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Exchange-rate management in Brazil

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This paper examines four hypotheses: (i) in Brazil, as in other peripheral countries in the post-crisis context, a policy choice appears to have been made for a flexible exchange rate within a currency band ("dirty float"); (ii) the underlying reasons for this policy appear to have more to do with pass-through of exchange-rate variations and precautionary demand for reserves than with the maintenance of a competitive real exchange rate; (iii) in the country's peculiar situation, considerable capital mobility is conjoined with large and liquid financial derivatives markets and a reserves build-up policy that carries a high fiscal cost; (iv) until April 2006, reserves accumulated in much the same way under the floating exchange-rate system as they had under the currency band regime; there have been changes since then owing to the rapid growth of reserves.

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I
Introduction

In 1999, in line with the dominant trend among leading emerging economies, the Brazilian authorities adopted a floating exchange-rate system. The managed exchange-rate policies (fixed rate or bands) that were the rule in these economies in the 1990s had the virtue of ensuring the stability of the nominal exchange rate (one of the key prices in capitalist economies), but proved extremely vulnerable to real currency appreciation and speculative attacks, culminating in a series of currency crises in the second half of the decade. After these crises, the policies mentioned gave way to floating exchange-rate systems. Although this system was adopted officially in most emerging countries, in practice the respective monetary authorities sought to check exchange-rate movements by intervening actively in the currency markets. In other words, the predominant exchange-rate regime in the period since the crisis has actually been a dirty float with different degrees of intervention, in which a central bank presence has been the rule and not the exception. Systematic currency market intervention —"fear of floating", as Calvo and Reinhart (2000) put it— appears to be the result of "defensive strategies" in an international financial environment characterized by alternately rising and falling capital flows. They include: (i) reducing external vulnerability by building up excess official reserves, or "precautionary demand" (Flood and Marion, 2002; Jeanne and Rancière, 2006), and (ii) adopting export-based growth policies (Dooley, Folkerts-Landau and Garber, 2005; Aizenman and Lee, 2005; Soto and García, 2006).

The dirty float system relieved the acute external vulnerability of the Brazilian economy, which had resulted in a current-account deficit of about 4% of gross domestic product (GDP) during the fixed or managed exchange-rate period (1995-1998), with a consequent US$ 180 billion expansion of external liabilities. Between 2003 and mid-2007, when the international financial crisis originating in the United States subprime mortgage market broke out, this regime was implemented in an exceptionally favourable international context. Rising commodity prices and a high level of international financial liquidity ensured a continuing balance-of-payments adjustment despite the tendency for the real to appreciate.

What will be examined here is the way the floating exchange-rate system was managed in Brazil between 1999 and 2007, with emphasis on the period of abundant capital flows into peripheral countries (from 2003 until mid-2007). Four hypotheses will be examined: (i) as in other peripheral countries in the post-crisis context, Brazil appears to have opted for a dirty float policy; (ii) the underlying reasons for this policy appear to have more to do with pass-through of exchange-rate variations to domestic prices and precautionary demand for reserves than with the other factors that would justify "fear of floating", such as the desire to maintain a competitive real exchange rate; (iii) the Brazilian experience is characterized not only by a combination of considerable capital mobility and large and liquid financial derivatives markets, but also by a lack of transparency regarding the goals and targets of exchange-rate policy and the high fiscal cost of the reserves build-up policy; (iv) until April 2006, reserves continued to accumulate under the floating exchange-rate system much as they had under the currency band regime; there have been changes since then owing to the rapid growth of reserves.

This study is divided into four sections. Following this Introduction, section II presents the institutional format and determinants of the Brazilian floating exchange-rate system and calculates the indicators of the country's "fear of floating". Section III analyses the way this regime was managed in the 2003-2007 period and section IV conducts an econometric exercise designed to bring out the factors determining changes in currency reserves and their accumulation pattern under the managed and flexible exchange-rate systems. Lastly, some final considerations are presented in section V.

II

The floating exchange-rate system in Brazil

The floating exchange-rate system was introduced by the Central Bank of Brazil in January 1999 after speculative attacks had greatly depleted reserves during the preceding months, leading the authorities to seek financial assistance from the International Monetary Fund (IMF). Under the Brazilian institutional model, it is the Central Bank that determines the exchange-rate regime, its targets and its management (i.e., exchange-rate policy).[1] However, international reserves belong to the Union.[2] They are administered by the Central Bank, and the accounting results associated with management of the currency are converted every six months into Union revenue or expenditure items.

The new exchange-rate system preceded the inflation targeting regime established in June 1999. Despite its precedence in time, it seems that in the institutional context of the economic policy framework in place since 1999 (whose pillars also include primary surplus targets), the floating exchange-rate system ranks well below the inflation targeting regime, which was established by presidential decree and whose goals and indicators are the responsibility of the National Monetary Council (CMN). This hypothesis is supported by the scarcity of official documents referring to the floating exchange-rate system and its management and the fact that none of them (including Notification no. 6,565, which instituted the floating exchange-rate system) lay down the general macroeconomic objectives of this regime.[3] Although the notification does establish the aim of exchange-rate policy (mitigating short-term exchange-rate volatility), it does not spell out the underlying macroeconomic objective. As Moreno (2005) points out, this aim may be subordinated to different objectives that are not mutually exclusive, such as controlling inflation, supporting external competitiveness and maintaining financial stability.

By reviewing the proceedings of the Central Bank of Brazil Monetary Policy Committee (COPOM) and the inflation reports, it is possible to form some hypotheses about these objectives.[4] References to the effects of the exchange rate on domestic price indices in some of these documents (which form part of the inflation targeting system) reveal that, besides the preservation of financial stability, management of the floating exchange-rate system in Brazil also has the (sometimes unacknowledged) aim of controlling inflation. The lack of disclosure about the objectives of this system appears to be due not to any explicit strategy to enhance its effectiveness (given that Central Bank interventions in the currency market are fully disclosed) or to accountability standards being lower than for monetary policy, but rather to its subordination to that policy.[5] This being so, one theory might be that the macroeconomic goals of the floating exchange-rate system are implicit and largely coincide with those of the inflation targeting regime, namely price stability and financial system stability. These goals have not been constant over time, however, but have varied with a more general factor influencing the management of this regime, namely the phase in the international liquidity cycle, as detailed below.

The obvious hierarchical relationship between the monetary system (dominant) and the exchange-rate system (subordinate) in the institutional framework of economic policy is not peculiar to Brazil. On the contrary, whether because exchange-rate movements are particularly liable to feed through to inflation in emerging economies, or because of their greater vulnerability to the recent instability of capital flows, a number of countries that have paired a floating exchange rate with inflation targeting have included inflation control and financial system stability among the macroeconomic objectives of the exchange-rate system. This hierarchy reflects the vital role of

[1] Emerging countries have different models for regulating currency markets. Central banks are not necessarily responsible for running exchange-rate policy and managing reserves (Moser-Boehm, 2005).

[2] In accordance with Article 21 of the 1988 Federal Constitution of the Federal Republic of Brazil.

[3] The Central Bank of Brazil website (www.bcb.gov.br) has no section dealing with the exchange-rate system or exchange-rate policy, whereas there is a huge section on the inflation targeting system. The only explicit reference to exchange-rate policy is in the annual reports of the Bank.

[4] COPOM sets the base interest rate in Brazil.

[5] In general, as Moser-Boehm (2005) points out, governance aspects seem to be less explicit for foreign-exchange intervention than for monetary policy decisions.

exchange-rate movements in the virtuous functioning of inflation targeting regimes in these countries, and not their irrelevance (Grenville, 2000; Mohanty and Scatigna, 2005).

The main peculiarity of this pairing in Brazil is the fact that these goals are not made explicit, even though the Central Bank is the institution responsible for managing both systems, a factor that minimizes the likelihood of the kind of policy coordination problems seen in certain countries where exchange-rate policy is conducted by the government. In economies that thus combine a floating exchange rate with inflation targeting, for example, it is explicitly recognized that stabilizing inflation requires exchange-rate management to take account of a high level of trade exposure and pass-through (Ho and McCauley, 2003).

Where the legal situation is concerned, Notification 6,565 stipulates that official interventions in the currency market should be occasional, suggesting that the exchange rate will be allowed to fluctuate in a way that approximates to a "clean float". In the situation that followed the crisis of the 1990s, however, what seems to have predominated in Brazil, as in other peripheral countries, was a "dirty float" exchange-rate policy. Furthermore, the goals and targets of this policy did not remain constant following its adoption and it was not confined to interventions in the spot currency market, but involved a broader array of instruments. Before analysing the different dimensions of the dirty float policy, it is important to answer two related questions: (i) is there "fear of floating" in Brazil? (ii) what were the factors that shaped this policy?

A preliminary response to the first question can be sought in the indicators of relative volatility developed by Hausmann, Panizza and Stein (2000) to detect the existence (or otherwise) of "fear of floating" in emerging countries that have adopted floating exchange-rate systems. These indicators are an attempt to solve, at least in part, the problems raised by the indicators of absolute volatility (in international reserves, interest rates and exchange rates) presented in Calvo and Reinhart (2000)—measured by the frequency with which monthly fluctuations in the variables remain within predetermined ranges throughout the period considered.[6]

Hausmann, Panizza and Stein (2000) use indicators to assess relative volatility between exchange and interest rates and between exchange rates and reserves, using the standard deviation as a measure of volatility for these rates and, in the case of reserves (measured in monetary units), taking the standard deviation divided by the mean of the M2 aggregate (to avoid distortions due to different units). These indicators have the merit of taking account of the level differentials of the variables (in accordance with the use of these volatility measures) and of showing how the monetary authorities have reacted (through higher interest rates or currency market intervention) relative to the scale of the shock experienced.

Souza (2005) and Souza and Hoff (2006) calculated similar indicators for Brazil from January 1999 to December 2005 and concluded that, taking the mean of those seven years, there was no fear of floating in Brazil. The results obtained by those authors indicate very similar values in the indicators of Brazil and the United States (0.26 and 0.23 in the case of the exchange-rate/reserves indicator and 1.39 and 1.33 in the case of the exchange-rate/interest-rate indicator) and suggest that the exchange-rate system in operation is close to a genuine float (the indicators for Asian countries are much lower and indicate that interest rates and reserves are being used to stabilize the exchange rate). Updating this calculation to June 2007 (see table 1) yields a practically identical result for the exchange-rate/reserves indicator (0.25), which bears out the true float hypothesis, and a lower result in the case of the exchange-rate/interest-rate indicator (1.13), which would indicate a greater willingness to

TABLE 1

Brazil: "fear of floating" indicators, 1999-2007

	Relative volatility	
	Exchange/ interest	Exchange/ reserves
January 1999-December 2005	1.39	0.26
January 1999-June 2007	1.13	0.25
January 1999-December 2002	1.34	0.42
January 2003-June 2007	0.73	0.17

Source: prepared by the authors on the basis of data from the Central Bank of Brazil.

[6] There are three main problems with these indicators: (i) the interest-rate volatility indicator tends to overestimate variations in countries with higher average interest rates, a description that fits most emerging countries; (ii) not all interest-rate changes reflect attempts to stabilize the exchange rate; (iii) exchange-rate volatility may be the result of powerful external shocks affecting the country.

use interest rates to stabilize the exchange rate over this longer period (January 1999-June 2007).

Analysing the behaviour of relative volatility indicators over the whole period (January 1999-December 2005 or January 1999-June 2007) does not seem the best approach, as it masks importance differences in their trajectory following the adoption of the floating exchange-rate system. These differences are largely associated with the behaviour of capital flows to emerging countries, and thus to Brazil. As figure 1 shows, it is possible to identify two distinct phases in this cycle from 1999 onward, each with its own challenges and room for manoeuvre in exchange-rate policy.

The first period, which began in January 1999 and ended in December 2002, was the "down" phase in the liquidity cycle of the 1990s. During those four years, the rise in risk aversion among global investors after the Asian and Russian crises led to a sharp retrenchment in flows of external financial capital to emerging countries (portfolio investment and other capital flows, including bank lending in its various forms). Total flows did not turn negative thanks to the relatively favourable performance of foreign direct investment.

The second phase lasted from 2003 to mid-2007, with an upturn in the liquidity cycle beginning in the former year. The level of liquidity in the latter year was unprecedented. As in other cyclical booms preceding busts, the first half of 2007 was characterized by excessive euphoria that resulted in an extraordinary level of absorption of external resources by emerging economies, easily offsetting the lacklustre performance of the second half of the year after the outbreak of the United States subprime mortgage crisis. Net flows, which include direct and portfolio investment and bank lending, totalled US$ 617.7 billion.[7]

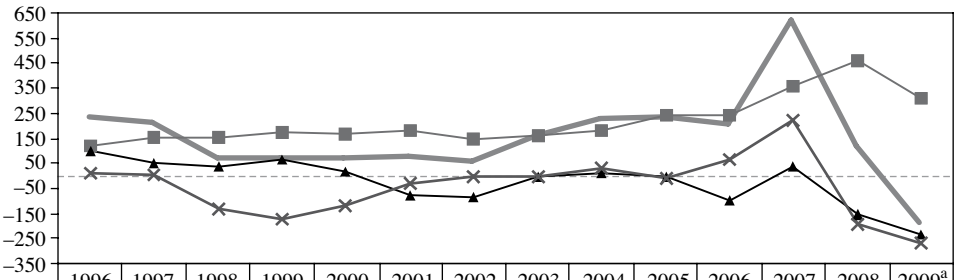
Calculating relative volatility indicators for these two periods reveals the differences of behaviour in the "pessimistic" and "optimistic" phases of the international liquidity cycle. In the period from January 1999 to December 2002, both indicators (exchange rate/interest rate and exchange rate/reserves) reached high values (1.34 and 0.42, respectively) relative to the whole period, and particularly the second period (January 2003-June 2007). Conversely, the results for this period (0.73 and 0.17, respectively) are lower than the period total and than those of the first period.

Although the indicators calculated by Hausmann, Panizza and Stein (2000) for the two subperiods (January 1999-December 2002 and January 2003-June 2007) captured major differences in relative

7 See Biancareli (2009), World Bank (2009), Lane (2008) and Reinhart and Reinhart (2008) on the subject of international liquidity cycles in emerging countries.

FIGURE 1

Net capital flows into emerging countries
(Billions of dollars)



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009[a]
Total flows	226.57	207.49	61.59	67.64	63.68	73.50	53.93	154.19	221.92	226.86	202.89	617.73	109.49	–190.21
Direct investment	116.53	151.06	156.63	171.91	164.00	180.47	144.44	161.35	183.94	243.69	241.37	359.03	459.28	312.77
Portfolio investment	96.69	50.30	39.81	67.03	17.24	–76.90	–86.43	–3.83	10.00	–5.57	–100.71	39.47	–155.20	–234.51
Other capital flows	13.39	6.14	–134.85	–171.30	–117.56	–30.08	–4.08	–3.33	27.97	–11.26	–62.23	219.23	–194.59	–268.47

Source: International Monetary Fund, World Economic Outlook Database, April 2009.

[a] Forecast.

volatility between the external financing bust and boom phases, they are clearly insufficient to characterize the floating exchange-rate system in Brazil and explain the specificities of its operation in these two phases. According to these indicators, Brazil had less "fear of floating" in the pessimistic phase than in the optimistic one, which does not seem to make sense, given not only the strong pass-through effect but also the increased external vulnerability of the economy and the greater currency mismatch for the private sector in the first phase.[8] The lower relative volatility in the second phase does not reflect a greater "fear of floating" but rather the positive effects of the favourable external context on the volatility of the exchange rate and the other financial variables (interest and reserves). The resumption of currency purchasing by the Central Bank of Brazil in the spot currency market from late 2004, made possible precisely by this context, also seems to have helped reduce this volatility (see section III). While these indicators were higher than those used by Calvo and Reinhart (2000), they also have some limitations: reserve purchases may have been a precautionary demand strategy and thus not aimed at influencing the level or volatility of the exchange rate, besides which the monetary authorities have other exchange-rate and even economic policy instruments (including capital controls) available to them to meet their exchange-rate targets.

This means that, if analysed in isolation without considering the external and internal (structural and macroeconomic) factors influencing the management of the floating exchange-rate system, these indicators can lead to faulty conclusions. The phase of the international liquidity cycle influences the management of the floating exchange-rate system in emerging economies generally and Brazil in particular, owing to its high degree of financial openness. While this cycle is the main external factor influencing management of the system, the degree of financial openness can be regarded as the main structural internal factor.

The financial opening of the Brazilian economy began in the late 1980s and was extended over the course of the 1990s. The institutional changes made in that period led to significant liberalization of foreign portfolio investment in the domestic financial market and the international capital market. Thus, when the floating exchange-rate system came into effect, on 16 January 1999, financial opening in the Brazilian economy was already quite well advanced. A decisive measure that opened it up considerably more was adopted a year later, on 26 January 2000. Resolution 2,689 deregulated applications by foreign investors in share and fixed-income security markets and gave them unrestricted access to the local financial derivatives market, where they had hitherto been limited to operations to cover their positions in spot markets. Although the Brazilian financial derivatives market was already more highly developed than most emerging countries' by the late 1990s, foreign investors' freedom of action in the Mercantile & Futures Exchange (BM&F) would greatly increase its liquidity and depth and have considerable repercussions on the management of exchange-rate policy that would only be felt in the phase of optimism, particularly after 2004 (see section III).

This high degree of financial openness, and global investors' access to the organized financial derivatives market in particular, intensified the effects of booms and busts in capital flows on the country's key prices, particularly the exchange rate (which became the main mechanism for transmitting capital flow volatility to financial markets and the real economy), but also reinforced the interaction between exchange-rate, monetary and fiscal policies (inevitable in economies that embraced financial globalization) and reduced their respective room for manoeuvre. In this context, management of the floating exchange-rate system (and also of the inflation targeting policy) was largely subordinated to the wealth allocation decisions of global investors. However, the interaction between external factors (international liquidity cycle) and structural internal ones (degree of financial openness) had different repercussions for system management in the "pessimistic" and "optimistic" phases of the cycle. There were different challenges and degrees of freedom for exchange-rate policy depending, to a large extent, on the balance-of-payments situation and external vulnerability of the Brazilian economy —these being arguably the most decisive domestic macroeconomic variables affecting it.

The further opening of the Brazilian economy in 2000, when Arminio Fraga Neto was President of the Central Bank of Brazil, did not have concrete effects during the early stages of the floating exchange-rate system (January 1999 to December 2002), when the country was affected by external currency constraints and the consequent structural scarcity of sellers and

[8] Studies such as those of Hakura and Choudhri (2001) and Mohanty and Scatigna (2005) have suggested that Brazil and Turkey are among the countries with the highest levels of currency pass-through.

excess of buyers in the Brazilian currency market. In this context, foreign investors scaled back their positions in Brazilian assets, and the BM&F was no exception. The volumes traded on that exchange increased in 1999, once the upheaval caused by the alteration in the exchange-rate regime had passed, and in 2000, only to fall back again following the speculative attack in 2001 (see table 2). A decisive contribution to the "evaporation" of liquidity in this market in a context of excess dollar demand (whether for risk cover or for speculation) was the ban on the Central Bank operating with currency derivatives that was imposed under the agreement with the International Monetary Fund (IMF) in March 1999 (and retained in the 2001 agreement). In consequence, the effects of the mismatch between foreign currency supply (weak flows) and demand (flows and stocks) have fallen mainly on the spot foreign-exchange market and on public securities indexed to the exchange rate.

TABLE 2

Volumes traded on the Mercantile & Futures Exchange, by asset type
(Dollars)

Year	Currency	Interest-rate
1999	12 166 257	25 292 621
2000	12 164 002	25 290 221
2001	21 612 354	43 835 697
2002	17 349 055	71 186 758
2003	19 320 993	83 553 886
2004	27 421 447	139 066 000
2005	41 810 287	146 655 688
2006	59 824 092	174 569 023
2007	115 883 665	263 434 704

Source: summary of Mercantile & Futures Exchange (BM&F) data.

During this period, the monetary authority's room for manoeuvre in pursuing its main goals was severely limited by three factors: (i) its inability to operate in the currency derivatives market, (ii) the limited volume of international reserves available for interventions in the spot currency market (less than the assets available to the Central Bank of Brazil because of the limits imposed by the agreement with the IMF) and (iii) the now very large build-up of public securities indexed to the exchange rate.

In their efforts to meet the goals of the floating exchange-rate system in the pessimistic phase, the Central Bank authorities did not confine themselves to intervening in the spot currency market but used other exchange-rate policy instruments, such as issuing securities indexed to the exchange rate and currency swaps, which are equivalent to selling dollars forward and buying contracts for Interfinancial Deposits (DI), securities that yield the Brazilian short-term interest rate. In 1999 particularly, the monetary authority also adopted regulatory measures to stimulate the supply of currency in the foreign-exchange market and, most importantly, to restrain demand.

III

The floating exchange-rate system in the optimistic phase

The combination of financial openness and deep derivatives markets proved a "double-edged sword" when it came to managing the floating exchange-rate system in Brazil, with each "edge" manifesting itself at different phases in the international liquidity cycle. As summarized earlier, during the phase of pessimism and scarce external resources, this combination intensified the effectiveness of speculative attacks against the Brazilian currency and reduced the scope for exchange-rate management to restrain pressure for devaluation. In the optimistic phase, which began in 2003 and lasted until mid-2007 (when the subprime mortgage crisis broke out in the United States), with capital flows returning and external trade and flows showing positive results (owing to the depreciation in the earlier period, but also to the international trade cycle), the adoption of an over-tight monetary policy resulted in an uninterrupted trend towards appreciation, which was mainly responsible for the effectiveness of the inflation targeting policy.

Although kept subordinate to inflation targeting, exchange-rate management was given greater latitude by

the benign external environment, and this contributed decisively to the favourable evolution of the balance of payments (with the current account in surplus from 2003 and the financial account after 2005). It is possible to identify two distinct periods of exchange-rate management in this phase of optimism, the first running from January 2003 to November 2004 and the second from December 2004 to mid-2007. The Central Bank barely intervened in the spot currency market in the first period. This was as might have been expected from January 2003 to July 2004, when the exchange rate remained stable following the early months spent correcting the excessive interventionism of exchange-rate policy in 2002. Even after July 2004, when the currency began its long appreciation, the authority was only intermittently active in the market, given the implicit objective of using this process to achieve its inflation targets. In that period, the main strategy of exchange-rate policy was the aggressive redemption of currency bonds, which continued into the following period.

The second period (December 2004 to June 2007) was characterized by the return of the Central Bank as a buyer in the two segments of the currency market, spot and forward. Intervention in the spot market was temporarily suspended between March and September 2005, even though the real continued to appreciate. From October 2005, the Central Bank maintained a constant presence in this market with the explicit goal of accumulating international reserves without imposing a trend or floor on currency fluctuations or heightening volatility in the market (BCB, 2007). Given the restrictive monetary policy of the period, the authority consistently adopted a strategy of sterilized intervention, i.e., it set out to neutralize the monetary impact of its currency purchases by selling public securities on the open market.

The policy of accumulating international reserves, adopted in late 2004 to strengthen the country's external position directly (by creating a "cushion" of foreign-currency liquidity) and indirectly (by positively influencing external ratings) came up against two major limitations: the large build-up of mainly short-term securitized public debt indexed to the policy rate (the Special System of Clearance and Custody or SELIC rate) and the large differential between domestic and external interest rates, which made these reserves extremely costly to maintain (in absolute terms and by comparison with other emerging countries). A rough calculation of this cost in June 2007, when reserves reached US$ 147 billion and there was a 7.08% differential between the SELIC rate and the yield on 10-year Treasury notes (the favoured destination for these reserves), puts it at US$ 10.5 billion a year.[9] If account is taken of exchange-rate movements from late 2004, when the reserves build-up policy was renewed, this cost was even higher, as the dollar depreciated against the real over the period.

This same interest-rate differential, in the context of a sharp reduction in country risk, stimulated short-term capital inflows in pursuit of profits from arbitrage or speculation and played a decisive role in the appreciation of the currency after September 2004. In other words, a high policy rate in the Brazilian economy has two simultaneous and contradictory effects: on the one hand, it stimulates the build-up of the country's short-term external liabilities (in the form of fixed-income portfolio investments and short-term debt), while on the other, it increases the cost of maintaining the foreign-currency reserves that are the "cushion" needed to cope with the potential for this liability to go into reverse. It is no coincidence that the financial account recorded a surplus of US$ 87 billion in 2007.

Certain factors contributed decisively to the boom in capital flows in 2007, even as the policy of policy rate cuts continued. First, the expectation of achieving an "investment grade" rating (which was only awarded in late April 2008) stimulated foreign portfolio investment. Second, in January 2007 the Central Bank slowed down the pace of cuts in the policy rate (from 0.5% to 0.25%) and country risk continued to diminish in the international market, ensuring a continuing large gap between the SELIC rate and the so-called "arbitrage-neutral SELIC" rate (see figure 2), which is the sum of country risk and the lowest-risk interest rate (the federal funds rate, which is the United States Federal Reserve policy rate) and represents the cost of Brazilian borrowing abroad. This encouraged investors to arrange short-term credit lines to carry out arbitrage operations in the local financial market.

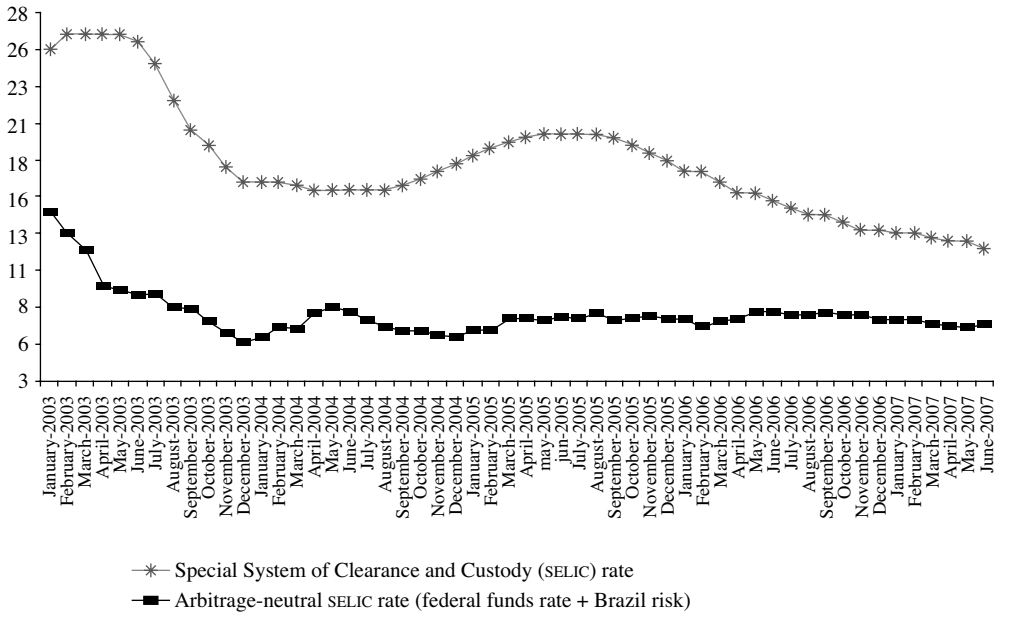
These same factors led foreign investors to maintain or even extend their positions in the Brazilian financial derivatives market. Derivatives linked to the exchange rate of the real, traded locally (BM&F) and in the over-the-counter market, played a decisive role in

[9] Working independently, McCulley and Tolouil (2007) used a similar methodology and reached a result equivalent to the one presented in this paper.

FIGURE 2

SELIC and arbitrage-neutral SELIC rates

(Percentages)



Source: Central Bank of Brazil and Federal Reserve System.

currency appreciation from 2004.[10] The positions of these investors were largely in short selling contracts that turned a profit when the real appreciated. Thus, in the optimistic phase of the international liquidity cycle alone, the combination of a floating exchange rate and foreign investors' unrestricted access to the BM&F led to an increase in the liquidity and depth of this market and, consequently, in opportunities for arbitrage and speculation with the exchange rate of the real. Against a background of declining country and exchange-rate risk, foreign investors' operations in the spot and forward currency markets heightened the appreciation of the real over 2007. This tendency, in turn, further increased the profitability of these operations and encouraged more of them, creating self-fulfilling prophesies. With the currency supply thus expanding, the Central Bank of Brazil stepped up its interventions in the spot currency market, lifting Brazilian international reserves to unprecedented levels. Despite this large-scale official intervention, however, the real continued to appreciate steadily (in nominal and real terms).

The continued appreciation of the real notwithstanding the currency purchases by the Brazilian monetary authority was due, in part, to the strategy of intervening in the spot currency market.[11] In the up phase of the international liquidity cycle, the goal of Central Bank buying in the currency market was to reconstitute a foreign-currency liquidity "cushion" and reduce exchange-rate volatility, while trying not to influence the appreciating trend of the real (which proved essential to the effectiveness of the targeting policy). In this context, the level of the exchange rate was not a target of exchange-rate management. The Brazilian authority only intervened in certain circumstances to reduce the pace of appreciation of the real, adopting a strategy of "leaning against the wind" since sudden changes in the level of the currency can increase uncertainty, stimulate speculative movements and exacerbate exchange-rate volatility.[12] In accordance with its general macroeconomic goals and their respective targets, the Central Bank pursued

[10] The financial derivative mechanism employed in this over-the-counter market is the non-deliverable forward (NDF).

[11] As in most of these countries (Archer, 2005), the bulk of trading is done by electronic auction (Mercantile & Futures Exchange clearing system, introduced in 2006) or by telephone via Central Bank of Brazil dealers in the interbank market.

12 Regarding this strategy, see Mihalijek (2005).

a strategy, announced in advance to its dealers, of acting at day's end before the market closed to "mop up" dollars at prevailing prices, without seeking to influence market quotations. As Archer (2005) points out, this is precisely the strategy recommended when the monetary authority is not setting out to influence the exchange rate.

However, while the real might have appreciated much less dramatically if the Central Bank of Brazil had adopted another intervention strategy in the spot currency market, it would have appreciated nonetheless. It can plausibly be argued that a change in this strategy would only have slowed the pace of exchange-rate appreciation, but would not have been sufficient to halt it given the extent of the economy's financial openness. In this context, contrary to what the conventional theoretical approach assumes, emerging countries, vulnerable as they are to sudden surges or stops in capital movements, are actually faced with an "impossible duality" (Flassbeck, 2001): adoption of a floating exchange-rate regime does not guarantee automatic adjustment of the balance of payments and monetary policy independence; on the contrary, it strengthens the relationship between the policy rate and the nominal exchange rate and the influence of global investors' portfolio decisions on these key prices. This relationship manifested itself in different ways depending on the phase in the international liquidity cycle.[13] In the period of abundant liquidity (see figure 2), it was interest-rate movements that came to shape the trajectory of the exchange rate. Furthermore, the inability of the Central Bank to control the policy rate and nominal exchange rate simultaneously in a context of freely mobile capital was taken to an extreme by two specific factors: the high fiscal cost of sterilization operations and the existence of large and liquid financial derivatives markets.

A brief international comparison will illustrate the relative size of this market and the amount of (mainly foreign investors') money riding on the appreciation of the real. Not only is the BM&F one of the world's leading derivatives exchanges – specifically, it ranked eighth in the two-month period January-February 2007 – and the second-largest emerging-market exchange (only the South Korean exchange, where share index options predominate, is larger), but the number of contracts traded there experienced the fastest growth of any of them between the first two months of 2006 and the first two months of 2007.[14]

Thus, the most singular feature of the Brazilian currency market is the size, liquidity and depth of its forward segment, characteristics that are inseparable from the unrestricted access of foreign investors to this segment, which strengthened the channels of transmission between the latter's investment decisions, the interest rate and the nominal exchange rate and made arbitrage between offshore and onshore currency derivatives trades a viable proposition. This characteristic of the Brazilian currency market also shaped the management of exchange-rate policy. From February 2005, the Central Bank decided to offer currency derivatives, known as reverse swaps (which are exactly the opposite of the swaps made available during periods of depreciation in the real). With its reverse swap operations, the monetary authority positioned itself at the opposite extreme from foreign investors in BM&F currency trades, taking dollar purchase positions with a view to easing downward pressure on the dollar (i.e., appreciation of the real) in the future. As with interventions in the spot currency market, the provision of reverse swaps only slowed the pace of appreciation in the real, preventing the forward dollar price (and thence the spot price) from plummeting.

Given the context of extensive capital mobility and the existence of large and liquid financial derivatives markets, the Brazilian monetary authority would be unable to determine both the interest rate and the exchange rate of the real simultaneously. By opting for a tight monetary policy to ensure the effectiveness of the inflation targeting policy, the authority abandoned any kind of target for the nominal exchange rate, which became the determined variable in the system and, at the same time, the key to this effectiveness. In this period of plentiful external liquidity and an appreciating real, the high level of pass-through

[13] Conversely, as Mohanty and Scatigna (2005) point out, economies that maintain some degree of control over capital flows are able to insulate their monetary and exchange-rate policies from the effects of these cycles, at least in part.

[14] See Johnson (2007). In the first two months of 2007, real-related currency derivatives negotiated on the Mercantile & Futures Exchange occupied an unprecedented position in terms of the number of contracts traded in organized currency derivatives markets: "BM&F's U.S. Dollar contract led the sector for the second year in a row with a 51.4% increase to 10.97 million contracts. It was follow by CME's Euro FX contract which rose 22% to 6.73 million contracts." Another explanation for this unprecedented figure is that some global investors used these contracts as a proxy for derivatives of emerging currencies that correlate closely with the real (such as the Turkish lira and the South African rand) but are not traded in deep and liquid organized derivatives markets.

in the Brazilian economy became an "ally" of this policy, given the positive effects of appreciation on domestic inflation.

Thus, exchange-rate policy cannot be said to have been ineffective in the period. The Central Bank was not only fully aware of the role played by appreciation of the real when it came to meeting strict inflation targets, but actually induced it by running a tight monetary policy (alleging demand pressures). The goals of intervention were to contain volatility in the currency market and, most importantly, to build up reserves, and both were achieved fairly successfully.

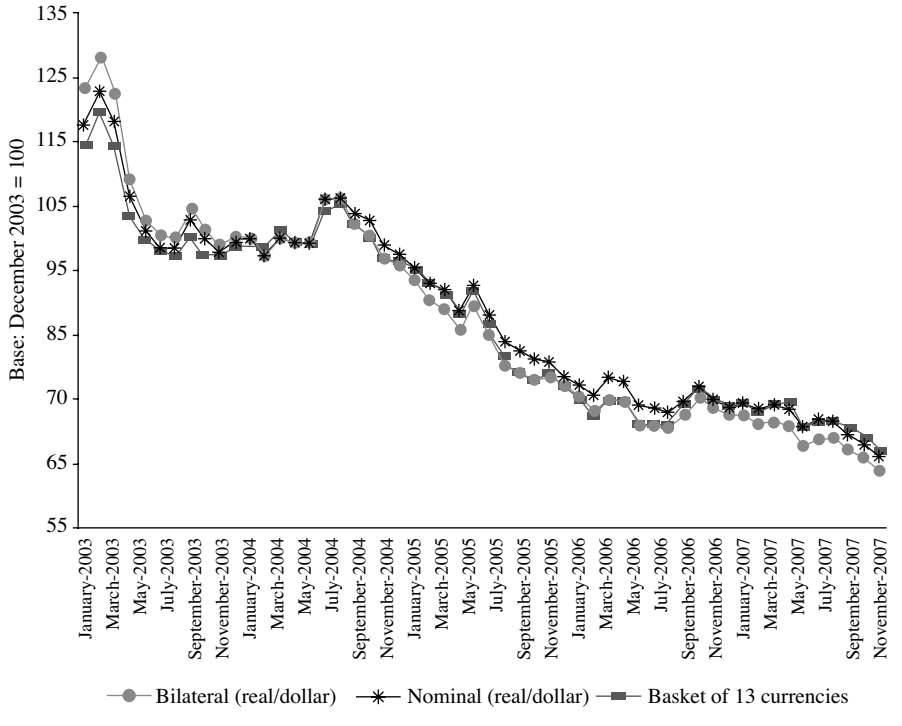
Nonetheless, this policy choice had two adverse side-effects. First, there was the real-term appreciation of the Brazilian currency. As figure 3 shows, following correction of the excessively interventionist stance of exchange-rate policy fro m 2002 to early 2003 and the brief spell of stability between May 2003 and May 2004, the real strengthened virtually without interruption, both bilaterally (against the dollar) and effectively (against a basket of 13 currencies). In the up phase of the international liquidity cycle (January 2003 to June 2007), the real experienced a bilateral appreciation (against the dollar) of 55.9% and an effective appreciation of 46.9% (this lower percentage was due to the dollar's loss of value against the other currencies over the period).

The second effect was a consequence of the first and consisted in a loss of competitiveness for manufactured goods exports, as the main commodities exported by Brazil benefited in the appreciation period from rising international prices.[15] According to the export profitability index calculated by the Foreign Trade Studies Centre Foundation (FUNCEX), the main

[15] This rise was associated both with demand from China and with speculation in futures markets, stimulated by a context of dollar devaluation and low interest rates in the central countries. See Gottschalk and Prates (2006) and UNCTAD (2009).

FIGURE 3

Indices of the real exchange rate (real/dollar) and effective exchange rate (real/basket of 13 currencies)

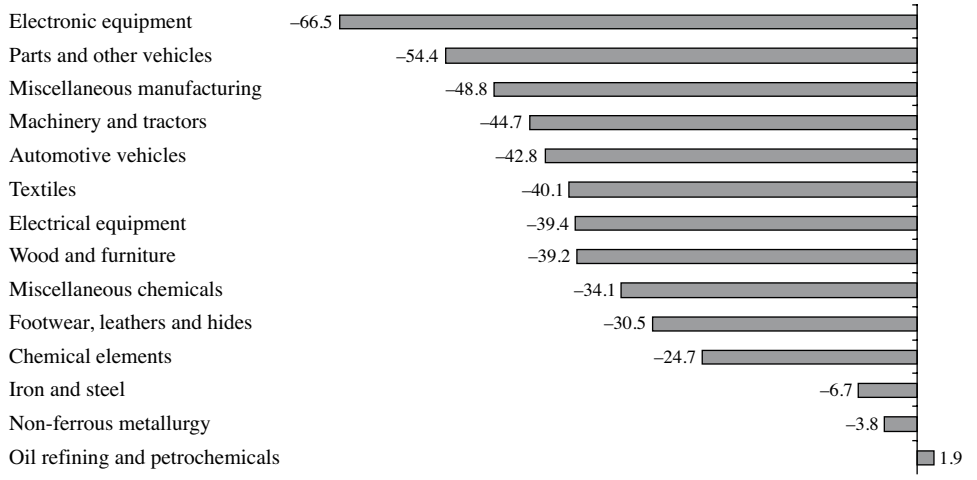


Source: prepared by the authors on the basis of data from the Foreign Trade Studies Centre Foundation (FUNCEX).
N.B.: Deflated by the consumer price index.

manufacturing export sectors recorded a sharp decline in profitability between 2003 and 2007 (see figure 4), and this was most acute precisely in those with the greatest technology content and value added (such as electronic equipment, spare parts and other vehicles, machinery and tractors and automotive vehicles). Conversely, in commodity processing industries, which also benefited from this rise, profits either fell by less (iron and steel and non-ferrous metallurgy) or actually increased (oil refining and petrochemicals).

FIGURE 4

Export profitability index



Base: third quarter, 2003 = 100

Source: prepared by the authors on the basis of data from the Foreign Trade Studies Centre Foundation (FUNCEX).
N.B.: The sectoral export profitability indices are calculated from the average nominal exchange rate for the month (real/dollar), corrected for the ratio between the respective sectoral export price indices and the corresponding sectoral cost indices.

IV

The evolution and determinants of international reserves: an econometric exercise

This section will seek to explain the behaviour of international reserves in Brazil between 1995 and 2007, considering that two exchange-rate regimes applied in that time (managed exchange rate in 1995-1998 and floating rate in 1999-2007), with a view to establishing whether there were changes in the determinants and pattern of reserves accumulation under the dirty float system by comparison with the system of exchange-rate bands.

The econometric model used is a univariate structural time series model.[16] The following series were used: international reserves (RS), current-account balance (CA), net inward foreign direct investment (FDI) and net inward portfolio investment (FPI). Table 3 gives the estimated hyperparameters for the unobserved components of the RS series.[17]

[16] The methodology proposed by Harvey and Shephard (1993) was used. Starting from a set of observations of a single variable, a univariate time series econometric model was constructed. The structural models, meanwhile, follow the approach of decomposing the series analysed into its unobservable components. The best fit for the unobservable components in the structural model of international reserves followed the approach suggested by Harvey and Koopman (2005). See Harvey (1989) on the advantages of univariate structural time series models and on the use of the Kalman filter.

[17] The source for all the series used are raw data from the Central Bank of Brazil (www.bcb.gov.br). These were processed as follows:

TABLE 3

Hyperparameters estimated for the reserves logarithmic model, 1995-2007

Components	Estimates	Q ratio
σ_{ε}^2	0.000	0.0000
σ_{η}^2	571.11 x 10^{-5}	1.0000
σ_{ς}^2	1.1705 x 10^{-5}	0.0020
AR(1)	3.3239 x 10^{-5}	0.0058

Source: Central Bank of Brazil.
Ljung-Box Q (11.7): 13.994 (0.0513). N-BS: 323.15 (0.0000).

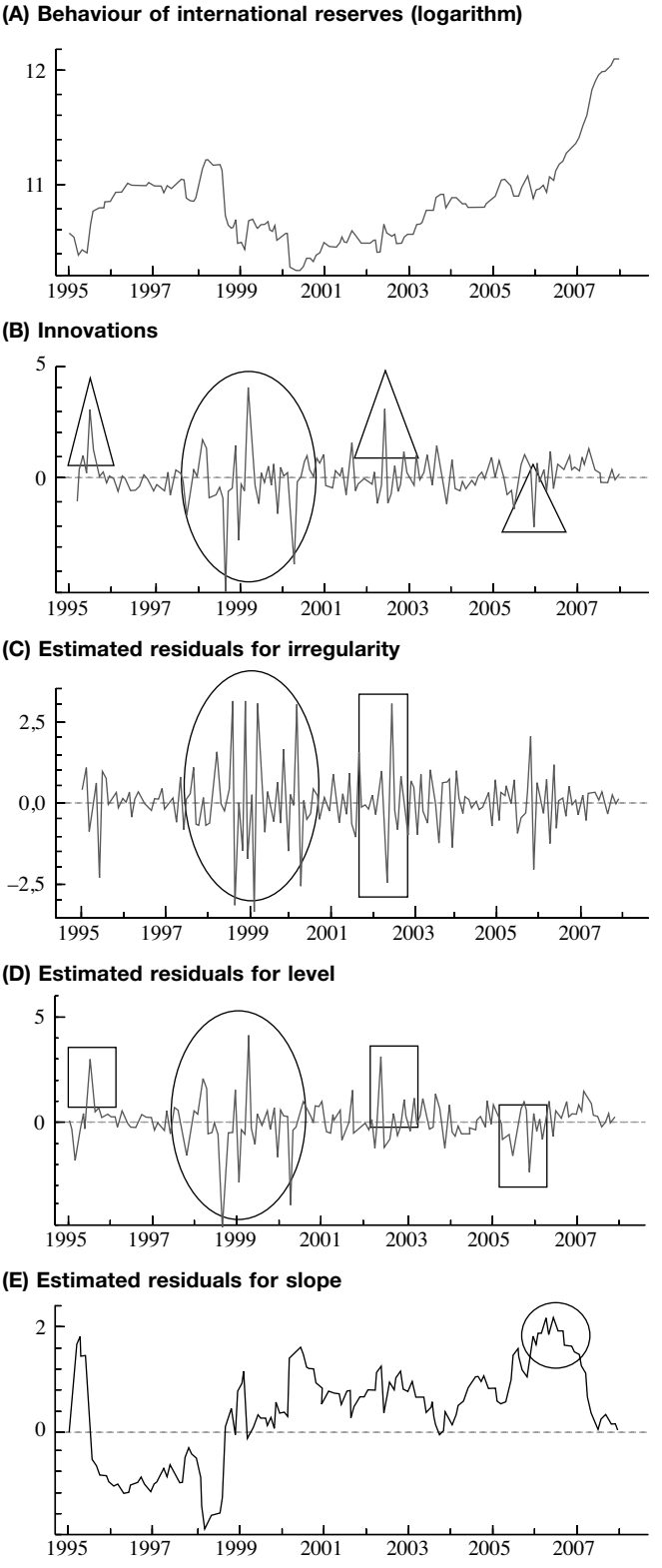
The inclusion of an autoregressive term in the model presented in table 3 was determined by the way the international reserves series for Brazil varies. This term also mitigates alterations in the irregularity component. Consequently, σ_{ε}^2 is observed to behave non-randomly, and this means that alterations in the RS dynamic mainly take the form of changes in the linear parameter (level) and the angular parameter (slope) of its trend, σ_{η}^2 and σ_{ς}^2, respectively. Two statistics were established following observation of the behaviour of the innovations estimated: (A) Ljung-Box Q (p,q), which defines a serial autocorrelation test in the residuals estimated, and (B) Bowman-Shenton, which establishes the normality of the distribution of these residuals. The first statistic indicates a lack of serial autocorrelation in the disturbances estimated, taking a 5% significance level. Where the Bowman-Shenton statistic (N-BS) is concerned, however, the hypothesis that the distribution of the estimated residuals behaves normally is rejected. This finding establishes the presence of high values for these innovations, so that observation of their dynamic becomes crucial. Figure 5 presents: (A) the behaviour of RS, (B) the estimated model innovations, (C) the estimated residuals of the irregularity component, (D) the estimated residuals of the level of the trend and (E) the estimated residuals of the slope of the trend, and the periods of greatest volatility in the innovations estimated are made explicit (panel B). It is no coincidence that there should have been great volatility between October 1997 and April 1999, a time of financial crises in emerging markets (Asia in October 1997, Russia in August 1998 and Brazil in January 1999). However, the months of greatest strain were those from September 1998 to April 1999, a period of crisis during which the Brazilian exchange-rate regime altered. Besides these periods, isolated movements can be observed in the volatility of these innovations in March and July 1995, associated with the uncertainty produced by the Mexican crisis, followed by the recovery of reserves. Other periods of great volatility came in April 2000 with the Argentinean crisis, June 2002 (pre-election period or "Lula effect") and December 2005.

Comparison of panels B and D shows that innovations are heavily influenced by the dynamic of the estimated residuals of the level of the trend in the RS series. Both the dynamic and the size of the two disturbances are similar. Regarding the size of the estimated residuals of the unobserved components in the RS series, one thing that stands out is that the largest of them is in the angular parameter of the trend. This indicates that changes in the RS trend occur abruptly, i.e., following a break in the trend level of this series, not in its slope, which suggests a sudden stop dynamic (Izquierdo, Talvi and Calvo, 2006). Nonetheless, in April 2006 there was a peak in the estimated residuals of the trend slope, so that periods of great volatility in the estimated innovations of the irregularity component are practically the same as those indicated in relation to the estimated residuals of the trend level. Owing to the greater amplitude of the latter, a level break can be identified as the predominant element.

Table 4 details the months in which substantial alterations in RS behaviour are most feasible. It turns out that including the binary variables in the months indicated with extreme values, taking two standard deviations, produces a correct fit for the estimated residuals. In other words, there is a normal distribution in relation to these innovations. Furthermore, taking a 5% statistical significance level, the hypothesis that the estimated parameters for all the binary variables proposed are equal to zero is rejected. The unobserved

(i) Brazilian international reserves, international liquidity concept (RS): this series is obtained in current dollars, seasonally adjusted, on the basis that its dynamic might be affected by the trade balance. A logarithmic transformation was also implemented when the series was decomposed into its unobserved components; (ii) current-account balance of the Brazilian economy (CA): this aggregate is calculated in current dollars, subject to a seasonal adjustment for the reason already given in relation to the RS series; (iii) net inward foreign direct investment in Brazil (FDI): as with the previous series, this aggregate is obtained in current dollars, but no seasonal adjustment is required; and (iv) net inward portfolio investment in Brazil (FPI): this series too is expressed in current dollars and requires no seasonal adjustment.

FIGURE 5



Source: Central Bank of Brazil.

component strongly influencing movements in RS is confirmed to be their trend level, irrespective of the exchange-rate regime.

Another important finding is that statistically the rate of reserves growth remained unchanged until April 2006, when it began to accelerate, even though a floating exchange-rate regime was operating in the Brazilian economy. In other words, the pattern of reserves accumulation was similar up until April 2006 under both the managed exchange-rate regimes and the floating system. From that time on, reserves growth accelerated even though the formal exchange-rate regime was one of free flotation. Figure 6 shows the alterations that took place in the RS series.

TABLE 4

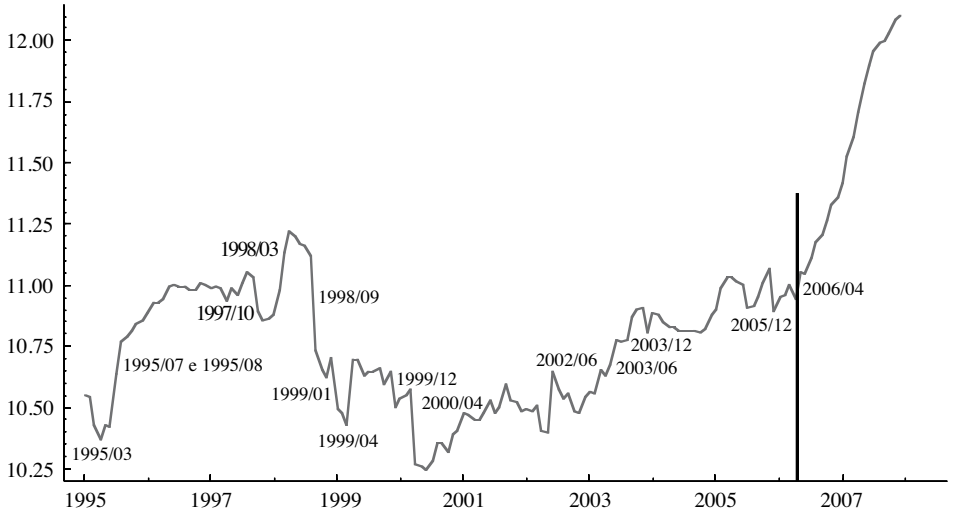
Estimates of binary components for the reserves logarithmic model, 1995-2007

Components	Coefficient	t-statistic	p value
Irregularity dummy (April 1998)	0.07980	2.8378	0.0052
Level dummies (March 1995)	–0.13216	–3.324	0.0011
Level dummies (July 1995)	0.23176	5.8462	0.0000
Level dummies (August 1995)	0.12577	3.1725	0.0018
Level dummies (October 1997)	–0.12438	–3.1376	0.0020
Level dummies (March 1998)	0.14100	3.5462	0.0005
Level dummies (September 1998)	–0.40070	–10.108	0.0000
Level dummies (January 1999)	–0.23975	–6.0299	0.0000
Level dummies (April 1999)	0.29051	7.2915	0.0000
Level dummies (December 1999)	–0.16135	–4.0377	0.0001
Level dummies (April 2000)	–0.28999	–7.2785	0.0000
Level dummies (June 2002)	0.25808	6.4867	0.0000
Level dummies (June 2003)	0.11402	2.8659	0.0047
Level dummies (December 2003)	–0.11151	–2.7905	0.0059
Level dummies (December 2005)	–0.19044	–4.7658	0.0000
Slope dummies (April 2006)	0.052275	5.6526	0.0000

Source: Central Bank of Brazil.
Ljung-Box Q (11.7): 10.974 (0.1398). N-BS: 1.5549 (0.4596)

FIGURE 6

International reserves in Brazil, logarithmic scale, 1995-2007



Source: Central Bank of Brazil.

It is necessary to particularize the dynamic of the RS series shown in figure 4 together with the sign of the parameters attained by the binary components presented in table 4. The first period delimited was one in which the level of RS fell (in March 1995) because of the Mexican crisis, followed by two months of strong recovery (July and August 1995). The Asian crisis is clearly reflected in the change of level of the series analysed in October 1997. In March 1998, the volume of RS increased strongly once again. Following that month, there was a series of sharp contractions in the level of the decomposed series and in April 1999 there was a positive change. These deteriorations in RS were associated with the financial crises in the Russian and Brazilian markets. The Argentinean crisis, for its part, shows up in the reserve losses recorded in December 1999 and, most particularly, in April 2000. Positive changes are observed in RS levels until December 2003, and there were some small changes in that month and in December 2005. This insignificant drop in level did not obviously affect the dynamic of RS, because in April 2006 a large change in the growth rate of this aggregate is indicated, with RS accumulation accelerating considerably.

Hitherto, statistical analysis of the international reserves time series has reinforced the hypothesis of the preceding analysis that exogenously determined liquidity cycles influence the behaviour of official interventions in the Brazilian currency markets, captured in this paper by variations in official reserves. According to textbook models, the introduction of a free float in 1999 should have been followed by a slowdown in the build-up of reserves. Not only did this not happen but from 2006 there was a structural break in the series suggesting an accelerating build-up. This coincides with the Central Bank strategy of improving the country's external solvency profile during an upturn in the international liquidity cycle.

With the RS series characterized in its unobserved components, the aim of the next exercise will be to pin down the determinants of this variable in Brazil during the period from January 1995 to December 2007.[18] As already mentioned, two significant alterations in the movement of the RS series were observed: considerable volatility between September 1998 and April 1999 and an alteration in the rate of RS accumulation growth, but only from April 2006. When these movements are examined, the focus narrows to three periods in the dynamic of the economic aggregate analysed, covering the months from January 1995 to August 1998, May 1999 to March 2006 and April 2006 to December 2007, respectively. The number of months in the last period is rather small for the purposes of the econometric exercise proposed in this section. The econometric method is applied in a way that uses the association between the second and third periods, controlling for the change of slope in the RS series by the addition of binary variables. The statistical model that will be used in the attempt to identify the structural determinants of RS in Brazil will be applied to two periods, then: from January 1995 to July 1998 and from May 1999 to December 2007. Equation (1) identifies the basic model, considering an equation in level form, which is to be estimated:

$$RS_t = \beta_0 + \beta_1 + \beta_1 CA_t + \beta_2 . FDI_t + \beta_3 . FPI_t + \varepsilon_t \quad (1)$$

where CA represents the current-account balance, FDI is net inward foreign direct investment, FPI denotes net foreign portfolio investment and ε symbolizes the effects of the variables not included in the proposed model.[19]

When the unit root tests are carried out on the series indicated in equation (1) for the first period established, it transpires that the RS series is the only one to be first-order cointegrated, i.e., it concludes with the presence of a unit root (Enders, 2004). The presence of a unit root is not observed for the other series, which correspond to I(0).[20] The characterization of series I(1) and I(0) determines the need to use equation (1) in difference form:

$$\Delta(RS_t) = \beta_0 + \beta_1 . \Delta(CA_t) + \beta_2 . \Delta(FDI_t) + \beta_3 . \Delta(FPI_t) + \varepsilon_t \quad (2)$$

Equation (2) was initially estimated without considering the breaks referred to in the exercise whereby the RS series was decomposed into its unobserved components. The binary variables referred to were then included and the resulting alterations

[18] The exercise in this section is based on Aizenman and Lee (2005).

[19] It should be recalled that the exercise in this section consists of determination models, which means that we are not attempting to predict reserve movements, so that it is clearer to characterize ε as omitted variables.

[20] The statistical responses obtained are independent of the test specified, whether augmented Dickey-Fuller (ADF) or Phillips-Perron (PP).

observed. Table 5 presents the statistical results of the model defined earlier for the January 1995 to August 1998 period, without dummies.

TABLE 5

Reserves model without inclusion of binary variables

(January 1995-August 1998)

Variable	β_i	t-statistic	p value
Constant	713.27	0.9976	0.3240
Δ (*CA*)	0.6573	2.8313	0.0075
Δ (*FDI*)	0.0934	0.2699	0.7887
Δ (*FPI*)	0.8916	4.5143	0.0001
AR(1)	0.4941	3.2579	0.0024

Source: Central Bank of Brazil.
R^2: 0.52347
Akaike information criterion: 18.46272
Schwartz information criterion: 18.66958
Durbin-Watson: 1.8507
White heteroskedasticity: 3.2523 (0.7766)

TABLE 6

Reserves model with inclusion of binary variables

(January 1995-August 1998)

Variable	β_i	t-statistic	p value
Constant	475.54	1.5187	0.1381
Δ (*CA*)	0.4722	1.8125	0.0787
Δ (*FDI*)	0.3749	0.9424	0.3526
Δ (*FPI*)	0.4111	1.9463	0.0599
DU 1995/03	–3529.20	–1.7478	0.0895
DU 1995/07	6724.50	3.3719	0.0019
DU 1995/08	5205.10	2.6666	0.0116
DU 1997/10	–7815.51	–3.7110	0.0007
DU 1998/03	7066.89	2.9840	0.0052

Source: Central Bank of Brazil.
R^2: 0.70484
Akaike information criterion: 18.14289
Schwartz information criterion: 18.51151
Durbin-Watson: 1.8284
White heteroskedasticity: 6.9518 (0.80297)

An AR(1) term is included in an attempt to correct the serial autocorrelation in the residuals estimated. Nonetheless, the Durbin-Watson (D-W) statistic is in an unclear area.[21] In this first model estimated, the components influencing the variations in RS are FPI and CA, so that the estimated value of the parameter linked to the first variable is higher than that of the second. This result assigns a greater influence to capital movements intended for foreign portfolio investment in determining RS variations (see section III).

Table 6 details the statistics of the model estimated for the first period, considering the alterations in level of the trend for the RS series identified earlier. Dummies were introduced for changes in level from March 1995, July 1995, August 1995, October 1997 and March 1998. It should be stressed, however, that we are working with series in differences, and the test for structural change in the linear parameter of the trend was applied to the series in level. Thus, considering the characterization of expression (2), what are obtained are specific binary variables, i.e., the unit value for just the month where the behaviour of the series changes. In this way, an alteration in the linear parameter of the series in level (level dummies) becomes just a disturbance in the series in difference.

The D-W statistic is once again in an intermediate area, but implementing the B-G test establishes a statistic of 0.1692 with a p value of 0.6808, determining the rejection of serial correlation for the innovations estimated. The W-H test determines rejection of heteroskedastic behaviour for the residuals. The Akaike and Schwartz information criteria and R^2 indicate that this model is a better fit for the data than the model presented in table 5. Nonetheless, the variables considered statistically significant in explaining the movements of RS at a 5% level now require a 10% statistical significance level. In other words, when a level of significance with a lower tolerance is taken, the shocks caused by international crises provide a better explanation for RS behaviour than the Brazilian balance-of-payments accounts. Consequently, when a 10% statistical significance level is taken, the same variables as proved decisive in explaining RS variations in the model set out in table 5 continue to present the same property. It is striking, however, that the value of the parameter related to FPI was lower than that for CA. In other words, when abrupt changes in the level of the aggregate analysed are controlled for, the current-account balance is more important than movements in net inward portfolio investment in

[21] We then implemented the Breusch-Godfrey (B-G) serial correlation test, prescribing a statistic of 0.7090 with a p value of 0.3998 and rejecting the presence of autocorrelation in the residuals estimated. Furthermore, the White test for heteroskedasticity (W-H) does not reject homoskedasticity in the innovations estimated. Consequently the behaviour specified for the residuals agrees with traditional statistics theory.

explaining RS variations. Consequently, reserves loss or accumulation shocks, expressed in the dummies, relate more to movements originating in FPI than in CA in the period between January 1995 and August 1998. Lastly, it is observed that the signs encountered in the binary variables listed in this model are identical to those established in the exercise of decomposing RS into their unobserved components, confirming the good fit of the statistics presented in table 6.

The same exercise was then applied to the second period, May 1995 to December 2007. Regarding the degree of cointegration of the series selected, it transpires that the RS series is I(1), irrespective of the unit root test applied. The tests applied to the CA and FPI aggregates presented divergences. When the ADF statistic was used, both series were I(1), whereas with the Phillips-Perron (PP) method they came out as I(0). In the FDI series both tests indicate an absence of unit root. Consequently, the econometric exercise structured as per expression (2) is delimited in this second period. The results in table 7 do not incorporate the binary variables and there is an observable need to impose an AR(1) term on the structure proposed in order to correct the serial autocorrelation established in the residuals estimated. Furthermore, this specification does not manifest the problem of heteroskedasticity in the innovations. As for the variables that are important in determining the RS variations, the only one that showed statistical relevance was FPI, taking a 10% significance level.

In the next model estimated, account is taken of alterations in the RS series, which are demonstrated in the decomposition exercise for that aggregate. There was an alteration in the RS volume growth rate from April, giving rise to the introduction of a dummy alteration variable in the slope of the statistical model to be characterized.[22] Table 8 sets out the statistical results arrived at with this new specification.

Notwithstanding the lack of serial autocorrelation in the residuals estimated after this component is adjusted using an AR(1) term, this characterization presents the non-homoskedastic residuals. When the results of this model are compared with the one detailed in table 7, this difficulty does not prevent us from discovering a better data fit. Furthermore, as in the previous result, the only variable that presented statistical significance in the determination of the RS variations was FPI. However, it is necessary to look for the weighting of the heteroskedasticity problem in the distribution of the residuals estimated by including a White matrix. This new specification is presented in table 9.

The heteroskedasticity test employing the White matrix indicates that RS are explained solely by shocks. In the Brazilian economy, in other words, the balance-of-payments current account does not determine the

TABLE 7

Reserves model without inclusion of binary variables

(May 1999-December 2007)

Variable	β_i	t-statistic	p value
Constant	1 348.19	2.2418	0.0272
Δ (*CA*)	0.5014	1.5744	0.1186
Δ (*FDI*)	0.0232	0.2202	0.8262
Δ (*FPI*)	0.2136	1.8940	0.0612
AR(1)	0.4142	4.4768	0.0000

Source: Central Bank of Brazil.
R^2: 0.2034
Akaike information criterion: 19.23801
Schwartz information criterion: 19.36668
Durbin-Watson: 2.1977
White heteroskedasticity: 7.07613 (0.3138)

TABLE 8

Reserves model with inclusion of binary variables

(May 1999-December 2007)

Variable	β_i	t-statistic	p value
Constant	591.87	1.417	0.1599
Δ (*CA*)	0.2466	1.0440	0.2993
Δ (*FDI*)	0.0415	0.5444	0.5875
Δ (*FPI*)	0.1923	2.3504	0.0208
DU 1999/12	–6 912.95	–2.9300	0.0043
DU 2000/04	10 306.72	–4.3867	0.0000
DU 2002/06	9 636.61	4.1338	0.0001
DU 2003/06	3 880.25	1.6515	0.1021
DU 2003/12	–6 710.77	–2.8756	0.0050
DU 2005/12	12 398.99	–5.2673	0.0000
DU 2006/04	4 691.50	5.2545	0.0000
AR(1)	0.3359	3.2719	0.0015

Source: Central Bank of Brazil.
R^2: 0.6486
Akaike information criterion: 18.55682
Schwartz information criterion: 18.86564
Durbin-Watson: 2.0656
White heteroskedasticity: 41.2922 (0.0000)

[22] A binary slope variable in an econometric architecture in difference becomes a level dummy, which assumes the introduction of the element "1" after the period delimited, so that a succession of zeroes appears first.

TABLE 9

Reserves model with inclusion of binary variables and White matrix
(May 1999-December 2007)

Variable	β_i	t-statistic	p value
Constant	591.87	1.7680	0.0804
Δ (*CA*)	0.2466	1.1089	0.2704
Δ (*FDI*)	0.0415	0.6153	0.5399
Δ (*FPI*)	0.1923	1.4505	0.1504
DU 1999/12	–6 912.95	–12.4519	0.0000
DU 2000/04	–10 306.72	–17.2839	0.0000
DU 2002/06	9 636.61	6.4099	0.0000
DU 2003/06	3 880.25	8.1172	0.0000
DU 2003/12	–6 710.77	–5.5780	0.0000
DU 2005/12	–12 398.99	–10.2520	0.0000
DU 2006/04	4 691.50	3.3512	0.0012
AR(1)	0.3359	2.6354	0.0099

Source: Central Bank of Brazil.
R^2: 0.6486
Akaike information criterion: 18.55682
Schwartz information criterion: 18.86564
Durbin-Watson: 2.0656
White heteroskedasticity: 41.2922 (0.0000)

volume of international reserves absorbed. Although it is a better fit, the model presented in table 9 does not permit a statistical specification of the macroeconomic aggregates conditioning RS variations in Brazil. Indeed, observation of the variance in the residuals estimated shows this rising after April 2006 to a value of 1.51 x 107. For the purposes of comparison, between May 1999 and March 2006 this value was 2.97 x 106. This alteration was established in the month that marked the turning point in the downward trend of the RS series. The choice was thus made to exclude the months following this turning point and, consequently, the binary variable representing the change in the rate of growth in the series analysed, with the model being restructured using a period from May 1999 to March 2006.

The statistics estimated, adjusted to the new suggested period, can be observed in table 10. In addition, an AR(1) term was introduced into the new model to correct the autocorrelation of the residuals estimated. The evidence provided by these new estimates suggests that the hypothesis of heteroskedasticity in the innovations is to be rejected, establishing a behaviour pattern for these components that fits traditional statistics theory. The main determinant of variations in Brazilian RS is net inward portfolio investment. This finding agrees with the previous exercise, which did not include the binary variables of the econometric model (the period including the turning point in the decline of the series analysed was excluded).

Indeed, it can be stated in general that the FPI variable is the main determinant of international reserves accumulation in the Brazilian economy throughout the period considered. Nonetheless, a longer series is badly needed so that the behaviour of reserves in the period subsequent to April 2006 can be analysed and this finding confirmed. Something else that has emerged is the importance of external shocks associated with financial boom and bust cycles, something already ascertained in the analysis of section III.

TABLE 10

RS model with inclusion of binary variables
(May 1999-March 2006)

Variable	β_i	t-statistic	p value
Constant	488.35	1.7912	0.0776
Δ (*CA*)	0.3482	1.6369	0.1061
Δ (*FDI*)	0.1617	1.0161	0.3131
Δ (*FPI*)	0.2253	2.1729	0.0332
DU 1999/12	–6 709.98	–3.7100	0.0004
DU 2000/04	–9966.65	–5.5026	0.0000
DU 2002/06	9 283.40	5.2165	0.0000
DU 2003/06	4 047.44	2.2551	0.0273
DU 2003/12	–6 382.83	–3.5765	0.0006
DU 2005/12	–11 894.95	–6.5661	0.0000
AR(1)	0.2393	2.0330	0.0458

Source: Central Bank of Brazil.
R^2: 0.6514
Akaike information criterion: 17.97613
Schwartz information criterion: 18.30130
Durbin-Watson: 2.0070
White heteroskedasticity: 17.4059 (0.1349)

V
Final considerations

This article set out to reveal the extent to which management of the floating exchange-rate system in Brazil did or did not partake of the tendency observed among the main emerging economies to adopt a "dirty float" strategy in practice. The existence of an international financial environment marked by cycles of exogenously determined optimism and pessimism would appear to provoke reactions such as "fear of floating" or the precautionary build-up of international reserves. The econometric exercises conducted suggest that: (i) the reserves accumulation pattern was statistically similar in the periods during which a managed (1995-1998) and floating (1999-2006) exchange-rate regime was applied; (ii) from April 2006 a major structural shift is seen, with the reserves build-up accelerating; (iii) exogenously determined financial cycles seem to influence reserves movements; and (iv) capital flows appear to affect reserves more than flows of goods, services and income (current account).

Similarly, this article has sought to examine some institutional peculiarities of the Brazilian situation, including the substantial depth of the country's derivatives markets, which greatly increases the vulnerability of the exchange rate in these cycles. It was also shown that the management of the floating exchange-rate system in Brazil has been subordinated to the more general goal of price stabilization (i.e., to the inflation targeting regime), something that is not exclusive to Brazil. In this context, with the level of the exchange rate neglected as a policy goal after 2003, the authorities ceased to use exchange-rate management to defend the external competitiveness of exports, a strategy that seems to have been applied time and again in Asian economies. According to analyses like that of Rodrik (2007), this option can pose a risk, even in the medium term, to the maintenance of trade and current-account surpluses that are robust enough to permanently and sustainably offset the country's external vulnerability.

Emphasis must be laid on the high fiscal cost of the strategy of official currency market intervention by the Central Bank of Brazil (and thus of reserves accumulation) and we need to ask whether, within the same economic policy framework, the Brazilian monetary authority might not be able to employ a combination of different instruments in the spot and derivatives markets. Unlike currency purchases in the spot market, reverse swaps do not increase foreign currency liquidity, but they do entail equally high fiscal costs for the Treasury. The Central Bank could have opted for a strategy of intervention in the spot currency market and had a greater influence on the appreciation trend of the real. This would have allowed it to make less use of these derivatives or replace them with operations in the BM&F forward market which, while less transparent than swaps (carried out via auctions), would be more effective at moderating the currency's future appreciation against the dollar.

(Original: Portuguese)

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