

Investigating the rationale for exchange market interventions and the building of international reserves in emerging countries: the case of Brazil after stabilization (1995-2008)
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Abstract: Accumulation of high levels of convertible currency has been a robust trend among emerging countries in the recent years. In this paper we investigate the rationale behind reserves accumulation in Brazil. Specifically, we ask: have the Central Bank of Brazil's interventions in the exchange market been better supported by the mercantilist thesis or by the precautionary view? Our findings suggest that monetary authorities' market interventions do not seem to be related to 'fear of floating' concerns, this finding is in contrast with the mercantilist view that Brazil manages its foreign exchange rate.

Keywords: Exchange rate, reserves accumulation, external vulnerability

JEL: F31, F41

Resumo: Nos últimos anos, a acumulação de elevados níveis de reservas em moedas conversíveis por parte de países emergentes tem se revelado uma tendência dominante. Este trabalho investiga a racionalidade por detrás da acumulação de reservas no Brasil. Mais especificamente, questiona-se se as intervenções do Banco Central são explicadas pela tese mercantilista ou pela visão precaucional. As evidências encontradas sugerem que as intervenções não parecem estar associadas ao "medo de flutuar", o que contrasta com a perspectiva mercantilista.

Palavras-chave: Taxa de câmbio, acumulação de reservas, vulnerabilidade externa

Introduction

Monetary authorities in several emerging countries have been recently intervening in foreign currency markets. As a consequence, a large build up of international reserves has been an impressive tendency amongst the main emerging countries in the last decade, especially in the few last years. This evidence raised the hypothesis that many emerging countries may have hidden aims for their economic policies. For example, an unofficial exchange rate would be targeted, instead of allowing a legitimate free floating exchange regime to be effectively in place. The trend has recently gained some relevance in economic debates, especially related to the side effects associated with the enlargement of sovereign wealth funds among those countries. As a common recent feature, Asian economies and Middle East oil exporters have run up large current-account surpluses, piling up foreign reserves, mostly in American Treasury securities, in order to prevent their currencies from rising.

The broadening of precautionary demand for reserves by several emerging countries has marked their macroeconomic strategies since the Mexican (1994) and Asian (1997-8) financial crises (Aizenman *et al.*, 2004, Dooley *et al.*, 2004, Eichengreen, 2004). This means that adopting free floating exchange rate regimes among those countries, in the aftermath of this sequence of financial crises, has not been sufficient to manage their external transactions. Purchases of foreign currency may actually constitute a response to two extreme and closely linked concerns: (i) the search for reducing external vulnerability, via broadening the potential capacity in sustaining external liquidity through the increase of official reserves; and (ii) the 'fear of floating', i.e., the attempt of sustaining the exchange rate in a level other than the one which would be expected if only competitive conditions existed in exchange markets. As it is well-recognized among economists, in a pure free floating exchange regime, monetary authorities do not need to keep foreign reserves. Nevertheless, recent literature has suggested that, in the context of deregulated global finance, the precautionary demand for reserves may constitute a national strategy. On the other hand, many economies, especially in the East Asia, seem to be running export-led growth regimes via robust and steady exchange market interventions and accumulation of foreign reserves.

This paper revisits this debate specifically in relation to Brazil. We focus on the rationale for the accumulation of reserves in Brazil in the recent period. More specifically, we ask if, firstly, the adoption

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of a free floating regime had affected the policy of accumulation of reserves, modifying the pattern of interventions of the monetary authority in the exchange markets. Secondly, if the reserves are associated to the mercantilist thesis or is more related to the precautionary view, and finally if the reserves have been the substitute for capital controls. The paper is structured in four main sections. Initially, it investigates the actual stage of the research on reserves demand theory, emphasizing the mercantilist and precautionary thesis and the main empirical works. Section 3 examines the hypothesis of ‘fear of floating’ in Brazil, following Souza & Hoff (2003)’s procedures. Section 4 presents the econometric exercises to estimate the reserves’ determinants, also including the analysis of the financial liberalization hypothesis. Main findings and concluding remarks are summarized afterwards.

2. The literature on international reserves: a brief review on the reserves’ demand theory and the empirical findings

Literature on international reserves has been identified since the 1960s and 1970s, when reserves were demanded to control the exchange rate arrangements that characterized the so-called Bretton Woods system. At that time, the ‘buffer’ function of international reserves to smooth the balance of payments’ variations (mainly related to current account unbalances) constituted the main motive underlying this common feature of the external policy³. Recently, this literature has regained relevance, following the ongoing movement of accumulating high levels of foreign currency among the emerging countries. However, the approach is distinct from the previous studies. Reserves are now seen as a mean to reduce the incidence of international crises, a new feature of the actual international financial architecture. In this sense, reserves have lost their own function of working as a mechanism to absorb transitory disequilibria in the current account. New tasks seem to be in place, enhanced by the fact that the exchange rate mechanism, once supposed to adjust the unbalancing capital flows, have not been effectively in place to clear the balance of payments and avoid the maintenance of reserve positions.

Reserves today constitute sovereign assets affecting the exposure of a developing country to the sovereign-risk and cost adjusts (Aizenman *et al.*, 2005). A lesson following the financial crises, prescribed by Aizenman, Lee & Rhee (2004) is that monetary authorities should carefully observe capital flows and stick the level of international reserves to their short-term external liabilities (Greenspan, 1999, Ggidotti, Sturzenegger & Villar, 2004). Financial crises of the 1990s have unveiled the limited access of emerging countries to international credit lines, suggesting this other important function of international reserves. They may indeed be seen as a precautionary savings to economies with conditional access to global capital markets – a self-protection via liquidity increasing, which may also reduce the cost of external credit for an emerging country (Rodrik, 2006). The imperfect integration, related to sovereign-risk, turns the accumulation of precautionary reserves a welfare-improving policy (Feldstein, 1999).

Therefore, one focus of empirical literature understand accumulating reserves as a mechanism for product stabilization and international crisis’ risk reduction, as Ben-Bassat & Gottlieb (1992), Bussiere & Mulder (1999)⁴, Aizenman, Lee & Rhee (2004), García & Soto (2004), Jeanne & Rancière (2006), and Aizenman & Lee (2006)⁵. Furthermore, reserves affect not only the probability of a crisis, but also the associated costs. Depending on how reserves are used, and in the case when the origin of a crisis is a liquidity shock, grand sums of international reserves may allow countries to avoid cost assets liquidation. By the same token, Rodrik (2006) asserts that countries with high levels of reserves are more capable to deal with panics on financial markets and sudden reversals on capital flows, reducing not only costs but the probability of such events. By their turn, De Gregorio & Lee (2004) find a significant effect of self-liquidity – seized as the ratio of reserves related to domestic liabilities (M2) and to short-term debt – in reducing the cost of a crisis on balance of payments.

In the beginning of the 21st century, the huge volume of international liquidity and the facility that financial flows move abroad from one country to another indicate the deepening globalization of the markets in relation to the 1990s, partially explaining the reasoning for huge reserve holdings. This

3 See Flood & Marion (2002) and Lopes (2005) for a review on this literature.

4 Bussiere & Mulder (1999) quantify the amount of reserves required to compensate weak fundamentals and avoid crises.

5 This line of research also involves the literature on ‘Early Warning System’, which focus on the quantitative estimation of reserves to reduce the probability of an international crisis.

corroborates the hypothesis that nowadays emerging countries are still subjected, if not more, to financial crises' side effects, affecting all markets more or less developed, even though it may be difficult to measure the probability of occurrence and the size of the next liquidity shock. As Loyola (2007) emphasizes, the actual financial globalization is not comparable to any previous moment in the economic history, especially counting with intensive use of financial innovations, a new challenge to economic management. In this context, De Gregorio & Lee (2004), and Park & Lee (2002), among others, have showed that the costs of financial crises are associated to loss of product. Indeed, real product growth would follow a 'V' shape during the period before and after financial crises. However, the post-crisis growth rate does not exceed the pre-crisis average, unveiling that crises involve permanent losses in terms of GDP. Even the 'Asian tigers' of the 1990s were not immune to short-term capital's sudden stops⁶. Eichengreen (2006, p.12), in the same way, point that investment rate in emerging Asian economies except China (and maybe India) has been kept significantly bellow 1996 levels, even ten years after the Asian crisis. This would contrast with the formation of excessive savings kept in international reserves, given the risk aversion of financial crises on those countries.

In Brazil, academic research in this field is still restrict⁷. We have identified only one study specific addressing international reserves. Lopes (2005) evaluates the effectiveness of reserves as a 'shield' against sudden stops. His conclusion is that the stock of reserves reduces the probability of occurrence of crises but, once started, it would tend to be stronger than in the case of lack of international reserves. Reserves would tend to accentuate the falling of capital flows during crises. A parallel study is Hoff (2004), who analyses the determinants of the monetary authority's intervention on the exchange market in floating regimes. Her main conclusion is that the misalignments of the real exchange rate have triggered the interventions that took place starting in the middle of 1999.

At the same time, this line of research faces a serious concurrent thesis. Part of the literature considers the policy of accumulating reserves as a mechanism to improve exports competitiveness, which would require the monetary authority to manage more actively the exchange market. Initially proposed by Dooley *et al.* (2003), this view interprets reserves accumulation as stemming from the market interventions to avoid the appreciation of the domestic currency. China would be the *hour concurs* example in this view, but also it's applied to other Asian developing economies that follow similar external policies. Aizenman & Lee (2006), Hviding, Novak & Ricci (2004), Dooley *et al* (2003) and European Central Bank (2006) follow this approach in analyzing international reserves as a mercantilist policy's mechanism. IMF (2003) also recognizes the relevance of the mercantilist policy to explain the strategy of accumulating reserves among the Asian emerging economies. Therefore, while the precautionary approach link directly the accumulation of reserves to the exposure to sudden stops, capital flight and volatility, mercantilist's view it as a residual of an industrial policy, which can, at the same time, impose side externalities to other export countries (Aizenman & Lee, 2005). Nevertheless, Flood & Marion (2002)'s explanation for the recent tendency of accumulation of high levels of international reserves not only in the emerging world but also in the developed ones, is based on the own international scenario of excess of liquidity.

That is the context within which we develop our analysis on the rationale for exchange market interventions and the building of international reserves in Brazil. Our main objective is to identify evidences supporting the relevance of the claims of the precautionary versus mercantilist motives underpinning the external policy of the country. In the next section, we start off investigating the hypothesis of the presence of 'fear of floating' underlying the monetary authority's interventions in the exchange market.

3. Central Bank's interventions in the exchange market: is there 'fear of floating' in Brazil?⁸

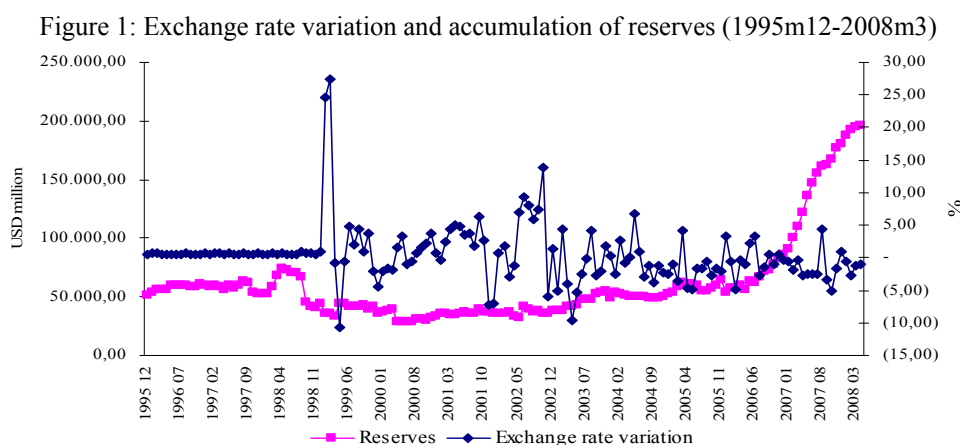
6 See Aizenman & Lee (2006); Aizenman, Lee & Rhee (2004).

7 Given the little academic development of this subject in Brazil, one of the aims of this paper is to fill up this gap on the Brazilian economic research agenda.

8 We follow closely the strategy of Calvo & Reinhart (2000) and Souza & Hoff (2003). Hausmann *et al.* (2000) also is a good resource to this section, through its volatility indicators related to exchange rate and reserves, and between exchange and interest rates to characterize an exchange regime.

Brazil has officially adopted a free floating exchange regime in 1999, falling in line with the then tendency among several emerging countries in abandoning strictly fixed exchange regimes after the monetary crisis that have hit the region since the middle 1990s. Nevertheless, intermediate or more flexible regimes in the sense of allowing currencies to float pegged to a convertible or a currency composite basket has still predominated in the post-Bretton Woods era⁹. This hypothesis has been strengthened by the recent tendency identified among the East Asian countries, in administering exchange regimes more pronouncedly, practice also known as ‘dirty’ floating. Even though many countries may declare themselves running floating exchange regime, rigorously there is a huge gap between the declared (free floating) exchange regime and the current practice of administering and controlling the level and the volatility of the exchange rate. The debate over this phenomenon has been known in the literature as ‘fear of floating’. Even though in Brazil this practice cannot be considered so as expressive, the suspect still holds. Recently in March, 2008, Brazil has implemented some measures to avoid the excessive appreciation of the domestic currency and at least to relieve the pain on the competitiveness of the export sector¹⁰.

Indeed, the authorities have declared that their frequent interventions in the exchange market were done to stabilize the exchange market and avoid strong variations in the rate. Additionally, when an inflation targeting system is in place in a periphery economy as Brazil, the aim to control the exchange rate is usually a standard mechanism used as an ‘anchor’ to stabilizing prices. This characteristic is especially relevant when there is a high pass-through of the exchange rate to inflation, due to the high dependency of a country with abroad in terms of trade. Figure 1 gives support to the hypothesis that reserve holdings may be related to the ‘fear of floating’ hypothesis. Reserves have been accumulated in tandem with a reduction on the foreign exchange rate volatility.



In this section we concentrate in investigating the hypothesis of ‘fear of floating’ as a guide to the recent exchange interventions’ policy of the Central Bank of Brazil, symptom that helps to identify (or not) the presence of a mercantilist view governing Brazilian external economic policy. Theoretically, an administered exchange rate regime presents lower exchange rate volatility coupled with greater volatility on reserves and interest rates, in comparison to countries such as the USA and Japan. Among the factors that justify the presence of fear of floating in emerging economies, Calvo and Reinhart (2000) describe that when circumstances are favorable (i.e., there are capital inflows), many countries can be reluctant in leaving nominal (and real) exchange rate to excessively appreciate, because it could mean a loss of competitiveness and diversification of tradeables’ export sector.

⁹ If in the beginning of the 1980s, IMF records almost 95% of the countries were administering their exchange regimes, in 2000 this practice has come down to 73% but still achieving 81% in 2005. IMF’s data suggest in fact that, despite this reduction, the management of exchange rate is still one main monetary policy concern for local authorities not only in emerging markets but also in the core economies.

¹⁰ Decree RFB 6.391/08, basically introducing a 1.5% tax on short-term foreign capital inflows, associated to the Resolution BCB 3.548/08 allowing exporters to keep 100% of their proceeds abroad. Both measures were implemented to reduce excess of dollars on the Brazilian market.

Therefore, the standard procedure to verify this hypothesis involves the estimation of some indicators to be compared to those benchmark free floating regimes. Given this reference, we start comparing the Brazilian regime since 1999 to a group of other countries, mainly emergent, using the standard indicators used in previous estimations. We also construct indicators for the first phase of the Real Plan (1994-1998), to compare the actual stage to the experience of a fixed exchange rate regime. In this sense, we present two groups of indicators. First, following Calvo & Reinhart, the exchange rate, reserves and interest rate's volatility are seized by the frequency on which monthly variations are between certain pre-defined limits. The second group is inspired by Hausmann *et al.* (2000), where volatilities are measured by the standard deviation and put in relative terms, i.e., comparing the exchange rate's volatility in relation to the reserves and interest rates' volatility. The underlying idea in these indicators is that, in a real floating exchange regime, exchange rate volatility is relatively high, while reserves and interest rates present relatively low volatility. The higher the frequency beyond the limits of 1% and 2.5%, the greater the variation of the exchange rate – and the closer a country is to a floating exchange rate regime.

Table 1 is a slightly modified and updated version of the one Calvo & Reinhart (2000) constructed for his sample. Indicators were calculated for 1999-2007, for a group of economies including USA, Japan, Brazil and some other emerging Asian and Latin American countries that have adopted at least formally a floating exchange regime. Results are the frequency distribution of monthly variations of exchange rate. It's noteworthy that the Brazilian experience after the implementation of the free floating exchange regime has presented variations much more expressive than the recorded ones among the central economies (USA, Euro area and Japan). While in average almost 90% of their exchange rate's variation has been lower than 2.5%, Brazil has registered more than 50% of its variations higher than the interval of 2.5%. At the same time, almost 90% of the interest rates' monthly variations have been wider than 0.25pp, in contrast with the verified average on those countries of more than 90% inside the 0.25pp interval. Reserves have been much more volatile in this period, reflecting the policy of accumulation of large amounts and all related sovereign payments abroad. This data allows two interpretations. Even though the large variations in interest rates and reserves than the benchmark regimes have not been predicted to hold for a free floating model, it's not possible to conclude for the presence of 'fear of floating' in Brazil and reject the presence of a free floating regime, *vis-à-vis* the basic condition of larger exchange rate variations characterizing the Brazilian case is evident. Second, the larger volatility of interest rate and reserves may likely had been related to factors other than the 'fear of floating' concern. Even though the indicators for reserves and interest rates would not be expected to hold for a free floating exchange regime, they must be interpreted circumscribed to the relative differences of external insertion of the countries. Indeed, they have been much more pronounced in Brazil, as would be expected considering the institutional distinctions of a periphery economy in relation to the core ones.

Table 1: Volatility of Reserves, Interest Rate and Exchange Rates (Jan/1999-Dez/2007).

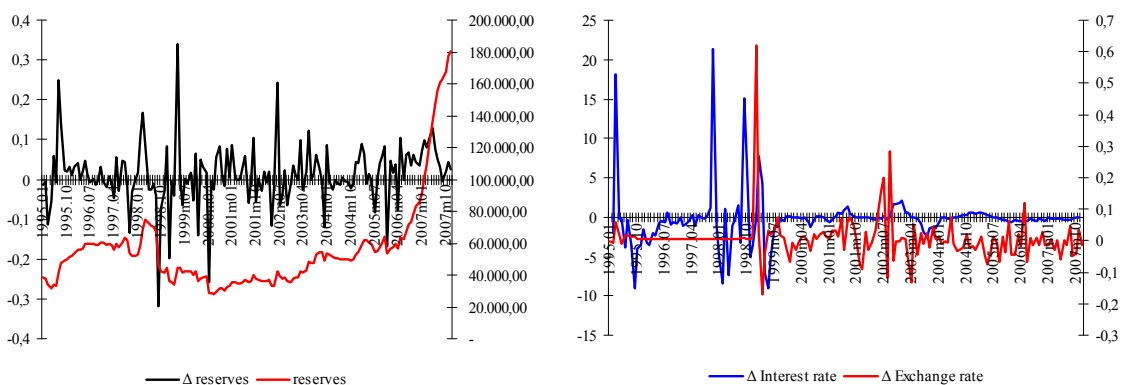
| Country | Interest rate | | | Reserves | | | Exchange rate | | |
|---------------------------------|----------------|-------------|---------------|------------|--------------|------------|---------------|--------------|------------|
| | F \pm 0.25pp | F $>$ 0.5pp | F \pm 0.5pp | F \pm 1% | F \pm 2.5% | F $>$ 2.5% | F \pm 1% | F \pm 2.5% | F $>$ 2.5% |
| <i>Latin American countries</i> | | | | | | | | | |
| Argentina | 6.94 | 61.11 | 38.89 | 50,00 | 95,37 | 4,63 | 36,11 | 65,28 | 34,72 |
| Bolivia | 3.70 | 50.00 | 50.00 | 20,37 | 33,33 | 66,67 | 62,04 | 91,67 | 8,33 |
| Brazil | 12.96 | 30.56 | 69.44 | 11,11 | 34,26 | 65,74 | 19,44 | 49,07 | 50,93 |
| Brazil (1) | 10.63 | 76.60 | 23.40 | 24,07 | 50,00 | 50,00 | 20,37 | 100,00 | - |
| Chile | 63.54 | 20.83 | 79.17 | 33,33 | 78,70 | 21,30 | 31,48 | 65,74 | 34,26 |
| Colombia | 61.11 | 74.07 | 25.93 | 20,37 | 55,56 | 44,44 | 25,00 | 61,11 | 38,89 |
| Mexico | 37.96 | 43.52 | 56.48 | 28,70 | 62,04 | 37,96 | 31,48 | 66,67 | 33,33 |
| Paraguay | 25.00 | 63.89 | 36.11 | 27,78 | 72,22 | 27,78 | 37,04 | 71,30 | 28,70 |
| Peru | 61.11 | 29.63 | 70.37 | 19,44 | 36,11 | 63,89 | 52,78 | 89,81 | 10,19 |
| Uruguay | 14.81 | 74.07 | 25.93 | 67,59 | 93,52 | 6,48 | 43,52 | 73,15 | 26,85 |
| Venezuela | 5.56 | 91.67 | 8.33 | 12,04 | 34,26 | 65,74 | 52,78 | 80,56 | 19,44 |
| Average | 29.27 | 53.94 | 46.07 | 29.07 | 59.54 | 40.46 | 39.17 | 71.44 | 28.56 |
| <i>Asian countries</i> | | | | | | | | | |
| Indonesia | 24.07 | 62.04 | 37.96 | 31,48 | 60,19 | 39,81 | 17,59 | 59,26 | 40,74 |
| Japan | 100.00 | 0 | 100.00 | 38,89 | 82,41 | 17,59 | 39,81 | 80,56 | 19,44 |

| | | | | | | | | | |
|------------------------------|-------|-------|--------|-------|-------|-------|-------|-------|-------|
| Korea | 95.37 | 2.78 | 97.22 | 57,41 | 82,41 | 17,59 | 44,44 | 80,56 | 19,44 |
| Malaysia | 96.30 | 0.93 | 99.07 | 47,22 | 78,70 | 21,30 | 51,85 | 93,52 | 6,48 |
| Philippines | 66.67 | 19.44 | 80.56 | 29,63 | 57,41 | 42,59 | 37,04 | 77,78 | 22,22 |
| Singapore | 75.63 | 6.48 | 93.52 | 12,96 | 27,78 | 72,22 | 64,81 | 99,07 | 0,93 |
| Thailand | 75.00 | 25.93 | 74.07 | 50.93 | 81.48 | 18.52 | 51.85 | 85.18 | 14.82 |
| Average | 76.15 | 16.8 | 83.2 | 38.36 | 67.2 | 32.8 | 43.91 | 82.27 | 17.72 |
| <u>BRIC</u> | | | | | | | | | |
| Russia | 13.89 | 77.48 | 22.22 | 25,93 | 60,19 | 39,81 | 68,52 | 87,96 | 12,04 |
| India | 26.32 | 68.42 | 31.58 | 56,07 | 87,85 | 12,15 | 47,22 | 88,89 | 11,11 |
| China | 96.36 | 3.64 | 96.36 | 35,19 | 68,52 | 31,48 | 58,33 | 94,44 | 5,56 |
| <u>Anglo-saxon countries</u> | | | | | | | | | |
| USA | 86.11 | 3.70 | 96.30 | 46,30 | 83,33 | 16,67 | 60,19 | 94,44 | 5,56 |
| Sth Africa | 62.96 | 15.74 | 84.26 | 61,11 | 93,52 | 6,48 | 25,93 | 50,93 | 49,07 |
| Canada | 81.48 | 1.85 | 98.15 | 22,22 | 41,67 | 58,33 | 38,89 | 77,78 | 22,22 |
| Australia | 74.07 | 0 | 100.00 | 14,81 | 34,26 | 65,74 | 25,93 | 67,59 | 32,41 |
| Euro Area | 93.52 | 0.93 | 99.07 | 33,33 | 85,19 | 14,81 | 53,27 | 88,79 | 11,21 |

Obs. Argentina: jan/02-dez/07; Brazil (1): jul/94-dez/98, fixed exchange rate regime.
Exchange rate: average in the period. Thailand: end of period. Source: IFS (IMF)

The distinction of the actual floating regime in Brazil with the previous fixed one is also noteworthy. As figure 2b shows, exchange rates have started to flow after 1999, corroborating the existence of a real free floating exchange regime. In this sense, Brazilian exchange rate regime seems to have evolved to a *de fact* more volatile regime, which characterizes a floating regime. So, the hypothesis of ‘fear of floating’ does not hold on these terms, *vis-à-vis* there is a much more volatile exchange rate regime detached from the previous stability. Interest rate, by its turn, seems also to follow a more stable pattern after 1999. This evidence is in accordance with the different phases of the economic policy in practice: in the first period, interest rates were used to calibrate the balance of payments while exchange rate was a mechanism to control prices’ volatility; in the second term, interest rates are the mechanism to control inflation, while exchange rate is the official instrument to equilibrate the balance of payments. Reserves, meanwhile, does not seem to present huge changes in its pattern (figure 2a). Even though reserves had been, in average, slightly more stable during the administered period, a volatile standard has been kept even during the following free floating regime.

Figure 2: Brazilian reserves, exchange and interest rates (1995-2007)



Source of gross data: Ipeadata.gov.br.

We complement the investigation at this stage with another set of indicators. Table 2 reports two relative volatility tests, based on Hausmann *et al.* (2000)’s tests¹¹. The following indicators seize the relative volatilities between exchange rate and reserves, as well as between exchange and interest rates.

¹¹ It is important to note that volatility indicators may be sensitive to the respective initial levels of reserves and interest rates. Countries more prone to suffer from ‘fear of floating’ may tend to keep higher levels of reserves. In this case, relatively volume exchange market interventions tend to be underestimated when seized in terms of the ratio of absolute variations relative to the levels of reserves. The same may occur related to the level of exchange rates.

Exchange and interest rates' volatility are measured by its standard deviation, while reserves' volatility is captured by the coefficient of variation. In this context, if the 'fear of floating' is real and a country is trying to keep its exchange rate stable or is following a crawling peg, the standard deviation will tend to zero. Observing the relationship between exchange and interest rates' volatilities, the higher the tendency of the central bank to stabilize the exchange rate via interest rates, the lower this ratio will be. Brazilian experience with an administered exchange rate regime until 1999, when interest rate's volatility was the instrument to balance external flows and keep the exchange rate stable, presented a ratio of 0.0765, lower than the benchmark USA's ratio (0.1940). Argentina (0.0247), Bolivia (0.0650), India (0.0081), Paraguay (0.0521), Peru (0.0796), Russia (0.0314), Singapore (0.0704), Uruguay (0.0903) and Venezuela (0.0474) are all developing countries which seem to present a stable exchange rate regime similar to the characteristics of the previous Brazilian experience. These are countries where 'fear of floating' concerns may play a role.

The second relative indicator on table 2 is regarded to the reserves' variations. The higher the tendency of the central bank to use them to stabilize the exchange rate, the lower the ratio of exchange rate and reserves' volatility. Again, results are not conclusive, and the same shortcomings for the previous indicators must be considered. Great accumulators of reserves presented lower values for this indicator: China (0.0175), India (0.0273), Japan (0.0512), Korea (0.0542), Malaysia (0.0306), Russia (0.0155) and Singapore (0.0522), reflecting, at least partially, the large accumulation of reserves in this period. Other emerging economies such as Philippines (0.0938), Mexico (0.0981), Peru (0.0551), besides the Euro Area (0.1040), all seem to run a more stable exchange regime than the American one. In this case, results may not disregard the hypothesis of 'fear of floating' playing a role in these economies. On the other extreme, Chilean regime (0.6092) seems to be more volatile than the American benchmark (0.1690). Brazil, during its administered regime, presented a value of 0.0985, while after 1999 it achieved 0.1535. That is to say, Brazil seems to be running a much more flexible exchange regime than before 1999, quite similar to the genuine floating exchange regime in the USA. This result, different from the majority of the emerging economies, does not support the relevance of 'fear of floating' conducting Brazilian monetary authority's market interventions.

Table 2: Exchange rate's volatility relative to interest rate & reserves (jan/99-dez/07)

| Country | θ 's σ /i's σ | θ 's σ /res' var |
|---------------|------------------------------------|--------------------------------|
| Argentina | 0,0247 | 0,2111 |
| Australia | 1,0750 | 0,0568 |
| Bolivia | 0,0650 | 0,0195 |
| Brazil | 1,5448 | 0,1535 |
| Brazil (1) | 0,0765 | 0,0985 |
| Canada | 0,3802 | 0,1598 |
| Chile | 0,1102 | 0,6092 |
| China | - | 0,0175 |
| Colombia | 0,4798 | 0,1337 |
| Euro Area | 0,3608 | 0,1040 |
| India | 0,0081 | 0,0273 |
| Indonesia | 0,1765 | 0,2729 |
| Japan | 0,0152 | 0,0512 |
| Korea | 0,7441 | 0,0542 |
| Malaysia | 0,3260 | 0,0306 |
| Mexico | 0,3401 | 0,0981 |
| Paraguay | 0,0521 | 0,0841 |
| Peru | 0,0796 | 0,0551 |
| Philippines | 0,4386 | 0,0938 |
| Russia | 0,0314 | 0,0155 |
| Singapore | 0,0704 | 0,0522 |
| South Africa | 1,2439 | 0,0717 |
| United States | 0,1940 | 0,1690 |
| Uruguay | 0,0903 | 0,1459 |
| Venezuela | 0,0474 | 0,2078 |

Obs. Time span for Argentina since 2002, when a floating regime has been introduced.

For such, the main conclusion of this section is that, different from the majority of Asian and Latin American countries, Brazil has passed the tests, in the sense that the hypothesis of the presence of ‘fear of floating’ sustaining the exchange rate policy does not hold for the actual exchange regime in Brazil. Therefore, it seems reasonable to conclude that the exchange fluctuations have not constituted a priority concern to the Brazilian authorities, result similar to Souza & Hoff (2003). This agrees with the fact that many researchers have pointed that Central Bank of Brazil seems to accept an appreciation bias of the Real. Volatility on the exchange rate related to the appreciation of the domestic currency seems to be welcomed in the Brazilian recent experience, as it constitutes an additional instrument for its institutional mission of targeting inflation¹². This means that monetary authorities’ market interventions do not seem to be related to ‘fear of floating’ concerns. This finding is in contrast with the mercantilist view that Brazil manages its foreign exchange rate, and we should look for additional hypothesis to explain the building of reserves in Brazil. In the next section, we keep our inquiry on the reasons underlying the interventions in the exchange markets and the pattern of the Brazilian international reserves, testing the mercantilist view with additional techniques.

4. The rationale of the Central Bank of Brazil’s interventions in the exchange market/ Determinants of the Brazilian reserves: some econometric evidences¹³

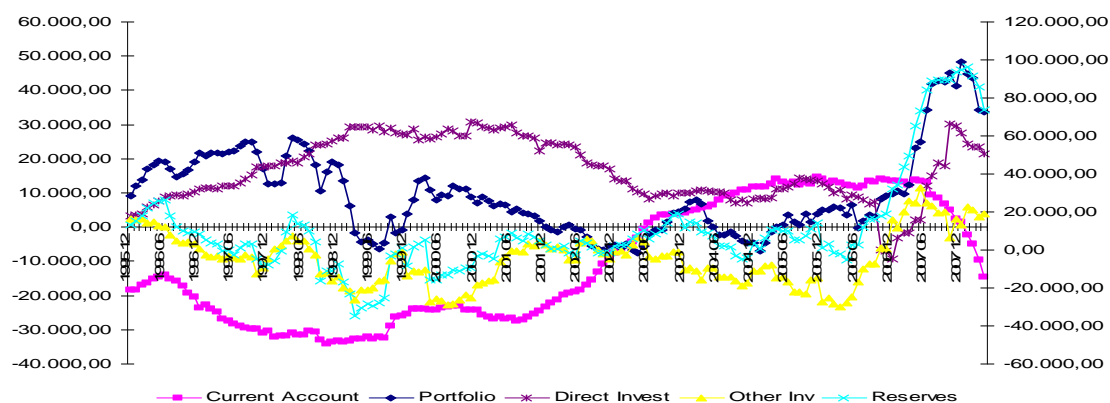
In this Section we evaluate empirically the management of international reserves by the Brazilian monetary authority. Given the main previous conclusion that the hypothesis of ‘fear of floating’ does not hold to explain the actual interventions of the monetary authority in the Brazilian exchange market, we keep focused on investigating additional hypothesis explaining the rationale of the Central Banks of Brazil’s policy. We examine three main relevant aspects. First, has the adoption of a free floating regime in 1999 affected the policy of accumulation of reserves, modifying the pattern of interventions of the monetary authority in the exchange markets? Or, is it a relevant determinant of the Central Bank’s actions in the exchange market? Second, what is the main rationale for the Central Bank’s policy of accumulation of high levels of international currency? Have the reserves been more associated to the mercantilist thesis or to the precautionary view? We also try to answer if the reserves have been the substitute for capital controls that were gradually put away in the external management of Brazilian economy since the 1990s, given the particular dynamism of the financial account commanding the external insertion of the Brazilian economy. We examine if financial liberalization has imposed an upward tendency to the reserves policy, investigating the correlation of and the causality between both time series.

We first illustrate some factors that are behind the accumulation of international reserves in the aftermath of the introduction of the floating exchange regime in 1999 by taking a look at the evolution of international reserves and other related macroeconomic variables. International reserves were USD 33 billion (in terms of usable amount) in March, 1999, but gradually built up to USD 198 billion by the end of May, 2008. As a fraction of GDP, international reserves rose from 4.32% to 14.46% over the same period. A swift glance at the plotted data (figure 3) indicates that direct investment has been the most relevant inflow since 1995, when Brazil was already gradually opening its capital account, pushed by the then privatization process that took place more firmly during the first term of Cardoso (1995-1998). More recently, the recovery of the export sector allowed Brazil register a current account surplus after the large depreciation of Real following the sudden stop and reversal of capital inflows associated to the victory of a leftwing candidate for the presidency in 2002. In 2007, large portfolio inflows coupled with continued inflows of foreigners’ direct investment and also other net investments, played an important role in the rapid accumulation of international reserves.

¹² See, e.g., Diniz (2006).

¹³ We follow closely the investigatory strategy of Azeinmann *et al* (2004).

Figure 3: Annually accumulated capital flows to Brazil (1995m12-2008m4)



Source of gross data: www.bcb.gov.br; Reserves: accumulated stock. Other series: 12 month moving average net flows.

In order to assess more formally the responsiveness of international reserves to those factors noted above, we run a reduced-form regression. The regressions relate changes in international reserves to monthly variations of the current account, direct investments, portfolio and other investment of the financial account of the balance of payments (table 3). We have included Other Investments in the regression. The series is statistically significant and its contribution improves a lot R^2 . All components presented parameters statistically identified at 1% level, and DW statistic indicates no serial correlation on residuals on model II. However, White test reject the hypothesis of no heteroskedasticity on the stochastic disturbances. To solve this problem, the estimations of the coefficient covariances were corrected using the White's heteroskedasticity consistent covariance matrix estimator (model III). In this sense, classical assumptions related to the stochastic component are all valid in this specification, allowing for more statistically robust results. We have also run the omitted variable test for this time series, corroborating model III. This kind of test helps to evaluate the early hypothesis that these flows would not contribute significantly to the pattern of international reserves.

Granger causality tests support these findings. Running bivariate Granger causality tests, we've examined if lagged values of a variable y precede another given x variable. As variables do not cointegrate two by two, according to Granger *et al.* (1998), we have used the conventional formulation for the Granger test. Basically, the relation between reserves and other investment flows has been the most significant. Reserves variations precede other investment variations and other investment variations cause, in the Grange meaning, reserves, at normal levels of significance. Given other investments comprise many short term flows, specially related to international trade that the Central Bank of Brazil historically has closely monitored and sometimes, when external funding ceased it substituted them to keep funding the exports; even more, due to the fact that the credits and debts with the IMF flow from reserves to/from abroad via this account, this finding seems to be very plausible. At a similar token, Granger causality tests reinforce the direction of causation from portfolio and current account balances to reserves, stating that the opposite direction does not hold. Given the positive coefficient for each variable and the accumulation of reserves, this means the Central Bank of Brazil is purchasing the excess of foreign currency inflows provided by these accounts. The same conclusion holds for direct investment and reserves, as direct investment flows help to explain reserves variations¹⁴.

Table 3: Reduce Form Equations

Dependent variable: D(Res)

Sample (adjusted): 1995M02 2008M04

| Variable | model I | | model II | | model III | |
|--------------|-------------|----------|-------------|---------|-------------|---------|
| | Coefficient | t-value | Coefficient | t-value | Coefficient | t-value |
| CASA | 0.635180* | 4,028086 | 0.900671* | 16,3542 | 0.900671* | 8,5047 |
| DIR_INVESTSA | 0.372943* | 2,761449 | 0.968957* | 19,4233 | 0.968957* | 28,0233 |
| PORTFOLIOSA | 0.982336* | 8,909103 | 0.992497* | 33,9162 | 0.992497* | 40,0643 |

14 Figures, estimations and main results are available upon request.

| | | | | | | |
|-------------------------|----------|---|-----------|---------|-----------|---------|
| OTHERINVSA | - | - | 0.907274* | 23,7616 | 0.907274* | 12,6189 |
| Adjusted R ² | 0.339454 | | 0.921057 | | 0.921057 | |
| DW | 1,863284 | | 2,059989 | | 2,059989 | |
| Schwarz | 19,18415 | | 17,08526 | | 17,08526 | |

Notes: Series are all stationary (ADF, PP & ZA unit root tests). Other investment inflows comprise loans, trade credits, currency and deposits transfers, and the IMF's loans, following the IMF's methodology for Balance of Payments, adopted in Brazil. * Coefficient significant at 1% level. The inclusion of a constant was not significant in the model. The suffix SA denotes series were seasonally adjusted (method of the difference from moving average).

The dynamic of the Brazilian international reserves have been directly related to the patterns of these main accounts of the balance of payments, as would be expected. Specifically, a 1.0 (one) dollar increase in the current account surplus led to a 0.90 dollar increase in international reserves, the same occurring with the same variation on Other Investments. Direct Investments, which may present inflows not in currency but in machinery or even the conversion of previous external loans, presents a factor of 0.96, while portfolio flows, achieved 0.99. This exercise does not confirm our prior conjecture that the result of the stock of international reserves is not significantly associated with the current account performance. In fact, this result is simply explained in terms of accounting. Since all international transactions must be registered in the balance of payments of the country with abroad, the surplus or deficit of these transactions must be reflected on the international reserves, *vis-à-vis* it supplies or absorb the lack or excess of convertible currency that is required as the result of the private transactions in the Brazilian exchange market. When outflows predominate, reserves tend to decrease in the same pace, the opposite being true as well. Statistically confirmed the relevance of the result on each account of the balance of payments to explain the pattern of the international reserves, to determine which flow has been predominant to allow for the accumulation of reserves one should look to their absolute results.

We now formally investigate¹⁵ which underlying thesis may better explain the demand for international reserves in Brazil. Even though the presence of 'fear of floating' has not been supported by evidence, does the rationale of exchange interventions find any support on the mercantilist thesis? Or had the precautionary thesis played a bigger role in the rapid accumulation of international reserves? What about the precautionary thesis? We start modeling by recognizing the existence of five key factors that explain reserve holdings: economic size; current account vulnerability; capital account vulnerability; exchange rate flexibility; and opportunity cost (IMF, 2003, p.80/1). Our empirical model incorporates a set of explanatory variables to include measures for each of these determinants. Growth of population and real GDP per capita are expected to increase reserves. A more open economy is expected to be more vulnerable to external shocks, so greater trade openness would be associated with higher reserve holdings (IMF, 2003, p.81). The larger the external shocks (say, export volatility), the higher the level of reserves. At the same time, if the monetary authority's interventions are related to the mercantilist thesis, exports' growth must be positively correlated to reserves, *vis-à-vis* the higher the exports proceeds demanding higher purchases by the central bank. As with the current account, greater financial openness expounds an economy to higher crisis vulnerability and thus may influence the demand for reserves. In addition, the greater the potential for resident-based capital flight from the domestic currency, the higher the level of reserves. Meanwhile, greater flexibility is theoretically expected to reduce the demand for reserves, because central banks no longer need a large stockpile of reserves to manage a pegged exchange rate. However, many countries adopting more flexible exchange rate regimes (including managed floats) have kept accumulating large sums of reserves, and appear reluctant to allow much actual variability, giving rise to the literature connect to the mercantilist view.

Consequently, focusing on the exchange rate may provide complementary information, and point to a direct relationship between exchange rate volatility (higher during the floating regime) and accumulation of reserves (higher in the recent past), as would be empirically expected for Brazil. If a country runs a dirty regime and manipulates the exchange rate to achieve or maintain international competitiveness, interventions in exchange market are expected to avoid real appreciation of the domestic currency. If this is the case, deviations from PPP would unveil an interventionist policy of the BCB, in the

15 This analysis builds on IMF (2003) and Aizenman, Lee & Rhee (2004).

mercantilist meaning¹⁶. We measure the opportunity cost of holding reserves as the difference between the yield on reserves and the marginal productivity of an alternative investment. More specifically, the difference between American and Brazilian basic rate set by central bankers, in nominal and real terms. Theoretically, the greater the opportunity cost, the lower the level of reserves. Empirically, with interest rates hitting historical low levels in many central countries (IMF, 2003, p.81), the cost of holding foreign exchange reserves has likely increased for many emerging economies, including Brazil over the last few years, and may not be a robust determinant for the holding of large reserves actually.

Table 3: Regressions of Reserves on Explanatory Variables (1995m12-2008m4)

| | D(Reserves) |
|---|--------------------|
| <i>Economic size</i> | |
| D (Real GDP per capita) | 20.72795 (3.88)* |
| D(GDP) ¹ | 0.888593 (2.19)* |
| <i>Current account vulnerability</i> | |
| D(Imports) ^{1 2} | 6.46E-7 (1.26)# |
| D(Trade openness) | 108.0794 (0.58)# |
| Export volatility ^{2 3} | 0.051018 (0.87)# |
| D(Exports) ^{2 3 4} | 0.000537 (0.85)# |
| <i>Capital account vulnerability</i> | |
| D(Financial openness) | 3.238871 (0.23)# |
| D(Broad money/ GDP) | -812.2554 (-0.76)# |
| <i>Exchange rate flexibility</i> | |
| D(Deviation from PPP) ^{4 5} | 68.87336 (1.39)# |
| Real Exchange rate variation ⁵ | -256.0219 (-3.38)* |
| <i>Opportunity cost</i> | |
| Nominal interest differential | -185.2659 (-3.91)* |
| Real interest differential | -44.17559 (-0.95)# |

Notes: regressions include fixed effects, if not stated otherwise; numbers in parenthesis are t-values. * denotes significance at 1% level; ** at 10% level; # not significant. Series were seasonally adjusted, using the difference from moving average method, available on Eviews 5.0. ¹: constant not significant; ²: lagged one period, to avoid current endogeneity; ³: not significant even for the floating regime after 1999m1; ⁴: export volatility is the monthly variation of exports, in %, while D(exports) stands for the monthly exports proceeds, in USD; ⁵: since 1999m1.

Simple correlations between reserves and each of the explanatory variables present some results consistent with theoretical predictions (Table 3)¹⁷. As expected, real reserves are positively and significantly correlated with real GDP per capita, even though the variations of GDP have not been robust to explain reserves policy. Reserves are correlated with the ratio of imports to GDP proxing current account vulnerability, but also not significantly. *De facto*, even though the formal rule governing the reserves policy in Brazil predicts the maintenance of the country's imports capacity during an external turmoil¹⁸, reserve holdings have accumulated much higher amounts of foreign currency¹⁹. In this sense, formal rule and empirical practice seem to be unaligned. On the other hand, even though the other three indicators for current account vulnerability are not significant in acceptable levels, some comments are forward. The size of the international trade does not seem to be significant to explain reserves holdings in Brazil. As total exports and imports increase, one would expect reserves to (slightly) increase, given the precautionary concern related to imports capacity and the mercantilist view in support of exports. On the other hand, exports volatility *per se* has not constituted a robust relation with reserves, result that tends to weaken the mercantilist hypothesis.

16 PPP, in its simplest form, asserts that the rate of currency depreciation is approximately equal to the difference between domestic and foreign inflation rates.

17 Time span defined according to available data. The explanatory variables used in the analysis are the empirical counterparts of the factors discussed above for which data are available.

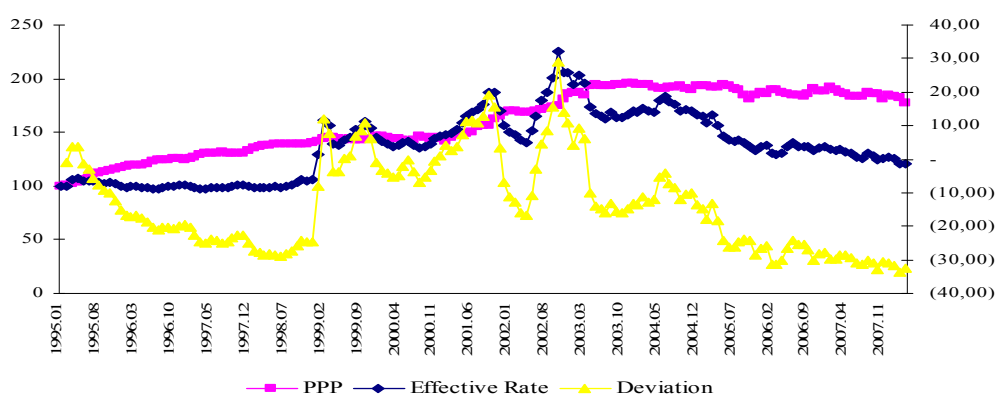
18 Resolution 82, 18/12/1990, by Federal Senate.

19 Figures, estimations and main results are available upon request.

The mechanism to sustain exports would be as follows: the greater exports proceeds tending to appreciate the domestic currency would be counterbalanced by the monetary authority mopping up the excess of liquidity in the exchange market. In theory, these interventions would keep the currency stable and sustain the export driver in a developing economy. So, the higher the exports, the higher the reserves, relation not verified in Brazil. Even though in absolute terms the accumulated time series has increased, abrupt month variations have been verified, especially after the floating exchange regime has been in place (figure 3). Given the appreciation of more than 100% of the domestic currency since 2003²⁰, the recovered dynamism of the export driver had steadily decayed in tandem with the appreciation of the exchange rate, pushing the current account back into deficit in 2008. Also, the potential of at least four thousand enterprises able to export has not been used, according to researchers in the Federal Economic Research Bureau (Araujo & De Negri, 2007). Together with the fact that several multinationals companies in Brazil have transferred their industrial production to abroad or simply stopped exporting, the robust side effects of running a free floating regime in a financially integrated scenario certainly does not support the mercantilist thesis playing a big role in Brazil.

Capital account vulnerability is also not significant to explain reserve holdings. Financial openness, captured by the sum of all capital and financial account transactions, is positively correlated with reserves, as expected, but is not robust. In this sense, early hypothesis that the gradual financial integration of Brazil with international flows would explain reserve holdings does not find much ground. On the other hand, the possibility of capital flights in the dimension of broad money in Brazil does not seem to represent a real concern for the BCB, as the association is negative. Two interpretations follow from the exchange rate's indicators. The rate of deviation of the exchange rate in relation to PPP is not significant to explain reserve holdings. This evidence reflects the fact that Brazil has run a free floating regime and does not follow a depreciated exchange target that would be more tied up to the reserves policy (figure 4).

Figure 4: Deviations from PPP (1995-2008)



Source of gross data: www.bcb.gov.br. Right-Y axis for deviations from PPP (in %).

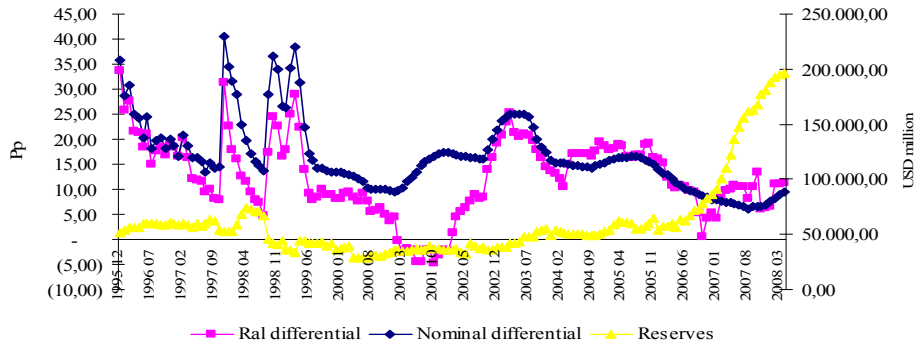
Meanwhile, the exchange volatility indicator is significant and negative, as theoretically expected (the greater flexibility of the exchange rate, the lower the demand for reserves). This result seems contradictory at a cursory glance, given Brazil has run a legitimate floating regime and has also increased its reserves' position. Nevertheless, the parameter is capturing the fact the exchange volatility has been lower since 2003, explained by the fact that Brazilian economy has not been hit by large capital flights or sudden reversals, and also by the large market interventions of the BCB to accumulate stocks of reserves.

Consistent with theory, opportunity costs of holding reserves are negatively correlated with reserves (figure 5). The result implies that interest rate differentials have followed a downward pattern, as seems to be the tendency in the present case. Nevertheless, this result does not imply opportunity costs are irrelevant. In fact, BCB has incurred into a high fiscal cost to hold such a large sum of foreign currency, and the hypothesis that a window of opportunity has been in place associated to reduced costs for buying

²⁰ The Economist, p.103, May 24th, 2008.

foreign currency seems to be groundless in this case. Different from China or Japan, e.g., large accumulators of reserves running negative real interest rate, high levels of (nominal and real) interest rates have been characteristic in Brazil in this period²¹.

Figure 5: Reserve accumulation and opportunity cost (1996-2008)



Source of gross data: www.bcb.gov.br.

We now develop a benchmark multivariate regression to explore the factors discussed above, focusing on the variables related to our investigation among the traditional determinants of the demand for international reserves, as discussed previously. Basically, the econometric model incorporates the proxies for each of the key factor normally accepted to explain reserve holdings, as follows:

$$RES_t = \beta_0 + \beta_1.GDP_t + \beta_2.IMP_t + \beta_3.EXP_t + \beta_4.EXP_VOL_t + \beta_5.IAC_t + \beta_6.IAF_t + \beta_7.M2GDP_t + \beta_8.PPPDEV_t + \beta_9.XCHG_VA_t + \beta_{10}.NOM_DIF_t + \varepsilon_t \quad (1)$$

where: *RS* stands for reserves; *GDP* is the GDP growth; *IMP*, total imports; *EXP*, total exports; *EXP_VOL*, the volatility of export receipts; *IAC*, trade openness index, the ratio of the sum of total imports and exports to GDP; *IAF*, the financial openness indicator, the ratio of total financial and capital account flows to GDP; *M2GDP*, broad money, the ratio of M2 to GDP; *PPPDEV*, the deviation of the real effective exchange rate from its equilibrium value, based on the PPP; *XCHG_VA*, the exchange rate volatility; and *NOM_DIF*, for the opportunity cost of holding reserves seized by interest rate differentials. All time series were provided by Ipeadata and Central Bank of Brazil, in monthly basis, and were seasonally adjusted by the method of the difference from moving average. Time span was defined according to the availability of data, starting on December, 1995 until April, 2008 for almost all series, which provides a representative sample for the exercises. Series defined in USD million were monotonically transformed in logarithms to smooth variations and produce more homogeneous coefficients on the equation. We've also examine for structural break, given the suspect that the change of level related to the strong accumulation of reserves from 2006 up to 2008 could effectively constitute a structural break on the time series. We've applied the Chow forecast test, which estimates two models – one using the full dataset, and the other using a shorter sub-period. If there's a robust difference between the two models, F-statistics and Log Likelihood Ratio tests will identify it, casting doubt on the stability of an estimated relation over the sample period. Neither of the forecast tests statistics rejects the null hypothesis of no structural change²².

Before estimating the parameters of the equation, it's also fundamental to examine the stationarity of the series and formally test for the presence of unit root. The adopted method consisted first in identifying the presence of non-stationary and, next, introducing specific solutions. This first step was put through the realization of three unit root tests: Augmented Dickey-Fuller (ADF), Phillips-Perron

21 This point will be addressed in the next paper.

22 Figures, estimations and main results are available upon request.

(PP) and the method of Zivot-Andrews (ZA)²³. It's also important to examine for autocorrelation on the errors on the estimated regression to be sure that the model selected to verify the presence of unit root, is correct. Tests were done using the software Eviews 5.0, which generate the critic values to test the null of the unit root. We didn't find serial correlation on the residuals of the model adopted to test for unit root. *Latu sensu*, results are convergent, and series are all either I(0) or, in the majority, I(1). This is not a surprise, since the non-stationary dynamism is the rule and not exception among economic time series (Fava, 2000). We find²⁴ that it's not possible to reject the presence of a unit root for RESERVESA; GDPSA; M2GDPSA and NOM_DIFSA. LNIMPORTSA, LNEXPORTSA, IACSA and PPPDEVSA were specified as I(1) by ADF and PP tests, and I(0) by ZA. In this case, we consider these series non-stationary in levels, given the dynamism of the series during the period and the fact that we are not controlling each structural breaks ZA suggests to model them in levels. Meanwhile, all specifications reject unit root for EXP_VOLSA; IAFSA, and XCHG_VASA²⁵. This result requires to model equation (1) in differences:

$$\begin{aligned} \Delta(RES_t) = & \beta_0 + \beta_1.\Delta(GDP_t) + \beta_2.(IMP_t) + \beta_3.\Delta(EXP_t) + \beta_4.\Delta(EXP_VOL_t) + \\ & \beta_5.\Delta(IAC_t) + \beta_6.\Delta(IAF_t) + \beta_7.\Delta(M2GDP_t) + \beta_8.\Delta(PPPDEV_t) + \beta_9.\Delta(XCHG_VA_t) + \\ & \beta_{10}.\Delta(NOM_DIF_t) + \varepsilon_t \end{aligned} \quad (1.a)$$

Table 4 presents the identification of the parameters, according to (1.a):

| | I | II | III | IV | V | VI |
|--------------------------------------|-----------|-----------|-----------|-----------|-----------|-----------|
| <i>Economic size</i> | | | | | | |
| GDP growth | 1.41E-06* | 1.26E-06* | 1.66E-06* | 7.45E-07* | 7.77E-07* | 7.52E-07* |
| <i>Current account vulnerability</i> | | | | | | |
| Imports | 0.009104 | 0.009581 | 0.008170 | - | - | - |
| Trade Openness | 0.001783 | 0.001614 | 0.001903 | - | - | - |
| Export volatility | 0.000240 | 0.000234 | 1.79E-05 | - | - | - |
| Export | 0.039308 | 0.035074 | 0.008941 | - | - | - |
| Current account balance | - | - | - | 1.75E-05* | 1.76E-05* | 1.74E-05* |
| <i>Capital account vulnerability</i> | | | | | | |
| Financial openness | 8.56E-05 | 8.53E-05 | 4.90E-05 | - | - | - |
| Broad money/GDP | -0.009835 | -0.011140 | -0.022774 | - | - | - |
| Short term external debt | - | - | - | 0.006523 | - | - |
| Foreign Portfolio Inflows | - | - | - | 0.024810* | 0.025171* | 0.024840* |
| Foreign Other Invest | - | - | - | 0.007758* | 0.007747* | 0.007757* |
| Financial liberalization | - | - | - | - | -0.368295 | - |
| <i>Exchange rate flexibility</i> | | | | | | |
| Deviation from PPP | -0.000243 | -0.000252 | -0.000422 | - | - | - |
| Real exchange rate variation | -0.002799 | -0.002791 | -0.001858 | - | - | - |
| <i>Opportunity cost</i> | | | | | | |
| Nominal interest differential | -0.00809* | -0.00802* | -0.00378* | -0.00287* | -0.00293* | -0.00289* |
| <i>Others</i> | | | | | | |
| Floating regime | - | - | 0.002909 | - | - | - |
| Outlier 1998m9 | - | - | 0.305891* | 0.141714* | 0.135075* | 0.141774* |
| Outlier 1999m4 | - | - | 0.274536* | 0.137680* | 0.138972* | 0.137594* |
| Contagion effects | - | -0.005567 | - | - | - | - |
| Factor for serial correlation | - | - | - | 0.475778* | 0.475152* | 0.476025* |
| Adjusted R-squared | 0.134448 | 0.131254 | 0.299991 | 0.648129 | 0.648997 | 0.650694 |
| DW test | 2.075428 | 2.083741 | 1.906017 | 2.483889 | 2.491117 | 2.484315 |

23 The Zivot-Andrews unit root test allows for a single endogenously determined break on the time series that is under scrutiny. See Enders (2004) for the two first tests and Andrews (1992) for the specification of the ZA test.

24 Figures, estimations and main results are available upon request.

25 LN stands for logged series, while the suffix SA denotes series were seasonally adjusted.

Notes: number of observations: 147. Models without fixed effects (not significant). ¹: imports, exports and exports volatility lagged 1 period. *, 5% level of significance; ** for 10%.

A high level of R^2 is not expected, as we do not focus on a forecast to reserves. Therefore, the final level of 0.65 for this statistics is acceptable when the concern is to identify the relationships among variables. Results of the multiple-variable analysis of the demand for reserves are in line with those of the simple correlations and with those in the existing literature²⁶. As foreshadowed by the simple correlations, reserve holdings are positively and significantly related to economic size (GDP), and negatively correlated to exchange rate variations and differential of interest rates. Reserves seem not to be related to the current account vulnerability's indicators in regression I, the same occurring with the indicators for capital account vulnerability (financial openness and the ratio of broad money to GDP), which are also not significantly correlated with reserves.

Regression I is the basic model, when only interest rate differentials and GDP growth are relevant explanatory variables at 5% level of significance. F-statistics indicate that at least one of the explanatory variables is significant to explain the reserves policy. It's noteworthy that volatility of the real/dollar exchange rate has not constituted a significant explanatory variable for the reserves policy at the 5% level in this period. Nevertheless, the negative sign for the parameter indicates an inverse relation between exchange rate and reserves. In this case, Central Bank has accumulated reserves during periods of exchange appreciation and lost reserves during depreciation periods. Even though relevant only at the 10% level, the negative coefficient is consistent with the theoretical prediction, suggesting the exchange rate flexibility may indeed have substituted reserve holdings to control the exchange market.

Aiming to incorporate variables that may have interfered in the reserves pattern and improve the adjustment of the model, we have checked the relevance of additional proxies. We tested the necessity to control the effects of the Asian and Russian crises. Actually, from May, 1998, until June, 2006, reserves had decay more than USD 46 billion. Even though the monetary authority had effectively used such amount not just to keep the fixed exchange rate system but also to counterbalance huge capital flights mainly in 1998 (when reserves had decreased USD 30 billion), the dummy is not statistically significant (regression II). We also conducted omitted variable test, which helps to verify if a set of additional variables makes a significant contribution to explaining the variation in the dependent variable (reserves). Unit root tests show the variable is not stationary. As reserves is characterized also as I(1), we tested the variables in differences. The same conclusion holds, in the sense that it is not possible to reject the null that the additional regressor is not significant²⁷.

As between August and September of 1998 there was a huge punctual decrease of roughly USD 21 billion on reserves, we tested for a pulse dummy at this date. Additionally, another fact is relevant. In April, 1999, Brazilian reserves received USD 10 billion from IMF, halting the long decreasing period that took place since 1998. We've input another pulse variable to control this fact. It is noteworthy that the IMF's funding was vital to recompose the Brazilian external liquidity in that period. We've also tested if the change of exchange regime in 1999 has been significant for the reserves policy in Brazil. The outliers in September, 1998, and in April, 1999 are significant. On the other hand, the introduction of a free floating exchange regime does not seem to have altered the pattern of the accumulation of reserve holdings in Brazil (regression III). After the turbulence of the initial years of the floating regime, an apparent strategy to rebuild foreign reserves seems to have put forward, which rhythm seemed to have been similar to the verified during the administered regime in a first moment. Chow breakpoint test does not reject the null of no structural change in 1999, supporting this result. Omitted variable test also corroborates the results²⁸.

Regression IV in table 4 adds proxies for capital account vulnerability to the explanatory variables employed in regression III (an autoregressive component was required to correct for serial autocorrelation). Variables are added to capture the policy response to changes in the external financial flows and external debt: LNSTEXTDEBTS, logged short term external debt; LNFRPORTINFSA, the

26 See Flood & Marion (2002) and Aizenman & Marion (2002).

27 Figures, estimations and main results are available upon request.

28 Figures, estimations and main results are available upon request.

logged foreign portfolio inflows; and FROTHIVSA, the other investment flows, all seasonally adjusted. Results provide evidence that reserves have been calibrated by foreign capital inflows, agreeing with the precautionary view. Indeed, foreign portfolio inflows have constituted one important source of convertible currency for the Brazilian market after 1995. Short term debt has not been observed, though. This result is also plausible if one considers Brazilian short term external debt has been reduced in this period and is actually in very low levels, roughly at USD 11 billion. Additionally, foreign portfolio and other investment flows are significant added variables, supported by the omitted variables test²⁹. This gives support to the precautionary thesis explaining reserves policy.

Regression V tests the most significant variables and adds the current account flows to capture the policy response to changes in the status of Brazil's current account. Over the period 1995-2002m6, Brazil recorded current account deficits that amounted to almost 187 billion dollars in total. In sharp contrast, however, starting in the second semester of 2002 the current account deficit turned into a surplus and remained in surplus until the last quarter of 2007. Over the period 2002-2007, Brazil accumulated a current account surplus of more than 45 billion dollars. When the current account is in surplus, a central bank is inclined to purchase foreign exchanges to mitigate appreciation pressure on the national currency. Regression V identifies a robust correlation between current account balances and the pattern of Brazilian reserves, but the mercantilist thesis cannot be supported only based on this evidence. Level of imports and exports, the volatility of exports and the grade of trade openness have not been significant in Regression I to III. These findings suggest that Brazilian policymakers are not much concerned about either the magnitude of export receipts or the grade of trade openness of the economy, based on the assumption that the own floating regime will clear transactions while altering the level of the exchange rate. The upward movement of exports following the depreciation of the real after 2002 and recently the end of current account surpluses in the beginning of 2008 shows that external transactions have been done according to a free floating regime.

Certainly, market interventions of the Central Bank had enlarged the cycle in the sense that it avoided a more rapid exchange rate appreciation. However, the mercantilist thesis finds support neither in terms of the variables tested in validating the export driver nor in the claim that Brazil runs an administered floating regime. This is consistent with the notion elaborated in the previous section, as the presence of 'fear of floating' is refuted. In this context, the most plausible interpretation for the large variation in the country's level of reserves is that the Central Bank of Brazil is likely to have intervened in the foreign exchange market to take advantage of a window of opportunity created by Brazil's large current account surplus. At the same time, its interventions have certainly acted to mitigate more pronounced exchange rate volatility, given the huge amount involved in steady interventions especially throughout 2006 and 2007. Instead, they have not prevented real appreciation of the real, *vis-à-vis* the deviations of the exchange rate from its equilibrium does not explain the reserves policy. Different from many Asian countries, Brazil cannot be considered manipulating the exchange rate to maintain international competitiveness.

A proxy to test for financial liberalization (ICC1, logged) is also included. Early hypothesis in this work has been that the gradual process of financial liberalization that took place in Brazil since the 1990s required the Central Bank of Brazil to adopt high level of reserves as the instrument for the external management of the country, in a precautionary basis. As Rodrik (2006) recognizes, 'market intervention' in the form of taxing short-term capital inflows has developed an unsavory reputation that 'market intervention' in the form of buying reserves does not have. So, a link of reserves to financial liberalization seems to be plausible. Even more, chronological order of financial liberalization and then the more relevant accumulation of reserves also helped to sustain this interpretation. However, results are not supportive to this statement. Even though not significant, the coefficient is negative, in the opposite expected direction. In this context, it's more probable that these events are not strongly linked. Even more, as the link of financial openness to reserves is also not robust, the great exchange transactions of Brazil with abroad have not implied *per se* high levels of reserves. Given financial transactions tend to clear themselves in the market, one interpretation for this fact is that the monetary authority does not need to controls capital flows anymore. In this case, reserves are not supposed to be a substitute for previous

29 Figures, estimations and main results are available upon request.

capital controls, being much more related to concerns related to the capital sudden stops or reversals. The free floating exchange rate has been the natural mechanism to clear and manage external transactions, even though this greater instability may impose side effects to the level of activity of the domestic economy.

Regression VI drops the explanatory variables with insignificant estimated coefficients, and the remaining ones were corrected for heteroskedascity on the stochastic disturbances using the White's consistent covariance matrix estimator. All components presented parameters statistically identified at 5% level, and DW statistic indicates no serial correlation on residuals on the model. Classical assumptions related to the stochastic component are all valid in this specification, allowing for more statistically robust results. It's quite intriguing the result governing reserves and interest rates. On the one hand, it's true that the Central Bank of Brazil runs an inflation target system as the core of the economic policy in Brazil since 1999, and high levels of nominal and real interest rates in Brazil have been common and subjected to massive critics among Brazilian economists. On the other hand, the parameter for differentials of interest rates is positive and significant. In fact, differentials on the opportunity cost of holding reserves has decreased in this period³⁰, even though the absolute level of interest rates in Brazil is still one of the highest in terms of international levels. In this context, we cannot discharge that the reduction of the opportunity cost has allowed a greater accumulation of foreign currency in Brazil.

Summing up, regressions shows that the main drivers of the increase in reserves are the rising GDP of the country, current account balances, foreign portfolio and other investments flows and differential of interest rates. The change of exchange regime has not changed the attitude towards reserve holdings. After a period of decay following the financial turmoil in 1999, the monetary authority restarted to accumulate reserves in an attempt to mitigate the external exposure of the nation. The change has come to exist much later, by changing international reserves in tandem with a window of opportunity related to the current account surpluses. As discussed above, it seems that the Central Bank is playing a much more passive role in the external front. Even though current and capital account surpluses have been in fact the determinants to increase international reserves allowing excess of foreign exchange liquidity on the Brazilian market, the Central Bank of Brazil's market intervention on the demand side does not seem to have been used to sustain the country's international competitiveness. While this process of accumulating reserve holdings may have decreased the perceived vulnerability of the country to external shocks, culminating in the upgrade of the government bonds to investment grade in May of 2008, the mercantilist thesis does not exhibit any sign of playing a more determinant role on the reserves policy. *De facto*, monetary authority's market interventions do not seem to have imposed enough incentives to alter the current external flows and preserve or expand export competitiveness.

Concluding remarks

The paper has investigated the rationale behind the monetary authority's exchange market interventions and the parallel accumulation of foreign reserves in Brazil. Different from the majority of East Asian and Latin American countries, data reviewed in section 3 is consistent with the interpretation that the exchange fluctuations in Brazil have not constituted a priority concern to the Brazilian authorities. This finding is similar to Souza & Hoff's work (2003). Indeed, prolonged real appreciation of the domestic currency does not seem to explain the market interventions by the monetary authorities, *vis-à-vis* it helps to sustain inflation close to targets, the real institutional mission of the Central Bank of Brazil. As monetary authorities' market interventions do not seem to be related to 'fear of floating' concerns, this finding is in contrast with the mercantilist view that Brazil manages its foreign exchange rate.

The main finding is that the monetary authority interventions in the foreign exchange market and the parallel policy of reserve holdings cannot be supported by the mercantilist thesis. Variables correlated to that perspective have not been statistically significant to explain the Central Bank of Brazil's market interventions (section 4). Besides, our investigation shows that exchange market interventions and reserve holdings have not been used to sustain either an unofficial exchange target regime or the country's exports competitiveness (section 4). Brazil seems to have run a genuine free floating regime since 1999 (section 3). The introduction of the effective free floating exchange regime in 1999 does not seem to be

30 Figures, estimations and main results are available upon request.

relevant in explaining the actual Brazilian external policy. Our results also suggest that the reserves policy has not changed with the introduction of the *de facto* free floating exchange regime in 1999, as theoretically expected. After a period of decay following the financial turmoil in 1999, the monetary authority restarted to accumulate reserves in an attempt to mitigate the external exposure of the nation. This change happened much later in 2005, when a window of opportunity created conditions to increase the level of reserves.

Government policy regarding the level of the exchange rate and reserve holdings in Brazil cannot be linked to an active export-led growth policy. International competitiveness does not appear to have been particularly significant in explaining the rationale of the Brazilian external policy. Even though current and capital account surpluses have provided the excess of liquidity to increase international reserves, the Central Bank of Brazil's market intervention on the demand side does not seem to have been used to sustain the country's international competitiveness. While this process of accumulating reserve holdings may have decreased the perceived vulnerability of the country to external shocks, culminating in the upgrade of the government bonds to investment grade in May 2008, the mercantilist thesis does not constitute a robust determinant for the monetary authority's external policy. Even though the current account balance has been significant to explain reserves holdings, the monetary authority's market interventions do not appear to have imposed enough incentives to alter the current external flows and preserve or expand export competitiveness. The work of Araujo & De Negri (2007) completely corroborates with this conclusion.

Additionally, financial integration does not seem to have demanded higher levels of reserves, while financial deregulation does not explain the building of reserves in Brazil. Here it appears that the higher turnover of the exchange market has been sufficient to clear the transactions, without providing additional levels of reserves. This means the actual higher levels of reserves cannot be explained due to the higher turnover in the foreign exchange market. At the same time, the gradual financial liberalization process in Brazil has not been significantly connected to the reserves policy. In this case, early hypothesis that the Central Bank of Brazil counts with additional levels of foreign reserves, to compensate the shortage of mechanisms to control unbalanced external financial flows, does not hold. Despite difficulty in identifying a strong correlation between these variables, it seems plausible to suggest that international reserves should have the ability to mitigate the probability of output collapses (which are induced by sudden stops or capital flights during a financial turmoil). Actually they replace capital controls that would be useful to curb large capital unbalances and reduce the probability of financial crises.

Our regressions suggest that the imports rule has not lately governed the market interventions policy. The current legal rule addressing reserves to be pegged to the imports level does not explain the actual pattern of reserve holdings. In this case, imports level may matter today less than would be thought in a scenario of excess of liquidity. As the level of reserves has been much higher than the level the legal rule prescribes, other concerns, relative, e.g., to capital flights or sudden stops, may matter more. The imports rule aside, the precautionary thesis is still liable to explain reserve holdings in Brazil, even though not related to the current account transactions. Indeed, while current account surpluses had provided part of the proceeds to the enlargement of reserves, reserves have not influenced them, in the Granger sense. At the same time, since the monetary authority's interventions have not been linked to the current account balance, this evidence is also a claim against the mercantilist approach. As Brazil runs a genuine free floating regime, the exchange rate mechanism appears to be the main determinant to explain the current account results. Alternatively, the rationale for market interventions and reserve holdings seems actually to be linked to the level of foreign financial inflows, in a precautionary basis. The actual context of deregulated and volatile capitals that may move abroad quickly may require the Central Bank of Brazil's interventions to reduce the instability in the exchange market during a financial turmoil. As large foreign capital inflows had also constituted one of the main sources for reserve holdings in Brazil, it seems sensible that the monetary authority may hold reserves in tandem with the volume of these unstable flows. Macroeconomic stability involves taming unbalanced capital flows in the exchange market, if necessary. Capital can suddenly flow out, as it did during the Asian crisis a decade ago and in Vietnam this year³¹. That's the precautionary basis for the Brazilian reserve holdings. For such, developments in

31 See 'Capital inflows to China: hot and bothered'. Section Finance and Economics. The Economist magazine, June 28th 2008. p.95/6.

the external policy should be seen against the background of a general enlargement of the balance of payments providing an excess of liquidity in the period under review, especially after 2003, mainly related to the exogenous (and inherently unstable) dynamism of capital flows.

Yet, a precautionary based reserves policy involves welfare concerns. This differs from the mercantilist approach, which views the level of international reserves as residual, and is not concerned with associated fiscal costs. Instead, the precautionary demand view attempts to identify of an 'optimal' stock of international reserves, as interest rates have been significant for determining reserve holdings. In this case, we cannot discount the claim that the reduction of the opportunity cost has allowed greater accumulation of foreign currency in Brazil. If differentials of interest rate were higher than actually verified, reserves would have been kept in lower levels. Nevertheless, even though the opportunity costs of holding reserves have decreased in this period, absolute levels of interest rates in Brazil are still one of the highest in international terms. This means that Brazil still runs high associated fiscal costs. The question that follows is this, are the associated costs higher or lower than the expected benefits derived from this policy? Identifying the effects and examining the costs and benefits of holding large sums of foreign reserves remains a task for future research.

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