 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 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 long-run terms of trade is another important variable associated with changes in the long-term structural behaviour of the real exchange rate, and it is related to macroeconomic theory. 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".[8]

On the other hand, the FEER theory 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. In this sense, according to Williamson (2008: 2):

> a FEER involved an exchange rate that is indefinitely sustainable on the basis of existing policies. It should be one that generates a current account surplus or deficit that matches the country's underlying capital flow over the cycle, assuming that the country is pursuing internal balance as best as it can and that it is not restricting trade for balance-of-payments reasons.

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. Yet, the forces that deviate the real exchange rate from its "fundamental"

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

long-term equilibrium are explained by either very short-term price rigidity, 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), a distinguished Brazilian economist, has proposed a structuralist approach which allows for understanding both the determination and the general trend of the real exchange rate in emerging economies. According to the author, in a world with floating exchange rate regimes and high freedom of capital movements, the currencies of countries with average income have a chronic tendency to overvalue rather than undervalue.[9]

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

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

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

The author does not reject the existence of an equilibrium real exchange rate. However, while in the mainstream approach 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 (see Bresser-Pereira, 2010, chapter 4). As far as the real exchange rate

[9] 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 propose an index of overvaluation through which we will estimate, in turn, the long-term "optimal" real exchange rate for the Brazilian economy.

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 real exchange rate behaviour is offered by the Keynesian literature. Starting with the notion that the long term is the sum of a sequence of short-term events (see Hahn, 1984), the Keynesian theory rejects the distinction between long-term and short-term equilibrium exchange rates.[10] In this sense, 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. In her own words:

> Due to the increased role of financial considerations in the working of the global economy, an analysis of exchange rate behaviour has to concentrate on the working of financial markets and the institutions that operate in them. However, if positions taken by asset market players are acknowledged to be the driving force of exchange rate movements, an attempt has to be made to understand the motivations and trading strategies adopted by these players. This approach will not only require an alternative view of "fundamentals", but necessarily has to be country specific and account for the complexity of foreign exchange markets in emerging countries (Kaltenbrunner, 2008: 2).

As a matter of fact, even Keynes (1923), then living in a world with a lower amount of financial flows, recognized that short-term capital flows are one of the main transmission channels of interest rate differential between countries and exchange rate

[10] 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. That is to say, policy makers could be responsible for the "suboptimal" real exchange rate level and should target its "optimal" level through appropriate economic policy instruments.

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). In fact, Peel and Taylor (2002) remind us that Keynes argued that the uncovered interest rate parity had a persistent tendency not to hold in practice due to the less than perfect elasticity of the supply of arbitrage funds. The most important point to stress here is that, 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 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. [11]

There are many empirical works that estimate the determining factors of the real exchange rate based exclusively on PPP theory (see, for instance, Frankel and Rose, 1996; Coakley et *al*., 2004; Rodrik, 2008) and others that make the same estimation based on the FEER theory (Williamson, 1995, 2008; Aguirre and Calderon, 2006; Cristiansen et *al.*, 2009). Yet, it must be recognized that both the above mentioned Structuralist and Keynesian theories of the real exchange rate have not been tested empirically.

However, as will be shown ahead, since our model also rejects the long-term variables determined by "fundamental" forces as required by the PPP and FEER theories, we can say that it is closer to both the Structuralist and Keynesian approaches. In our theoretical framework, the long-term "optimal" real exchange rate is influenced by both structural forces, such as productivity changes and terms of trade – which in turn are influenced not only by market forces but also by long-term economic policies, namely industrial and technological policies[12] – and short-term economic policies. The extent to which the actual real exchange rate tends to deviate from that "optimal" level

[11] This evidence gives support to our already mentioned first stylized fact, according to which, in practice, the uncovered interest rate parity has recurrently been violated in emerging countries that are highly open to short-term capital flows.

[12] 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 above mentioned long-term economic policies.

will depend on a diversity of long-term and short-term forces, such as the degree of financial openness, the change in aggregate productivity, monetary policy and so on.

3.1 The theoretical model

We propose a completely modified theoretical and empirical version of the model first presented by Razin (1996) and summarized by Razin and Collins (1999). Before presenting our modifications, it is convenient to show the model proposed by these authors. Razin and Collins' model is based on the IS-LM long-term equilibrium solution for a small economy producing only a single traded good, in which the short-term deviations from the long-term trend are due only to short-term real and monetary stochastic shocks. The real exchange rate is determined by the following equation:

$$RER_t = g_t(y_t^s, d_t, i^*) + f_t(e_{mt}, e_{yt}) \qquad (2)$$

where the (actual) real exchange rate RER_t in period t is jointly determined by two forces: the long-term forces related to economic fundamentals and represented by the function g_t ( ); and the short-term monetary and real shocks, represented by the function f_t ( ). They assume that g and f are linear functions. While the variables that comprise the function g ( ) are only real variables (y_t^s is the real output, d_t is real aggregate demand and i* the world interest rate), those that are incorporated into the function f ( ) are variables that represent short-term real and monetary stochastic shocks (ε_m and ε_y are real and monetary shock variables, respectively). In theoretical terms, the solution for the RER_t is represented by a combination of the flex-price solution for g ( ), plus a linear combination of stochastic shocks f ( ). It is important to stress that, in this theoretical formulation, in an ideal world in which all prices are flexible and there is no nominal price rigidity or other short-term economic disturbances, the actual real exchange rate RER_t would converge to its long-term trend represented by g ( ). Then, in Razin and Collins' model, the deviation of RER_t from its long-term equilibrium trend is explained by short-term real and monetary shocks.

In our model, however, not only the long-term "optimal" real exchange rate, but also deviations of the actual real exchange rate from that "optimal" level are jointly explained by long-term structural forces and short-term economic policies. We reject

the conventional view of the existence of automatic forces driving the real exchange rate either towards a long-term equilibrium (such as the PPP approach) or a long-term "optimal" level (as inherent in our framework). By supporting this argument, our theoretically modified model is expressed as:

$$RER_t = g_t(structlt_t) + m(st_t) \quad (3)$$

where RER_t continues to be the actual real exchange rate, but both the functions g ( ) and m ( ) are different from Razin and Collins' (1999) approach. In fact, all the variables that comprise Razin and Collins' (1999) function g ( ) are totally linked to fundamentals. In our model, however, 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. And, for emerging countries like Brazil, the component m ( ), far from being influenced by random real or monetary shocks, like in Razin and Collins' (1999) model, incorporates the set of short-term variables st_t that are directly and indirectly influenced by short-term macroeconomic policy. In fact, short-term economic policy variables can produce different trajectories for the real exchange rate. In many cases, erratic economic policies combined with deep financial integration with the world economy can amplify the real exchange rate's trend of overvaluation.

In other words, 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.

With such changes in the original formulation, when the theoretical model is expressed in econometric specification (see Section 4), we cannot only capture the main determining factors of the recent actual real overvaluation of the Brazilian currency, but also evaluate the policy space of short-term economic policy, 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.

4. Real exchange rate overvaluation: empirical evidence for Brazil in the 2000s

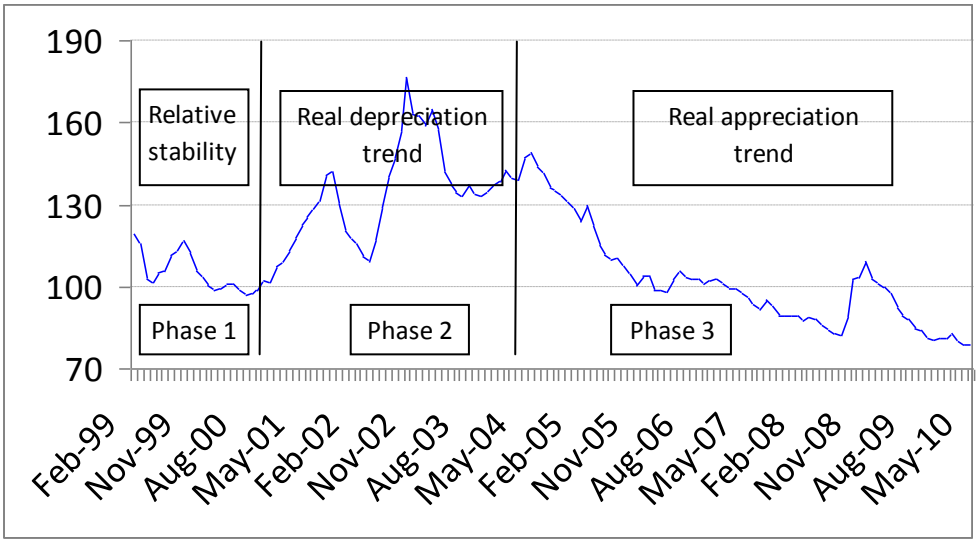
This section empirically investigates the determining factors of the real exchange rate in Brazil after the implementation of the flexible exchange rate regime in January 1999. The Brazilian currency has presented a trend towards overvaluation of its real exchange rate ever since inflation became controlled in the mid-1990s. The stabilisation plan launched in 1994 (*Plano Real*) was based on a fixed exchange rate regime, which was abandoned in January 1999, following the speculative attacks on most currencies in emerging countries in the second half of the 1990s.

The phase of the floating exchange rate regime that was implemented with an inflation targeting policy 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 most part a dominant pattern until the eruption of the international 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 May, 2010. At least three distinct phases can be identified, showing different behaviours in the real exchange rate. It is convenient to stress that this division takes into account not only the actual trajectory of the real exchange rate, but also the calculated standard deviation in each phase.[13] The first phase 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, when the real exchange rate seemed to have reached an equilibrium level.

[13] Considering the standard deviation and the trajectory of the evolution of the real exchange rate, we divided the phases as follows: relative stability from February 1999 to December 2000 (standard deviation of 6.7); real depreciation trend from January 2001 to May 2004 (standard deviation of 16.8); and real appreciation trend from June 2004 to May 2010 (standard deviation of 16.8).

Figure 1: Actual real effective exchange rate (monthly data)
Brazil, February 1999-May 2010
2000 average real exchange rate = 100



Source: Brazil's Central Bank.

After this short period of relative stability, the Brazilian currency showed a trend towards depreciation in real terms until mid-2004. The second phase in the trajectory of the real exchange rate was marked by the negative expectations of the election of a candidate (Luiz Inácio Lula da Silva), who was then adversely evaluated by markets in Brazil. This political fact substantially raised the degree of uncertainty among private agents, which was reflected in an increase in the real exchange rate volatility. In October 2002, the real depreciation of the Brazilian currency reached its highest level.

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. The third phase of the real exchange rate evolution is characterized by greater dynamism in the economy,[14] although higher growth rates tend to be associated with an undervalued currency. This

[14] Real GDP grew at 5.7% in 2004; 3.2% in 2005; 4.0% in 2006; 6.1% in 2007, and 5.1% in 2008.

behaviour, however, has not been observed in the Brazilian case in the recent period. 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. In addition, in absence of capital controls, the excess inflow of external capital forced the Brazilian *real* to appreciate.

In addition, it is important to stress that the introduction of a floating exchange rate regime in 1999 was followed, as mentioned, by the implementation of an inflation targeting regime, which, in Brazil's case, has relied almost exclusively on the manipulation of the basic interest rate (*SELIC*) as the sole instrument to control inflation. During the whole period, domestic interest rates were maintained relatively high compared to the rest of the world. This implied that the short-term interest rate differential worked as a continuous stimulus to attract short-term foreign capital, which strongly contributed to the real exchange rate volatility. Interventions in the foreign exchange market aimed at controlling volatility and overvaluation have been used more effectively in the last five years, even though this strategy tends to increase gross public debt due to the high cost in sterilizing the monetary impact brought on by Brazil's Central Bank purchase of international reserves.

4.1 Econometric implementation

Our theoretical model presented in equation (3) will be translated into the following econometric specification (equation 4), which is consistent with the theoretical discussion above:

$$\ln RER_t = c_0 + a_1 \ln Y_t + a_2 \ln ToT_t + a_3 \ln CA_t + \\ + b_1(\ln IDIFER)_t + b_2(\ln IDIFER)_{t-1} + b_3 \ln STKF_t + b_4 \ln IR_t + b_5 \ln CR_t + e_t \quad (4)$$

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 (4)) and those directly or indirectly associated with the short-term policies (variables with the β coefficients on the right

side of equation (4)). In choosing this way to write the empirical equation, we expand our econometric application to develop and calculate an index of overvaluation of the Brazilian real exchange rate in the period in question.

The variables of the model are specified in logarithms as follows: *RER* is the actual real effective exchange rate; *Y* is the real GDP *per capita* in US dollar; *ToT* is the terms of trade; *STKF* is the net short-term capital flow expressed as a ratio of GDP; [15] *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; *CR* is Brazil's risk premium; ε_t is a random error variable, and it is also to be assumed to contribute to deviating the actual real exchange rate from its long-term "optimal" level; and the subscript *t* is the time reference (in our econometric modeling, it refers to a month).[16, 17]

The variables chosen to represent the structural conditions to determine the real exchange rate are largely used in the empirical literature, and they do not deserve additional comments (see, for instance, Helmers, 1988, Edwards, 1988, Rodrik, 2008). In our econometric implementation, the variables chosen are considered to be the most relevant in explaining the changes in the long-term structural real exchange rate.[18] Yet, our variables either directly managed or indirectly influenced by short-term economic policy are found throughout empirical studies, such as Meese and Rogoff (1983), Edwards (1988), Calvo, Leiderman and Reinhart (1993), among others. For our specific purpose, the short-term variables chosen are considered to be the most important for an emerging economy under the specific discussion in Section 2.

In the recent Brazilian academic debate, some economists argue that the overvaluation trend of the real exchange rate is a consequence of Brazil's low capacity

[15] 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.
[16] 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*.
[17] The data sources are described in Appendix 1.
[18] Needless to say that, in keeping with our theoretical purpose, these variables are also influenced by the long-term economic policies.

to increase its total domestic savings, which is caused, in turn, by the public sector's poor efforts towards augmenting its savings flows (see, for instance, Wajnberg, 2008**;** Ferreira and Cardoso, 2009; and Pastore, Pinotti and Pagano, 2010). Rigorously speaking, in the Brazilian debate, there are two main theoretical positions on the relationship between the real exchange rate and domestic savings. The first line of thought argues that the overvaluation trend of the real exchange rate in Brazil reflects the low total domestic savings. In this sense, current account deficits can be temporarily accepted since they can be financed by external savings (see Ferreira and Cardoso, 2009; Pastore, Pinotti and Pagano, 2010). The second line, which we support, states that the immediate negative effect of a country that adopts a strategy of economic development based on the absorption of external savings is the appreciation of its real exchange rate. This implies an artificial increase in real wages and aggregate consumption and, consequently, a reduction in total domestic savings (see Bresser-Pereira and Gala, 2008; and Resende, 2009) [19]

In principle, we could include other variables, such as Brazil's total savings, private savings, public sector savings, the gross debt of the public sector, the stock of external direct investment in Brazil, and so on. However, since the incorporation of many variables would imply a loss in the degrees of freedom in our model, we opted to keep our model as parsimonious as possible, only including the most important variables linked to our theoretical discussion.

In the empirical procedure, we had to pursue two basic econometric issues: first, the potential non-stationarity of the variables to be regressed; second, the potential endogeneity of our explanatory variables specified in the empirical model. As for the first issue, we implemented appropriate unit root tests. The Augmented Dickey-Fuller (ADF, proposed by Said and Dickey, 1984) and Phillips-Perron – PP (1988) tests revealed that, 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% significance level. The results of these tests are shown in Appendix 2 (Tables 1 and 2).

[19] Krugman (1995) also supports the second line of thought arguing that "it is naive to imagine that changes in the government's financial balance can translate directly into changes in physical trade flows, without working through a mechanism such as the exchange rate".

Before applying the co-integration test, it is important to stress that error correction models (ECM) are generally applied to non-stationary series which have a co-integration relationship. In principle, as supported by Campbell and Perron (1991), in reaching a co-integrated 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 have a good fit. In fact, as we already discussed in Section 3, since one of the main transmission channels from the interest rate differential to the real exchange rate is through the net short-term capital flow, the removal of this variable does not damage the consistency of the model. Therefore, we continue with our estimation removing the variable *STKF* from equation (4), which is re-expressed by the following equation:

$$\ln RER_t = c_0 + a_1 \ln Y_t + a_2 \ln ToT_t + a_3 \ln CA_t + \\ + b_1(\ln IDIFER)_t + b_2(\ln IDIFER)_{t-1} + b_3 \ln IR_t + b_4 \ln CR_t + e_t \quad (5)$$

Having now established that the variables of equation (5) are non-stationary and possess the same order of integration I (1), we are able to apply the co-integration test so as to verify whether a linear combination of these variables is stationary. Following Granger (1981) and Engle and Granger (1987), if a unit root test reveals the residuals are stationary, i.e., I (0), we could conclude not only that all variables of our single equation are co-integrated in levels, but also that the estimated coefficients by ordinary least square (OLS) are consistent (Hamilton, 1994: 857; Greene, 1997: 856-857). In fact, as Table 1 shows, the ADF and PP tests prove we can reject the null hypothesis of unit root in the residuals. So, according to 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 co-integrated.

Table 1

Unity root tests in the residual

Tests	*t* statistics	Critical values		
		1%	5%	10%
Augmented Dickey-Fuller	-7.226	-2.582	-1.943	1.651
Phillip-Perron	-7.314	-2.582	-1.943	1.651

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

As to the endogeneity issue inherent to the econometric implementation by OLS, as Baffes *et al.* (1999) show, even the relevant exogeneity tests proposed by Engle, Hendry and Richard (1983) might not be able to solve endogeneity problems when the marginal distribution of the explanatory variables shifts. [20] However, in a model where more than one variable is endogenous, the Johansen (1988) co-integration procedure is then preferable 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 co-integration vectors. The number of co-integration vectors is determined by trace and eigenvalue tests.[21] The results are presented in Table 2.

Table 2

Johansen Test of Cointegration Rank

	Trace statistics			Max-Eigen statistics		
	Eigenvalue	Critical Value	Prob. 5%	Eigenvalue	Critical Value	Prob. 5%
None	200.0713	150.5585	0.0000	90.68323	50.59985	0.0000
At most 1	109.3881	117.7082	0.1492	34.39791	44.49720	0.4009
At most 2	74.99016	88.80380	0.3242	28.75081	38.33101	0.4045

Note: 4 lags and 126 observations after adjustments

The null hypothesis that there is a lack of co-integration relationship is rejected at 5% significance level, both for trace and maximum eigenvalue test statistics. This means that there is strong evidence to support the existence of a co-integration vector which represents the long-term relationship among the variables of our model.

[20] Although Razin and Collins (1999) had called attention to potential endogeneity of some variables introduced in their empirical implementation, e.g. the trade balance (exports minus imports of goods and non-factor services), they did not pursue these econometric issues. As for our model, one could suspect that, among others, the current account *CA* could have an endogeneity relationship with our endogenous variable actual real exchange rate *RER*.

[21] See Enders (1995) and Hamilton (1994).

Subsequently, following the two methodologies suggested by Baffes *et al.*(1999) for estimating a single equation of the real exchange rate, we will estimate the coefficients of equation (5) by both ordinary least squares (OLS) and the error correction model (ECM). The results are presented in Table 3.

Table 3: Estimated model for Brazil

Dependent variable: real exchange rate

Variable	Description of the variables	OLS coefficient (t-statistics between brackets)	Variable	ECM coefficient (t-statistics between brackets)
C	Constant	7.8220*** [8.921]	***C***	8.0379
lnY	Log of the real GDP per capita	-0.3460*** [-7.551]	lnY_{t-1}	-0.4927*** [-9.485]
lnTOT	Log of the terms of trade	-0.4945** [-2.3104]	$lnTOT_{t-1}$	-0.5687* [-1.582]
lnCA	Log of the current account balance/GDP	0.23042*** [12.636]	$lnCA_{t-1}$	0.23042*** [12.636]
Ln(IDIFER)	Log of the short-term interest rate differential	0.1229*** [2.9483]	***Ln(IDIFER)***	- -
$Ln(IDIFER)_{t-1}$	Log of the lagged short-term interest rate differential	-0.1472*** [-3.489]	$Ln(IDIFER)_{t-2}$	-0.1607*** [-4.236]
lnIR	Log of the stock of international reserves/GDP	0.1141*** [4.0044]	$lnIR_{t-1}$	0.1655*** [5.5196]
lnCR	Log of the Brazil's risk premium	0.0644*** [2.8889]	$lnCR_{t-1}$	0.0606** [2.0842]

Notes on OLS model: R-squared: 0.86495; Adjusted R-squared: 0.8575; Durbin-Watson: 1.6769; F-statistics: 117.1182;
Prob (F-statistics): 0.0000; Number of observations: 136 after adjustments
Notes on ECM model: 4 lags; Number of observations: 126 after adjustments
Note: *** Significant at 1 percent level; ** Significant at 5 percent level; * Significant at 10 percent level.

The results of the estimation show that our empirical model is relatively well-suited. In general terms, all signs of the estimated coefficients resulted as expected and in accordance with our theoretical discussion in both OLS and ECM models. The terms of trade *ToT* presented a negative sign, as expected, and not only was it the most important variable to explain the long-term structural real exchange rate in Brazil, but was also statistically significant. This result confirms the current suspicion (e.g. Bresser-

Pereira, 2010) that, by having strongly increased the international specialisation in agricultural products and manufactured commodities in the last decade, Brazil has benefited from high international relative prices of these goods, but at cost of tendentiously appreciating its currency in real terms in the long run. We found that an improvement of 10% in the terms of trade appreciates the long-term structural real exchange rate 4.9% in the OLS model and 5.7% in the ECM model.

The real GDP per capita *Y* presented a negative sign, as expected, and was statistically significant. An increase of 10% in this variable over time implies an appreciation of 3.4% in the OLS model and 4.9% in the ECM model in the long-term structural real exchange rate, according to the Balassa-Samuelson effect. However, the representative power of this variable to explain significantly the behaviour of the long-term structural real exchange rate in Brazil 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 social policies (e.g. the Family Assistance Program (*Bolsa Família)*, among others) which led to a significant improvement in income distribution.[22] This explains why the coefficient of the real GDP per capita *Y* in our regression proved to be one of the most significant, confirming the importance of this variable when explaining the behaviour of the long-term structural real exchange rate in Brazil.

The expected sign of the third variable of the structural part of the model, the current account balance to GDP ratio (*CA*), is ambiguous. On one hand, *ceteris paribus*, the more a country shows current account surplus, the more appreciated its currency will be in real terms. In this case, one should expect a negative sign for the current-account balance to GDP ratio (Baffes *et al*., 1999).[23] On the other hand, we could also

[22] It is common for economists in Brazil to calculate the labour productivity in the manufacturing sector as the gross physical production/hours worked ratio (see, for instance, IEDI (2010)). However, this methodology is misleading for it tends to overestimate the results. The more appropriate measure for that indicator should be the value added/hours worked ratio (see Nelson, 1996; and Bonelli and Fonseca, 1998). In fact, if this latter indicator is used, the annual average growth in labor productivity in the Brazilian manufacturing industry in the 1996-2007 period was -0.1% in real terms (calculated by authors, based on the Annual Manufacturing Survey/Brazilian Statistical Office – *Pesquisa Industrial Annual*/*IBGE*). If we take into account the total factor productivity (TFP), an indicator of aggregate efficiency, the annual average growth was less than 0.5% between 2002 and 2009 (against 4% in China and 2.6% in India (see The Economist, November 18, 2009)).

[23] To be exact, Baffes *et. al* (1999) consider as one of the "fundamental" explanatory variables of their

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.

The variables associated to short-term economic policies are assumed to be partially responsible for the deviations of the actual real exchange rates from their long-term estimated level. The short-term interest rate differential is considered one of the most important policy variables to interfere in the determination of the real exchange rate and was statistically significant. As supported by the analysis in Section 2, the very short-term impact of the interest rate differential might mean not only an increase in the country's risk premium – since a higher short-term interest rate differential reflects the expectations for currency depreciation ("fear of depreciation") –, but also a "fear of inflating", given the context of the current inflation targeting regime in Brazil.[24] So, we should expect a positive sign in the interest rate differential, as shown in the 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 flows. Among the variables responsible for deviating the actual real exchange rate from its long-term estimated level, the lagged interest rate differential showed the greatest elasticity, since an increase of 10% in the interest rate

model the ratio of exports minus imports of goods and services to GDP, instead of the current-account balance to GDP ratio. However, the reasoning under the expected sign of both variables is the same.

[24] Rigorously speaking, the high current level of the Brazilian stock of international reserves helps to reduce "the fear of depreciation", for an eventual depreciation of the Brazilian currency, by increasing the US dollar value of that indicator, would reduce the total net external debt. In this case, the high short-term interest rate differential in Brazil in current days rather reflects a "fear of inflating".

differential in Brazil implies a real appreciation between 1.5% (OLS) and 1.6% (ECM) in the Brazilian currency in the short term.

The stock of international reserves showed a positive sign, and it was statistically significant. This variable, represented in the model as a ratio of GDP, is, along with the interest rate differential, one of the most important to impact the short-term real exchange rate. It is necessary to stress, though, that the relationship between this variable and the real exchange rate is ambiguous. On 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 avoid real exchange rate appreciation (a defensive strategy). So, if this is the case, the expected sign should be positive. This seems to be the case for Brazil in the period under analysis. The results suggest that a 10% increase in the stock of Brazilian international reserves in relation to GDP causes a real depreciation of 1.1% (OLS) or 1.6% (ECM).

The third variable associated with short-term economic policies, the country's risk premium, presented a positive sign, implying that a higher coefficient of this variable is associated with an undervalued currency in real terms, as suggested by the theoretical literature. The implied elasticity of the real exchange rate with respect to the country's risk premium was 0.06, thus a 10% increase in this variable depreciates the real exchange rate by 0.6%.

4.2 The index of overvaluation and the long-term "optimal" real exchange rate

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.

The index of overvaluation can be expressed in logarithms as the difference between the actual and the long-term estimated real exchange rates, as follows:

$$\ln OVERV_t = (\ln RER_t - \ln R\hat{E}R_t) \qquad (6)$$

We call ln $OVERV_t$ an index of overvaluation in period *t*, where *RÊR* is the long-term estimated *RER*. Like Rodrik (2008), we use the logarithmic transform, *ln OVERV*, which is centred at zero.[25] The interpretation of this index is as follows: whenever *ln* $OVERV_t$ exceeds zero, it indicates that the real exchange rate is undervalued, and when it is below zero, the currency is overvalued. It is necessary to stress that this difference does not mean either undervaluation or overvaluation in relation to the long-term "optimal" level, but rather in relation to the estimated long-term trend level.

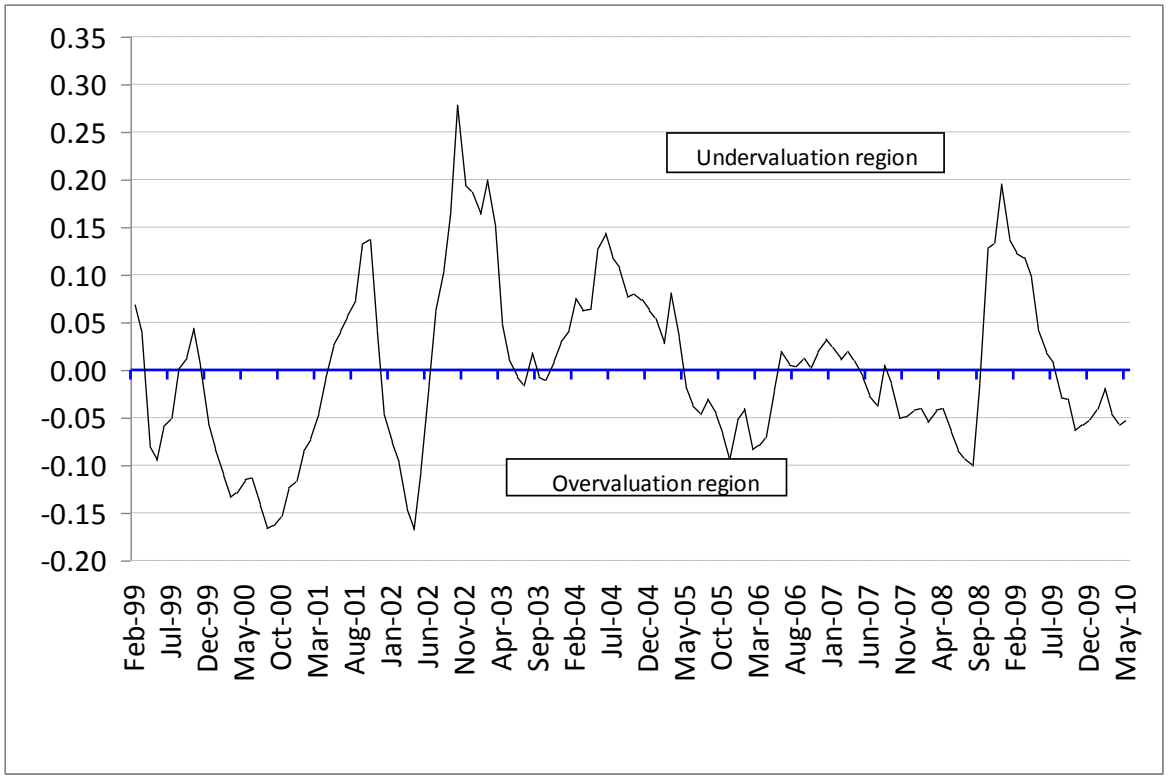
Figures 2 and 3 show the deviations of the actual real exchange rate from its long-term trend in Brazil in the period under analysis.

[25] It should be mentioned that the usual procedure is to estimate either exchange rate "misalignment", like Razin and Collins (1999), or an "index of undervaluation" like Rodrik (2008). Our index of overvaluation, however, is quite different from both authors. Razin and Collins (1999), for instance, estimated the "misalignment" as the difference between the actual *RER* and the estimated *RÊR* related to only the component associated with the fundamentals. Rodrik (2008), in turn, in his econometric implementation, despite having considered a fixed effect for time, regressed the actual real exchange rate on only one long-term variable (the real GDP per capita) and calculated his "index of undervaluation" as the residual of the estimated model, an inappropriate methodology from our point of view.

Figure 2

Index of overvaluation of the Brazilian currency: February 1999 – May 2010

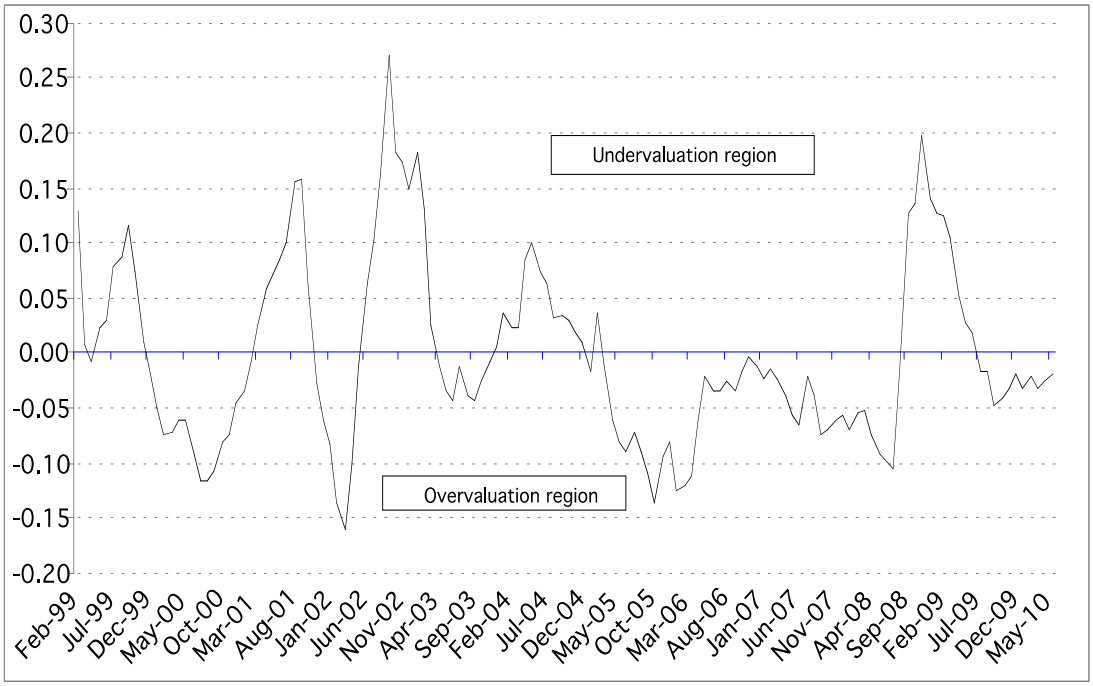
***ln OVERV* – OLS model**



Source: Estimated by authors according to procedures specified in equation (6).

Figure 3

Index of overvaluation of the Brazilian currency: February 1999-May 2010 (*ln OVERV*) – ECM model



Source: Estimated by authors according to procedures specified in equation (6).

Subsequently, Figures 2 and 3 show that the index of overvaluation most accurately reproduces the general trajectory of the real overvaluation of the exchange rate in Brazil between February 1999 and May 2010. In fact, both figures precisely and clearly replicate three significant characteristics of the Brazilian real exchange rate behaviour in the last decade (note that some general trends are very similar to the actual real effective exchange rate shown in Figure 1), through which the economy has for the first time experienced a combination of a floating exchange rate regime with vast freedom for capital movements.

The episodes that produced strong and damaging depreciations happened exclusively as a 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).

As our index measures the actual overvaluation against our estimation of the long-term trend of the real exchange rate, the results show that the Brazilian currency has almost been persistently overvalued throughout the whole period. One could argue that, on average, our index of overvaluation is relatively low compared with the actual real effective exchange rate. However, it should be underscored that this average could have been reduced by severe episodes of overshooting of the Brazilian currency in the aftermath of internal and external shocks, which we previously described.

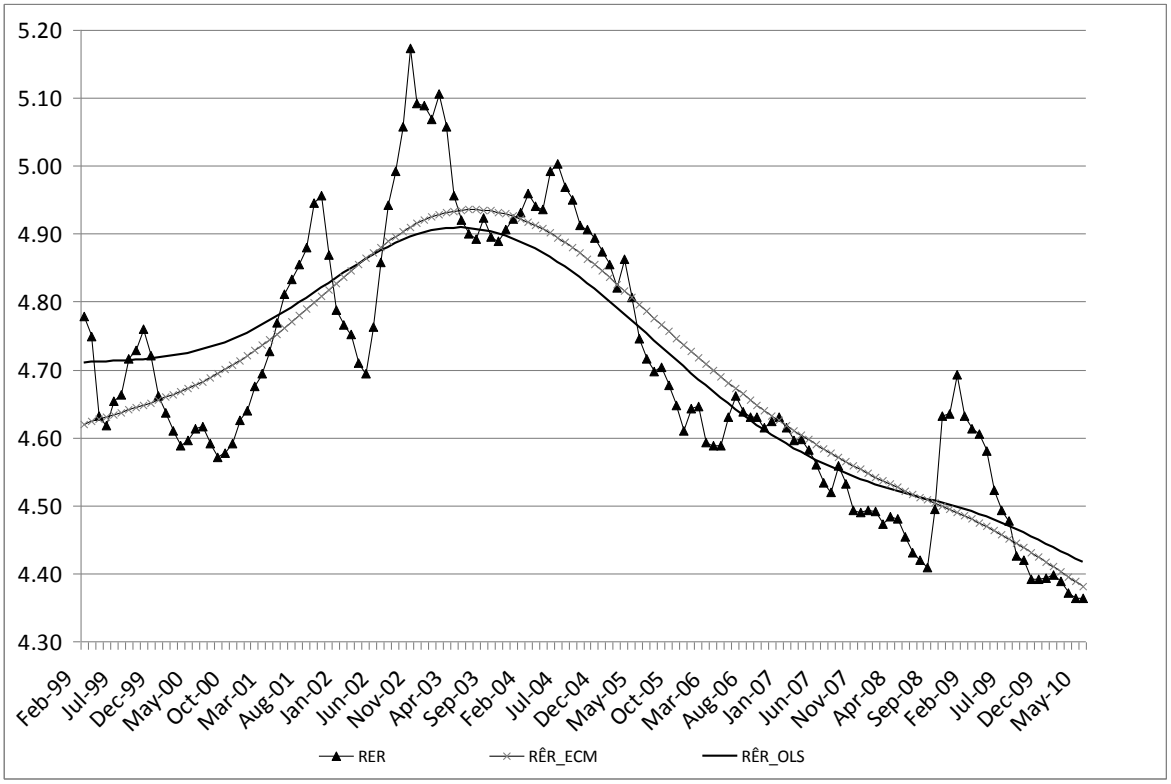
Figure 4 jointly shows the actual (RER) and long-term estimated real exchange rates $R\hat{E}R$ (this latter both by OLS and ECM) between February 1999 and May 2010 (all indicators in logarithms).

Figure 4

Actual and long-term estimated real exchange rates in Brazil:

February 1999 – May 2010

(in logarithms)



Source: Estimated by authors according to the described methodology.

Figure 4 calls attention to three 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 model to capture the long-term trend of the real exchange rate overvaluation in Brazil throughout the period; second, the very close results of the estimations by both OLS and ECM demonstrate that both the explanatory variables and the methodologies chosen to estimate the determining factors of the long-term trend of the Brazilian real exchange rate overvaluation to be appropriate; and third, contrary to what is supported by the theoretical and empirical literature on which the real exchange rate level is more appropriate for assuring economic development, there has been a chronic tendency of the long-term real exchange rate in Brazil to 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.

On the contrary, the trend of the Brazilian real exchange rate overvaluation is predominantly explained by two forces: one structural and the other associated with the practice of monetary policy in Brazil throughout the period under analysis. While the first one is a consequence of high international relative prices of commodities, which, by tendencially improving the terms of trade, puts the Brazilian economy under the risk of Dutch disease – according to Bresser-Pereira's (2010) hypothesis –, the other one is due to the high short-term interest rate differential, which is also responsible for pushing the real exchange rate towards a long-term "suboptimal" trend.

Given these specificities, one could speculate what the level of the long-term "optimal" real exchange rate would be, that is, the one that could prevent the current process of Brazilian early deindustrialisation and, hence, not damage economic development. An attempt to estimate this level should consider, as a first step, a shorter period, when, roughly speaking, the economy had showed fewer unbalanced macroeconomic indicators. This occurred from mid-2003 to mid-2005. Considering only this period, the index of the long-term estimated real exchange rate was 132.89 (average of the period). For illustrative purposes, comparing this level with the index of the real exchange rate observed in January 2011 (= 76.40 on average), the Brazilian real exchange rate showed a real overvaluation of around 73 per cent related to its long-term "optimal" level. In Appendix 3, we describe the steps for estimating the long-term "optimal" real exchange rate.

Since the empirical literature concludes that a small real undervaluation is the best policy for assuring economic development (Williamson, 2008; Barbosa *et al.*, 2010), our next step is to take into account that our long-term "optimal" real exchange rate must include a small undervaluation. Then, going back to our index of overvaluation (see Figures 2 and 3), since the real undervaluation of the Brazilian currency was around 4.4 per cent in 2004 (on average), we suspect that Brazil reached its long-term "optimal" real exchange rate in that year. This supposition is supported by statistical evidence according to which that year also showed good performance in terms of 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.[26] By applying the same procedures described in Appendix 3, we realized that the index of the long-term "optimal" real exchange rate in 2004 was 134.10 (average of the year). Comparing this with the index of the actual real exchange rate in January 2011, the average nominal exchange rate should be around 2.91 Brazilian *reais* per US dollar for reaching that "optimal" level (against an observed average nominal exchange rate of 1.67 Brazilian *reais* per US dollar). So, in January 2011, the real exchange rate was overvalued around 74 per cent in relation to the long-term "optimal" level.

One could argue that this level of overvaluation might be overestimated. However, it is necessary to remember that this result has no association with a long-term equilibrium real exchange rate (in the same vein as PPP theory) and incorporates some small real undervaluation. So, it must be compared to our long-term "optimal" real exchange rate, that is, the real exchange rate necessary for putting the economy on the path to catch-up and economic development in the long run.[27] Since our model is not based on the PPP approach and uses, as the explained variable, the actual real effective exchange rate (which is based on a basket of currencies and not only on the US dollar), there may be some imprecision in this comparison. However, as a preliminary exercise, it can be useful to support our estimation model.

5. Concluding remarks and economic policy implications

In his classic paper, Dornbusch (1976) definitively showed that a fixed exchange rate regime with high capital mobility is not sustainable in the long term. His main argument is that, if the real exchange rate is strongly overvalued, this increases current account deficits as well as leading to a rapid growth of external debt, and this situation ends up putting the economy under a speculative attack. He also advised that an economy with relatively free capital movements should not choose a fixed exchange rate. The transition from a fixed exchange rate to a floating exchange rate regime in Brazil in the beginning of 1999 is an example of what Dornbusch's model foresaw. In

[26] Although in 1999 a small real undervaluation can also be observed (see Figures 2 and 3), statistics data indicate that macroeconomic performance was quite inferior to that of 2004.
[27] Note that our definition of a long-term "optimal" real exchange rate is close to Bresser-Pereira's (2010) concept of "industrial equilibrium" exchange rate.

fact, by not having followed this author's recommendations, the introduction of a floating exchange rate regime in 1999 in Brazil was, in practical terms, a measure of economic policy forced by the markets, which was initiated as soon as the speculative attack that had begun in the end of 1998 generated an overshooting of the Brazilian exchange rate.

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 – is on the current agenda of 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 of the real exchange rate.

In this paper, by means of descriptive statistics and econometric evidence, we showed that the evolution of the Brazilian real exchange rate has been characterized by high volatility and a trend of persistent overvaluation. 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. The estimated equation for the real exchange rate provided the coefficients to run an estimated measure of the structural and short-term real exchange rate, which, when compared with the actual real exchange rate, allowed us to calculate an index of overvaluation. This index showed the extent to which the terms of trade and the lagged differential between Brazilian and foreign interest rates are the main factors explaining the deviations of the Brazilian actual real exchange rate from its long-term trend level.

Aizenman *et al.* (2010) showed econometric evidence that, since the 1997 financial crisis, Asian emerging market economies have been successful in damping the negative impacts of large short-term net capital flows on the real exchange rate overvaluation through massive accumulation of international reserves.[28] The authors

[28] For a critical analysis of the accumulation of reserves policy, see Cruz and Walters, 2008.

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 January 2011 (around 75 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 preserving price stability. This challenge would demand policy-makers to assume a target for the "optimal" level of the real exchange rate in the medium and the long-run.

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 stock of international reserves had a positive sign, which is 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 relevant 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 in 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.

The terms of trade figured as the main factor responsible for the overvaluation trend of the Brazilian currency in the long run. Since this result is explained in turn by the behaviour of 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.

On the other hand, 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. For instance, 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; Squeff *et al.*, 2009).[29] On the other hand, 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, but also to augmenting the public investment/GDP ratio in Brazil.[30] It is necessary to remark, however, that fiscal policy responsibility *per se* is not sufficient in reducing high interest rates in Brazil.

Finally, Brazilian policy makers should not discard the use of more effective mechanisms for capital control as a relevant mechanism for economic policy. Taking into account that international interest rates might be maintained at a very low level in

[29] We must recognize that there have been small changes in the way Brazil's Central Bank manipulates the monetary policy under the inflation target regime. For instance, while before the September 2008 financial crash, the control of both actual inflation and inflation expectations had been managed almost exclusively by the Brazilian short-term policy rate (*SELIC*), since then Brazil's Central Bank has been adding other instruments and strategies, such as compulsory reserve requirements, capital requirements to strengthen bank balance sheets and the apparent and undeclared acknowledgment of the challenges and high costs associated with the reaching the current inflation target (4.5% for 2011) in a single calendar year, especially taking into account that world basic products and commodity prices will tend to remain in high levels in the next few years.

[30] The total investment of the central government as a proportion of Brazilian GDP was only 1.3% in 2010 (see the website of the Brazilian Treasury at http://www.tesouro.fazenda.gov.br), a very low rate for a country with poor physical and social infrastructure.

the near future, due to the stagnant environment in the world economy, the actually high short-term interest rate differential will continue to contribute to the appreciation of the Brazilian currency in real terms.[31] 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).[32]

For at least two reasons, real exchange overvaluation should be 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 contraction.

[31] When this paper was started in May 2010, almost no capital control measures had been adopted by the Brazilian authorities, although the overvaluation trend of the Brazilian currency has been continuous since 2004. As this trend deepened in 2010, three measures of capital control - until then a forbidden topic among Brazilian economic policy-makers -, were introduced up to March 2011, and it is likely that stronger quantitative controls will soon be imposed.

[32] There are some academic studies that put in doubt the ability of central banks to efficiently manage quantitative capital controls, arguing that investors in financial markets also find mechanisms to overpass the official controls (see Carvalho and Garcia, 2008 for the Brazilian experience in the nineties, and Calvo, 2010, for the general case). However, we could not ignore that there have been well succeeded experiences with capital controls, at least in the short and medium run (see, for instance, BIS, 2008, for detailed country experiences).

Appendix 1 – Description of the data source

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

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

Appendix 2

Table 1

Augmented Dickey-Fuller test (ADF): in levels and first differences

Variable	lags	*t* statistics	Critical values:		
			1%	5%	10%
RER	1	-1.725	-4.027	-3.443	-3.146
Y	2	-2.076	-4.027	-3.443	-3.146
TOT	1	-2.265	-4.027	-3.443	-3.146
CA	11	-0.672	-4.027	-3.443	-3.146
IDIFER	3	-2.822	-4.027	-3.443	-3.146
STKF	0	**-11.427**	-3.427	-2.578	-3.146
IR	0	-2.481	-4.027	-3.443	-3.146
CR	3	-2.105	-4.027	-3.443	-3.146
DRER	0	-9.646	-4.027	-3.443	-3.146
DY	1	-9.620	-4.027	-3.443	-3.146
DTOT	0	-15.188	-4.027	-3.443	-3.146
DCA	4	-10.897	-4.027	-3.443	-3.146
DIDIFER	2	-5.535	-4.027	-3.443	-3.146
DSTKF	3	-10.306	-3.427	-2.578	-3.146
DIR	0	-12.454	-4.027	-3.443	-3.146
DCR	1	-11.031	-4.027	-3.443	-3.146

Note: ADF at level with trend and intercept

Table 2

Phillips-Perron Test(PP): in levels and first differences

Variable	lags	*t* statistics	Critical values:		
			1%	5%	10%
RER	4	-2.238	-4.027	-3.443	-3.146
Y	8	-2.274	-4.027	-3.443	-3.146
TOT	6	-3.028	-4.027	-3.443	-3.146
CA	8	-2.789	-4.027	-3.443	-3.146
IDIFER	0	-3.093	-4.027	-3.443	-3.146
STKF	5	**-11.436**	-3.427	-2.578	-3.146
IR	0	-2.481	-4.027	-3.443	-3.146
CR	2	-2.254	-4.027	-3.443	-3.146
DRER	0	-9.714	-4.027	-3.443	-3.146
DY	2	-10.041	-4.027	-3.443	-3.146
DTOT	14	-15.188	-4.027	-3.443	-3.146
DCA	18	-49.772	-4.027	-3.443	-3.146
DIDIFER	5	-18.571	-4.027	-3.443	-3.146
DSTKF	28	-55.767	-3.427	-2.578	-3.146
DIR	3	-12.475	-4.027	-3.443	-3.146
DCR	0	-11.050	-4.027	-3.443	-3.146

Note: ADF at level with trend and intercept

Appendix 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, 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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