WHY DOES REAL EXCHANGE RATE OVERVALUE IN BRAZIL? THEORETICAL DETERMINANTS, EMPIRICAL EVIDENCE AND ECONOMIC POLICY DILEMMAS

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ABSTRACT

One of the most controversial topics in recent economic literature concerns the determinants of the real exchange 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. This paper theoretically discusses and empirically analyses these determining factors of the real exchange rate in Brazil in the 2000s. The Brazilian economy has shown a tendency of real overvaluation of its currency since high inflation was controlled in the mid-1990s. This tendency has only been interrupted by occasional internal or external shocks. Our empirical study is a modified version of the econometric model proposed by Razin and Collins (1999). Like these authors, our theoretical and empirical models break down the determining factors of the actual real exchange rate into long-term and short-term factors. However, while Razin and Collins (1999) assume that deviations of the real exchange rate from its long-term trend are caused by short-term shocks, we assume that they are influenced by the direct and indirect impacts of short-term economic policy. Most of the our econometric results concerned with estimating the real exchange rate in Brazil in the 1999-2010 period corresponded to those expected, according to the theoretical literature. Even taking into account that our econometric estimation is based on monthly data, the results showed that for more than 55% of the period the Brazilian real exchange rate was overvalued. The empirical evidence also showed that Brazil's risk premium, the stock of international reserves and the lagged differential between Brazilian and foreign short-term interest rates reveal the most significant level, explaining the real overvaluation of the Brazilian currency. Based on these results, we discuss some economic policy dilemmas that policy-makers face and present some policy suggestions.

RESUMO

Apesar de não haver consenso teórico sobre a determinação da taxa de câmbio real, a literatura empírica tem mostrado que uma tendência contínua de sobrevalorização da moeda de um país em termos reais tem efeitos negativos sobre o crescimento econômico de longo prazo. Este artigo analisa teórica e econometricamente os determinantes e o nível de desalinhamento da taxa de câmbio real no Brasil no período 1999-2010. Os dados observados revelam que, desde a eliminação da inflação crônica, em meados da década de 1990, a economia brasileira tem mostrado uma tendência à sobrevalorização de sua taxa de câmbio real. Esta tendência só tem sido interrompida por choques internos ou externos. Nosso estudo empírico é uma versão modificada do modelo econométrico proposto por Razin e Collins (1999). Assim como estes autores, nossos modelos teórico e empírico separam os determinantes da taxa de câmbio real nos componentes de curto prazo e de longo prazo. No entanto, enquanto Razin e Collins (1999) assumem que os desvios da taxa de câmbio real de sua tendência de longo prazo são causados por choques de curto prazo, nós assumimos que os desvios são influenciados pelos impactos diretos e indiretos decorrentes da política econômica de curto prazo. Os principais resultados econométricos referentes ao Brasil no período 1999-2010 corresponderam ao esperado de acordo com a literatura teórica. Mesmo levando em consideração que nossa estimação econométrica é baseada em dados mensais, os resultados mostraram que a taxa de câmbio real ficou sobrevalorizada em 55% do período analisado. As evidências empíricas também mostraram que o prêmio de risco-Brasil, o estoque de reservas internacionais e o diferencial entre as taxas de juros interna e externa, com defasagem temporal de 1 mês, foram as variáveis mais significativas para explicar a sobrevalorização real da moeda brasileira. Com base nesses resultados, analisamos os principais dilemas de política econômica a serem enfrentados, e fazemos algumas sugestões de política que permitam a correção do desalinhamento da taxa de câmbio real no Brasil.

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

Palavras-chave: taxa de câmbio real, desalinhamento da taxa de câmbio real, sobrevalorização real; dilemas de política econômica, Brasil

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Why does real exchange rate overvalue in Brazil? Theoretical determinants, empirical evidence and economic policy dilemmas

1. Introduction

One of the most controversial topics in recent economic literature is about the determinants of the real exchange rate. At least two alternative theories dispute arguments about how to establish the long-term real exchange rate and what causes exchange rate misalignments. 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 a same *numeraire*, predicts that this ratio should 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 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 the long-term economic growth (Razin and Collins, 1999; Prasad, Rajan and Subramanian, 2006; Dollar and Kraay, 2003). Rodrik (2008) and Berg and Miao (2009) went beyond 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 liberalization 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 period 1996-2009, Barbosa et. *al*. had 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 practice 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 flexible exchange rate regime and free capital mobility face greater volatility in their nominal exchange rate. Indeed, since over short periods nominal exchange rates are highly volatile 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). Also, as suggested by the "original sin" proposition, the foreign indebtedness process of developing economies involves a mismatch between the value of assets and of obligations, which might induce indebted countries to accept exchange rate overvaluation in order to reduce the burden of foreign debt, and/or to reduce exchange rate risk. These characteristics of developing economies under flexible exchange rate regime and large capital flows tend to reduce their policy space, that is to say, the ability to use macroeconomic policies counter-cyclically. As Aizenman, Chinn and Ito (2010) show, emerging Asian countries have been relatively successful in reducing 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, in virtue of continuing high interest rates, the cost of sterilizing the monetary impact of the purchasing of international reserves by the Central Bank has negative impacts on gross public debt.

Brazilian currency has shown a real overvaluation trend since inflation was controlled in the mid-1990s. After 2003, this trend has become stronger, and it has intensified since the aftermath of the 2008 international financial crisis, given the increase in the capital flow 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 (an speculative attack against the unsustainable semi-fixed exchange rate

regime with large capital mobility), in the mid-2002 (because of the negative expectations from markets on the possibility of the victory of a particular candidate to the Presidency of Brazil, then evaluated as leftist) and in the aftermath of the global crisis in September 2008. The foreign scenario of increased capital volatility in a world financially integrated exacerbates the trilemma of economic policy for Brazilian policy-makers, that is to say, the difficulty of balancing 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 the increase in policy space, our aim in this paper is to propose an econometric model that captures the main determinants of the real exchange rate in Brazil in the 2000s. Our empirical study, which covers the period 1999-2010 and uses monthly data in the econometric implementation, is a modified version of the econometric model first presented by Razin (1996) and summarized by Razin and Collins (1999). The econometric specification is useful not only to capture the main determinants of the real exchange rate overvaluation trend, but also to measure the level of misalignment. The remainder of the paper is organized as follows. Section 2 briefly discusses the theory of the real exchange rate determination and proposes a theoretical model which explains the determinants of the long-term real exchange rate and the short-term factors that cause the actual real exchange rate to deviate from its long-term trend. Section 3 analyses the economic policy dilemmas that policy-makers have to face in order to avoid large real exchange rate misalignments in an economy with a floating exchange rate regime and free capital mobility. Section 4 shows the main econometric results. Section 5 draws the main conclusions and makes some policy suggestions for Brazil.

2. **Real exchange rate: theoretical determinants and causes of misalignments**

At least two theories compete for offering the most convincing hypothesis to explain both the determinants of the real exchange rate equilibrium in the long term and the causes of deviations of this trend in the very short term: the theories of purchasing power parity (PPP) and the fundamental equilibrium exchange rate (FEER). The theory of purchasing power parity (PPP), 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 cost, trade barriers or other short term disturbance that ratio should 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 assumption is that the goods that compose the common basket are completely identical. Since this assumption is very difficult to hold in the real world, the more accepted version is the relative version of the PPP theory, which assures that the equilibrium real exchange rate can be kept 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

$$\theta = e_t + p_t - p_t^* \qquad (1)$$

where θ_t is the real exchange rate;
e_t is the nominal exchange rate (defined as the domestic currency price of foreign currency);
p_t and p_t* are the domestic and foreign price levels, respectively.

This definition implies that a fall in both nominal and real exchange rates means an appreciation. In a survey on the PPP theory, Taylor and Taylor (2004) showed that, except for countries facing very high inflation rates, even the relative PPP theory does not hold in the short term. However, after the diversity of empirical work published from the 1990s on, there is now (more than in the past) sound evidence that the PPP holds in the long term. They also remind us that this evidence became more convincing after econometric studies incorporated nominal rigidities into the models and show 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 the empirical studies have shown a strong reversion of the real exchange rate equilibrium through time. Then, a condition for an econometric study that does not show a biased result is to incorporate variables that can capture structural change of the economy, such as both the so-called Balassa-Samuelson effect and the terms of trade. The former refers to a tendency for countries which show higher changes in productivity of tradable goods compared with non-tradable ones 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 terms of trade is another important variable associated with changes in the long-term equilibrium of the real exchange rate and it is related to traditional trade theory. As showed by Dornbusch, Fischer and Samuelson (1977), given some very restrictive conditions (constant returns to scale, perfect competition in the market of goods and factors, etc.), free trade implies that the relative price of export goods in a country tends to increase related to its import goods, that is to say, tends to improve its terms of trade. Then, an improvement of long run terms of trade is associated with a real exchange rate appreciation[1].

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) "a FEER involved an exchange rate that is indefinitely sustainable on the basis of existing policies. It should be one to generate a current account surplus or deficit that matched 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" (p.2).

There are many empirical works that estimated the determinants of real exchange rate misalignments based exclusively on PPP theory (see, for instance, Frankel and Rose, 1995; Coakley et *al*., 2004; Rodrik, 2008) and others that did the same estimation based on the FEER theory (Williamson, 1995, 2008; Aguirre and Calderon, 2006; Cristiansen et *al*., 2009). However, as it will be shown ahead, since our model captures not only the long-term variables associated to the PPP theory, but also the short-term variables directly or indirectly influenced by the short-term economic policy which could (or not) reveal itself inconsistent with the long run equilibrium in the sense of FEER theory, we can say that it combines both the theoretical PPP and FEER frameworks.

We propose a 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´s 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 only due to short-term real and monetary stochastic shocks. The real exchange rate is jointly determined by the following equation:

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

where the (actual) real exchange rate θ_t in period t is jointly determined by two forces: the long-term forces related to structural changes in the economy and represented by the function $g_t(\ )$; and the short term real and monetary shocks, represented by the function $f_t(\ )$. They assume that g and f are linear functions. While the variables that composes the function g ( ) are only real variables (y_t^s is the real output, d_t is real aggregate demand and i^* the real 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 θ_t is represented by a combination of the flex-price

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

solution for g ( ), plus a linear combination of stochastic shocks f ( ). It is important to stress that in an ideal world in which all prices were flexible and there were not any nominal price rigidity or other short-term economic disturbances, the actual real exchange rate θ_t would converge to its long term trend represented by g ( ). Then, in the Razin and Collins´s model, the deviation of θ_t from its long-term equilibrium trend is explained by short-term economic shocks.

As Edwards (1995) pointed out, while the long-term equilibrium real exchange rate is determined by only real variables, the actual short-term real exchange rate can only be determined by both real and monetary variables. Then, since the component f ( ) means that nominal price rigidities are introduced into the model, Razin and Collins (1999) showed that the equation (2) can be solved by a combination of a jointly *flex-price* solution for component g ( ) and a *full-fledged* solution for the component f ( ), which incorporates the real and monetary shocks. However, Taylor and Taylor (2004:18-19) argue that deviations of the real exchange rate from its long-term trend are linked not only to real and monetary shocks, but also to some combination of monetary policy and price stickiness, which plays an important role in the short-run volatility of exchange rates, and can actually amplify it. Then, our theoretical modified model is expressed as:

$$\theta_t = g_t(y_t^s, d_t, i^*) + m(st_t) \tag{3}$$

where θ_t and the variables that composes the function g ( ) are the same of Razin and Collins´s (1999) model and represent the main determinants of the long-term equilibrium real exchange rates. The component m (.), differently from those authors, incorporates the set of short-term variables st_t that are directly and indirectly influenced by the short-term macroeconomic policy. Such variables are, for instance, the nominal short-term interest rate (given the world interest rate), the movement of short-term net capital flows, and the stock of international reserves of the Central Bank, among others. With such changes, when the theoretical model is expressed in econometric specification (see Section 4 ahead), we can not only capture the main determinants of the recent actual real overvaluation of the Brazilian currency, but also measure the misalignment level. Although this procedure is similar to that adopted by Rodrik (2008) and Berg and Miao (2009), these authors in their econometric implementation do not take into account the short term effects of macroeconomic policies on the deviation of the actual real exchange rate from its trend. Despite the fact that the model does not capture important characteristics related to the working of foreign exchange markets, such as the dynamic changes and the forward looking behavior, its simplicity is attractive enough to provide a useful and comprehensive empirical implementation.

3. Macroeconomic impacts of exchange rate misalignments in emerging economies and economic policy dilemmas

In open economies financially integrated and with free capital mobility, the exchange rate plays a fundamental role in macroeconomic policy as its level and volatility affect inflation, balance of payments, investment decisions and economic growth. As we have seen, economic literature on growth suggests that, unless the Balassa-Samuelson effect is considered, continuous real overvaluation of the exchange rate does not favor economic growth. Given this assumption, our aim in this section is to provide analytical arguments to further investigate which mix of short-term economic policies would favor growth strategies with exchange rate stability. Our theoretical focus will be on emerging economies that face greater difficulty in the macroeconomic adjustment of the exchange rate, given their greater vulnerability to the external movement of capital flows. In a regime of floating exchange rate, emerging economies face special challenges in keeping domestic and external equilibrium, which in many cases narrows their policy space. So, considering that the real exchange rate is a key variable influencing growth in the short and long term, and that its behavior in the short term is influenced by economic policy measures, our aim in this section is to discuss stylized facts that impair a wider policy space for emerging economies.

3.1 Flexible exchange rates with free capital mobility: the "impossible trinity" and issues for emerging economies

As well documented in economic literature, the choice between alternative exchange rate regimes involves a trade-off between the advantages of a fixed exchange rate regime (either of fixed rates or administered rates) and the advantages of a flexible exchange rate regime. The first 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 loss of autonomy of the monetary policy. Also, international experience in the 1990s had shown that emerging countries that adopted administered exchange rate regime and no capital control were vulnerable to speculative attacks against their currencies. Nowadays most of the emerging countries adopt a floating exchange rate regime.

In theoretical terms, a floating exchange rate regime would allow for a greater autonomy of the monetary policy, as it can be a solution to the 'impossible trinity'. According to this proposition, it is not possible to keep a fixed exchange rate regime, free capital mobility and monetary policy autonomy and, at the same time, to provide a consistent solution to economic policy. Since a flexible exchange rate regime, in its turn, could guarantee monetary policy autonomy, and therefore low volatility of interest rates, this latter policy instrument could not be used to stabilize the exchange rate. In practical terms, however, given the great financial integration of 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 exchange rate regime.

Calvo and Reinhart (2002) argue that systematic interventions in the exchange rate markets by central banks characterize a "fear of floating" behaviour. According to the authors, emerging economies are more susceptible to live with exchange rate instability due to capital movements, as they suffer from low credibility in their policies and institutions. Because of low credibility, monetary authorities are forced to increase interest rates more often, following the threat of a significant devaluation in the exchange rate. The positive difference between domestic and external interest rates would attract foreign capital, stabilizing the exchange rate.[2] However, in the case of Brazil, the "fear of floating" argument is misleading to explain why Brazilian monetary authorities are induced to augment the short term interest rate, contrary to the practice observed in other emerging economies, especially in Asian countries. As Silva e Vernengo (2009) argue, since the inflation target regime was introduced in Brazil in 1999, Brazil´s Central Bank has managed the monetary policy in a very conservative way[3]. In practice, its only goal has been to keep the inflation low and very close to the targeted rate. Silva and Vernengo (2009) conclude that, in the case of Brazil, rather than a "fear of floating" behaviour, Brazil´s Central Bank shows a "a fear of inflating" behaviour, meaning that this assumption would better explain the high short term interest rates differential. It should also be added that they show that the pass-through effect between the changes in the exchange rate and domestic prices in the Brazilian economy is low. Another alternative explanation for frequent interventions in the foreign exchange market in emerging economies is suggested by Prates *et al* (2008). The authors argue that given the financial globalization, monetary authorities can adopt "defensive strategies" to prevent exchange rate from high volatility. These strategies would imply: a) the over accumulation of international reserves[4], a sort of

[2] This would suggest a positive correlation between exchange rate and interest rate variation.

[3] To give an example of the conservative manner in which Brazil´s Central Bank manages the monetary policy, after the burst of the financial global crisis in September 2008, Brazilian basic interest rate (*SELIC*) was kept unchanged at 13.75% per year until January 2009, even taking into account the recessionary environment in Brazil, the low inflation rate and the deflationary expectations due to the global financial 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).

[4] As we will see ahead, this strategy has been pursued more aggressively by Asian countries than Latin American countries, including Brazil, in virtue of the high cost (in terms of augmenting gross public debt) of sterilizing the monetary impact of purchasing international reserves by the central bank.

precautionary demand, in order to reduce external vulnerability and/or b) an incentive to grow led by exports, a 'mercantilist strategy'.

The above considerations imply that the choice of a flexible exchange rate regime, in practice, imply an intermediary exchange rate regime. This means to say that the central bank interferes in the foreign exchange market every time it chooses to reach a macroeconomic goal. Considering specifically the foreign exchange market, interventions can be justified either to adjust the nominal exchange rate trajectory or to stabilize real exchange rate, reducing its volatility and misalignment.[5]

The success of the defensive strategies to reduce exchange rate volatility can be evaluated according to the policy space monetary authorities have to implement counter-cyclical measures aiming at increasing output and employment and reducing external vulnerability. This space is reduced when short-term economic policy has to be used to restore balance of payments equilibrium.[6] So, considering the implementation of short-term economic policies, the challenge to be faced by emerging economies financially integrated is how to avoid exchange rate volatiltiy and sustain growth with price stability.

Aizenman *et al* (2010), discussing how emerging Asian countries are trying to reduce high volatility of their nominal exchange rate, base their argument considering a modified version of the 'impossible trinity'. Their theoretical reference to the explanation about the loss of autonomy of the monetary policy in a floating exchange rate regime and free capital mobility is the well known Mundell-Fleming model. As state 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 concept, 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 the monetary policy, foreign exchange intervention and capital mobility. However, Aizenman *et al.* showed sound econometric evidence that, since the Asian crisis of 1997, the Asian countries have been well succeeded in by-passing the "impossible trinity" by 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 practice, an administered floating exchange rate regime.

The logic of the Mundell-Fleming model states that the link between domestic and foreign sectors depend on the exchange rate regime, or, to put in other words, the choice of the exchange rate regime has implications on how domestic prices and 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 to guarantee domestic equilibrium. In this sense the implementation of the monetary policy should be independent of other macroeconomic goals, while the floating exchange rate regime and capital mobility are responsible for keeping the balance of payments in equilibrium. With free capital mobility, it is assumed that a flexible exchange rate regime will 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 observed that since the internal stability of the model with floating exchange rate and capital mobility depends on the manipulation of the interest rate, this latter instrument

[5] For an interesting discussion about the "fear of floating" in Brazil after 1998, see Souza (2005). His main conclusion is that the Brazil´s Central Bank intervened in the foreign exchange market in the 1999-2002 period to avoid the negative impacts on domestic prices of external instability in the financial markets. In this sense Brazilian authorities would be more tolerant with an appreciation trend of the currency than with a depreciation trend. (p. 540)

[6] Bresser-Pereira and Gala (2006) argue that economies that have adopted a development strategy based on the absorption of external saving, had, in general, their space of policy reduced. The theoretical argument that supports such strategy, that is, the external saving complements internal saving to boost growth, does not consider the fact that countries that use external saving are not in the same position to negotiate their foreign debts with their creditors. This means to say that emerging countries must pay back their debt in the creditor's currency, as their own is not convertible.

affects the stability of domestic prices in an indirect way.[7] The variation of the interest rate aiming at controlling aggregate demand affects first the short-term capital flow, which, in its turn, affects the exchange rate which, in its turn again, is adjusted to restore the equilibrium in the market of goods and services and the balance of payments. In this way, in open economies with free capital mobility the transmission mechanism of the monetary policy occurs through the exchange rate. 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.

Besides this asymmetry in the sensitivity of the adjustments,[8] it should also be considered that emerging economies have specificities which might make the adjustment mechanism become less efficient. These characteristics are: non-convertible currency, high volatility in the flow of capital and recurrent and persistent current account deficits.

So, considering these characteristics, the operation of a floating exchange rate regime in emerging economies is often associated with a high volatility in the nominal exchange rate, which leads to systematic interventions in the foreign exchange market. As we have already mentioned, these interventions can be justified as a defensive measure to respond to the greater sensitivity of the emerging economies to external shocks, and does not necessarily mean a 'fear of floating'.

Obstfeld (2008) pointed out that, taking into account the short-term nominal price rigidities, another collateral effect of the flexible exchange rate regime with free capital mobility in emerging economies is that changes in the world demand for assets or domestic products are quickly translated into an overvaluation of the real exchange rate. According to the author:

> *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. (p. 38)*

So, the greater volatility in the nominal exchange rate in emerging economies emerges as an additional difficulty in the administration of the trilemma of economic policy, and it is due to the fact that in these economies, in general, the balance of payments equilibrium depends on continuous flows of foreign capital. Under this circumstance, in order to attract foreign capital, emerging economies have to operate with high interest rates. The consequence of such conditionality is that high interest rates put pressure on public debt, and also it penalizes economic growth.

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, devaluations of the domestic currency might cause dramatic losses in the stock of wealth of debtors 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 valuation of domestic currency have a positive effect on the balance sheet of indebted agents in foreign currency, and the opposite effect is observed when international liquidity is scarce.

Recent literature on capital and financial liberalization has shown that the specificities of emerging economies financially integrated in the world financial market has imposed on them situations that narrows their policy space. These situations can be described as stylized facts to orient our further discussion about what the causes of real overvaluation of the Brazilian currency are in recent times.

[7] But notice that the internal stability is not achieved by the direct effect of changed credit conditions on effective demand: it is achieved instead by the indirect effect of changes in the exchange rate. (Mundell, 1960, p. 239).

[8] Also it should be noted that, since over short periods nominal exchange rates are highly volatile 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).

3.2 Some stylized facts about real exchange rate volatility and misalignment trend for emerging countries

1 –*Unstable expectations in relation to the exchange rate increases the spread of risk*: The uncover parity of the interest rate ($i= i^*+e^e$) determines that the domestic interest rate, i, is equal to the international rate, i^*, plus the expectation of exchange rate depreciation, e^e. Any difference between i and i^* implies a variation in e^e, that should equilibrate the rate of return on bonds. So, when the domestic currency is expected to depreciate ($e^e>0$), the spread of risk will increase. If a high instability in the foreign exchange market is observed, the threat of a depreciation puts pressure on the domestic interest rate to keep domestic assets attractive, and so an appreciation of the exchange rate is expected, as a response to the manipulation of the domestic interest rate by the central bank to avoid currency devaluation. The systematic increase in the short-term interest rate differential represents an additional incentive to sustain the exceeding flow of foreign short-term capital, especially that of speculative nature.

2- *Excess of international liquidity attracts foreign capital and deteriorates the public debt*: When international liquidity is plentiful and the inflow of foreign capital is in excess 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 public debt, on the other, equal to that 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.

3 – *Appreciation of domestic currency deteriorates the net public debt ratio to GDP and has a negative impact on the country's risk premium*: An appreciation of the domestic currency implies that the value of the reserves in domestic currency falls worsening the net public debt ratio and reducing the central bank's financial gains. This implies an increase in the burden of the public debt and an increase in the fiscal deficits. According to Kregel (2006), central banks in emerging countries end up financing gains of foreign investors that borrow in their own markets to profit from the positive interest rate differential in emerging economies.

4- *Depreciation of the exchange rate has a negative impact on inflation*: If a depreciation in domestic currency is perceived as a threat to inflation control, monetary authorities may adopt an inflation targeting policy to reinforce their commitment to keeping prices under control. (Goldfajn and Werlang, 2000). According to Ocampo and Vos (2006), however, this commitment may lead economies with low credibility to accept overvaluation of their currencies, when international liquidity is plentiful and short-term terms of trade shocks are favorable. So, the relationship between the short-term interest rate differential and the real exchange rate can be interpreted as having different impacts according to the period under observation. . In the very short term, especially after the economy faces a shock, this differential has a positive association with the real exchange rate, as the spread of risk might increase. However, in a longer period of time , the higher the short-term interest rate differential is, the more appreciated the currency will be in real terms. Needless to say that the impact of high short-term interest rate differential on the real exchange rate appreciation occurs through the transmission from the former to the increasing of short-term capital inflows. In practice, it should be noted that when the central bank increases the domestic interest rates to reduce inflation, the effect of this policy (given the external interest rate) on the attractiveness of short-term capital flow occurs with some time lag.

5 – *High interest rates discourage private investment:* When high short-term interest rates differential causes an overvaluation of the real exchange rate, real wages tend to increase. Then, a consumer-led growth implies an increase in imports of consumer goods and so increases competition with domestic production. In this case, domestic prices might fall or slow down, and the real exchange rate appreciates, decreasing the

competitiveness of exports. So, it seems that there is a vicious cycle between high short-term interest rates differential, real exchange rate overvaluation, low inflation and, again, real exchange rate overvaluation.

In sum, the widening of the policy space implies an adjustment in the two key prices of the economy – interest rate and exchange rate. This adjustment must allow for the expansion of aggregate demand, in particular of exports, in order to relax external restriction to growth. In general, the economic policy dilemma to be faced by emerging economies in the short term can be summarized in how much the exchange rate misalignment will affect domestic prices, the level of aggregate demand and the burden on foreign debt commitments, in particular, on public debt. The best combination of these fundamental prices will help in the solution of the economic policy trilemma, and, consequently, in the widening of the space of policy.

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

Our aim in this section is to investigate empirically the determinants of the real exchange rate in Brazil after the implementation of the flexible exchange rate regime in January 1999. The Brazilian currency is presenting a trend towards overvaluation of its real exchange rate ever since inflation became controlled in the mid-1990s. The stabilization plan launched in 1994 was based on a fixed exchange rate regime, which was abandoned in January 1999, following the speculative attacks against most currencies of emerging countries in the second half of the 1990s.

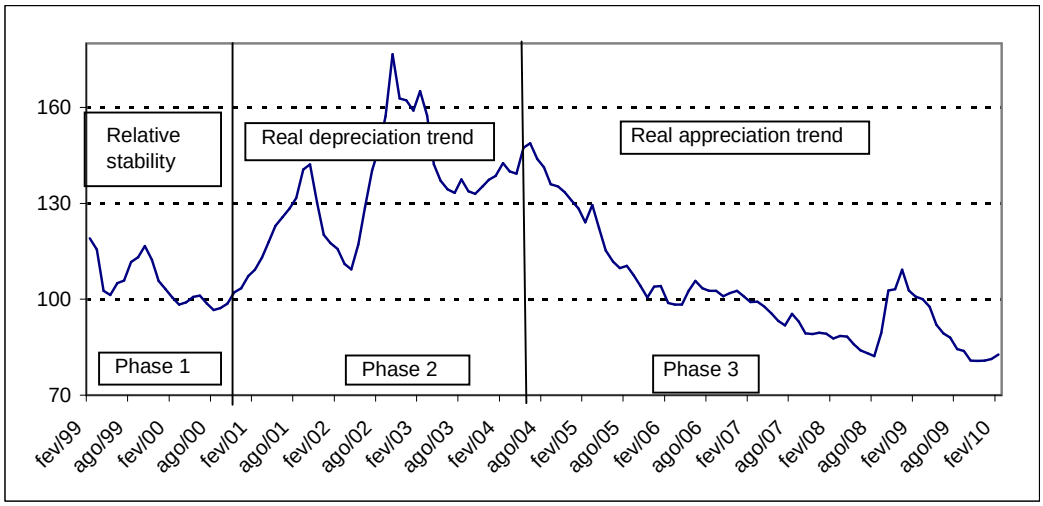
The phase of flexible exchange rate regime that was implemented with an inflation targeting policy did not bring stability to the real exchange rate. Mostly after 2004, the trend towards real appreciation of the Brazilian currency, the Real became a dominant pattern, which has been intensified in the aftermath of the 2008 international financial crisis.

Figure 1 shows the evolution of the real exchange rate from February 1999 to February 2010. At least 3 distinct phases can be identified, showing different behaviors of the real exchange rate. It is convenient to stress that this division took into account not only the actual trajectory of the real exchange rate, but also the calculated standard deviation in each phase. [9] The first phase is characterized by a sharp depreciation in exchange rate in the months immediately after the change in the Brazilian exchange rate regime. The fluctuation of the real exchange rate in 1999 was followed by a relatively stable evolution in 2000, when the real exchange rate seemed to have reached an equilibrium level.

[9] Considering the standard deviation and the trajectory of the evolution of the real exchange rate, we divided the phases as follows:

Phases of the evolution of the Brazilian real exchange rate	Standard deviation	Real exchange rate trend
From February 1999 to December 2000	6.7	Relative stability
From January 2001 to May 2004	16.8	Real depreciation trend
From June 2004 to February 2010	16.6	Real appreciation trend

Figure 1: Real effective exchange rate (monthly data): Brazil 1999-2010
2000 average real exchange rate = 100



Source: Brazil´s Central Bank

After this short period of 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 election of the first left wing candidate in Brazil. This political fact rose the degree of uncertainty among private agents, which 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 currency. The third phase of the real exchange rate evolution is characterized by a greater dynamism of the economy,[10] although higher growth rates tend to be associated with an undervalued currency. This is not observed in the Brazilian case in recent times. The expansion of the world trade, mainly after 2004, favored the terms of trade of the country, allowing for growth and real appreciation of its currency to occur simultaneously. In the absence of capital controls, the excess of inflow of external capital put pressure to appreciate the Brazilian Real.

Considering the whole period of analysis, the phase of stability in the real exchange rate represented less than 10%. This evidence suggests that the policy space in the Brazilian economy was reduced under flexible exchange rate regime and inflation targeting, although growth rates had shown a significant recovery after 2004. The situations described as stylized facts in Section 3 can be identified to explain high volatility and real exchange rate misalignment in the period under analysis in Brazil.

In short, the change from a fixed exchange rate regime to a flexible regime in 1999 was followed, as mentioned, by the implementation of an inflation targeting regime, which in the Brazilian case relies 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 kept 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 real exchange rate volatility. Interventions in the foreign exchange market aiming at controlling volatility and overvaluation, in general, tends to increase gross public debt due to the high cost to sterilize the monetary impact of purchasing international reserves by Brazil´s Central Bank. Also, as it is typical of emerging economies, the Brazilian economy suffers from unstable expectations about the value of its currency. This is due, in part, to external vulnerability, as its currency is

[10] 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.

non-convertible. Finally, it should be considered that real exchange rate misalignment associated with high volatility does not favor sustainable growth, as changes in the relative prices blur long term expectations that guide investment in fixed assets. Moreover, a trend towards appreciation of the currency in an environment of relatively low rates of investment induces to de-industrialization.[11]

In sum, the foreign scenario of increased capital volatility in a world with a high level of financial integration exacerbates the trilemma of economic policy for the Brazilian policy-makers, that is to say, the difficulty of balancing competing objectives of economic policy: price stability, exchange rate stability and capital mobility.

4.1 Econometric implementation

4.1.1 The econometric model

We translated our theoretical model presented in equation (3) into the following econometric specification:

$$\theta_t = c_0 + [\alpha_1 Y_t + \alpha_2 ToT_t + \alpha_3 LTKF_t + \alpha_4 CC_t] + [\beta_1 (IDIFER)_t + \beta_2 (IDIFER)_{t-1} + \beta_3 STKF_t + \beta_4 IR_t + \beta_5 CR_t] + \varepsilon_t \quad (4)$$

Like Razin and Collins (1999), we chose the most appropriate candidates to represent the variables associated with the changes in the real exchange rate in the long term (variables within the first set of brackets on the right hand of equation (4)) and those associated with deviations of the actual real exchange rate from its long term equilibrium (variables specified within the second set of brackets on the right side of equation (4)). The variables of the model are specified as follows: θ is the actual real effective exchange rate; *Y* is the real GDP per capita in U.S. Dollar; *TOT* is the terms of trade; *LTKF* and *STKF* are, respectively, the net long term and short term capital flow expressed as a ratio to GDP; *CC* 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 this same variable expressed with a lag of one period; *IR* is the stock of Brazilian international reserves; and *CR* is Brazil´s risk premium; ε_t is a random error variable; and the subscript *t* is the time reference (in our econometric modeling, it refers to month)[12].

The variables chosen to represent the impacts of the structural changes of the economy on the shifting of long-term equilibrium of 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, Razin and Collins, 1999). Yet our variables either directly managed or indirectly influenced by short-term economic policy are found dispersed in empirical studies, such as Meese and Rogoff (1983), Edwards (1988), Calvo, Leiderman and Reinhart (1993), among others. Anyhow, the short-term variables were taken up from the underlining discussion in Section 3, which points out the difficulties emerging economies have in administrating short-term economic policy, in an attempt to avoid real exchange rate volatility and misalignment.

To model the relationship between the real exchange rate and its determinants, we first followed some econometric procedures[13]. In order to check if the series are stationary, we first used the Augmented Dickey-Fuller (ADF), Phillips Perron and Kwiat Kowski-Pillips-Schmidt-Shun's tests, observing all variables in level and first-difference[14]. As these tests revealed that all variables were characterized by unit root in level, the presence of time autocorrelation could produce a loss of efficiency. However, since the variables are stationary in the first-difference, our next step was to test the co-integration among them. If the test revealed

[11] There is an ongoing debate in Brazil on this issue. See, for instance, Nassif (2008) and Oreiro and Feijo (2010).
[12] The primary sources are described in the Annex 1.
[13] The entire database and results of the tests can be made available upon request to the authors.
[14] For details, see Greene (1997).

that the variables are co-integrated, the regression in level[15] could be done without showing spurious results. Then, we checked the co-integration among variables according to Johansen's co-integration test (see Johansen, 1988), whose results are presented in Annex 2. These results allowed us to estimate the variables in level[16]. The model was estimated according to the ordinary least squares (OLS) methodology[17]. Table 1 presents the results of our estimation.

Table 1: Estimated model for Brazil
Dependent variable: real exchange rate

Variable	Description of the variables	Coefficient	P-value
C	Constant	108.9616	0.0002
Y	Real GDP per capita	-0.05681	0.0000
TOT	Terms of trade	-0.100319	0.7302
LTKF	Net long term capital flow/GDP	-0.036412	0.2758
CC	Current account balance/GDP	0.264349	0.0000
IDIFER	Short term interest rate differential	1042.898	0.014
$IDIFER_{t-1}$	Lagged short term interest rate differential	-739.4773	0.0759
STKF	Net short term capital flow/GDP	-0.01762	0.1943
IR	Stock of international reserves/GDP	10.79147	0.00070
CR	Brazil´s risk premium	0.017594	0.00000

Notes: R-squared: 0.816873; Adjusted R-squared: 0.803364; Standard error: 8.072152;
Sum squared residual: 7949.476; F-statistics: 60.46731; Prob (F-statistics): 0.0000.
Number of observations: 133

The results show that our empirical model is relatively well fitted. In fact, the R-squared and the adjusted R-squared were 0.81 and 0.80, respectively. The structural variables of the model determine the long term equilibrium real exchange rate. As expected, the real GDP per capita presented a negative sign, as an increase in this variable over time implies a real exchange rate appreciation, according to the Balassa-Samuelson effect. The terms of trade in our model presented a negative sign and a low statistical significance. The sign is coherent with the literature discussed in Section 2, according to which a country´s terms of trade is a structural variable whose improvement in the long run tends to appreciate the currency in real terms. The net long term capital flow presented the expected sign, but also a low statistical significance. The larger the long term capital flow surplus over time, the more appreciated the real exchange rate. The economic importance of this variable for the long term equilibrium of the balance of payments in Brazil is the reason to keep it in the model. The current account balance was statistically significant and presented a positive sign, implying that a positive long term trend in the current account is an indication of a real undervalued currency, as suggested by the theoretical literature.

[15] According to Gujarati (2003), this means that the econometric model would not lose any valuable information. For more details, see Gujarati (2003).
[16] Annex 2 shows that we can reject the hypothesis that the variables are not co-integrated at the significance level of 5% See MacKinnon, Haugh and Michelis (1999).
[17] We run the Jarque-Bera test and confirmed the normality of residuals.

The variables associated to short-term economic policies are assumed to act as responsible for the deviations of the actual real exchange rates from their long-term equilibrium. The short-term interest rate differential, considered as a variable of policy to interfere in the determination of the real exchange rate, showed to be statistically significant. As we used this variable also lagged, the results can be interpreted in two ways. As supported by the analysis in Section 3, the very short term impact of the interest rate differential might mean not only an increase of the spread of risk, as a higher short-term interest rates differential reflects the expectations of currency depreciation, but also a "fear of inflating", given the context of the current inflation target regime in Brazil. So we would expect a positive sign in the interest rate differential, as shown in the model. At the same time, this increase in the spread of risk is reinforced every time the Brazilian economy faces either an internal or external shock, which, by provoking a sudden stop in capital flows, compels Brazil´s Central Bank to keep the short-term interest rates differential positive and high. So, the incorporation of the lagged short-term interest rates differential into the econometric model is based on the assumption that the short-term interest rates differential impacts with a lag the real exchange rate through the short-term capital flows. This variable not only showed a negative sign, as expected, but also presented statistical significance.

The net short-term capital flow showed a negative sign as expected. Despite this variable being recognized by theoretical and empirical literature as having direct effects on the real exchange rate changes, its statistical significance was low in explaining the Brazilian real exchange rate. It is important to stress, however, that the main channel of transmission from the lagged short-term interest rate differential to the real exchange rate is through the impact of the former to the short-term capital flows. Here, it may be a problem of endogeneity between these two regressors that is not been treated in this paper[18].

The stock of international reserves showed a positive sign, and it is statistically significant. It is necessary to stress that the relationship between this variable and the real exchange rate is ambiguous. On the one hand, the larger the stock of international reserves, the lower is both the expectation of real exchange rate depreciation and the country risk premium, 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 a strategy of accumulating foreign reserves by the central bank as an attempt to avoid real exchange rate appreciation (a defensive strategy). Then, if this is the case, the expected sign should be positive. This seems to be the case of Brazil in the period under analysis. Brazil´s risk premium not only behaved as expected, but also was statistically significant. In fact, the lower a country risk premium is, the more appreciated its real exchange rate is.

4.1.2 Construction of real exchange rate misalignments

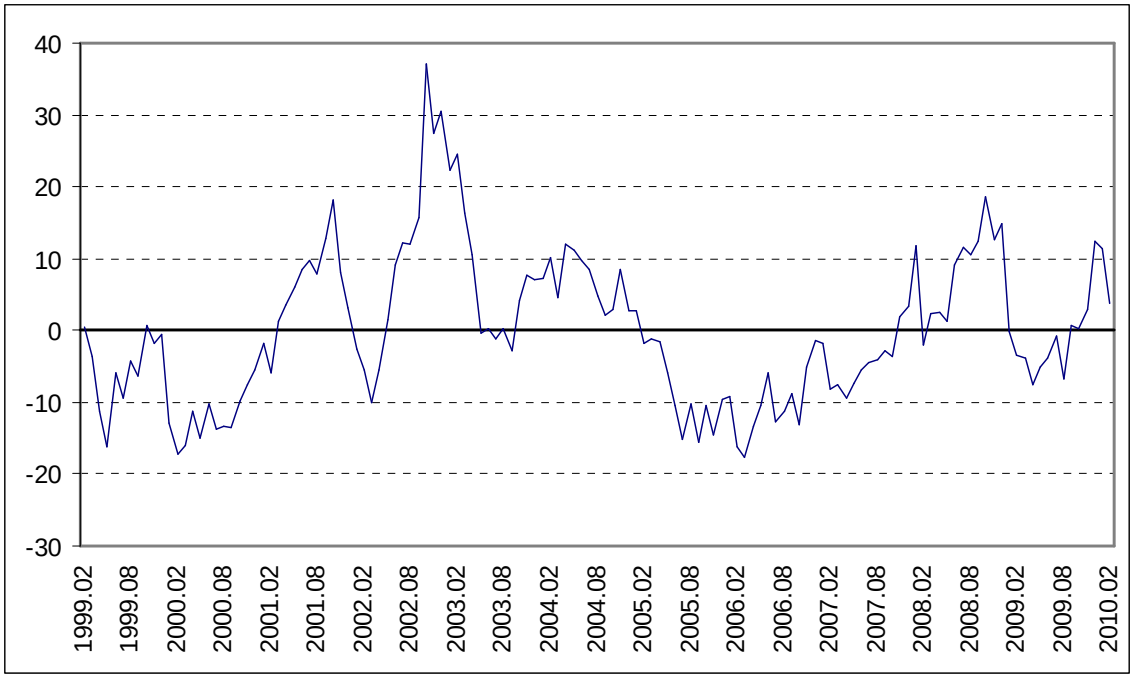
For constructing our measure of real exchange rate misalignments, we followed similar procedures taken by Razin and Collins (1999). Thus, our misalignment measure can be obtained as follows:

$$Mis_t = \theta_t - [\alpha_1 Y_t + \alpha_2 ToT_t + \alpha_3 LTKF_t + \alpha_4 CC_t] \quad (5)$$

Thus, a misalignment Mis_t is the deviation of the actual real exchange rate from its long-term equilibrium trend as estimated in the first part of equation (4). This result means that short-term misalignment is caused by the impact of short-term economic policy on the long trend trajectory of the real exchange rate. Figure 2 shows the estimated results for the misalignment levels in the Brazilian real exchange rate in the period 1999-2010 in a monthly basis.

[18] It is important to remind that Razin and Collins (1999) recognized the problem of endogeneity between some of the variables used as candidates to represent the long-term determinants of the real exchange rate, but they also did not treat it in their paper.

Figure 2: Estimated monthly real exchange rate misalignment in Brazil: 1999-2010



Source: Estimated by authors according to procedures specified in equation (5).

As Figure 2 shows the estimated results reproduce with close accuracy the general trajectory of the real exchange rate in Brazil in the period under analysis. In fact, the Figure replicates with good precision two general characteristics of the Brazilian real exchange rate behavior in the last decade in which the economy has for the first time experienced a combination of a flexible exchange rate regime with high, free capital mobility. First, the episodes of sharp real depreciation have almost exclusively happened as a response to either internal or external shocks, such as those of between mid-2002 and early 2003 and of the second half of 2008, as already mentioned above. Second, and most important, the Brazilian real exchange overvaluation trend is confirmed in the majority of the period under analysis. According to our estimation the real overvaluation of the Brazilian currency was observed in 55% of the period. One could argue that the estimated period (10 years) is not long enough to configure a long term trend. However, as our purpose is rather to evaluate the short experience of floating exchange rate regime with high freedom for capital movements, it would be misleading to incorporate the previous period in which Brazil combined either fixed exchange rate regime with capital controls (before 1992) or fixed exchange regime with high capital mobility (from 1992 to the end of 1998).

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 real exchange rate is strongly overvalued, this increases current account deficits and also leads 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 flexible exchange rate regime in Brazil in the beginning of 1999 is an example of what Dornbusch´s model advanced. In fact, by not having followed this author's recommendations, the introduction of a flexible exchange rate regime in 1999 in Brazil was, in practice, a measure of economic

policy forced by markets, which was initiated as soon as the speculative attack that had began at the end of 1998 generated an overshooting of the Brazilian exchange rate.

In the recent experience of a flexible exchange rate regime with relatively high capital movements in Brazil, policy-makers clearly face the challenges imposed by the "trilemma" of economic policy. So, 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 in the current agenda of economic policy.. In practice, it is not an exaggeration to say that Brazilian policy-makers have pursued monetary independence to assure price stability and high external financial integration as priority goals of economic policy, and so exchange rate volatility has been tolerated.

In our paper, we showed with descriptive statistics and econometric evidence that the evolution of the Brazilian real exchange rate has been characterized by high volatility and an overvaluation trend. This trend is supported by our econometric estimation, which showed that the real overvaluation of the Brazilian currency was observed in 55% of the period 1999-2010. The econometric exercise also showed that Brazil´s risk premium, the stock of international reserves and the current and lagged differential between Brazilian and foreign interest rates reveal to be significant to explain the misalignment of the real exchange rate of the Brazilian currency. Despite the short term net capital flow being recognized by theoretical and empirical literature as having direct effects on the real exchange rate changes, its statistical significance was low in explaining the Brazilian real exchange rate. It is important to stress, however, as supported by theoretical literature, that the main channel of transmission from the lagged short term interest rate differential to the real exchange rate is through the impact of the former to the short-term capital flows.

Aizenman *et al.* (2010) showed econometric evidence that, since the 1997 financial crisis, Asian emerging market economies have been well succeeded in damping the negative impacts of large net capital flows on the real exchange rate overvaluation through massive accumulation of international reserves.[19] The authors suggest that "policy makers in a more open economy would prefer pursuing greater exchange rate stability" (p. ii). Nevertheless, in the case of Brazil, our econometric results suggest that the most appropriate macroeconomic policy is to implement a mix of policy instruments.

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, in virtue of continuing 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, and it 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 relatively relevant in mitigating the real exchange rate trend. Then, as long as policy-makers are able to manage the impact of interventions in the spot foreign exchange market on the growth of gross public debt, Brazilian monetary authorities should continue to pursue the strategy of accumulation of international reserves.

Since the short-term interest rates differential in Brazil figures 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 standard. 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 of reducing the domestic interest rates. For instance, there are robust academic studies suggesting that the design of the inflation target regime in Brazil could be modified in order to give monetary authorities more room for reducing 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).

Finally, Brazilian policy-makers cannot discard the use of more effective mechanisms of capital control as a relevant mechanism of economic policy if it is actually necessary. Taking into account that international interest rates might be kept at a very low level in the near future, due the stagnant environment in the world economy, the actually high short-term interest rate differential will continue to contribute to

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

appreciate the Brazilian currency in real terms. Although we agree that this would be an extreme instrument of economic policy, even 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).

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 the long-term economic growth; and second, as stressed by Dornbusch (1988) a long time ago, although a floating exchange regime can provide the correction of an overvaluation in the medium-term, the aftermath of a correction by free-market forces is far from being a "first best" solution because it is translated into severe macroeconomic instability and requires high adjustment costs: balance-of-payments crises, inflation, high interest rates and real GDP contraction.

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Annex 1 – Description of the primary source of the variables

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 Brazilian R$ Real (series no. 4383) and transformed into US Dollar according to IPEA data series of exchange rates. Population estimated by the Brazilian Institute of National Accounts (IBGE) – http://www.bcb.gov.br

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

Long term net capital flow – Balance of Payments, Brazil's Central Bank..

Current Account Balance – Balance of Payments, Brazil's Central Bank.

Short term interest rates differential – difference between Brazil's Central Bank monthly interest rate series for SELIC (BCB Boletim/M.Finan. - BM_T JOVER12) and the US FED FUNDS monthly interest rate (FMI/IFS - IFS12_TJFFEUA12).

Short term net capital flow - Balance of Payments, Brazil's Central Bank.

Stock of international reserves – Brazil's Central Bank (series no. 3546).

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

GDP in current US Dollar – Brazil's Central Bank (series no. 4

Annex 2

Johansen cointegration test for all variables I (1) model

Data Trend:	None	Linear	Linear
Test Type	Intercept No Trend	Intercept No Trend	Intercept Trend
Trace	1	2	1
Max-Eig	2	2	2
Akaike Information Criteria by Rank (rows) and Model (columns)			
0	19.69318	19.74555	19.74555
1	19.5049	19.54244	19.48267
2	19.40562	19.42784	19.38305*
3	19.48422	19.50109	19.47157
4	19.59464	19.60504	19.58542
5	19.7499	19.74478	19.73251
Unrestricted Cointegration Rank Test (Trace)			
Hypothesized no of CE(s)	Trace Statistic	0.05 Critical Value	Prob.**
None *	137.7801	117.7082	0.0015
At most 1	78.13046	88.8038	0.2294
At most 2	39.37992	63.8761	0.868
At most 3	24.71069	42.91525	0.804
At most 4	13.28349	25.87211	0.7158
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)			
None *	59.64968	44.4972	0.0006
At most 1 *	38.75054	38.33101	0.0447
At most 2	14.66924	32.11832	0.9575
At most 3	11.42719	25.82321	0.9055
At most 4	7.173547	19.38704	0.8886

Note: Statistics generated in Eviews statistical software

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level

* Denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values