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Liquidity and Exchange Rate Dynamics: The increased Internationalisation of the Brazilian Real

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0- Introduction

This paper argues that Brazil's financial system has experienced a new stage of integration in international financial markets. Due to ongoing financial liberalization and the increasing liquidity of Brazil's financial markets, characterised by a strong concentration in short-term maturities and the willingness of the central bank to provide liquidity to the market, Brazilian assets have become constituent part of the portfolios of international investors. As such, they have become internationally traded asset classes, whose dynamics are largely determined by portfolio decisions of internationally operating financial institutions. The role as international portfolio asset is especially novel for the currency, the Brazilian real, which has become one of the world's most liquid and widest traded emerging market currencies. This, however, has important implications for exchange rate dynamics, which increasingly reflect international market conditions and can be entirely independent from the underlying economic situation.

The risks and merits of financial liberalization and integration in international financial markets has been widely discussed (e.g. Cozzi and Nissanke, 2009). In the mainstream economics' world of perfectly working functioning international capital markets, financial liberalization provides liquidity for countries which face temporary income shortfalls, channels funds from surplus to deficit units for productive investment and reduces consumption volatility and stimulates investment through effective risk sharing (e.g. Obstfeld and Rogoff, 1996). These direct benefits are often supplemented by indirect effects, such as the disciplinary effects on domestic policy makers, or collateral benefits, such as financial sector development, improved institutions and better macroeconomic policies (Kose et al., 2006). Empirical literature, however, does little to substantiate the claims that financial liberalization is good for economic growth (Prasad et al., 2003). More generally, there is little disagreement that capital account liberalization comes with significant risks and costs attached. The loss of monetary policy autonomy aside, these costs include increased fiscal constraints due to reduced taxing capacity and negative distributional effects (e.g. Obstfeld, 1998, Nissanke and Thorbecke, 2006). However, probably the severest and most disruptive effect of international capital flows has been the recurrence of financial crises. Mainstream economics has developed generations of financial crisis models, each trying to account for the specific characteristics of the recurrent financial crises that hit emerging markets. However, although these models – to a varying degree – account for the instability of capital flows, the dynamic of these flows remains ultimately embedded in domestic economic conditions, either in the form of open vulnerabilities such as in Krugman's (1979) first generation model, domestic financial fragilities in third generation models ((MacKinnon and Pill, 1998, Rodrik and Velasco, 1999) or expected vulnerabilities such as in Obstfeld's (1996) self-fulfilling

crisis model. Even in international contagion models the transmission channels remain ultimately embedded in domestic economic conditions, which are potentially affected by spillovers from other emerging markets (e.g. Calvo and Reinhart, 1996).

The financial integration postulated in this paper, however goes beyond this. Brazilian assets have ceased to be the investment target of a few specialised institutions, but have become part of the international trading arena. As such, Brazilian assets are now a constituent part of international investors' portfolios and are actively traded. This, however, implies that their dynamics can become entirely de-linked from domestic economic conditions and merely the result of the portfolio adjustment of international investors. This was especially visible in the international crisis of 2008, when portfolio adjustment and deleveraging in international financial markets led to one of the largest exchange rate depreciations among emerging markets.

The new form of Brazil's financial integration described in this paper also manifests itself in increasingly complex and varied links to international capital markets. While the above outlined literature on capital flows mainly concentrates on debt flows, new forms of capital flows have become dominant in the Brazilian economy. Equity investment and flows to the derivative market are now an increasing part of foreign investment. In both cases, the existence of an increasingly liquid market concentrated in very short-term maturities has allowed the active trading of assets and increased foreign participation. In addition the willingness of the central bank to act as counterparty in both, the appreciating and depreciating period, has contributed to the liquidity of Brazilian assets and their attractiveness for international investors. The ability to trade in a highly liquid derivative market in very short maturities has been especially instrumental in making the Brazilian real an internationally traded asset class.

These new forms of capital flows also reflect the increasing importance of *trading* operations for Brazilian assets. In addition to providing liquidity to investors, capital gains, or appreciation, are an important part of returns on equity and foreign currency investment¹. However, the ability to generate returns on capital gains is part and parcel of trading operations. More than that, trading itself might create capital gains further increasing the attractiveness of these asset classes for (international) financial investors². The importance of capital gains or losses for investment returns and the sensitivity of these to investor activity, however, might exacerbate exchange rate movements in both the appreciation and the depreciation period. Expected capital gains (or losses) fuel current trading, which in turn validates the expected price changes.

The paper is divided into five parts. The first part presents a short outline of the theoretical framework used to analyse exchange rate dynamics in emerging countries. Based on Keynes' Ch. 17 of the *General Theory* it argues that in addition to short-run return considerations, the demand for an asset is determined by its liquidity relative to other assets. In line with Minsky's writing liquidity is defined as the ability to meet outstanding obligations. In the international context this implies the possibility of quick conversion into the funding

¹ As the emphasis of this paper is on foreign investors, these are capital gains in US\$ terms, including both changes in the local equity index and the currency. In the case of the currency, exchange rate appreciation would be the only "capital gain".

² Indeed, while an increase in trading volume will lower the interest rate (and raise the price of interest bearing assets) there is a structural limit to this process. In the case of equity or currency investment, however, an increase in trading volume or increased demand for an asset will – *ceteris paribus* - have a positive effect on capital gains, with little structural limit to this process.

currency, the US\$, and the possibility to send the foreign currency abroad. Based on this theoretical framework the paper will discuss in part two the increased liquidity of the Brazilian financial system, with a special emphasis on the domestic currency. It argues that as a result of this increased liquidity, Brazilian portfolio assets, and as an especially new phenomenon, the Brazilian real have become integral part of the portfolios of international investors. To support this claim, the paper provides econometric evidence based on cointegration and multivariate VAR-GARCH analysis and qualitative results from interviews with Brazilian currency traders and fund managers in part three. Part four discusses the implications foreigners' exposure to Brazilian assets had for exchange rate dynamics before and during the financial crisis. The paper concludes with some thoughts on how this new form of financial integration affects macroeconomic and especially exchange rate management.

1- Theoretical Framework

In line with Minsky's writings this paper defines liquidity as the ability to meet outstanding obligations. Minsky's definition is based on Keynes' concept of liquidity, which he essentially put forward in his *General Theory*. In chapter 17 of the *General Theory (GT)*, Keynes argues that there are three attributes which different types of assets possess in different degree: yield, which comprises income and appreciation in money terms, carrying cost (cost of storage) and liquidity premium. The total return expected from the ownership of an asset over a period is equal to its yield minus its carrying cost plus its liquidity premium, i.e $q-c+l$ (p. 226). Money is the liquid asset par excellence, which in the eyes of Keynes justifies the holding of money in the presence of higher yielding assets. Liquidity is then defined as the ability to convert any capital asset into money, both in terms of its value preservation and time conversion. Thus liquidity has a temporal and wealth dimension at the same time. This creates a degree of liquidity among capital assets (called liquidity preference), which in turn defines capital assets pricing or portfolio allocation.

Money's liquidity stems from its ability to act as "temporary abode of purchasing power" which transfers wealth in a world of uncertainty and allows future possession of goods (Davidson, 2002). In an open economy the requirement of value-stability and money's ability to secure wealth assumes an additional dimension, as wealth owners not only decide between holding real wealth and nominally fixed claims in domestic currency, but also in which currency they prefer holding nominal wealth (Lüken genannt Klaben, 1993:37). While in a closed economy domestic money is generally the asset class with the highest liquidity premium, this does not need to hold in an open economy, where – in the eye of the asset holder - the functions of money could be better performed by a foreign currency, which is thus equipped with a higher liquidity premium. For Hajo Riese and the exponents of his "monetary Keynesianism", the currency's ability to store wealth *relative* to other currencies becomes the decisive factor of capital and hence exchange rate movements (Herr, 1992:84). They argue that at the heart of a currency's liquidity premium – or currency premium as they refer to it – lies its function as a store of value, which is derived from its ability to act as a stable unit of account. In this sense, they argue, acting as a stable unit of account is the basic function of money, as it allows the expression of prices in monetary terms and measures every form of wealth in the economy (Herr, 2001:161). The differential ability of different currencies to store wealth, in turn, creates a hierarchical international monetary system, at the top of which stands the US\$ dollar as the currency with the highest liquidity premium.

This view, however, does not explain why the US\$ is the currency with the highest liquidity premium and why the flight from the domestic currency does not happen into other value stable currencies. To understand the flight into the US\$ and thus exchange rate depreciations

against the US\$, one has to also consider the liability side of international monetary transactions. Because as unit of account money assumes another crucial role in the functions of the economy: it denominates monetary contracts. As Keynes (1997:237) points out "...the convenience of holding assets in the same standard as that in which future liabilities may fall due...is obvious." In this view, a currency's liquidity will be determined by its ability to meet outstanding monetary contracts. In the international context this implies that domestic currency will be held if it allows honouring external monetary contracts or external obligations.

This emphasis on the liability side of balance sheets in the definition of liquidity finds its expression especially in the writings of Minsky. According to Minsky, capital asset pricing and portfolio decision theories should take into account the liability positions that are interrelated with asset positions given that "...a portfolio decision has two interdependent facets. The first relates to what assets are to be held, controlled, or acquired; the second relates to how the position in these assets – i.e., their ownership or control – is to be financed" (Minsky, 1975:70). The introduction of the liabilities structure in the analysis of liquidity is fundamental, as the issuance of liabilities can show the level of risk taken by the economic units in their portfolio decisions.

In the international context this risk is influenced by two factors: first the automatic exchange rate exposure, which arises from domestic investment funded in international financial markets and second, the ability to convert domestic assets into foreign currency. Both risks have been mitigated by the increased liquidity of Brazil's financial system, which has been characterised by two factors: first, an increasingly short-term maturity of Brazilian financial assets and second, the willingness of the central bank to act as reliable providers of liquidity. The short-term maturity of Brazilian assets guarantees almost immediate resale and thus the ability to quickly convert these assets into cash. The willingness of the central bank to provide foreign currency to the market, on the other hand, allows for a safe conversion into US\$³.

As discussed in more detail in Kaltenbrunner and Paineira (2009), the central bank of Brazil has been an important operator in the foreign exchange market providing liquidity and acting as a counterparty to the market. This was true in the crisis moment, where it supplied huge amount of foreign exchange to the market, but was also crucial in the appreciation phase: through acting as counterparty to many of the foreign exchange related operations, the central bank has significantly contributed to the volume and liquidity of the derivatives market. In addition, as a result of its attempts to sterilize its US\$ purchases, the central bank has supplied a large amount of very short-term securities (repo) to the domestic banking sector. The ability to hold very liquid, high yielding securities, however, allowed the banking sector to capture additional foreign resources and significantly increased its room for manoeuvre in the crisis moment.

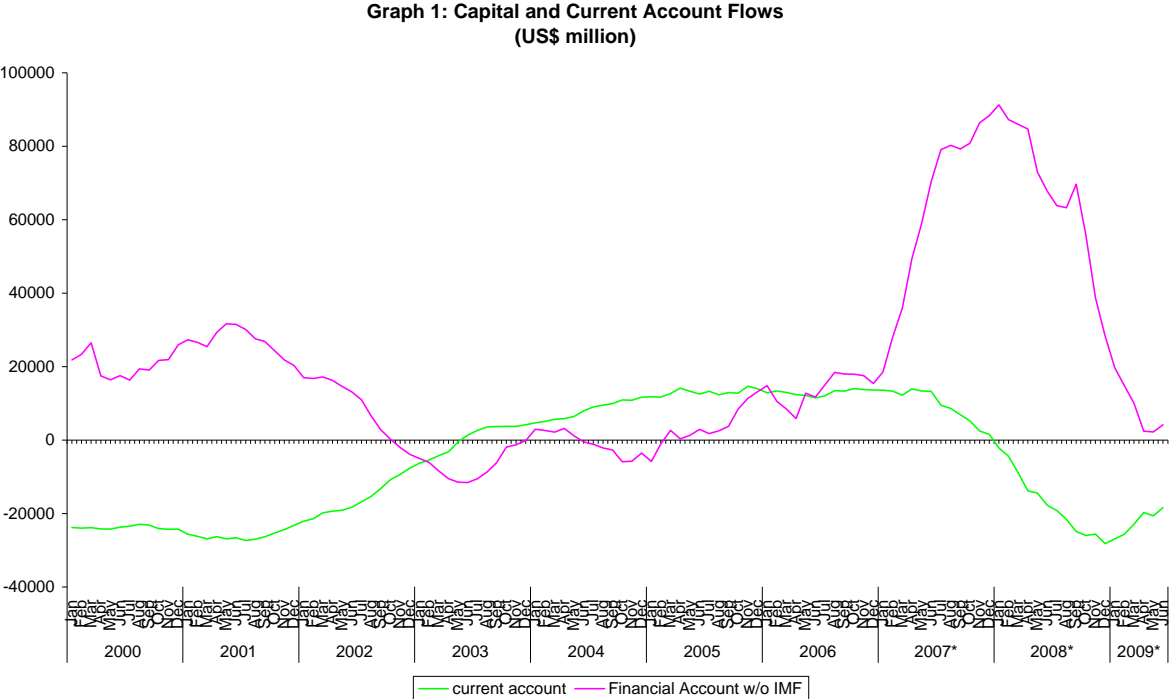
Finally, while the use of Keynes' concept of liquidity cannot entirely explain the demand for US\$ in times of increased uncertainty, Minsky's emphasis on the liability side can account for the volatile movements of the real against the US\$, which is the main funding currency in international financial relations and thus denominator of most external obligations. Thus any increased demand for US\$ in international financial markets, e.g. as a result of rising redemption payments, can lead to immediate exchange rate movements as international investors attempt to sell liquid assets. This was especially apparent in the international

³ Another institution which was important for the provision of "liquidity" in the times of crisis is the local futures and stock exchange (BM&F). The fact that margins at the exchange could be withdrawn in the crisis without any restrictions also contributed to the impression of the safe convertibility of the Brazilian real.

financial crisis of 2008: as international financial conditions turned, the large stock of foreign participation in Brazilian assets funded in US dollar and the liquidity with which these assets were traded led to a huge sell-off of Brazilian assets and one of the largest exchange rate depreciations among emerging markets.

2- Liquidity and Brazilian Assets as International Portfolio Assets

Graph 1 shows the behaviour of the Brazilian current and financial account – excluding transactions with the IMF - from the beginning of 2000 until June 2009. While the current account was strongly positive since the first quarter of 2003, net financial flows oscillated around zero until mid 2005 and picked up sharply at the end of 2006.



Source: Central Bank of Brazil (BCB) 2009.

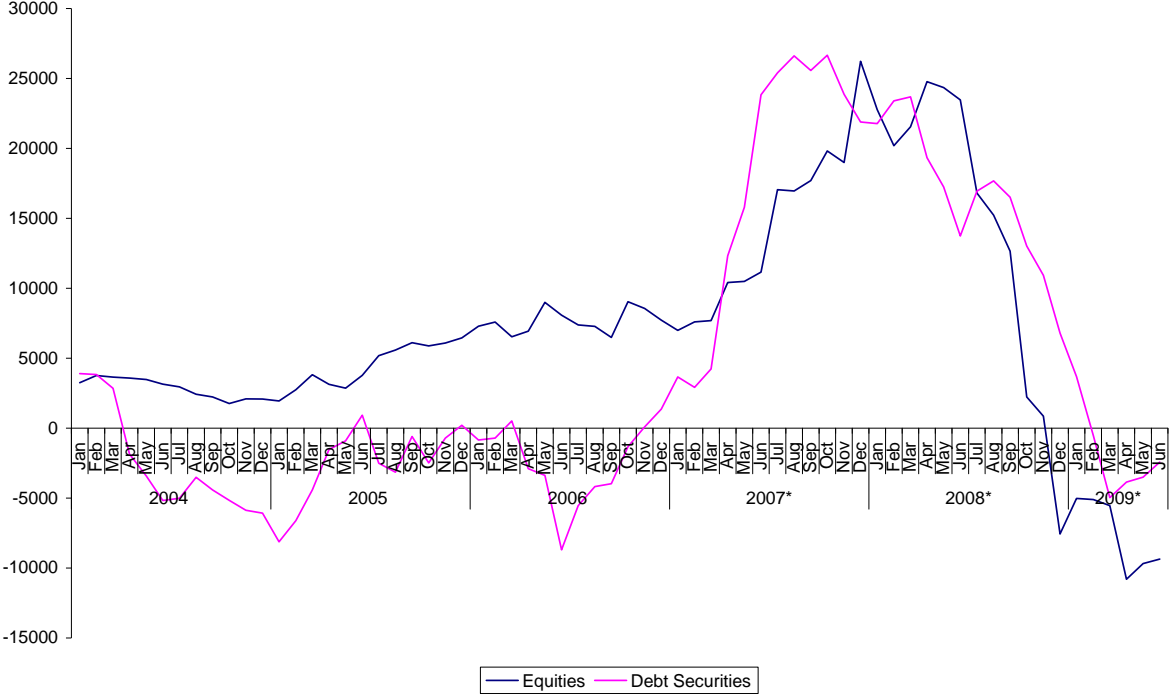
The dynamics of capital flows to Brazil reflect international market conditions. As a result of strong liquidity and the falling profitability of core businesses of international financial institutions, alternative and riskier investment classes experienced a common upturn in mid 2005⁴.

Graph 2 gives a more detailed picture of the behaviour of net portfolio flows between the beginning of 2004 and June 2009⁵. While remaining relatively stable (debt securities) or on a moderate upward trend (equities) over most of 2006 both stock market and fixed income investment experienced a substantial surge in the first quarter of 2007. More concretely, while there was a net inflow of portfolio investment of US\$33 billions between 2006 and middle of

⁴ Indeed, the start of the housing bubble in the US and the general increase in commodity prices is located around the same time. One hypothesis is that the inversion of the yield curve in the US during this period contributed to the turn to alternative asset classes. Arbitrage operations along the yield curve represent a core business of international banks, which had to turn to alternative sources of income as the curve inverted.
⁵ Net portfolio flows are essentially driven by foreign investment as portfolio investment abroad by Brazilians is still relatively low (in contrast to Brazilian foreign direct investment and banking flows which have shown a substantial increase over recent years as part of the internationalisation process of the Brazilian economy).

2007, the country received US\$41 billions between the summer 2007 and September 2008 when the international financial crisis hit Brazil.

Graph 2: Foreign Portfolio Investment (US\$ million)

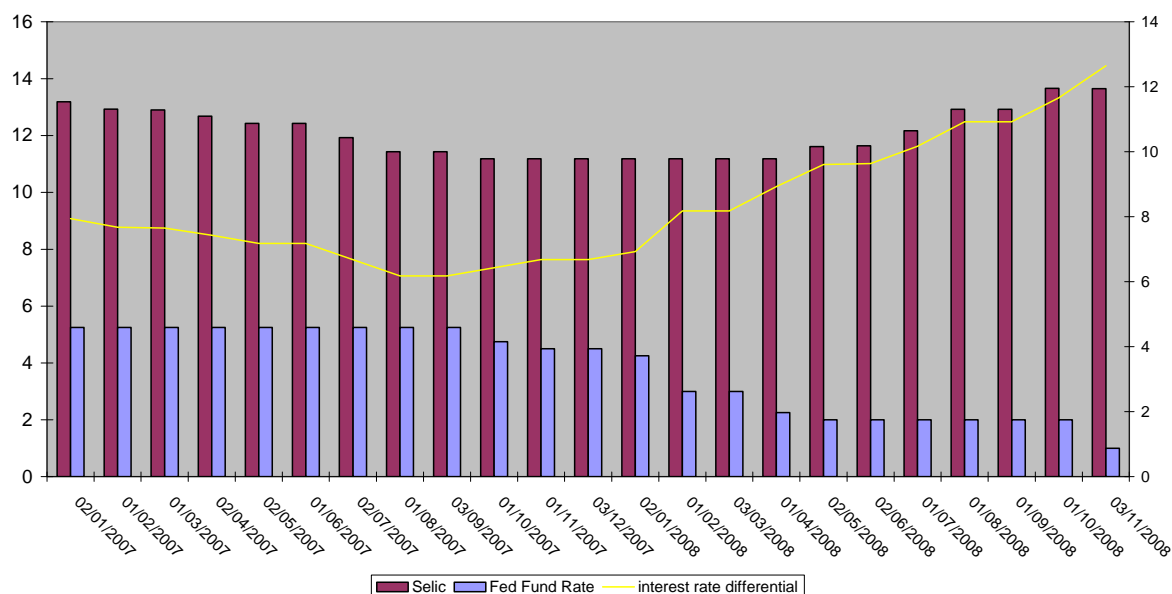


Source: BCB 2009.

Again, this reflects international financial market conditions: the observed surge in short-term capital flows to Brazil coincided with the first signs of the international financial crisis as repayment rates of sub prime mortgages in the US started to deteriorate and concerns about investments in the developed financial system emerged. Thus, as uncertainty increased in the international financial system, so did the demand for very short-tem and high yielding financial assets. These were offered by the Brazilian financial system. In addition, this search for high yielding and very liquid assets continued as the international financial crisis hit the developed world in August 2007. Falling profitability in developed financial markets – as prices of financial assets started to decline and the Federal Reserve decided to lower its main policy rate to deal with the effects of the crisis – lead to a hunt for “yield” around the globe, mainly into emerging countries with high real interest rates and sound fundamentals.

Graph 5 shows the interest differential between the Federal funds rate and the Selic, Brazil’s overnight rate, which – after a continued decline beforehand – started to rise again in August 2007-exactly when the international financial crisis struck.

Graph 3: Interest rate differential (%)



Source: BCB 2009

Interest rate developments in the US – with the US\$ being the main funding currency of international investments – were reinforced by the Brazilian central bank’s monetary policy decisions. In the midst of the financial crisis inflation concerns due to continuous high commodity prices prompted the central bank to further hike domestic policy rates. However, while this had little effect on commodity prices - which are determined in international markets – it gave further impetus to foreign capital inflows, especially in fixed income instruments.

However, returns in the Brazilian financial market were not only shaped by interest rate characteristic. Continuous exchange rate appreciation contributed substantially to capital gains on domestic assets.

Graph 4: CRB Commodity Index and Nominal Exchange Rate BRL/US\$



Sources: BCB 2009 and Bloomberg

Indeed speculation on future currency appreciation was one of the main carry trade operations in the Brazilian financial market before the outbreak of the financial crisis – and has been since then. As can be seen from graph 4 the exchange rate appreciated from nearly 4 in 2002 to 1.5 in the first week of August 2008, thus allowing strong capital gains in domestic currency⁶. This in turn created a situation of self-fulfilling expectations as continuing capital inflows further supported the exchange rate appreciation. Another sign of continuing exchange rate appreciation was the ongoing rise in commodity prices which had become tightly linked to developments in the Brazilian real⁷.

In addition to their high yields, the rising liquidity of Brazilian assets made them an increasingly attractive asset class for internationally operating financial institutions. The short-term nature of domestic assets and the commitment of the central bank to provide liquidity to the market, allowed quick re-conversion into US\$ dollar and thus active trading and protection against rising uncertainty in the wake of the crisis.

The increased internationalisation of Brazilian assets started with the renewed interest in emerging market assets around the beginning of 2005 and was exacerbated as the international financial crisis struck in the developed world. Beyond previous experiences with short-term capital flows, which were primarily directed at investment in the country and dominated by debt relations by a few specialist institutions, during this period Brazilian assets became standard part of international portfolios and an internationally traded asset class. This is also reflected in the rising participation of alternative investor groups, such as hedge funds

⁶ The volatility in 2002/2003 is linked to election uncertainty and concerns about the government's debt payment capacity.

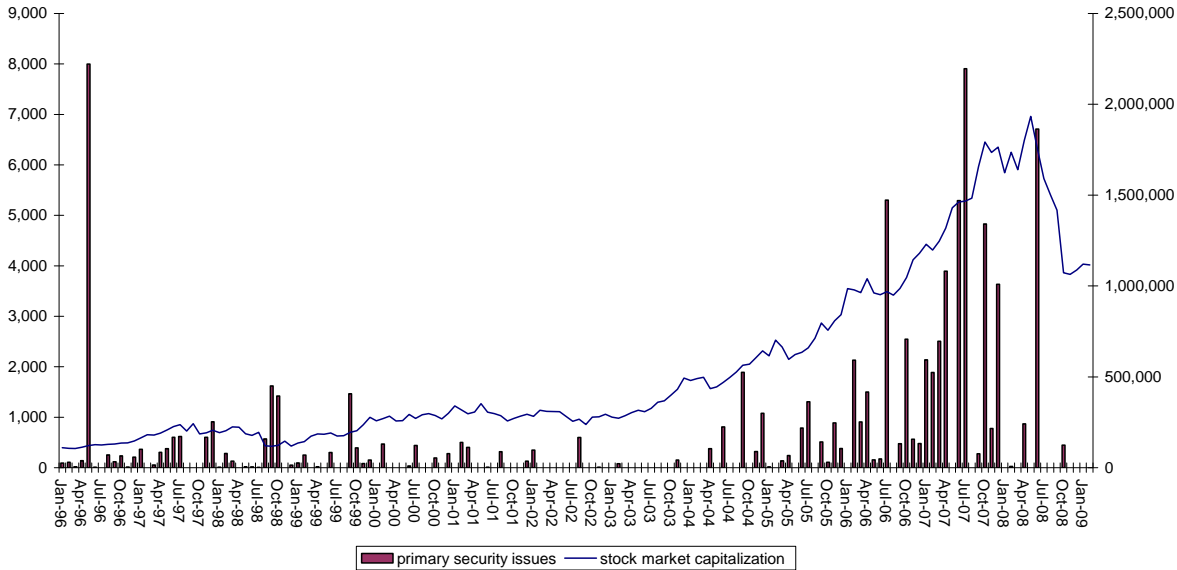
⁷ The relationship between Brazil's exchange rate and commodity prices is complex and circular. On the one hand, commodities and emerging market currencies are objects of the same investor class, aiming for high risk and high return assets (for the role of speculation for commodity prices see Newman, 2009). On the other hand, higher commodity prices directly affect external balances of several emerging countries further tightening the link between these two asset classes.

and private equity firms that are loosely regulated in the developed countries, highly leveraged and pursue unconventional, speculative and risky investment strategies (Chandrasekhar, 2008).

The new stage of integration of Brazilian assets in international financial markets and the importance of trading activities also manifest themselves in new forms of financial linkages and capital flows, for which capital gains are an important part of returns. Beyond debt flows, derivative and equity investment have become increasingly dominated by foreign investors. While this is a new phenomenon for equity and debt securities, this development is especially novel for the currency, the Brazilian real, which has become one of the widest traded emerging market currencies.

Graph 5 shows the substantial rise in primary security issues and capitalization of the Brazilian stock market. Although parts of this was driven by domestic investors, above outlined balance of payments flows testify to the increasing involvement of foreign investment in the Brazilian stock market. Indeed according to data of the local stock exchange (Bovespa) the foreign participation in Initial Public Offerings (IPOs) increased from 48% in 2005 to 76% in 2007.

Graph 5: Stock Market - Bovespa (R\$ millions)



Source: BM&FBovespa

Details on asset holdings of international financial institutions – especially by country origin – are hard to obtain. At the same time, data on the foreign participation in domestic stock market issues, as presented above, might underestimate the true importance of foreign investors in Brazilian assets due an increasingly liquid and active off-shore market. The international data company, Emerging Market Portfolio Research (EPRF), has country-specific data of the asset holdings of globally operating equity funds. Although this data still makes an estimation of absolute values of Brazilian equity titles in international portfolios difficult, it gives an interesting notion of the relative importance of Brazilian equities in international portfolios.

Table 1 shows the percentage share of selected emerging markets' equity titles in the portfolio of three different equity fund groups at the end of September 2008⁸.

Table 1:

Country	Funds and Total Funds Size		
	GEM Funds (US\$ 103 billion)	Global (ex US) Funds (US\$ 107 billion)	Global Funds (US\$ 66 billion)
Brazil	14.41	1.29	1.01
China	11.34	1.31	1.03
South Korea	10.26	1.24	1.13
India	7.14	0.94	0.38
Chile	0.76	0.07	0.08
Mexico	6.11	0.44	0.33
Russia	8.44	0.53	0.47
Turkey	3.04	0.24	0.08
South Africa	6.83	0.87	0.28

Source: EPFR Global

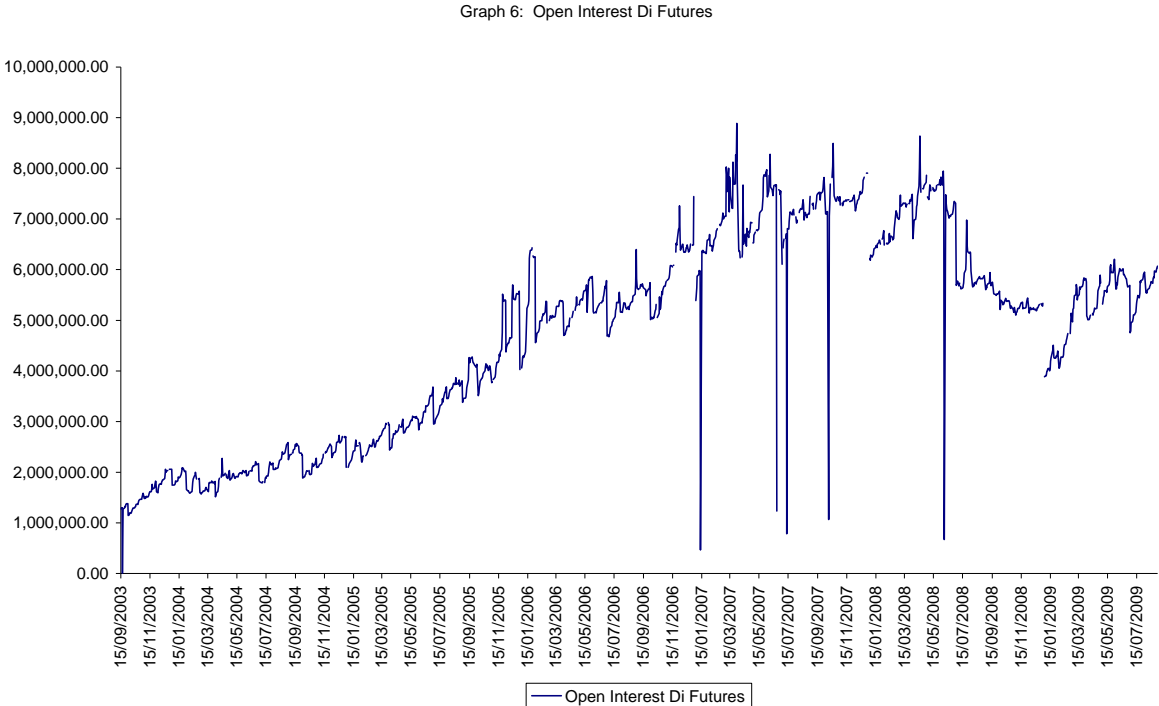
Notes: percentages are simple averages; GEM stands for Global Emerging Market Funds; the data presented are based on a trial sample and have not been purchased; please do not replicate

The importance of Brazilian equity titles in the portfolios of international funds is evident. For emerging market funds Brazilian assets top the league with a share of nearly 15%. For Global Funds Brazil is only overtaken by China and South Korea. For Global Funds (including the US) Brazil's share reaches 1.29%. This is nearly as high as the share of Italy (1.32%) and Spain (1.48%).

The liquidity of Brazilian financial assets – characterized by increasingly deep markets dominated by very short-term maturities – fuelled the participation of foreign investors in domestic asset classes and allowed their active trading. Probably the most obvious manifestation of this process is Brazil's huge derivative market, both in relation to the underlying financial markets and the economy as a whole. According to the Financial Times (8th of June 2009), Brazil's derivative and stock exchange, the BM&F Bovespa, is already bigger by market value than the NYSE Euronext, Nasdaq OMX and the London Stock Exchange.

⁸ These values are the outstanding stock to emerging market assets in September 2008, after large parts of the exposure to this investment group had already been reduced. Thus one can assume that the exposure was considerably larger before and during the first stage of the international financial crisis. In addition, although the absolute size of these holdings might be relatively small, the positions of foreign hedge funds - as will be discussed below – are directional for the entire market.

Graph 6 shows the increase in outstanding open contracts in the DI futures market⁹.



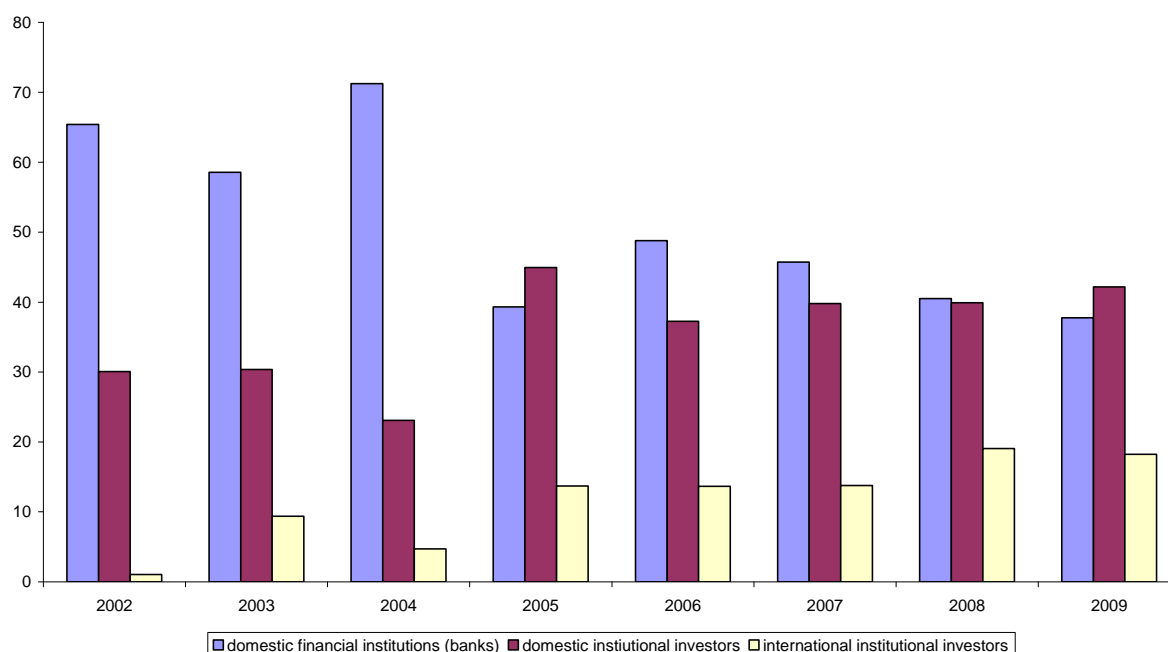
Source: Global Insight

Outstanding contracts increased continuously until the outbreak of the international financial crisis in August 2007 and – after a short dip – continued to do so until September 2008, when the international financial crisis finally hit Brazil. At its peak the weekly average of outstanding contracts stood at nearly 9 billion contracts. According to Costa et al. (2007) over the first half of 2006, average daily transaction volume in the DI futures market was six times that of the secondary market for fixed-rate government bonds. Thus, although partly driven by increased hedging needs as a result of rising issue of real-denominated fixed rate government debt, interest related futures seem to have become a substitute for underlying fixed income instruments. This has, among other things, been facilitated by a marked concentration in short-term maturities. According to data of the BM&F, more than 60% of outstanding contracts in the DI futures are of maturities of less than one year, while 94% of the contracts are of maturities of less than 2 years.

⁹ The Di rate is the average interest rate on overnight repurchase agreements that are collateralized by private securities and is compiled by the CETIP, a private clearing house.

Graph 7 shows the share of different investors groups in DI futures contracts.

Graph 7: DI Futures - Average Share of Market Participation (%)



Source: BM&FBOVESPA.

Notes: Data are from the 10th of January of each year.

One can observe a continuous increase in the foreign participation in DI futures, which reached its peak of above 20% before the crisis hit Brazil¹⁰. The foreign participation is even higher for futures which, in addition to the interest rates spread, also take account of the exchange rate variation (DI x US Dollar Spread Futures Contract). The share of foreign institutional investors in this instrument attained more than 20% at the beginning of October 2009.

The importance of foreign investors in Brazilian fixed income instruments is also reflected in the international funds data. Table 2 presents the share of bond titles of selected emerging markets in the portfolios of international bond funds:

Table 2:

Country	Funds and Total Funds Size	
	Dedicated Emerging Market Bond Funds (US\$ 21 billion)	International Bond Funds (US\$ 17.5 billion)
Brazil	14.6	1.00
China	0.49	0.13
South Korea	0.23	1.31
India	0.29	0.00
Chile	0.46	0.00
Mexico	7.57	1.79
Russia	10.43	0.21
Turkey	7.91	0.08

¹⁰ According to an official at the BM&F, foreigners like trading DI futures because they can do this with there standard analytical tools which they use for developed markets.

South Africa	2.17	0.34
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Source: EPFR Global

Notes: percentages are simple; the data presented are based on a trial sample and have not been purchased; please do not replicate

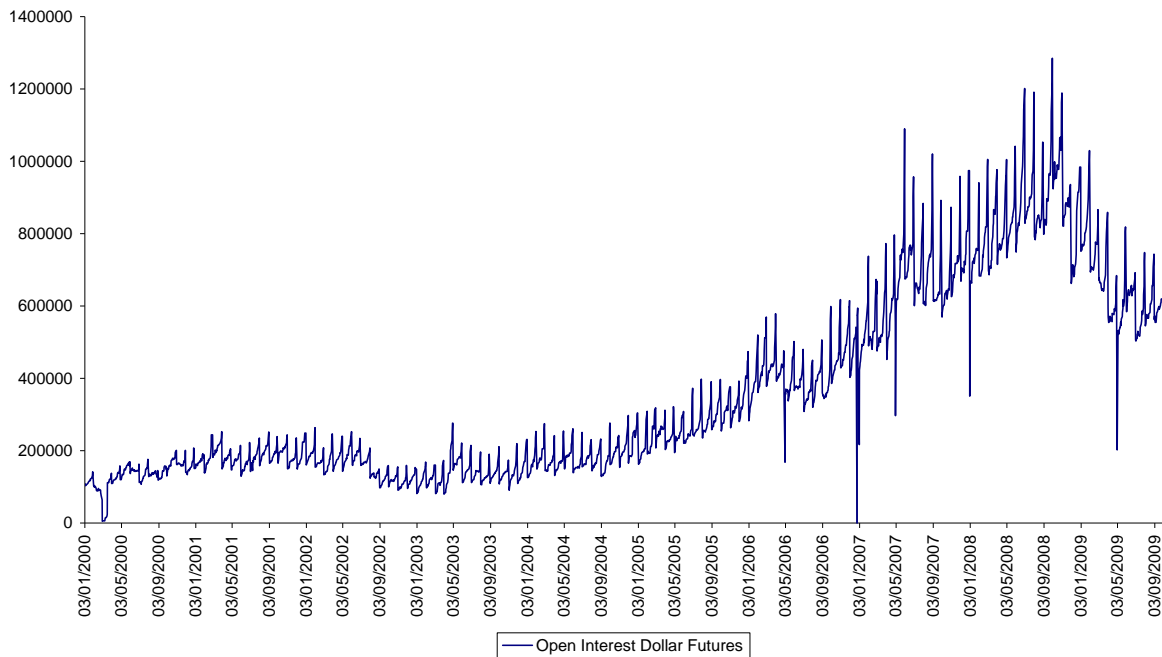
The share of Brazilian bond title in the portfolios of international funds is very large. For those funds specifically dedicated to emerging markets it widely surpasses the share of any other country and tops the league with nearly 15%. For international funds, only Mexico and South Korea have a larger exposure to foreign investment.

The increased importance of Brazilian assets in the portfolios of international investors is not limited to short-term portfolio investments, but also extends to the country's currency, the Brazilian real. The presence of a deep derivative market, concentrated in very short maturities, facilitated the active trading of currency by domestic and especially foreign investors. In addition, the willingness of the central bank to act as counterparty to foreign exchange transactions in both the appreciation and depreciation period provided liquidity to the market contributing to the attractiveness of the currency.

Indeed, in addition to persistent interest rate differentials and sustained exchange rate appreciation, the ability to quickly re-convert foreign investments into the funding currency is crucial for the success of carry-trade operations. The ability to do so quickly and at low cost in emerging foreign exchange market has contributed significantly to their attractiveness for international investors. As one financial market participant from the city of London put it "...the majority of people that play into the emerging market side do that on the currency side, because it is probably the most liquid of the asset classes within the emerging market arena...certainly in terms of being able to get in and out, the fx would be the best way of expressing your opinion on that market...".

Graph 8 shows the increase in open contracts in US\$ futures. While hovering around 200.000 contracts in early 2000, this reached an average of 1.000.000 contracts before the international crisis hit Brazil in September 2008. It stood around 650.000 contracts at the end of September 2009.

Graph 8: Open Interest Dollar Futures



Source: BM&FBOVESPA.

The average daily trading volume between May and June 2008 was around R\$30 bn, and reached values of R\$41 bn during the height of the crisis in September/October 2008. This compares to a daily volume of operations of around R\$4,4 bn and R\$5,5 bn on the spot market for the same period. Thus contrary to what happens in the rest of the world the size and depth of Brazil's derivative market has by far surpassed that of its spot market and in many instances replaced the underlying spot market. Indeed, many Brazilian financial market participants argue that the price of the exchange rate in the Brazilian market is formed in the futures rather than the spot market (for econometric evidence see Ventura, 2008). Again this partial substitution of the underlying market by derivative instruments was aided by the extreme short-maturities traded on the exchange. According to data from the BM&F more than 85% of the trading volume in the US\$ future were of a maturity of one month. 98% of the volume traded was in maturities up to two months.

This deep derivatives market concentrated on very short-term maturities has supplied domestic and especially foreign investors with the possibility to trade the Brazilian currency as an international asset class with the option of immediate exit. In addition, the possibility to trade on the derivative market rather than the underlying cash market has fuelled the increased participation of foreign investors. As pointed out by Saxena and Villar (2008) foreign exchange swaps are a cost-efficient way to fund financial market operations across jurisdictions. To keep a balance sheet in different jurisdictions that grants access to the money market/interbank market raises the cost of trading. In addition, operating on the derivative market allows much higher leverage as the only immediate cash transactions involved are the deposits of margins at the exchange¹¹. Derivative markets may also create new arbitrage opportunities across local financial markets, encouraging new trading strategies and thus profit opportunities for financial institutions (see BIS, 2009:Chapter E). Finally, remaining

¹¹ However, the high leverage of institutions operating on the derivatives market implies that the resulting exchange rate exposure will be much higher compared to exposure in the underlying asset, which will exacerbate price dynamics in both the appreciation and the depreciation phase.

restrictions on the cash market has meant that foreign players migrated to the derivatives market.

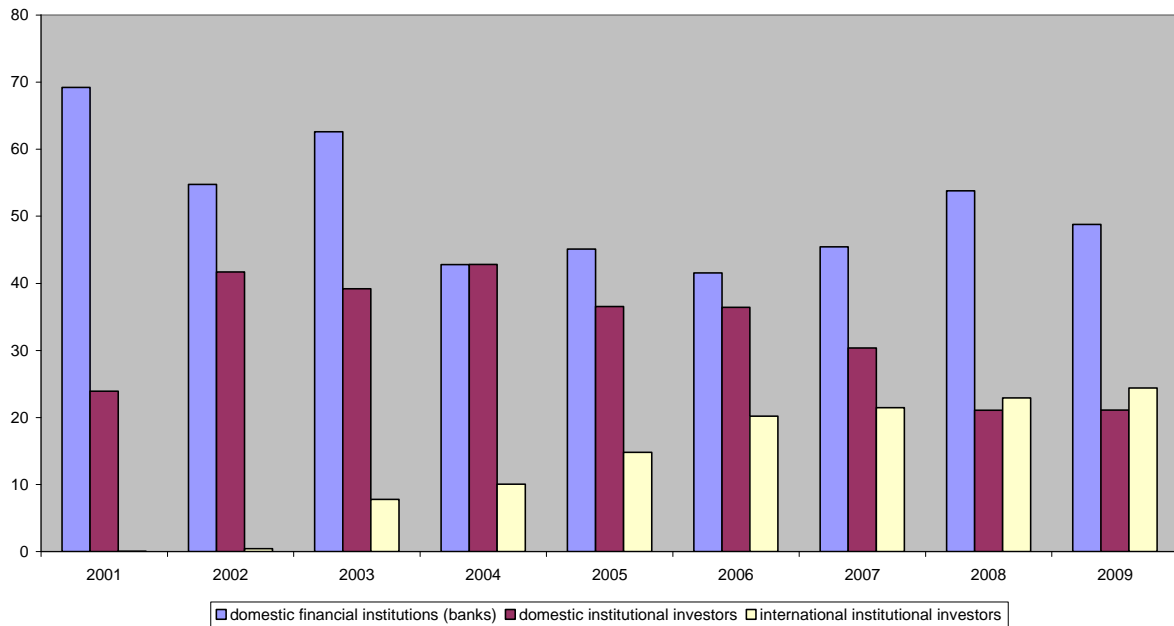
However, the role of Brazil's highly liquid derivatives market in contributing to the increased participation of foreign investors in Brazilian assets goes beyond financial applications on the futures market itself. First, the possibility to hedge any foreign exchange exposure in other financial applications, mainly the stock market, renders these investments increasingly attractive for foreign investors. The possibility to hedge against exchange rate risk with little actual resources involved is an important factor in the time of capital inflow or "normal" times. However, it assumes special importance in the times of crisis when exchange rate depreciation materializes. Second, even depositing a margin at the local exchange might be considered too costly or complex by many international investors. The existence of a deep and liquid derivative market, however, makes it possible for international, and to a smaller extent domestic banks, which have an account with the local exchange to sell domestic currency off-shore and hedge their exposure locally. This in turn has contributed substantially to the trading of Brazilian real on off-shore over the counter (OTC) markets¹². The importance of the local exchange is also reflected in a still relatively low share of Brazilian exchange rate futures traded on the Chicago Mercantile Exchange (CME). In September 2009, the monthly volume traded was 2,800 contracts. The accumulated annual trading volume to this date was 20,264 contracts¹³.

Graph 9 shows the share of three different investor groups domestic financial institutions (banks), domestic institutional investors (basically domestic hedge funds) and foreign institutional investors (international funds), in US\$ dollar futures open contracts. Foreign investors' share has clearly increased over recent years and reached nearly 25% in the beginning of 2009. It had increased to more than 33% in the beginning of October 2009, mainly at the expense of domestic financial institutions, whose share stood at 36% at the same time. Interestingly, the share of domestic hedge funds has declined substantially over recent years, standing at slightly above 20% in the beginning of October 2009.

12 The overall importance of the off-shore market for the Brazilian real is difficult to estimate. Interviews with foreign currency traders based in Brazil paint a varied picture depending on their institutions involvement on the off-shore market. However, most traders do seem to agree that the share of Brazilian real traded off-shore might reach 50% if not more. However, given that most of this exposure will be hedged on the local BM&F, this data remains a good representation of the importance of currency trading and the participation of foreign institutions therein.

¹³ That having been said, current attempts to further promote the internationalisation of the Brazilian real include the increased trading of BRL future contracts on the CME.

Graph 9: US Dollar Futures - Average Share of Market Participant (%)



Source: BM&FBOVESPA.

Note: Data are from the 10th of January of each year.

While positions of domestic banks in the US\$ futures market are partly driven by hedging needs, the operations of domestic and foreign funds are completely speculative by nature. Having no client base on their own, bets on future exchange rate developments by these institutions are pure carry trade operations. Indeed, according to a survey study with foreign currency traders operating in the Brazilian market, positions in the first US\$ futures to bet on future exchange rate changes have been the most common carry trade operation in the Brazilian market¹⁴. In addition, traders opined that the most important actors in the Brazilian market engaging in such carry trade operations are domestic and especially foreign hedge funds. Although a Brazilian characteristic of the recent crisis was the large speculative positions domestic companies, mainly big exporters, had in US\$ futures and the proprietary desks of domestic banks also engaged in such operations, foreign funds are still considered to be the most important actors for market and exchange rate dynamics, given the size of their exposure and the leverage they operate on.

3- The Brazilian Real as International Portfolio Asset – Empirical Evidence

If the claim was true that the Brazilian real has become an internationally traded currency, determined by speculative (carry trade) positions of international investors, one should observe a co-movement between the real and other currencies with similar characteristics. For example if international investors unwind their positions, may it be in response to declining risk tolerance or increased funding difficulties, one would expect currencies with the same risk-return-liquidity configuration to move together (Brunnermeier et al., 2009).

¹⁴ Qualitative results of this paper stem from 3-month fieldwork in Sao Paulo and Rio de Janeiro between April and June 2009. During this stay 30 interviews were conducted with currency traders, most of them proprietary or head traders, of the main financial institutions operating in the Brazilian foreign exchange market. This includes domestic and foreign banks and domestic hedge funds. The interviews were of a semi-structured nature, each lasting between half an hour and two hours. Not all 30 interviews have been analysed in detail to this date. Though the above results are still preliminary, they hold in general terms for the entire sample.

In addition to the Brazilian real, four currencies are considered: the Australian and New Zealand dollar, the Turkish Lira and the African Rand. The first two currencies are the most liquid and widely traded carry trade currencies. In addition, their movements are closely associated with commodity prices, partly as a result of their export profile, partly as a result of their functions as carry trade currencies¹⁵. The other two currencies are among the most widely traded emerging market currencies. Although also having an interesting carry (as a result of a sustained high interest rate differential with funding currencies, e.g. the Japanese Yen), they are perceived to be of slightly higher risk, mainly due to sustained current account deficits. Movements of the South African Rand are also closely associated with commodity prices, due to the country's dependence on the mining sector.

Table 3 shows the average daily turnover of the four currencies in April 2007.

Table 3:

Currency	Total Foreign Exchange Turnover
Brazilian Real	11,112
Australian Dollar	205,226
New Zealand Dollar	58,735
South African Rand	28,523
Turkish Lira	4,691

Source: Bank of International Settlement (BIS, 2007)

Notes: Data are daily averages in US\$ millions for April 2007

To analyse the relationship between the Brazilian real and these currencies, co-movements in their levels, the first difference (returns) and volatility are considered. While the former is tested through cointegration analysis based on the Engle-Granger method, the latter is modelled through multivariate VAR-GARCH models. The series are daily and expressed in their natural logarithm. The data period is chosen from the 1st of July 1999, when Brazil officially introduced its inflation targeting regime, until the 9th of September 2009.¹⁶

Graph 10 and 11 show the co-movement of the four currencies over this period.

¹⁵ The complex relationship between commodity prices and carry-trade currencies has been mentioned in a prior footnote. Once a currency has been identified as commodity currency by the market – often irrespective of the actual export profile – any increase in commodity prices will indicate future appreciation, fuelling carry trade positions to take advantage of the expected appreciation and thus self-validating and exacerbating the actual exchange rate appreciation.

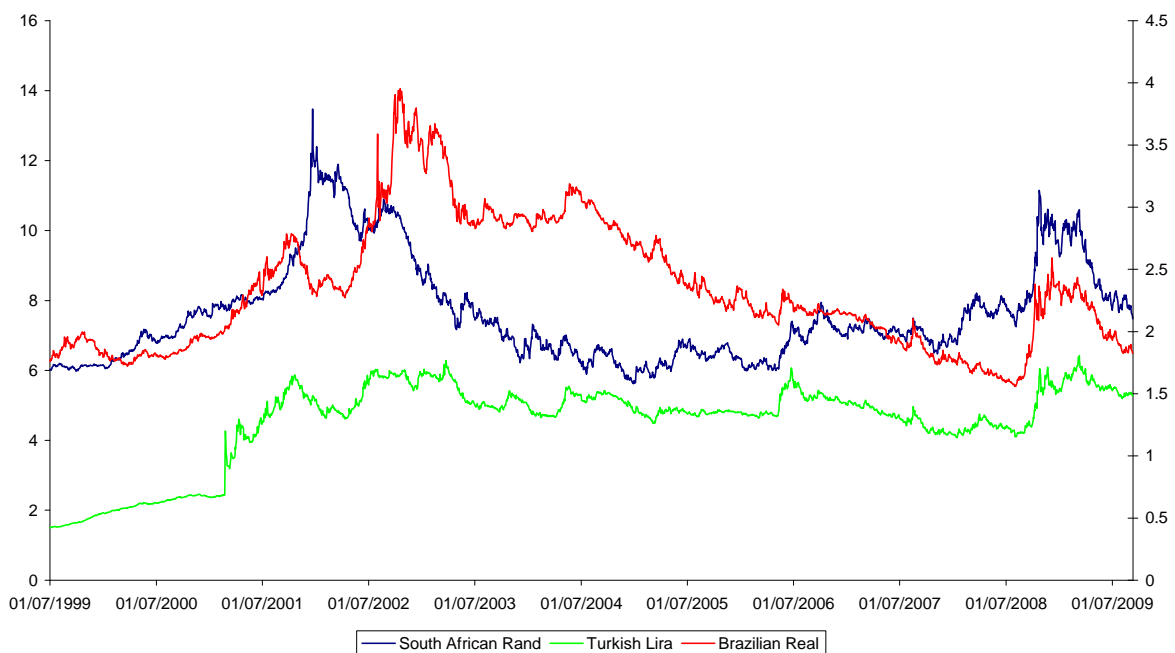
¹⁶ Since 1999 the central bank of Brazil has officially been operating under an inflation targeting regime. In this institutional arrangement monetary policy is primarily directed to keep the current inflation within a pre-announced band. To do so, the interest rate functions as the main policy instrument, whereas the exchange rate should only enter in the central bank's objective function if its dynamic adversely affects the inflation target. Nevertheless, the central bank has been an active operator in the foreign exchange market throughout the period, which is most openly expressed in the substantial accumulation of foreign exchange reserves (see e.g. Kaltenbrunner and Paineira, 2009). This, however, has changed little in the substantial exchange rate volatility (in both directions) experienced during this period.

Graph 10: Brazilian Real , Australian and New Zealand Dollar



Source: Datastream

Graph 11: Brazilian Real, Turkish Lira and South African Rand



Source: Datastream

Following an argument by Granger (1986), the existence of a cointegration relationship between different currencies has been primarily used to test for weak form market efficiency. If prices are weakly efficient they should incorporate all information available and should thus not be predictable. This, however, excludes a cointegration relationship, which is equivalent to the existence of an error correction term. A second strand of literature applies cointegration analysis to investigate for common stochastic trends of a system, especially for the European Monetary System (EMS) before the introduction of the Euro. The empirical results are, as

usual, mixed. Some authors (e.g. Baillie and Bollerslev, 1989, Sephton and Larsen, 1991) find evidence for cointegration and thus reject market efficiency in foreign exchange markets, others can continue to support market efficiency (e.g. Mac Donald and Taylor, 1989, Rapp and Sharma, 1999). In general, results crucially depend on the time period under observation. Cointegration is strongest between the exchange rates which participated in the EMS before the introduction of the Euro (Haug et al., 2000).

More interesting for this paper is a related, but alternative interpretation of a cointegration relationship between two currencies, which Kühl (2008) stresses in his paper: If two currencies vis-à-vis the same base currency are co integrated, they can be considered the same asset class (Dywer Jr. and Wallace, 1992, Ferré and Hall, 2002). This interpretation holds if perfect arbitrage between the currencies is possible. This could either be the result of a managed exchange rate strategy, such as in the EMS, or the fact that financial market participants consider the two assets very similar in their underlying characteristics.

To test for cointegration the Engle and Granger (1987) method is used. This choice is motivated by two considerations: first, the Johansen method as alternative strategy to test for cointegration is sensitive to heteroscedasticity in the data. However, ARCH effects are a common characteristic of high frequency exchange rate data. The advantage of the Engle-Granger method is that it allows taking into account “abnormal” error structures and might thus be more robust for high-frequency financial time series. Second, this paper is primarily interested in the bivariate relationship between the Brazilian real and the other currencies. Thus the loss of information by using a single equation rather than a system approach is not considered substantial.

Engle and Granger’s method is based on the definition of cointegration: if two series of the same order of integration produce a stationary error, these two series are characterised by a cointegration relation. Thus, in very simple terms, after pre-testing for the order of integration of the series, Engle and Granger’s method is based on the estimation of the cointegration relation and testing for the order of integration of the residual of this relationship. If cointegration is present, the relationship can be modelled in an error correction form.

Formally,

$$(1) x_t \sim I(1) \text{ and } y_t \sim I(1)$$

$$\text{if } x_t = c + y_t + \varepsilon_t \text{ and } \varepsilon_t \sim I(0).$$

Using Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) tests all variables are concluded to be I(1). Cointegration relationships are estimated for the Brazilian real and all other four currencies and the residuals are tested for stationarity. While the residuals between the Brazilian real and the New Zealand Dollar, South African Rand and the Turkish Lira exhibit substantial persistence, the error term between the real and the Australian dollar seems to fluctuate with relatively constant variance around its mean value from around 2005 onwards.¹⁷ This coincides with the time period, which was identified as the start of Brazil’s increased integration in international financial markets.

Thus, two time periods are estimated: one which spans over the entire sample period and one which starts in the beginning of 2005. For the entire sample period, no cointegration relation

¹⁷ Detailed results for all the currencies are not presented, but available upon request.

can be detected. However, estimating the relationship from 2005 onwards, some supporting evidence seems to exist. Equation (2) presents the test regression for stationarity of the residuals of the cointegration relationship between the Brazilian real and the Australian dollar between the beginning of 2005 and September 2009. To account for serial correlation in the test-regression an additional lag of the differenced residual is included. To control for persistent heteroscedasticity in the model, the regression is estimated with White heteroscedasticity consistent standard errors. Numbers in parentheses are t-statistics.

$$(2) \Delta(\varepsilon_t) = -0.015\varepsilon_{t-1} - 0.033\Delta\varepsilon_{t-1}$$

$$(-3.229) \quad (-0.561)$$

McKinnon (1991) critical values for a large number of observations and two variables are -3.9, -3.34 and -3.05 for a 1%, 5% and 10% significance level respectively. According to these critical values the null hypothesis of no cointegration (non-stationarity of the residuals) can be rejected at the 10% and almost at the 5% significance level.

If two variables are characterised by a cointegration relationship, they can be modelled in an error-correction framework. Moreover, if their relationship is stationary, standard critical values apply (Enders, 2003). Equation (3) shows the error correction model between the Brazilian real and the Australian dollar. Again, to account for serial correlation and heteroscedasticity, additional lags are included in the model and White Heteroscedasticity consistent standard errors are applied. Numbers in parentheses are t-statistics.

$$(3) \Delta brl = c - 0.009\varepsilon_{t-1} - 0.066\Delta brl + 0.095\Delta aus$$

$$(-2.32) \quad (-0.96) \quad (1.33)$$

While none of the lagged differences are significant, the Brazilian real, although with a relatively small magnitude, seems to significantly adjust to deviations from its “equilibrium” relationship with the Australian dollar since the beginning of 2005. Thus, one could argue that since the beginning of 2005, international investors have considered the Brazilian real and the Australian dollar as similar asset classes, trading the two currencies in a relatively tight band and arbitraging between them. The Australian dollar, however, has been one of the most liquid and widely traded carry trade currencies. In addition, the fact that strong arbitrage operations between the two currencies have been conducted, speaks of the increased liquidity and importance of trading in the Brazilian real¹⁸.

This quantitative evidence is supported and complemented by qualitative results from the survey study conducted with Brazilian foreign currency traders. Asked after which indicators they consider when taking position in the foreign exchange market, nearly all traders mentioned other currencies as important variables. A large part of the traders – interestingly with a higher proportion those operating in international banks or hedge funds – stated that the Australian dollar has become the most important currency to indicate future movements in the real. One trader of an international bank with large proprietary operations explained that arbitrage operations between the Brazilian real and the Australian dollar, both domestically and on off-shore markets, had become one of the most profitable currency trading strategies before and after the international financial crisis.

¹⁸ Another possible reason for the observed cointegration relationship between the Brazilian real and the Australian dollar could have been an attempt of the central bank to “peg” its currency to the Australian dollar. However, such exchange rate policy seems to be rather unlikely.

In a similar vein, one question asked the traders how they would compare the Brazilian real to other emerging market currencies. A large part replied that the Brazilian real is now one of the most liquid emerging market currencies with the deepest market among its peers. Indeed, for many traders the real has become an indicator for future movements of other emerging market currencies, rather than the other way around. A few traders even argued that the Brazilian real had entered an intermediate stage between emerging market currency and liquid and widely traded carry trade currency, such as the Australian dollar.

The existence of an “equilibrium relationship” between the levels of two currencies is a very restrictive condition on co-movement. Assets might be of similar characteristics if their returns or the volatilities of such returns affect each other. To study the relationship between the volatilities and co-volatilities of several markets multivariate GARCH models have been proposed (e.g. Bauwens et al., 2006, Silvennoinen and Teräsvirta, 2008). To appropriately model the returns, a VAR structure is frequently added to the mean equation of the GARCH model.

Multivariate GARCH models have been used to estimate the increased interdependence in international financial markets (Karolyi and Stulz, 2002). This includes on the one hand tests for increased correlation between domestic and international financial markets as a result of financial liberalization (e.g. Longin and Solnik, 1995, Bekaert and Harvey, 1995). On the other hand, multivariate GARCH models have been used widely to test for the existence of contagion as volatility from one market, most of the time an emerging market, spills over to other markets (e.g. Dungey et al., 2004, Marcal and Pereira, 2009). While in the first case, the interest lies in the increased financial correlation of returns over time, in the second case increased volatility spillovers in the time of financial dislocations are at the centre of analysis. This paper combines these two approaches: on the one hand, emphasis is on the volatility spillovers between similar markets, as in the financial crisis literature, however these are seen as a permanent phenomenon as the position of the Brazilian real as internationally traded currency leads to a co-movement with other currencies of similar asset characteristics.

The following conditional expected return equation accommodates each market’s own returns and the returns of other markets lagged one period.

$$(4) r_t = \alpha + Ar_{t-1} + \varepsilon_t$$

Where r_t is an $n \times 1$ vector of daily returns at time t for each market and $\varepsilon_t | I_{t-1} \sim N(0, H_t)$. The $n \times 1$ vector of random errors ε_t is the innovation for each market at time t with its corresponding $n \times n$ conditional variance-covariance matrix H_t . The market information available at time $t-1$ is represented by the information set I_{t-1} . The $n \times 1$ vector, α , represents long-term drift coefficients. This multivariate structure then enables the measurement of the effects of the innovations in the mean currency returns of one series on its own lagged returns and those of the lagged returns of other markets (the matrix A) (Worthington and Higgs, 2001).

To estimate the conditional variance-covariance matrix, the Baba-Engle-Kraft-Kroner (BEKK) model proposed by Engle and Kroner (1995) is applied. BEKK models have been, among others, applied to analyse the volatility transmission between and within developed and emerging stock markets (Worthington and Higgs, 2004, Beirne et al., 2008), bond markets (Ozon et al., 2007) and stock and currency markets (Fedorova and Saleem, 2009).

In general terms, multivariate GARCH models face a trade-off between modelling the volatility structure as accurate as possible and finding a specification which is parsimonious enough to allow for relatively easy estimation of the model. In addition, positive definiteness of the covariances has to be assured. The BEKK model has the attractive property that the conditional covariance matrices are positive definite by construction. In addition, it builds in sufficient generality, allowing the conditional variances and covariances to influence each other without requiring the estimation of a large number of parameters (Karolyi, 1995). That having been said, given that the entire variance and covariance structure is considered, models considering more than a few variables can quickly become infeasible to estimate. To avoid this and as the interest is only in the relationship between the Brazilian real and other currencies, only bivariate GARCH(1,1) models are estimated.

Following Engle and Kroner (1995) the BEKK parameterization of the conditional covariance matrix for a simple GARCH(1,1) can be written as:

$$(5) H_t = C_0' C_0 + \sum_{k=1}^K A_{1k}' \varepsilon_{t-1} \varepsilon_{t-1}' A_{1k} + \sum_{k=1}^K G_{1k}' H_{t-1} G_{1k}$$

Where c_{ij} are elements of an $n \times n$ symmetric matrix C_0 , which is restricted to be upper triangular. The elements a_{ij} of the symmetric $n \times n$ matrix A_{1k} measure the degree of innovation from market i to market j , allowing for own market and cross market influences in conditional variances. The elements g_{ij} of the symmetric $n \times n$ matrix G_{1k} indicate the persistence in conditional volatility between market i and j . Summation limit K determines the generality of the process.

For a bivariate GARCH (1,1) with $K=1$, this can be written as

$$(6) H_t = C_0' C_0 + \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} \varepsilon_{1t-1}^2 & \varepsilon_{1t-1} \varepsilon_{2t-1} \\ \varepsilon_{2t-1} \varepsilon_{1t-1} & \varepsilon_{2t-1}^2 \end{bmatrix} \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} + \begin{bmatrix} \beta_{11} & \beta_{12} \\ \beta_{21} & \beta_{22} \end{bmatrix} \begin{bmatrix} h_{1t-1} & h_{12t-1} \\ h_{21t-1} & h_{22t-1} \end{bmatrix} \begin{bmatrix} \beta_{11} & \beta_{12} \\ \beta_{21} & \beta_{22} \end{bmatrix}$$

Due to its matrix form, the parameters c_{ij} , a_{ij} and g_{ij} cannot be interpreted on an individual basis. Instead the functions of the parameters which form the intercept terms and the multivariate ARCH and GARCH effects are of interest (Tsay, 2005).

Equation 7 to 9 solve for the cross effects in the variance equations implied by the BEKK specification (Kasch-Haroutounian and Price, 2001).

$$(7) h_{11t} = c_{01} + a_{11}^2 \varepsilon_{1t-1}^2 + 2a_{11} a_{21} \varepsilon_{1t-1} \varepsilon_{2t-1} + a_{21}^2 \varepsilon_{2t-1}^2 + g_{11}^2 h_{11t-1} + 2g_{11} g_{21} h_{12t-1} + g_{21}^2 h_{22t-1}$$

$$(8) h_{12t} = c_{02} + a_{11} a_{12} \varepsilon_{1t-1}^2 + (a_{21} a_{12} + a_{11} a_{22}) \varepsilon_{1t-1} \varepsilon_{2t-1} + a_{21} a_{22} \varepsilon_{2t-1}^2 + g_{11} g_{12} h_{1t-1}^2 + (g_{21} g_{12} + g_{11} g_{22}) h_{12t-1} + g_{21} g_{22} h_{22t-1}^2$$

$$(9) h_{22t} = c_{03} + a_{12}^2 \varepsilon_{1t-1}^2 + 2a_{12} a_{22} \varepsilon_{1t-1} \varepsilon_{2t-1} + a_{22}^2 \varepsilon_{2t-1}^2 + g_{12}^2 h_{11t-1} + 2g_{12} g_{22} h_{12t-1} + g_{22}^2 h_{22t-1}^2$$

Volatility spillovers and volatility persistence from the other four currencies to the Brazilian real are reflected in the parameters a_{1j} and g_{1j} (where j = Australian Dollar, Newzealand Dollar, South African Rand and Turkish Lira).

The Broyden, Fletcher, Goldfarb, Shanno (BFGS) method is used to produce the maximum likelihood parameter estimates and their corresponding asymptotic standard errors. As recommended by Tsay (2005), the simplex method is used to refine the initial guess values. To test whether the model is correctly specified, the Ljung Box Q-statistic is employed to test for the randomness in the simple and squared noise term of the estimated MGARCH model. The Ljung Box Q-statistic is asymptotically distributed as Chi-Squared with $(p-k)$ degrees of freedom, where k is the number of explanatory variables.

Table 4 and 5 show the coefficients of the conditional mean equation and the volatility structure for the Brazilian real and the other four currencies under consideration. Two data periods are examined: first, the entire span of Brazil's inflation targeting regime from July 1999 to September 2009 and second the period from the beginning of 2005 onwards, which was identified as the beginning of Brazil's increased integration in international financial markets.

Table 4:

	Australian Dollar				New Zealand Dollar			
	Entire Period		Post 2005		Entire Period		Post 2005	
	Coefficient	P-Value	Coefficient	P-Value	Coefficient	P-Value	Coefficient	P-Value
Mean (1,1)	0.029	0.144	-0.004	0.891	0.027	0.168	-0.015	0.583
Mean (1,2)	0.057	0.002	0.030	0.373	-0.229	0.113	-0.006	0.804
Mean (2,1)	0.015	0.117	-0.112	0.411	-0.044	0.000	0.006	0.826
Mean (2,2)	0.011	0.518	0.011	0.677	0.033	0.033	<i>0.044</i>	0.084
C(1,1)	0.117	0.000	0.132	0.000	0.114	0.000	-0.128	0.000
C(2,1)	-0.004	0.806	-0.050	0.003	0.035	0.156	-0.066	0.044
C(2,2)	0.035	0.000	0.018	0.565	0.090	0.000	-0.089	0.000
A(1,1)	0.416	0.000	0.424	0.000	0.396	0.000	0.422	0.000
A(1,2)	0.003	0.705	-0.026	0.037	-0.011	0.290	0.003	0.916
A(2,1)	-0.013	0.502	-0.041	0.253	0.018	0.217	0.024	0.500
A(2,2)	0.174	0.000	0.171	0.000	0.197	0.000	0.226	0.000
G(1,1)	0.908	0.000	0.899	0.000	0.913	0.000	0.899	0.000
G(1,2)	-0.001	0.766	0.015	0.001	0.001	0.838	<i>-0.017</i>	0.092
G(2,1)	0.010	0.130	0.048	0.000	-0.015	0.022	<i>-0.025</i>	0.053
G(2,2)	0.983	0.000	0.974	0.001	0.973	0.000	0.960	0.000
MVQ	40.060	0.468	32.646	0.789	50.745	0.119	40.658	0.441
MVQ-SQ	47.300	0.199	33.784	0.745	57.783	0.034	28.738	0.907

Notes: the entire data period spans from the 1st of July 1999 to the 9th of September 2009; post 2005 ranges from the 1st of January 2005 to the 9th of September 2009; in contrast to the other currencies the New Zealand dollar is quoted as US\$/Domestic Currency; values in bold are significant at 5% level; values in italic are significant at 10% level;

Table 5:

	Turkish Lira				South African Rand			
	Entire Period		Post 2005		Entire Period		Post 2005	
	Coefficient	P-Value	Coefficient	P-Value	Coefficient	P-Value	Coefficient	P-Value
Mean (1,1)	-0.019	0.940	-0.033	0.269	0.030	0.133	0.008	0.791
Mean (1,2)	0.047	0.041	0.061	0.050	0.005	0.652	0.017	0.437
Mean (2,1)	0.022	0.273	0.004	0.870	-0.015	0.338	-0.024	0.472
Mean (2,2)	0.028	0.270	0.065	0.023	0.060	0.000	0.090	0.003
C(1,1)	0.103	0.000	0.097	0.000	0.126	0.000	0.131	0.000
C(2,1)	0.077	0.001	0.073	0.007	<i>0.026</i>	0.077	0.015	0.118
C(2,2)	0.117	0.000	0.107	0.000	0.067	0.000	0.095	0.000
A(1,1)	0.357	0.000	0.364	0.000	0.410	0.000	0.453	0.000
A(1,2)	0.037	0.118	0.060	0.029	0.021	0.104	0.095	0.000
A(2,1)	0.056	0.031	0.044	0.201	-0.003	0.818	-0.031	0.006
A(2,2)	0.396	0.000	0.395	0.000	0.266	0.000	0.201	0.000
G(1,1)	0.934	0.000	-0.939	0.000	0.909	0.000	0.894	0.000
G(1,2)	-0.011	0.211	0.010	0.251	<i>-0.001</i>	<i>0.058</i>	-0.026	0.000
G(2,1)	<i>-0.020</i>	0.054	0.021	0.094	0.004	0.348	0.016	0.000
G(2,2)	0.912	0.000	-0.908	0.000	0.965	0.000	0.988	0.000
MVQ	24.876	0.919	37.537	0.582	52.903	0.083	39.003	0.515
MVQ-SQ	35.726	0.482	57.305	0.037	30.845	0.850	20.222	0.996

Notes: the entire data period spans from the 1st of July 1999 to the 9th of September 2009; post 2005 ranges from the 1st of January 2005 to the 9th of September 2009; the entire period for the Turkish Lira ranges from 1st of January 2003 to 9th of September 2009; values in bold are significant at 5% level; values in italic are significant at 10% level;

MV and MV-SQ indicate coefficient and significance level of the Ljung-Box Q-statistic on the residuals and its squares. All models fit the data well, except for the New Zealand dollar for the entire period and for the Turkish Lira from 2005 onwards for which the null hypothesis is rejected at the 5% significance level. However, it is still valid at the 10% significance level and inference should thus still be possible.

The mean equations are generally not very significant. While for the whole inflation targeting period returns in the Australian dollar seem to affect returns on the Brazilian real, this result does not hold any more from 2005 onwards. Returns on the Turkish Lira, on the other hand, seem to have consistent effects on returns of the Brazilian real. According to Brazilian foreign currency traders, the Turkish lira and the Brazilian real have traditionally been traded as similar asset classes based on their risk characteristics and similar financial structures. As one trader put it ... “the Turkish lira is a good indicator of risk taking”... in financial markets. However, some traders have also pointed out that this link has become looser over recent years, due to Brazil’s improved fundamentals, most notably the current account and the vast amount of international reserves held by the central bank. As outlined above, the Australian dollar has become an increasingly important reference point for currency traders to judge future movements in the Brazilian real. As such, there seems to have been a structural change in the perception of the drivers of the Brazilian real. Beyond traditional high-risk, high-return emerging market currencies, liquid international commodity and carry trade currencies have become the reference point for the currency.

This qualitative evidence is supported by the estimated conditional variance covariance equations: while not significant for the entire inflation targeting period, there seem to be significant volatility spillovers (represented by A(1,2) and A(2,1)) and volatility persistence (G(1,2) and G(2,1)) between the Brazilian real and the Australian and New Zealand Dollar and the South African Rand for the period starting in 2005. This evidence is particularly strong for the Austrian dollar and the South African Rand, which show strong and bi-directional volatility persistence. Thus, past volatility shocks in these currencies will affect

future volatility of the Brazilian real, and vice versa. In addition, for both currencies, higher volatility in their returns will spill over to the Brazilian market (again for the South Africa Rand this relationship is bi-directional) There also seems to be some evidence of volatility spillovers from the Turkish lira to the Brazilian real. Finally, all series have significant own volatility spillovers (ARCH effects, reflected in the parameters A(1,1) and A(2,2)) and significant volatility persistence (GARCH effects represented by G(1,1) and G(2,2).

Table 6 and 7 show the coefficients of the mean equations and volatility parameters of the five currencies for the international financial crisis from August 2007 to December 2008 and the period since then¹⁹.

Table 6:

	Australian Dollar				New Zealand Dollar			
	Crisis		Post-Crisis		Crisis		Post-Crisis	
	Coefficient	P-Value	Coefficient	P-Value	Coefficient	P-Value	Coefficient	P-Value
Mean (1,1)	-0.140	0.019	-0.078	0.325	-0.109	0.050	-0.112	0.213
Mean (1,2)	0.081	0.313	<i>0.183</i>	0.081	0.006	0.896	<i>-0.133</i>	0.072
Mean (2,1)	-0.006	0.853	-0.127	0.042	-0.012	0.835	0.004	0.972
Mean (2,2)	0.042	0.476	0.085	0.290	-0.009	0.879	<i>0.000</i>	0.999
C(1,1)	0.174	0.002	-0.682	0.000	0.181	0.000	0.303	0.018
C(2,1)	0.030	0.370	0.052	0.733	-0.358	0.000	-0.423	0.005
C(2,2)	0.000	0.999	0.000	0.999	0.000	0.999	0.000	0.999
A(1,1)	0.440	0.000	0.137	0.126	0.602	0.000	-0.440	0.000
A(1,2)	-0.020	0.419	-0.356	0.000	-0.131	0.180	0.590	0.000
A(2,1)	0.027	0.787	-0.280	0.065	0.091	0.133	-0.233	0.014
A(2,2)	0.249	0.000	0.587	0.000	<i>0.138</i>	0.052	0.516	0.000
G(1,1)	0.892	0.000	-0.403	0.211	-0.700	0.000	-0.521	0.000
G(1,2)	0.007	0.384	-0.299	0.053	1.150	0.000	-0.707	0.000
G(2,1)	0.018	0.534	-0.592	0.039	0.215	0.214	0.366	0.000
G(2,2)	0.970	0.000	-0.596	0.004	0.760	0.000	-1.085	0.000
MVQ	35.990	0.651	40.716	0.439	29.723	0.883	34.573	0.712
MVQ-SQ	31.757	0.821	35.989	0.651	18.430	0.998	35.047	0.693

Notes: the crisis period spans from the 1st of August 2007 to the 31st of December 2008; the post-crisis period is from the 1st of January 2009 until the 9th of September 2009; values in bold are significant at 5% level; values in italic are significant at 10% level;

Table 7:

¹⁹ The decision to “end” the crisis period in December 2008 was mainly based on observed exchange rate dynamics of the countries under consideration. Most countries experienced their weakest point in this month and then started, though with some volatility, to appreciate again.

	Turkish Lira				South African Rand			
	Crisis		Post-Crisis		Crisis		Post-Crisis	
	Coefficient	P-Value	Coefficient	P-Value	Coefficient	P-Value	Coefficient	P-Value
Mean (1,1)	-0.070	0.272	-0.126	0.194	-0.140	0.027	-0.046	0.644
Mean (1,2)	0.010	0.840	0.200	0.085	-0.005	0.924	0.070	0.432
Mean (2,1)	-0.090	0.093	-0.083	0.265	-0.065	0.326	-0.282	0.012
Mean (2,2)	0.116	0.044	0.129	0.164	0.023	0.672	0.260	0.005
C(1,1)	0.021	0.774	0.921	0.009	0.101	0.356	0.000	0.997
C(2,1)	0.514	0.000	0.383	0.151	0.426	0.000	0.001	0.992
C(2,2)	0.375	0.000	0.000	0.999	0.000	0.999	0.000	0.999
A(1,1)	0.491	0.000	-0.092	0.588	0.510	0.000	-0.187	0.030
A(1,2)	0.309	0.000	0.230	0.033	0.420	0.000	-0.063	0.593
A(2,1)	-0.116	0.161	0.077	0.642	-0.029	0.661	0.191	0.010
A(2,2)	-0.599	0.000	-0.394	0.003	0.048	0.599	0.195	0.085
G(1,1)	1.073	0.000	-0.402	0.478	0.613	0.000	-0.918	0.000
G(1,2)	0.630	0.000	0.122	0.650	1.216	0.000	-1.583	0.000
G(2,1)	-0.318	0.000	-0.224	0.239	-0.999	0.000	1.251	0.000
G(2,2)	0.040	0.813	-0.965	0.000	-0.670	0.000	1.098	0.000
MVQ	46.069	0.236	44.933	0.273	39.123	0.510	41.611	0.401
MVQ-SQ	28.740	0.907	42.850	0.350	54.009	0.069	32.568	0.792

Notes: the crisis period spans from the 1st of August 2007 to the 31st of December 2008; the post-crisis period is from the 1st of January 2009 until the 9th of September 2009. Values in bold are significant at 5% level; values in italic are significant at 10% level;

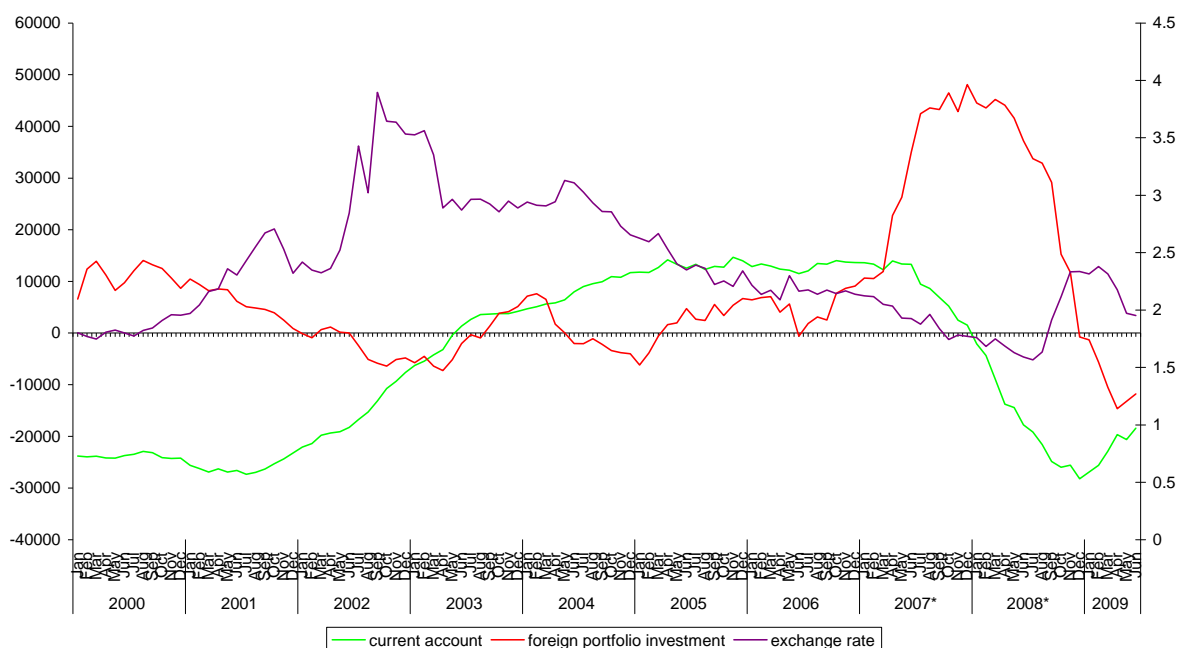
As to the coefficients of the mean equations, one can observe significant effects of past own returns for the Brazilian real in the crisis period (Mean (1,1)). The coefficients are negative which could point to some form of overshooting in exchange rate values during the crisis which is corrected in following periods. Another interesting fact with reference to the mean equations, is the significant effect of past returns of the Australian dollar and the South African rand on the Brazilian real for the post-crisis period. This could give further evidence of the increasing role of these currencies for dynamics in the Brazilian exchange rate.

Again, this is supported by the conditional variance-covariance equation. While not significant during the crisis period, one can observe significant variance spillovers and volatility persistence between the Brazilian real and the Australian and New Zealand dollar and the South African rand since the crisis. While for the former two the spillovers are bi-directional, the variance of the Brazilian real seems to affect the South African rand, rather than vice versa. Interestingly, during the crisis, volatility spillovers only exist between the Brazilian real and the two emerging market currencies. However, while volatility persistence is bi-directional, variance seems to spill over from the Brazilian real to the other currencies. Thus, in the crisis moment, volatility spillovers are again more prevalent among emerging market currencies, where however volatility in the Brazilian real seems to spread to other markets.

4 – Exchange Rate Dynamics

The increased use of Brazilian assets in international portfolios and their international trading has important implications for exchange rate dynamics: on the one hand it exacerbates exchange rate movements on the appreciation as well as the depreciation side; on the other hand exchange rate dynamics become increasingly de-linked from domestic economic conditions, reflecting international portfolio considerations rather than traditional economic “fundamentals”. Graph 12 shows the 12-month moving sum of the current account, the exchange rate and short-term financial capital flows to the Brazilian economy.

Graph 12: Exchange rate vs. Current Account and Portfolio Flows (US\$ million)



Source: Central Bank of Brazil, Balance of Payments Statistic

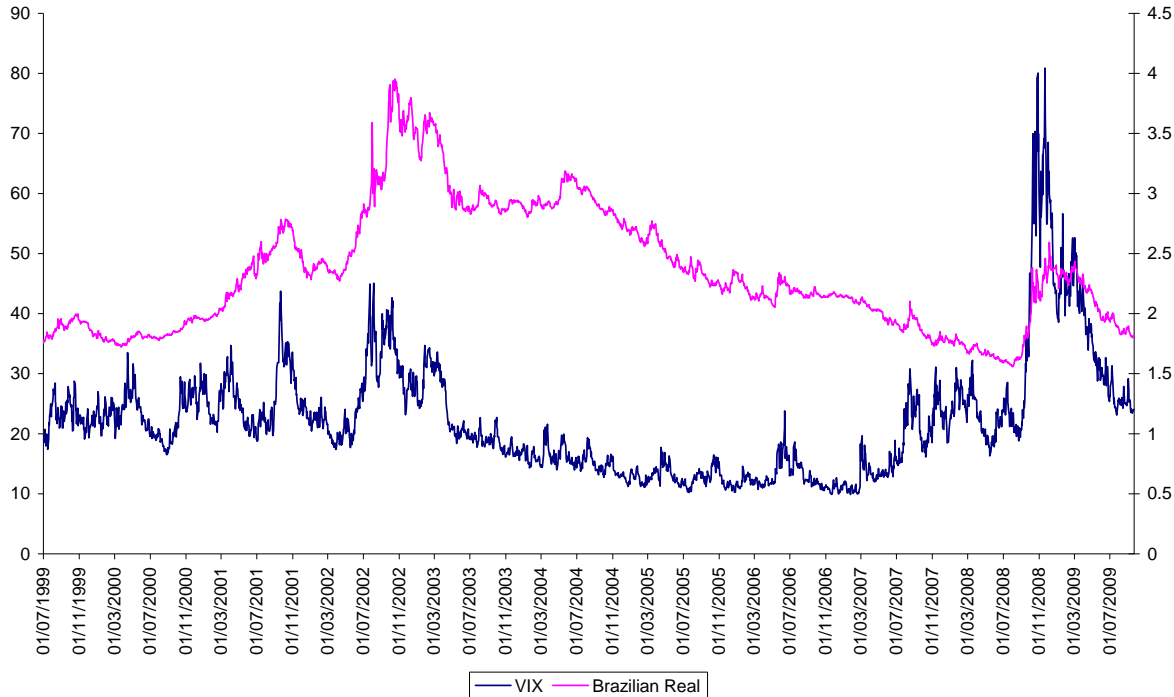
One can observe the large swings in the exchange rate: Despite substantial intervention by the central bank the currency appreciated from nearly R\$ 4 at the end of 2003 to close to R\$ 1.5 to the US dollar in August 2008, to then loose around 60% again until the beginning of December 2009. Although not totally independent from current account dynamics – the positive current account from the beginning of 2003 onwards contributed to initial stages of the exchange rate appreciation – one can observe the driving role of short-term capital flows, both for the appreciation as well as the crisis period²⁰. As already mentioned in the previous section these capital flows were mainly driven by short-term yield considerations to take advantage of the considerable real interest rate differential between developed and the Brazilian financial markets. In addition, the continuous exchange rate appreciation allowed substantial capital gains on these “carry trade operations”.

Graph 12 and 13 show the Brazilian real and the S&P500 and the VIX respectively. The VIX, a popular measure of the implied volatility of S&P500 index options, is often used as a gauge for market mood or risk aversion (Franke et al., 2008). Traded on the CBOE, it is not mechanically linked to exchange rates since it is derived from equity options. Nevertheless, one can observe a strong co-movement of this indicator of international market conditions and the Brazilian real. As global risk or risk aversion increases, so does the Brazilian real as international investors quickly adjust their portfolios to alternative investments. In addition to portfolio adjustment, funding constraints are likely to be particularly important during financial dislocations when global risk or risk aversion increases (Brunnermeier et al., 2009: 5). Interestingly, and in line with the above mentioned, the relationship seems to break down partly between mid 2007 – when the international financial crisis hit the developed world –

²⁰ Indeed, rather than a total de-link from underlying economic conditions, the increasing importance of short-term capital flows leads to an overshooting of the exchange rate beyond “fundamentals” to either capitalize on the expected exchange rate appreciation or avoid capital losses in the event of a depreciation. In Kaltenbrunner(2008) I attempt to present a theoretical framework based on Post-Keynesian economic thought about the nature of such “fundamentals”, which are defined as indicators of a country’s ability to repay its outstanding external obligations. Current work seeks to substantiate this theoretical work empirically.

and September 2008 when it also affected Brazil²¹, as falling returns and increased uncertainty in the developed world were compensated by investments in high yielding and very liquid assets in the Brazilian market.

Graph 12: VIX and Brazilian Real

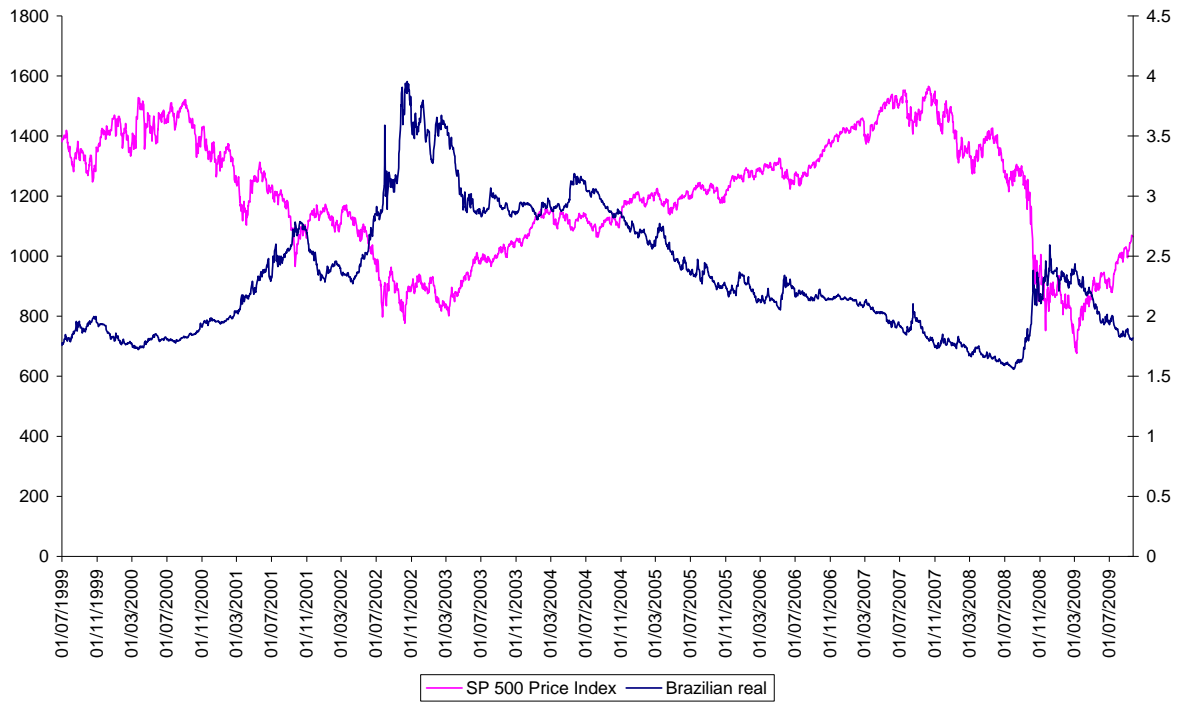


Source: Datastream

The co-movement between the Brazilian real and the S&P500 is striking. Similar to emerging market currencies, equities are considered higher risk assets and thus traded as a similar asset class. In addition, the rising importance of short-term foreign equity investment flows has tightened the link between the Brazilian real and international equity markets. Again, this relationship only breaks down in the first stage of the international financial crisis.

²¹ This is at least true for the trend. Increased volatility in the VIX is still reflected in “profit taking” during the sustained appreciation trend of the Brazilian real.

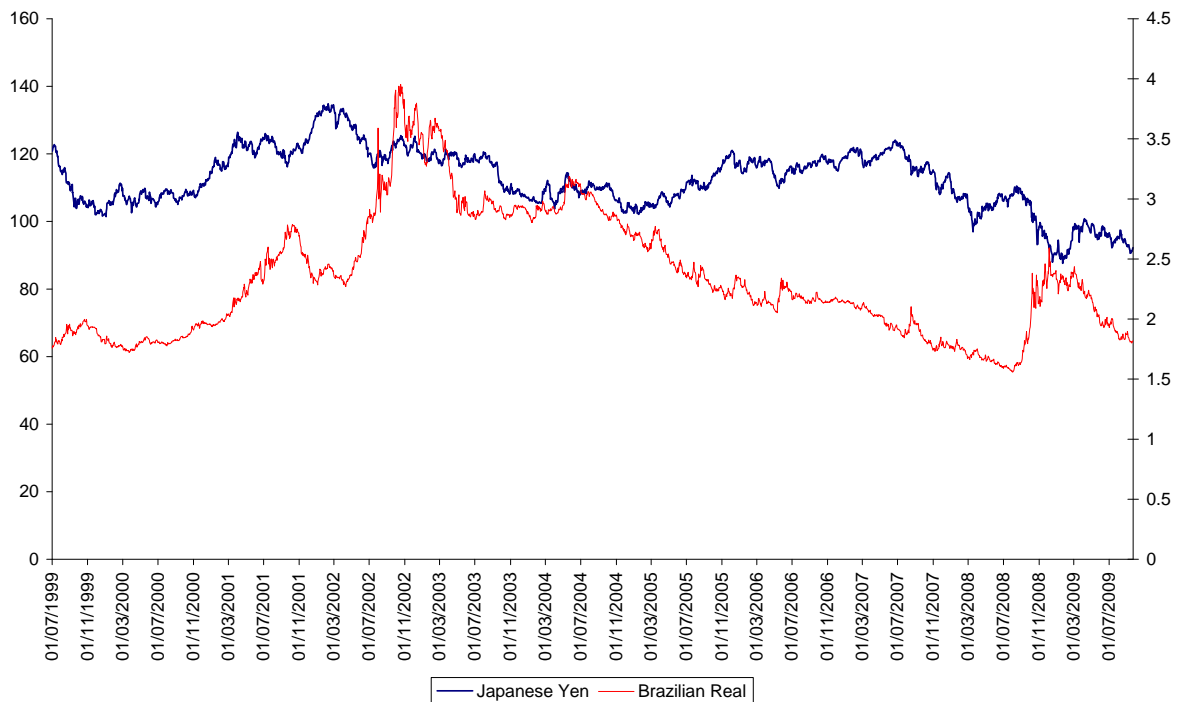
Graph 13: SP500 and Brazilian Real



Source: Datastream

The role of international portfolio diversification and adjustment can also be observed in the relationship between the Brazilian real and the Japanese Yen.

Graph 14: Japanese Yen and Brazilian Real



Source: Datastream

When asked for the novelty of the role of emerging market currencies in international portfolios, one financial market participant trading emerging market assets from the City of London pointed out that due to the increasing correlation between G10 currencies and other developed financial market indicators, international financial institutions move further and further away from their core business into exotic markets, such as Brazil, to gain diversification on their portfolio. This relationship is nowhere as clear as with the pronounced negative co-movement between the Brazilian real and the Japanese yen. The opposing relationship between these two currencies has been further exacerbated by the fact that the Japanese Yen has acted as main funding currency for international carry trade operations.

The importance of external conditions and the role of portfolio adjustment for exchange rate dynamics become most apparent in the moment of crisis. Despite good “fundamentals” (see Table 1) – Brazil had become a net creditor and although turning the current account was still in a good shape – the Brazilian real depreciated by more than 60% between August and December 2008.

Table 8:

Box Fundamentals (as % GDP)						
	Dec-06	Jun-07	Dec-07	Mar-08	Jun-08	Sep-08
Current Account	1.3	0.8	0.1	-0.6	-1.0	-1.7
Fiscal Position (primary surplus)	3.3	3.6	3.5	3.9	3.9	4.1
Public sector net debt	45.9	45.0	43.9	42.6	41.8	40.0

Source: ECB (2009)

This was one of the highest exchange rate depreciations among emerging countries. While most countries were affected by the international deleveraging process, this process was especially severe for Brazil for two reasons: First, as shown above, the share of Brazilian assets in international portfolios was one of the highest among emerging countries. At its peak in the middle of 2008, the total outstanding stock of foreign liabilities in the Brazilian economy reached US\$1 trillion. Second, the liquidity of the Brazilian market, characterised by its concentration in short-term maturities and the willingness of the central bank to provide foreign currency to the market, meant that the country’s assets were among the first and with largest volume to be sold. This was reflected first in the exchange rate’s value in the first week of August 2008 and accelerated markedly in September with the failure of Lehman Brothers.

Table 9 shows the depreciation of selected currencies against the US\$ dollar between the beginning of August and the first week of December 2008. The second column shows the appreciation of the same currencies since then. The volatility of the Brazilian real is striking: not only is it the currency which depreciated by far the most in the international financial crisis, it has also re-gained more than any other currency since then.

Table 9:

Currency	Depreciation in Crisis	Appreciation
Brazilian Real	66%	-27%
Australian Dollar	23%	-8%
New Zealand Dollar	30%	29%
Turkish Lira	39%	-5%
South African Rand	44%	-19%
Russian Rouble	20%	-5%
Hungarian Forint	40%	-7%
Indonesian Rupiah	30%	-14%

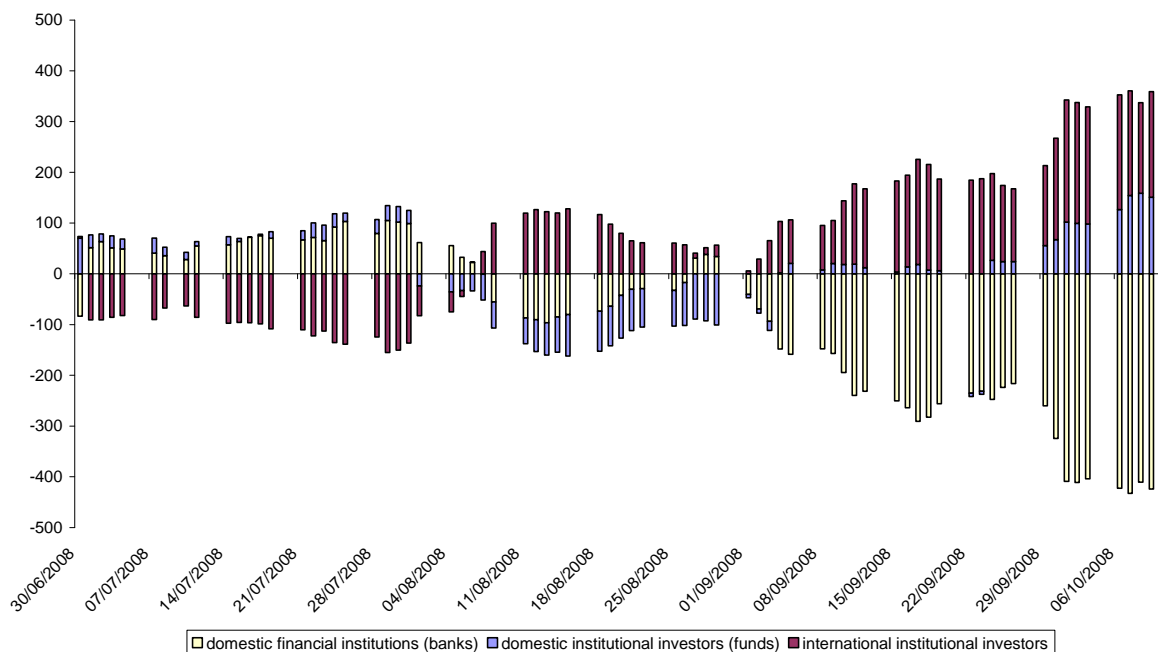
Philippine Peso	11%	-1%
Chilean Peso	34%	-17%
Mexican Peso	38%	-6%
South Korean Won	46%	-6%
Polish Zloty	49%	-6%

Source: Datastream

Notes: crisis period: 1st of August 2008 to 5th December 2008; appreciation period: 1st January 2009 to 23rd October 2009

The claim that it was portfolio adjustment by international investors rather than underlying “fundamentals” that led to the depreciation of the real can be supported with the data on open positions of foreign institutional investors in the US\$ futures market. After years of sustained exchange rate appreciation, the exchange rate turned in the first week of August 2008 and continued to depreciate thereafter. This change in the currency’s tendency coincided exactly with the change of positions of foreign investors in the US dollar futures market.

Graph 15: Net Open Interest in Dollar Futures per Market Participant



Source: BM&FBOVESPA 2009.

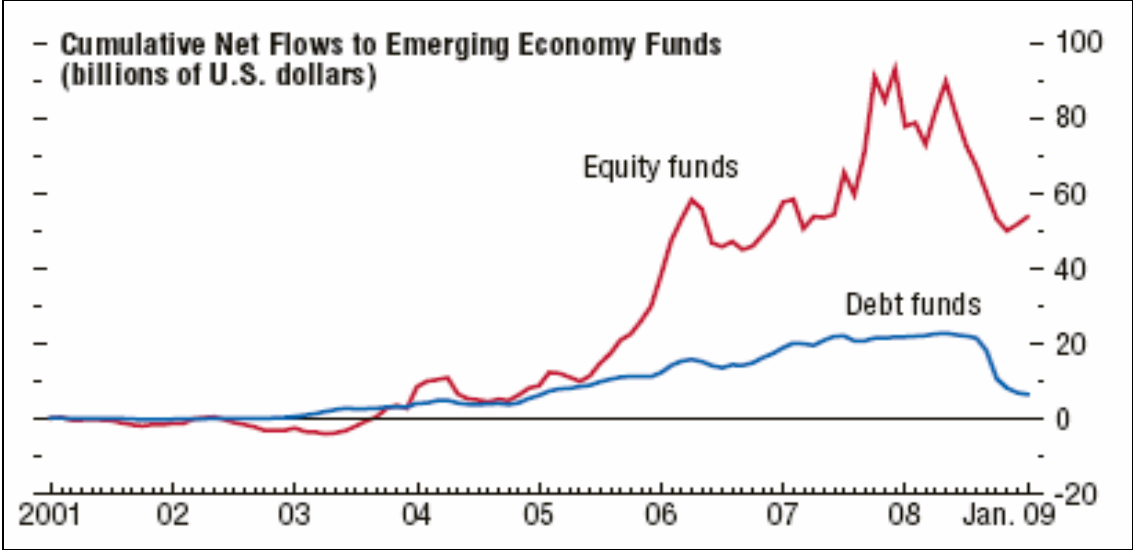
Foreign investors had maintained short US\$ positions (negative sign) since the beginning of the sustained appreciation trend in the middle of 2004 and kept their positions all the way through the outbreak of the international crisis in August 2007. Although switching to long positions in times of increased market uncertainty, e.g. at the near failure of Bear Sterns, the tendency for short positions remained even during the first stage of the financial crisis. In the first week of August 2008, however, these investors assumed long US\$ positions, partly to hedge their exposure in domestic assets markets, partly to speculate against a future real depreciation.

The hypothesis that it was positions taken by foreign investors on Brazil’s futures market which determined exchange rate dynamics during the crisis is further supported by actual

foreign exchange flow data of the central bank²². According to this data the balance of commercial and financial foreign exchange transactions in August and September 2008 were positive (with a surplus of US\$ 1.9 and US\$ 2.8 bn respectively). Nevertheless, despite the inflow of foreign exchange during this period, the exchange rate started to depreciate at the same time as foreign investors changed their positions in the derivative market²³.

Further evidence of this general deleveraging process is presented in Graph 16 which shows cumulative net flows to emerging economy funds for equity and bond market investment.

Graph 16:



Source: IMF; 2009: 113
Emerging Portfolio Fund Research

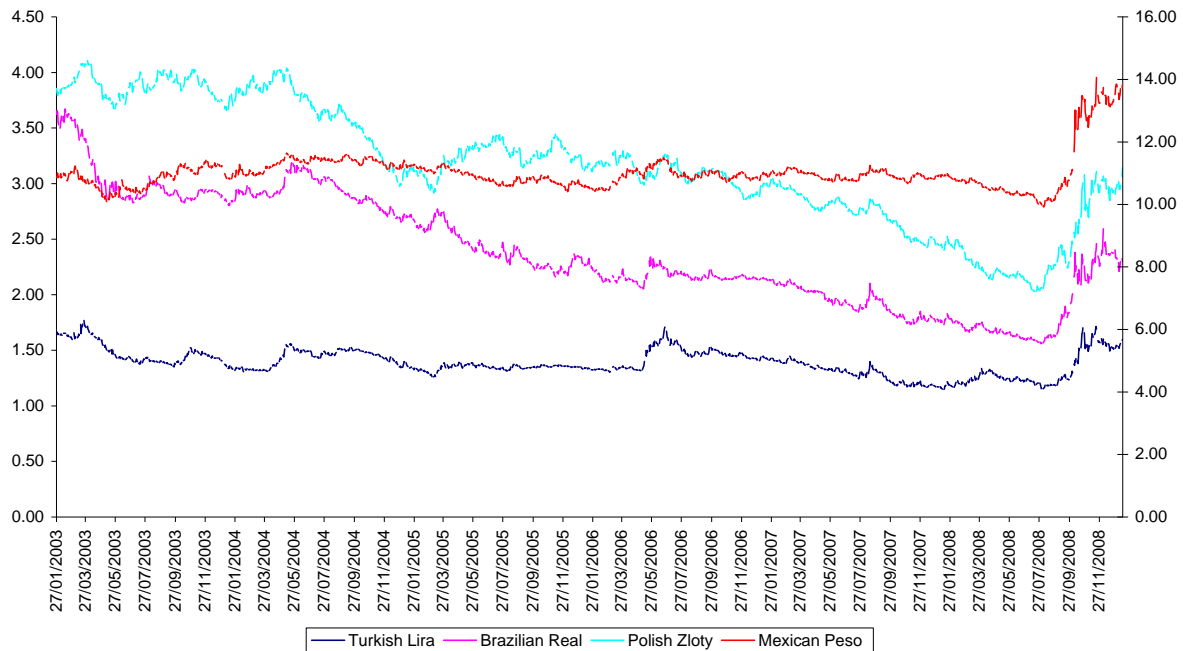
Flows to emerging equity markets experienced a last surge in the first half of 2008 to then decline from around June 2008 onwards. Flows into debt markets were maintained even longer and started to decline around August 2008. At the same time the Brazilian real started to depreciate.

This general reduction in exposure to emerging market assets in the second half of 2008 is particularly evident in the behaviour of selected emerging market currencies. Graph 18 shows the Brazilian real, the Mexican peso, the Turkish lira and the Polish zloty since the beginning of 2003. Their general co-movement aside, it is impressive to note that all four currencies, from three different emerging market regions, experienced their turning point in the first week of August. Although similar financial market and macroeconomic characteristics might have contributed to this dynamic, this highly synchronized movement supports our hypothesis of international portfolio adjustment as main driving factor of exchange rate movements.

²² One problem of this data is that it doesn't take into consideration off-shore operations, which have become increasingly important for Brazilian exchange rate dynamics. However, in a way this just further supports our argument as the exclusion of off-shore operations will lead to an underestimation of the importance of foreign institutions.

²³ The positive foreign exchange balance in August and September 2008 was mainly due to continued strong trade balance. The balance of financial transactions had turned negative in April 2008. Increasing outflows on financial transactions, in turn, are reflected in banks' switch to short position in the US\$ futures market as they have to hedge their long positions in the spot market.

Graph 17: Emerging Countries Currencies



Source: Bloomberg.

The final trigger why emerging markets finally turned in August 2008 is difficult to pin down. Given the general leverage of the system and overexposure to this asset class by international investors any small trigger could have led to this final adjustment. Indeed, international financial conditions deteriorated further in July 2008 as a result of the bankruptcy of the state sponsored Fannie Mae and Freddie Mac. One could argue that these institutions' bankruptcies acted like a signal to markets participants that the extent of the system's leverage had reached its limit.

5 – Conclusions

This paper has argued that the liquidity provided by Brazilian financial assets has made them a standard part of international investors' portfolios. This development has been shown for short-term portfolio investments, equity and bond flows, and as a particularly novel development, the Brazilian currency, the real. The increased liquidity of Brazilian assets, defined as the ability to meet outstanding obligations and characterised by an increasingly short-term maturity, and crucially supported by the operations of the central bank, has allowed active trading of Brazilian assets on international financial markets. This in turn had important implications for exchange rate developments: on the one hand exchange rates have been characterised by large movements far beyond traditional "fundamentals"; on the other hand exchange rate dynamics have been increasingly de-linked from domestic economic conditions and have become increasingly vulnerable to conditions in international financial markets. This can be observed on daily exchange rate changes, but has become especially obvious in the recent financial crisis.

It is important to note that this argument is different from the normal contagion argument, in which fundamentals problems of one emerging country spread over to another country with apparently sound fundamentals. In the portfolio channel advocated here exchange rate behaviour becomes entirely de-linked from conditions in the country or emerging markets and merely a result of return considerations of international banks and institutional investors. This

also stresses the important difference in argument between traditional exposures to short-term capital flows and the new stage of financial integration presented in this paper. While traditionally capital flows, although of short-term nature, were thought of as *investment* in emerging countries and thus driven by considerations about *domestic* conditions (justified or unjustified), recent integration in international financial market has made emerging market assets *trading* instruments, making portfolio decisions increasingly independent of domestic economic conditions. This has also been reflected in the new assets involved, such as equity and currency investment, whose returns are fundamentally shaped by the existence of capital gains.

This increased dependence of exchange rate dynamics on conditions in international financial markets is a direct result of Brazil's increased integration in international financial markets. However, as domestic assets become an integral part of international portfolios their price developments come to be determined outside the country and increasingly de-linked from domestic economic conditions. In addition, it severely reduces the space of policy makers to influence price formation. While this can create risks in different asset markets, this development is considered especially detrimental in the case of the exchange rate. As history and theoretical literature shows the exchange rate is an important relative price for developing countries and can play an important role as development instrument. Thus a policy choice to forego the power to influence this important price, in the economy of an emerging country like Brazil, has to be seen critically from a development perspective.

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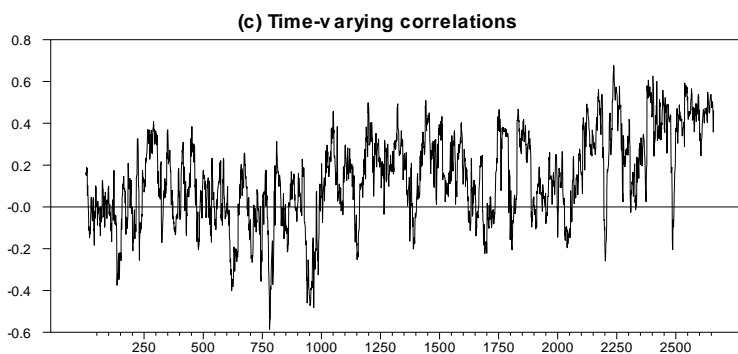
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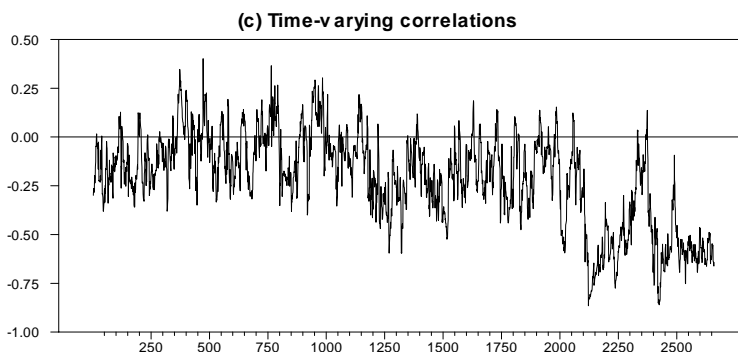
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Appendix: Time-Varying Correlations between Currencies (Entire Sample Period)

1. Brazilian Real – Australian Dollar

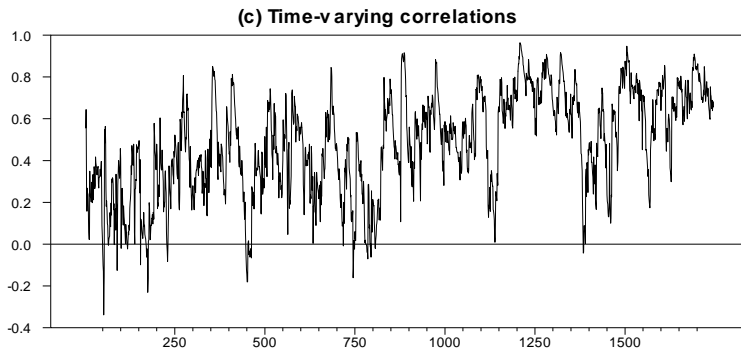


2. Brazilian Real – New Zealand Dollar



Note: The New Zealand dollar is quoted US\$/Domestic Currency; in this case, negative values also imply positive correlation

3. Brazilian Real – Turkish Lira



4. Brazilian Real – South African Rand

