The Case for an Intermediate Exchange Rate Regime with Endogenising Market Structures and Capital Mobility: An Empirical Study of Brazil

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Abstract

Set in the context of the recent theoretical and policy debates on appropriate exchange rate regimes for emerging market economies in a world of free capital mobility, the primary objectives of this paper are: i) to present the case for an intermediate exchange rate regime, drawing on recent theoretical and empirical literatures on behavioural finance and currency market structures; and ii) to examine empirically the experiences and evolution of the foreign exchange market in Brazil.

After a brief review of the policy debates in the introductory section (Section 1), we discuss theoretical discourses on appropriate exchange rate regimes for emerging market economies, drawing both on macroeconomic propositions and microeconomic market perspectives (Section 2). In Section 3, we discuss empirical studies of currency market conditions with focus on the most recent applications of behavioural finance models to currency markets. We emphasise the importance of endogenising structures of market conditions in our consideration of appropriate exchange rate regimes for emerging market economies. Section 4 presents hypotheses for empirical tests, methodology adopted and empirical results. Finally, our brief concluding remarks are offered in Section 5.

Key Words

Exchange Rate Regimes; Brazil; Monetary Policy

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1. Introduction

For any small open economy, exchange rates are universally regarded as the key relative price to determining its macroeconomic configuration. However, a question as to what constitutes the appropriate or optimal exchange rate regime for developing countries and emerging market economies has long been in the domain of intense debates among academics and policy makers alike. The choice of the exchange rate regime is complicated because the exchange rate policy affects both external balance and internal balance in terms of macroeconomic adjustment as a stabilization instrument as well as an expenditure-switching policy instrument. In turn, as expenditure-switching policy, the exchange rate policy influences not only net external trade balances through competitiveness of tradable goods but also the internal resource allocation between tradables and nontradables through changes in the real exchange rates.

In the earlier debate, this dual role of exchange rate policy had given rise to two distinct approaches, among development macroeconomists, to an appropriate exchange regime (Agénor and Montiel 1996): i) the real target approach with focus on the need to keep international competitiveness of tradable goods so as to ensure a viable and sustainable position in the current account; ii) the nominal anchor approach with focus on the need to ensure domestic monetary stability. Setting targets in real terms, the first approach is geared for the attainment of external balance. In order for exchange rates to satisfy the real targets overtime in face of various real shocks to the external balance, the approach opts for a regime that provides a greater ‘flexibility’ to the exchange rate. In contrast, the second approach opts for a regime that brings a greater ‘stability’ to nominal variables in order to ensure financial discipline.

Seen in this perspective, there is an inherent tension between two approaches. Therefore, a practical policy issue is then over the trade-off between the two objectives, and hence, the relative weight that should be assigned to each of these objectives in formulating exchange rate policy. Ultimately, it can be said that optimal management of exchange rates for a given economy depends on the policy makers’ objectives, the source of macroeconomic shocks, and its structural characteristics and special circumstances of an economy. For example, for a developing country whose external position imposes a binding constraint for economic growth, it may be of utmost importance to give a particular attention to the current account target in relation to its developmental objectives such as the need to develop non-traditional exports in its efforts to diversify its trade structure away from the commodity-dependence and the vulnerability associated with it. Such a developmental perspective would inevitably raise a critical question as to whether it is possible to define the fundamental equilibrium real exchange rate at a point of time1. If this is feasible, one can proceed to examine how different exchange rate regimes affect the level and path of the real exchange rate relative to such a benchmark value and trajectory.

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1 For example, Williamson (1995) set a quest for understanding the fundamental equilibrium exchange rate (FEER), by defining it in the Keynesian tradition but in an abstract form, as "the real effective exchange rate compatible with simultaneous achievement of internal and external balance in the medium term".
Given a variety of these policy considerations discussed above, there are several grounds to argue that intermediate regimes such as a target zone system or a crawling band system may be one of best options for many developing, emerging market economies to choose, as they combine elements of both ‘flexibility’ and ‘stability’. In theory, they could provide some scope for an independent monetary policy in a world of free capital mobility to permit the exchange rate to bear a part of the burden of absorbing unanticipated real and monetary shocks to a certain degree within the band. They could also potentially provide an anchor for monetary stability because certain monetary discipline is required to keep the exchange rate within the band. In practice, a central issue to resolve for sustaining any intermediate regime is, however, how to establish the ‘credibility’ of policy makers’ commitment to such exchange rate regimes.

Indeed, it is on this ‘credibility’ issue that a prospect for the ‘intermediate regime option’ was severely tested and challenged by a series of currency and financial crises plagued many emerging market economies in the 1990s. By the early 2000’s, there emerged a new consensus - the two corner-solution view - as a dominant position in the debate on the appropriate exchange rate regimes for emerging market economies prone to financial crises. Resorting to the ‘Impossible Trinity Thesis, this view argues that intermediate regimes are not viable under financial globalisation, because of their vulnerability to speculative attacks (self-fulfilling or otherwise). It is argued that under a floating regime, the monetary stability can be ensured, without having exchange rate-based stabilization in place, by adopting an inflation targeting framework and some variations of the Taylor Rule as a policy guide (Taylor 2001).

However, as Frankel (1999) suggests, the inconsistent trinity thesis does not, in principle, imply that countries cannot have a half-independent monetary policy and a half-fixed exchange rate by adopting intermediate regimes such as target zone; nor does it imply that countries cannot have both an independent monetary policy and a fixed exchange rate by imposing effective capital controls. In reality, ‘fear of floating’ has been prevalent among emerging market economies (Calvo and Reinhart 2002). Even among emerging economies of East Asia, many of which managed to stage a quick recovery from the devastated Asian Crisis of 1997-8, we find them continuously adhering to the East Asian dollar pegged regimes (Mckinnon and Schnabl, 2004). Given their bitter experiences with currency attacks and collapses, in order to surmount the fear over the loss of the ‘credibility’ towards their pegged regimes, many emerging economies have, instead, opted to hold a large amounts of international reserves for self-insurance purposes, far in excess of any foreseen shortfalls stemming from the needs for current account transactions (Jeanne, 2007 and Miller and Zhang, 2007).

At the same time, as we argued elsewhere in relation to the effect of the currency transaction tax (CTT) on market liquidity and efficiency (Nissanke 2005), the discourse on the appropriate exchange rate regime, in particular, on the desirability or the feasibility of policy-based interventions in currency markets is closely related and shaped by varied perceptions economists hold.
about how well and efficient currency markets function without intervention. A critical question debated in this regard is whether speculators or noise traders make exchange rates excessively more volatile than warranted by fundamentals.

Set in the context of these theoretical and policy debates on appropriate exchange rate regimes for emerging market economies in a world of free capital mobility, the primary objectives of this paper are: i) to present the case for an intermediate exchange rate regime, drawing on recent theoretical and empirical literatures on behavioural finance and currency market structures; and ii) to examine empirically the experiences and evolution of Brazil’s foreign exchange market under alternative exchange rate regimes. Brazil switched from a managed band regime to market-based floating after experiencing a speculative currency attack at the end of 1998. Since then the central bank has followed an inflation targeting regime, under which exchange rate movements should only enter the bank’s objective function if at odds with its inflation target. In this sense, we hope that our comparative empirical analysis of Brazil’s foreign exchange market under different exchange rate regimes should yield some valuable insights into how foreign exchange markets are structured and performed in an era of financial globalization, as the outcome of interactive forces among heterogeneous market traders/participants as well as between market traders on the one hand and the Central Bank on the other.

The paper is structured as follows: In Section 2, for building a solid case for intermediate exchange rate regimes, we discuss theoretical discourses on appropriate exchange rate regimes for emerging market economies, drawing both on macroeconomic propositions and microeconomic market perspectives. In Section 3, we discuss empirical studies of currency market conditions with focus on the most recent applications of behavioral finance models to currency markets. We emphasis the importance of endogenising structures of market conditions in our consideration of appropriate exchange rate regimes for emerging market economies Section 4 presents hypotheses for empirical tests, methodology adopted and empirical results. Finally, our brief concluding remarks are offered in Section 5.

2. Theoretical Discourse

The Possible Trinity - The Case for an Intermediate Exchange Rate Regime from a Macroeconomic Perspective

As financial globalization has accelerated, discussions on appropriate exchange rate regimes for emerging markets economies in macroeconomic literature have increasingly been framed in relation to the infamous theoretical proposition of ‘Impossible Trinity Thesis’. The thesis stipulates that policymakers in open economies face a macroeconomic trilemma: that is, whilst policymakers typically have three desirable objectives (exchange rate stability, free international capital mobility, and monetary policy independence to engage domestic economic goals), they are in practice forced to give up one objective, since only two out of the three can be mutually consistent. Resorting to this thesis, it is argued that the only exchange rate regimes that remain viable in an
era of free cross-border capital mobility are the two corners positions within the trinity, i.e. either pure floating or hard pegs within the trinity. Hence, this position is referred to in the literature as the two-corner view on the exchange rate regime, but also known as the hollowing out hypothesis or the bi-polar view. For example, Eichengreen (1999) concludes that “ --- a middle ground of pegged but adjustable exchange rates and exchange rate target zones will hollow out and policy makers will be confronted with a choice between floating and monetary union” (p.134).

However, it should be noted that this debate on appropriate exchange rate regimes is driven by the imperative of financial globalisation. The arguments rest on the assumption that financial openness alone should not be challenged in the trinity, either because of the considerable benefits which openness is promised to produce in emerging economies, or because free capital mobility is inevitable due to changes in global technology, market structure or politics. While the ‘impossible trinity thesis applies to any open economy, developed mature economies or emerging market economies alike, the policy constraint posed is seen as particularly severe for the latter group, reflecting their disadvantage position in global finance. As Eichengreen and Hausmann (1999) note, emerging market economies are handicapped by the ‘original sin’ due to incomplete domestic financial markets as an additional source of financial fragility that makes more susceptible to global financial and currency crises.

Indeed, the financial fragility and instability of emerging market economies is closely related to their asymmetric position vis-à-vis advanced countries in international finance as well to their structural characteristics. As Bordo and Flandreau (2001) note, the degree of `financial maturity' - the ability to issue international securities denominated in own domestic currency - is a key factor in distinguishing `core' countries from `periphery' ones for exchange rate regime choices over the past century. The prevalence of their “Fear of Floating” (Calvo and Reinhart, 2000) or “ the Case of Hard Peges” (Calvo 2000) is also closely related to: i) liability dollarisation, i.e. the condition in which financial contracts are expressed in foreign currency; ii)

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2 The original sin hypothesis advanced by Eichengreen and Hausmann (1999) refers to “a situation in which the domestic currency cannot be used to borrow abroad or to borrow long term even domestically. In the presence of this incompleteness, financial fragility is unavoidable because of all domestic investments will have either a currency mismatch…or maturity mismatch…” (p.3). Critically, as they note, these mismatches exist not because banks and firms lack either the prudence to hedge their currency exposures or the foresight to maturity mismatch, but because they are unable to do so due to their ‘emerging markets’ status.
fear of inflation due to the high pass-through coefficients (measurements of the speed of transmission of devaluation to inflation); and iii) their nascent capital markets. Despite the strong case made by many influential macroeconomists for the two-polar view (e.g. Fisher, 2001), Husain et al. (2005) shows that intermediate regimes have actually proved the most resilient over recent years.

Agents’ Behaviour and Market Conditions- The Case for an Intermediate Exchange Rate Regime from a Microeconomic Perspective

In mainstream economic thought the exchange rate is considered a relative price, which restores equilibrium in real or financial markets. As such, exchange rate movements can only result from changes in underlying “fundamentals”, which require an adjustment in relative prices (Harvey, 2001). While in the long run, the need for a balanced current account determines the exchange rate, asset market considerations, such as differential money supplies or interest rates, are acknowledged to predominate in the short-run. However, along with the acknowledgement of asset market consideration (and the search for micro foundations in neoclassical economics) came the incorporation of agents’ expectations and behaviour in exchange rate theory, which has shaped the policy debate on appropriate exchange rate regimes from this microeconomic perspective.

Those who argue that any intervention in currency markets would reduce market efficiency tend to treat traders and speculators as rational agents, i.e. informed investors guided by their expectations about future underlying fundamentals. That is, as traditional fundamentalists or ‘informed’ traders, market participants are seen to keep the exchange rate in line with macroeconomic fundamentals and help stabilizing markets around a new equilibrium. Traders whose judgments of an asset’s value are sufficiently mistaken lose money to arbitrageurs and so eventually disappear from the market. Hence, destabilizing trading cannot be profitable (Friedman, 1953 and Fama, 1965).

In this view, foreign exchange markets work efficiently in the sense that the price of an asset will reflect all relevant information about the fundamental variables that determine its value. The implications for exchange rate policy are clear: as markets work efficiently, freely floating exchange rates will generate the pareto-optimal solution and any form of government intervention can only be distortionary.

In contrast, those who see the case for intervention in currency markets argue that markets function inefficiently. For example, Frankel (1996) notes that speculative bubbles—a deviation from the value justified by fundamentals—are generated, as ‘noise traders’ (as opposed to ‘traditional fundamentalists’ or
‘informed traders’) follow the herd in the face of uncertainty. In their analyses, a critical distinction is usually made between informed traders and noise traders: while informed traders act on homogeneous rational expectation, noise traders make their decisions on the basis of ‘fad’ which are unrelated to fundamentals.

In this context, Jeanne and Rose (1999) suggest that whilst the volatility in exchange rates is generated both by fundamentals and noise, the source of excessive exchange rate volatility (i.e. speculative bubbles) is attributed to the presence of noise traders. In particular, their model shows that noise traders are attracted to the market in search for a risk premium, and that as the number of noise traders increases, so does the volatility of exchange rates.

Overall, these model support the view that speculators, acting on ‘fads’ or guided by extrapolative expectations at short-term horizon, can exert destabilizing effects on markets and ‘overshooting of the overshooting equilibrium’ takes place. Furthermore, not only do deviations from the rational stabilizing speculator exist, but they can - contrary to Friedman’s reasoning - also be profitable and have a lasting impact on financial sector prices.

Behavioural Finance

The role of agents’ expectations and behaviour in the price formation process is more explicitly modelled in the relatively recent behavioural finance approach. In this literature, exchange rate dynamics are the result of the interaction of heterogeneous agents in the foreign exchange market, where for one group of agents the assumption of rationality is abandoned.

Recurring to experimental results and evidence from psychology, sociology and organisational behaviour, the behavioural finance approach acknowledges that agents are not rational, not only constrained by the availability of information, but differ in their ability to absorb, understand and process information. This induces agents to use simple rules (“heuristics”) to guide their behaviour. One such trading rule is positive feedback trading or trend chasing, where past prices are extrapolated in the future. Agents do this not because they are stupid or irrational, but because the complexity of the world is overwhelming, making it pointless to understand it completely (De Grauwe 2005).

3 Keynes (1936) uses a ‘beauty contest’ analogy to describe fund managers’ herd behaviour, in that they must guess in an instant how other market players will interpret a new event and follow them accordingly.

4 This exposition is primarily based on the seminal paper by Frankel and Froot (1990) and the recent application and extension of this framework to the foreign exchange market by de Grauwe and Grimaldi (2006). Other contributions include Brock and Hommes (1997 and 1998), Lux and Marchesi (2000) and Farmer and Joshi (2002). Westerhoff (2005) and Xu (2005) explicitly focus on the foreign exchange market.

5 Other strategies that depend on extrapolative expectations are “stop loss” orders, which prescribe selling after a certain level of losses, regardless of future prospects, and portfolio insurance, which involves buying more stocks (to raise exposure to risk) when prices rise and selling stocks (to cut exposure to risk) when prices fall (Shleifer and Summers, 1990: 28).
and Grimaldi, 2006, hence force will be referred to as GG 2006). The widespread use of Chartism/technical trading, momentum trading or the evidence of herding in financial markets, could be characterised by such a trading rule (e.g. Galati and Melvin, 2005).

Formally,

\( E_{t,s}(\Delta s_{t+1}) = \beta \Delta s_t \)

Where, \( E \) is an expectations operator, \( s \) is the exchange rate and \( \beta \) is the extrapolation parameter (GG, 2006: 15). Such extrapolative expectations or positive feedback trading, however, act destabilising, driving the price of an asset away from its “fundamental” value.

In many of these models, a second group of traders, rational traders or “fundamentalists”, acting like Friedman’s stabilising speculator, counteract these destabilising forces and align financial asset prices to their “underlying value”. Again formally,

\( E_{f,s}(\Delta s_{t+1}) = -\psi(s_t - s_t^*) \)

Where \( s_t^* \) stands for the fundamental exchange rate (GG, 2006: 15). The price dynamics is ultimately determined by the interaction between the two agents and the weight assigned to the respective trading rule. Formally,

\( \Delta s_{t+1} = -\omega_{f,s} \psi(s_t - s_t^*) + \omega_{t,s} \beta \Delta s_t + \epsilon_{t+1} \)

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6 In practice, trading strategies followed by technical traders might be more complex than a mere feedback rule (see e.g. Schulmeister, 2006). However, the important principle that past price behaviour, rather than underlying fundamentals, determine the trading pattern remains valid.

7 This exposition assumes that agents can realize their expectations and trade according to them.

8 There are also models that only focus on one investor and not the interaction between heterogeneous traders (e.g. Barberis et al. (1998); Daniel et al. 1999). For this paper and especially its policy implications the interaction between heterogeneous traders, however, is important. In addition, as Frankel and Froot (1990: 94) point out, the large volume of foreign exchange trading in itself suggests that market participants are not identical agents, who share the same rational expectations.
where $\omega_{i,t} (i=f,c)$ is the respective share of fundamentalists and chartists (GG, 2006: 19). It is important to note that rather than two types of traders, the juxtaposition of “chartists” and “fundamentalists” is interpreted in terms of trading rules, which can be combined in one agent and prevail depending on market conditions and - more controversially – time horizon (Frankel and Froot, 1990). In addition, it is probably also the case that different market participants follow different trading rules more often, which could have important implications for the regulation of financial markets.

As GG (2006) show in computer simulations in such a scenario exchange rate dynamics can be characterized by two different kinds of equilibria: a fundamental equilibrium, in which fundamentalists and chartists co-exist and the former keep the exchange rate close to its fundamental value, and a bubble equilibrium characterised by the predominance of destabilizing chartists. In addition, the exchange rate is not only very often disconnected from its fundamental value, but also experiences more short-term volatility than the fundamental exchange rate and is occasionally subject to very large changes.

*Agents’ interactions*

Thus, an interesting question, especially for policy implications, is how the weight between the two trading rules is determined and what induces shifts between the fundamental and the bubble equilibrium. Several of the models which focus on heterogeneous traders point to the important interface between them and the risk the presence of noise traders creates for stabilizing arbitrageurs. Because, as we argued earlier (Nissanke 2005), the interaction between arbitrageurs and noise traders in currency markets is very complex, as the former often has to respond to the unpredictable behaviour of the latter rather than to expected changes in fundamentals.

To determine the weight between chartists and fundamentalists GG (2006) assume that agents regularly compare the utility of the alternative trading rules and switch between them according to their relative risk adjusted profitability. If an initial shock in the exchange rate increases the profitability of extrapolative forecasting an increasing share of traders will switch to this rule.

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(4) \quad \omega_{i,t} = \frac{\exp(\gamma \pi'_{i,t})}{\exp(\gamma \pi'_{f,t}) + \exp(\gamma \pi'_{c,t})}
\]

Where $\pi'_{ij} (i,j = f,c)$ are the risk adjusted profits and $\gamma$ measures the intensity with which the traders revise their forecast rule (GG, 2006: 17).

Similarly, Frankel and Froot (1990:101) argue that the traders’ weight changes over time according to their respective wealth generated through the
trading success. However, the latter authors do not explicitly consider the risk, the existence of chartists generates for stabilizing fundamentalists. As de Gruwe and Grimalidi point out: “Agents who use fundamentalists’ forecasting rules recognize that a profit opportunity arises when the exchange rate deviates from its fundamental value. However, because of the losses they incur and the large forecast errors they make during a bubble phase, these risk-averse fundamentalists switch to safer and more profitable forecasting rules. Arbitrage opportunities exist, but everybody is afraid to take these opportunities” (p. 34).

The attempt to introduce rationality in the system through the ex post application of a fitness rule, however, seems to miss the essence of financial markets, which are inherently forward looking and driven by ex ante expectations.

The role of risk is most explicit in de Long et al. (1990b): ‘Arbitrage does not eliminate the effects of noise because noise itself creates risk’ (p. 705). That is, the unpredictability of noise traders’ beliefs and expectations, which can be erroneous and stochastic in light of fundamentals, could create a ‘noise trader risk’—a risk in the price of assets that deters rational arbitrageurs from aggressively betting against them. This is because arbitrageurs are likely to be risk averse, acting with a short time-horizon. Hence, they tend to have limited willingness to take positions against risks created by noise traders. As a result, ‘prices can diverge significantly from fundamental values even in the absence of fundamental risk’ (De Long et al. 1990b: 705). Moreover, bearing a disproportionate amount of risk thus generated enables noise traders to earn a higher expected return than rational investors engaged in arbitrage against noise.

**Market Conditions**

As outlined above, exchange rate dynamics are the result of the complex interaction between noise traders and fundamentalists. This interaction, however, does not take place in a vacuum and the question arises whether and how “external” market conditions can affect the interface between these two types of heterogeneous traders. As we argued earlier (Nissanke, 2005), the market composition between the two types of traders shifts, as market conditions change. Equally, depending on market conditions, traders could switch their position from arbitrageurs to “destabilizing” speculators. Hence, as de Long et al. (1990a, 1990b) note, the interface between arbitrageurs and noise traders is non-linear.

Thus, we argue that emphasis has to be placed on both, what we call “objective” and “subjective” market conditions. While objective market conditions refer to the role of “fundamentals” in shaping the interaction between heterogeneous traders, subjective market conditions point to the institutional framework which influences the (subjectively felt) risk parameter of traders and hence the predominance of one trading rule over the other.

**Objective Market Conditions**
For Jeanne and Rose (1999) the entry decision of noise traders is positively related to fundamental variance and a risk premium (exchange rate volatility). Their paper predicts that when the volatility of fundamentals is low, there is a single equilibrium where noise traders are not active, resulting in a low volatility in exchange rates. Conversely, when the volatility of fundamentals is high, a large number of noise traders enter the market, producing a high volatility in exchange rates. When the volatility of fundamentals is in the intermediate range, however, multiple stable equilibria are possible, depending on the number of noise traders seeking for a risk premium.

For GG (2006) once in a bubble equilibrium, the higher profitability of chartists continues to drive the exchange rate away from its fundamental value. This leaves the question open whether there are underlying market conditions, which favour the development of a bubble in the first place. They argue that the development of multiple equilibria is crucially dependent on initial conditions – defined as an initial shock in the exchange rate. The larger the initial shock in the exchange rate, the more profitable the Chartist trading rule and the farther the attractors are removed from the fundamental exchange rate (p. 28). Hence, some sort of “underlying volatility” is necessary to enter the economy in bubble equilibrium. However it remains indeterminate, what will determine the outcome in an “intermediate” situation, as not any shock in the exchange rate has to result in a bubble equilibrium.

Hence, both publications agree that some form of fundamental variance is necessary to make it profitable for noise traders to enter the market. However, both remain indeterminate as to the specification and identification of such fundamentals.

The role of fundamentals is complex, theoretically as well as empirically, and is hardly dealt with in the behavioural finance literature. In other words while much emphasis is put on specifying the “noise trader” behaviour the theoretical assumptions about fundamentals remain unchallenged. They remain either firmly embedded in the monetary approach to exchange rate determination, or altogether unclear. However, if the expectations and behaviour of heterogeneous market players comes to the fore of the analysis and expectations cease to be formed rationally – in the sense that they are formed endogenously according to the model under consideration - there is little reason to expect a unique set of fundamentals to remain the permanent driver of exchange rate movements.

The fact that agents are heterogeneous and might use different models – across agent and time - to form expectations about future exchange rate values, has been acknowledged in mainstream exchange rate literature. One example is Bacchetta and van Wincoop 2004’s interesting scapegoat model, where investors

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9 For example GG (2006) never really define what they think “fundamentalists” base their assessment on. They mention either Purchasing Power Parity (PPP) or some fundamental equilibrium rate (FEER) à la Williamson, but do not spend more considerations on this topic. However, this paper questions the assumption that foreign exchange traders have an equilibrium rate à la FEER in their mind.
- due to confusion about the true source of exchange rate fluctuation - use fundamentals which show large imbalances as a “scapegoat” for exchange rate movements. In a similar vein, empirical literature has shown that the importance of fundamentals varies over time (e.g. Heimonen 2006). However, although the importance of financial market players in the determination of exchange rate dynamics is acknowledged, the same set of exchange rate fundamentals as specified in traditional exchange rate theory – mainly monetary variables – are maintained.

Post-Keynesian literature (see e.g. Davidson, 2002; Alvés, Ferrari Filho et al., 2000) has long criticised the assumption of an ergodic world, where underlying fundamentals can be calculated from past data, projected in the future and hence firmly pinned down by (if only a few) “fundamentalists”. In Keynes’ world of fundamental uncertainty, expectations and convention - the assumption that “the existing state of affairs will continue indefinitely”, - and the psychological confidence with which we hold this convention govern investment behaviour (Keynes, 1997: 152). However, if convention determines current market prices, foreseeing future convention and hence market psychology becomes crucial to maintain the value of one’s portfolio (Keynes, 1997: 155). It is not merely the short-horizon and risk created for rational arbitrageurs or the presence of “dumb” feedback traders, but the underlying uncertainty, and lack of a “true” anchor to the price system, which causes Keynes “beauty contest”.

Although we agree with the assumption of fundamental uncertainty, the importance of expectations and the state of confidence in the determination of exchange rate movements, we suggest that it is theoretically unsatisfactory to reject the notion of “fundamentals” per se. Indeed, if the expectations and behaviour of asset market players are acknowledged to be the driving factors of exchange rate movements, an attempt has to be made to understand the formation of these expectations and the motivations of asset holders. This has to go beyond the current set of mainstream fundamentals and specify alternative fundamentals, which are found to drive investors’ behaviour.  

Subjective Market Conditions – A Case for Exchange Rate Policy

In addition to fundamental risk, we argue that the interaction between stabilizing and destabilizing traders will be influenced by “subjective market conditions” – or the institutional setting – which influences the risk perception of market players. Probably the most important institutional setting in this sense is the exchange rate regime in place.

Now, in Jeanne and Rose’s (1999) noise trader model the entry decision of noise traders is positively related to a risk premium (exchange rate volatility), which itself is generated through the entry of noise traders in the market. Hence, similar to self-fulfilling crisis models the expectation of a higher risk premium is

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10 Although not discussed in this paper, we deal this issue within our current research programme.
validated through the resulting entrance of noise traders as it changes the structure of risks and returns in a way that makes it more attractive for other noise traders to join. Similarly, in GG’s (2006) model, exchange rate behaviour is crucially determined by the risk aversion parameter of fundamentalists.\textsuperscript{11} A fall in this parameter (subjectively perceived or objectively determined) induces fundamentalists to bet more aggressively against destabilizing noise traders and maintains the exchange rate in a fundamental equilibrium.

However, the view that exchange rate behaviour is determined by the interaction of heterogeneous traders, rather than directly by macroeconomic fundamentals, and that this interaction is fundamentally shaped by a subjectively felt risk perception, has important implications for exchange rate policy. Market structure has to be endogenized rather than taken as given and can be changed through government policy, which influences trading behaviour and/or the composition of traders operating in the market. In this view, a stabilized exchange rate does not transmit into higher fundamental volatility, but delivers stability “at no cost” as market conditions and hence market structure change.

For Jeanne and Rose, the monetary authority’s announcement to prevent exchange rate volatility is enough to deter destabilizing noise traders seeking for a risk premium and pins down the economy on the low volatility equilibrium. Although the stable exchange rate commitment constrains the monetary policy response function out of equilibrium, in equilibrium there is no observable sacrifice of monetary autonomy\textsuperscript{12}. The implication that the exchange rate regime in place effectively changes market structure is also analyzed in Flood and Rose (1999). In their model, the process governing the exchange rate changes according to expectations about future exchange rate volatility. They show that in periods where expected volatility is non-zero – such as in a floating regime or non-credibly fixed pegged exchange rate regime – forces other than those from money and goods markets come to determine the exchange rate.

Although Jeanne and Rose argue that their definition of stable exchange rates is flexible enough to encompass a wide spectrum of exchange rate regimes, it is probably most interesting in the context of the stabilizing properties of intermediate exchange rate regimes, such as target zones or Williamson’s (2000) Basket Band Crawl (BBC) proposition.

Indeed, in this regard, we should bear in mind, under conditions of self-fulfilling crises such as those examined in the second-generation model of

\begin{footnotesize}
\textsuperscript{11} De Grauwe and Grimaldi dedicate nearly the entire chapter 4 to this parameter and perform simulations how it affects exchange rate dynamics. They show that a reduced risk aversion by fundamentalists avoids bubble equilibria and pins down the economy at a “good” equilibrium. However, disappointingly, the authors do not use this parameter to derive implications for exchange rate policy.

\textsuperscript{12} The authors argue that their “announcement effect” is stronger than Krugman’s “honeymoon” effect, where the exchange rate is stabilized by the promise of interventions that have to be fulfilled in equilibrium (Jeanne and Rose, 1999).
\end{footnotesize}
currency crises (Obstfeld 1996), an issue at stake is not merely whether speculators increase exchange rate volatility, but also whether they generate and exacerbate exchange rate misalignments in terms of fundamentals. This is because noise traders could trigger a shift of exchange rate from an equilibrium with a low volatility of fundamentals to the one with a high volatility of fundamentals, by generating destabilizing speculative bubbles, as shown by Jeanne and Rose (1999).

Williamson (2000) recommends the intermediate ‘target zone’ regime, governed by the BBC rule, as a more appropriate exchange rate regime for most emerging market economies in preference over one of the two-corner solutions of pure floating or hard pegs. Williamson (2000) lists the fundamental reasons found in literature for preferring a band system over floating: (i) the band performs the function of crystalizing market expectations of where the equilibrium exchange rate may lay, and thus making expectations stabilizing at the time-horizons relevant for influencing market behaviour (Svensson 1992); (ii) a band has a pronounced effect in limiting exchange rate variability by preventing noise traders, particularly, stop-loss traders from making money by introducing noise into the exchange market (Rose 1996).

Hence, in contrast to the traditional target zone literature (Krugman, 1991), in this view target zones are not stabilizing, because agents are rational (“honey-moon effect”), but because it makes market expectations more rational as it is more difficult for irrational traders to survive in an environment with little volatility (Jeanne and Rose, 1999).13

GG (2006) arrive at a similar conclusion, although in their model rather than building ex-ante credibility, the existence of a target zone increases the profitability of fundamentalist trading ex-post as it strengthens the mean reverting behaviour of the exchange rate. Although the authors stress the sustainability of foreign exchange reserves, we suggest that their reactive theory understates the cost of defending the currency in the case of a speculative attack and/or the opportunity costs of holding a large stock of foreign exchange reserves.

Instead, we argue that the interesting aspect of a target zone would be its ability to build ex-ante credibility, which drives destabilizing noise traders from the market and makes costly intervention on the margins unnecessary. As stressed by “self-fulfilling “crisis models, the crisis mechanism works through speculators’ expectations of the choices the government would make in a tight

13 This argument is very similar to Krugman and Miller (1993), where a target zone forestalls currency crashes by keeping the exchange rate below the threshold that triggers stop-loss trading. The stabilizing properties of an exchange rate band system, through driving destabilizing noise traders from the system has also been expressed by Williamson (1983).
crisis situation (e.g. Obstfeld, 1996). If exchange rate volatility is not credibly contained, noise traders will not be impeded to enter the market.

In this sense, one could argue that the government’s firm commitment to defend the exchange rate band lowers the (subjectively felt) risk aversion of fundamentalists, encouraging them to bet more aggressively against destabilizing Chartists.

4. Empirical Analysis – The Study of Brazil

Empirical Prelude

There is extensive empirical evidence that the exchange rate seems to be unrelated to its fundamentals implied by macroeconomic theory. Probably the most prominent paper in this direction is Meese and Rogoff (1983), who show that a simple random walk has more predictive power of future exchange rate behaviour than any structural model\(^{14}\). In a similar vein, Flood and Rose (1999) document that exchange rate volatility is “excessive” in relation to the volatility of underlying fundamentals (money growth and interest rates)\(^{15}\).

Not only have fundamentals little predictive power for exchange rate behaviour, it has also been shown that exchange rates react unpredictably to news about those fundamentals (e.g. Goodhart (1988); Goodhart and Figliuoli (1991));. Interesting for this paper is the result by Andersen et al (2002), who find that announcement effects are asymmetric (bad news have stronger effects than good news) and seem to be a function of the state of uncertainty in the economy.

Empirical evidence that exchange rate stabilization could come at “no cost” has been convincingly presented by Flood and Rose (1995) and Baxter and Stockman (1989). The authors show that despite increase real exchange rate volatility under flexible exchange rates they find no systematic differences in the behaviour of macroeconomic aggregates under alternative exchange rate arrangements.

Due to the difficulty to identify and quantify exchange rate fundamentals an extensive share of empirical literature has concentrated on the time series properties of exchange rates and discovered anomalies, which stand in stark contrast to the efficient market rational expectations view of foreign exchange markets. First, there is widely documented evidence that exchange rate returns are not normally distributed and are subject to heteroskedasticity. While the first

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\(^{14}\) Recent empirical work based on cointegration techniques argues that while insignificant in the short-run, macroeconomic fundamentals seem to determine the exchange rate in the long-run (e.g. Mark, 1995). In addition, adjustment (to the fundamentals) might be nonlinear (e.g. Kilian and Taylor, 2001)

\(^{15}\) Another large strand of literature, which points to the fact that exchange rate markets are not populated by rationally optimizing agents, focuses on uncovered interest parity and “its failure” to hold empirically. For an overview, see Lewis (1995) and for a model, which tries to account for this “puzzle” through the presence of noise traders, see Mark and Wu (1998).
is evidence of large “excessive” spikes in the exchange rate, ARCH effects support the hypothesis of multiple equilibria, where periods of exchange rate tranquility alternate with periods of turbulence (e.g. de Grauwe and Grimaldi, 2006:5). Of special interest for this paper is the finding by Bauer and Herz (2005), who show that exchange rate trends – representing Chartist behaviour – result in higher exchange rate volatility, giving some support to the results in Jeanne and Rose.

The predictability of returns in the presence of price trends has led many to test the interesting implication that Chartist/technical trading is profitable and survives for long periods. Results tend to favour the hypothesis that Chartist is on average profitable and evolutionary stable (e.g. Schulmeister (2006); Neeley (1997)).

Finally, there is substantial survey evidence on the formation of expectations and alternative trading rules in foreign exchange markets. Frankel (1996) reports that traders, using the ‘Chartist technical analysis’ or the ‘momentum’ models, act on extrapolative expectations at short horizons under three months, while they act on adaptive, regressive or distributed lag expectations at longer horizons of three months to one year. Hence, he suggests that the former generates destabilizing speculations, while the latter produces stabilizing effects. In a similar vein, Cheung and Wong (2000) report survey evidence on Asian foreign exchange markets, that short-term variability is largely attributed to non-economic forces including bandwagon effects, over-reaction to news, speculation and technical trading, while fundamental trading dominates over longer horizon. In general, survey evidence (see also Allen and Taylor (1992); Menkhoff (1997)) reports that technical trading is an important complement to fundamental analysis, used to forecast market psychology and often acting in a self-fulfilling manner, detracting from fundamental analysis.

Spahn (2002), on the other hand, notes that chartists may be found more among institutional investors such as investment fund managers, rather than dealers-arbitrageurs. These empirical observations point to the importance of distinguishing those who act as arbitrageurs from those whose behaviour tends to be speculative, pushing markets away from equilibrium.

**Hypotheses**

Above theoretical considerations have two major implications for exchange rate behaviour. First, it is argued that floating exchange rates are subject to multiple equilibria, where “fundamental” equilibria alternate with bubble equilibria, in which destabilizing noise traders drive the exchange rate away from its “equilibrium” level. Second, it has been argued that the credible commitment to a target zone stabilizes the exchange rate “at not cost” by driving destabilizing noise traders from the market and lowering the risk (perception) of stabilizing traders. Although preliminary results of the existence of multiple equilibria will be presented the primary focus of the empirical work of this paper will be on the stabilizing effect of a credible target zone.
In general, empirical evidence has not been too kind to Krugman’s (1991) original target zone model, where the expectation of intervention at the margin should make speculators act in a stabilizing way and induce mean reverting behaviour in the exchange rate (Svensson, 1992: 125f). However, recent empirical evidence shows that exchange rate policy can have an important effect on the formation of expectations. Jeanne and Rose (2002) show that managed exchange rate regimes, have lower forecast dispersion and fewer deviations from uncovered interest parity than floating regimes. Williamson (2000: 23) points out that forward rates normally change by less than spot rates in target zones, indicating the presence of mean reverting expectations.

**Methodology**

Due to the difficulty to correctly identify and quantify the underlying exchange rate fundamentals – not to speak of its equilibrium rate –, this paper primarily bases itself on observed time series behaviour. More concretely, it analyzes the simple serial correlation pattern in exchange rate returns implied by the theoretical models presented above. To do so, it applies Lo and MacKinlay’s (1988) heteroskedasticity robust variance ratio test, extended by Chow and Denning’s (1993) multiple variance ratio test (MVR).

Lo and MacKinlay’s (1988) variance ratio test exploits the fact that without serial correlation in returns, the variance of the increments should be linear in the sampling interval (pp. 43). In other words, if a series $X_t$ is uncorrelated, the variance of its q-differences would be q times the variance of its first differences. Formally,

\[ Var(X_t - X_{t-q}) = qVar(X_t - X_{t-1}) \]

in which q is any positive integer. The variance ratio is then given by

\[ VR(q) = \frac{1}{q} \frac{Var(X_t - X_{t-q})}{Var(X_t - X_{t-1})} = \frac{\sigma^2_q}{\sigma^2_a} \]

The serial correlation tests in this paper are joint tests that no serial correlation is present at any lagged return under consideration. In this context, however, it has been argued that it is inappropriate to focus on the significance of individual variance ratios without controlling for the joint test size, as this could give rise to the problem of multiple comparisons among test statistics, which causes an inappropriately large probability of Type I error. Chow and Denning’s (1993) MVR test attempts to control for this problem by applying higher critical values to the maximum absolute value of a set of Lo and MacKinlay’s test statistic. For a more detailed exposition of methodology and critical values see Smith et al. (2002) and the Appendix.
And the test statistic

\( \hat{M}_r(q) = VR(q) - 1 \)  

Under the null hypothesis of no serial correlation, \( V(q) = 1 \). The authors derive the asymptotic distribution of the estimated variance ratios and calculate two test-statistics, \( Z(q) \) and \( Z^*(q) \). While the former tests for homoscedastic uncorrelated increments the latter controls for time varying variance, heteroskedasticity, in returns.\(^{17}\) Under the null hypothesis the test statistic follows a standard null distribution. Lo and MacKinlay (1988) further show that \( \hat{M}_r(q) \) is asymptotically equal to a weighted sum of autocorrelation coefficients

\[
\hat{M}_r(q) = \sum_{j=1}^{a-1} \frac{2(q-j)}{q} \hat{\rho}(j)
\]

hence for \( q=2 \)

\( \hat{M}_r(2) = VR(2) - 1 = \hat{\rho}(1) \)

Where \( \hat{\rho}(1) \) is approximately the first-order autocorrelation coefficient of the differences (pp. 48).

Using a Monte Carlo experiment Lo and McKinlay (1989) show that under the heteroskedasticity null (the asset price follows a martingale) the variance ratio test is more powerful than the Box Pierce Q-Statistic.\(^{18}\) In addition, Poterba and Summers (1988) find that variance ratio tests have slightly higher power than regression based tests for serial correlation.

As outlined in the theoretical section, one common way to formalize destabilizing noise trader behaviour is through the use of simple trading rules, such as positive feedback trading or trend chasing, where past prices are extrapolated in the future. This, in turn should result in short-run positive serial correlation in returns. Although this methodology uses a very simplified version of noise trading, it should allow identifying periods of sustained exchange rate trends, caused by Chartism or even stronger herding and panic in financial crises, where investors only trade on the currency’s past – weakening – value. While evidence of short-run momentum seems to be relatively robust in stock markets, evidence is mixed for the foreign exchange market (e.g. Fong et al. (1997) and Lee et al (2001)).

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\(^{17}\) For exact methodology and derivation of test-statistics please see Appendix.

\(^{18}\) The lack of power of the Q-statistic in the presence of heteroskedasticity might be especially severe in the case of foreign exchange rates, which have been shown to be subject to considerable ARCH affects (e.g. Engle et al. 1990). Campbell et al. (1997) further point out that the power of the Q-statistic will be critically affected by the order of autocorrelations included, which could impede detecting the presence of higher order serial correlation.
A second strand of literature has focused on long-run dependencies in asset returns. For example, Poterba and Summers (1988) show that the correlation in returns turns negative as the horizon increases and attribute this mean reverting behaviour to departures from fundamental values through noise traders and the eventual correction of “erroneous” market moves (p 28). Mean reverting behaviour in the exchange rate has been primarily tested on the basis of unit root tests. This strand of empirical literature has largely concluded that shocks to the exchange rate are permanent and rejected the hypothesis that the exchange rate is a stationary mean reverting process (e.g. Takagi, 1988).

This paper attempts to combine the two approaches presented above. Destabilizing noise trading is operationalised as simple positive feedback trading, which results in short-run positive serial correlation and momentum in returns. In addition, it is conjectured that if an “overshooting of the overshooting” in response to a shock to the exchange rate takes place, positive serial correlation in the short-run should be followed by some form of mean reversion or negative serial correlation in the long-run19.

In order to test for multiple equilibria the paper applies a methodology used by Yilmaz (2003) and Kim (2004), where moving sub-samples of fixed window size are applied to the exchange rate series. This methodology allows distinguishing between the different dynamics of the exchange rate series and - with some precision - identifying the structural breaks and switch to a different equilibrium.

One important caveat to this methodology, however, is that there are several possible alternative explanations for autocorrelation in exchange rate returns. While non-synchronous trading is judged less prevalent in foreign exchange markets, official intervention and a time varying risk premium have been advanced as possible explanations for the observed autocorrelation20. Finally and more fundamentally, foreign exchange behaviour cannot be analyzed detached from underlying fundamentals and the analysis of time series behaviour can only yield partial results.

The second and main hypothesis presented in this paper is that a credibly managed exchange rate regime – especially in the form of a target zone or crawling band – anchors convention, and drives destabilizing noise traders from the system. As a result, the exchange rate should fluctuate around the band’s parity.

19 The same conjecture is also tested in Cutler et al. (1989), who find significant evidence of short-run serial correlation in excess exchange rate returns, followed by mean reversion in the long run.
20 Indeed, it has been argued that price deviations from the random walk (martingale) do not by themselves imply market inefficiency, but can result from shifting risk premia which are consistent with efficient markets (e.g. Leroy (1973); Lucas (1978). In this context, however, Goodhart (1988) argues that “without an explicit theory of why there is such a premium and why it varies, It has not function but tautologically to save the theory” (Mankiw and Summers, 1984, In: Goodhart, 1988). In addition, Shleifer and Summers (1990) argue that observed asset price changes seem too excessive to be accounted for by a changing risk premium.
Following Mac Donald and Myrvin (1998) rather than focusing on exchange rate expectations, this paper directly tests the presence of mean reversion. As regressive expectations dominate “normal” overshooting à la Dornbusch (1976) and hence short-run negative serial correlation should dominate.

One caveat to this methodology is, that the focus on serial correlation patterns does not allow distinguish between stabilizing trading and “leaning against the wind” official exchange rate intervention. However, although intervention in a target zone should be limited to the margin – or unnecessary overall, due to the honeymoon effect – intra-marginal interventions has been a widespread phenomenon (Svensson, 1992).

**Results**

The country analyzed in this study is Brazil. This choice was motivated by several reasons: First, the focus is on emerging countries, with a certain degree of economic and financial development and integration in international financial markets. Brazil is among the emerging countries with the most developed financial market, where asset market considerations play an important role in the determination of exchange rate behaviour. Second, Brazil introduced a narrow band around the real on 6th March 1999, which was maintained until the financial crisis at the beginning of 1999. Since then the central bank of Brazil has followed an inflation targeting regime, where the exchange rate should only enter the central bank’s objective function if it has an effect on inflation. This allows analysing exchange rate behaviour under two very distinct exchange rate regimes. Finally, Brazil’s current floating exchange rate regime is characterised by substantial volatility, which could give interesting clues for the analysis of agents’ behaviour in emerging countries foreign exchange markets.

The series used is the daily, nominal spot rate to the US$ dollar, provided by Reuters through the financial statistical database Datastream. Exchange rate returns are calculated as the natural logarithm of the first difference of the nominal exchange rate series. Days with missing data have been deleted.

*Brazil: daily spot nominal exchange rate: 30/6/94-23/7/07*
Table 1 presents preliminary statistics about the difference in exchange rate behavior between band and floating exchange rate regimes.

<table>
<thead>
<tr>
<th></th>
<th>Band</th>
<th>Float</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.00034</td>
<td>-0.00003</td>
</tr>
<tr>
<td>SD</td>
<td>0.00179</td>
<td>0.01026</td>
</tr>
<tr>
<td>Skewness</td>
<td>3.33268*</td>
<td>-5.5459</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>50.50642</td>
<td>19.93752</td>
</tr>
<tr>
<td>Jar-Be</td>
<td>96558.16*</td>
<td>26526.63*</td>
</tr>
<tr>
<td>Q(1)</td>
<td>0.32</td>
<td>18.884*</td>
</tr>
<tr>
<td>Q(6)</td>
<td>10.03</td>
<td>72.687*</td>
</tr>
<tr>
<td>Q(12)</td>
<td>79.68*</td>
<td>77.844*</td>
</tr>
<tr>
<td>N° Obs</td>
<td>1007</td>
<td>2210</td>
</tr>
</tbody>
</table>

Notes: * indicates rejection at 0.05 level

Several points seem noteworthy. First, while the Brazilian real depreciated during the managed regime, the floating period is characterized by an appreciating currency. Second, and expectedly, the volatility – as measured in terms of standard deviation - is substantially higher in the floating regime. Third, deviations from normality are even more pronounced in the managed exchange rate regime. Finally, and probably most interestingly for this study, the managed exchange rate regime seems to be characterized by less autocorrelation in returns than the floating period. Although the evidence on ARCH effects is slightly less marked in the managed regime, this does not seem to fully explain the reduction in autocorrelation.

We have argued in this paper that floating exchange rate regimes are characterized by multiple equilibria, where calm periods alternate with periods.

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22 This could, one the one hand, reflect differing interest between governments and the investor community. While governments prefer weaker currencies to support external balances, investors generally profit from an appreciating currency. On the other hand, the floating period above studied, is a period of extremely high liquidity in international markets, which has been channelled into emerging markets. Hence the differing developments between managed and floating periods could also be a reflection of international liquidity conditions. A different inflation environment between the two periods could also give rise to this pattern.
during which destabilizing noise traders deviate the exchange rate from its “equilibrium value”. Destabilizing noise trading is operationalised as simple positive feedback trades, resulting in short-run positive serial correlation. Hence, in the presence of multiple equilibria, periods of no or insignificant serial correlation should alternate with periods of significant return dependency. We have further argued that in the presence of destabilising noise traders which cause the exchange rate to overshoot, a period of positive serial correlation should be followed by long-run mean reverting behaviour.

Finally, the stabilizing properties of exchange rate band systems should result in negatively correlated exchange rate returns as destabilizing noise traders are deterred from the market.

In order to test these hypotheses, and derive some indications about the differential exchange rate behaviour in alternative exchange rate regimes, Lo and MacKinlay’s variance ratio test is applied to a fixed size moving sub-sample. The window size is chosen at 512 observations. As the focus is on short-run serial correlation only lags of 2, 5 and 10 are considered.

Graph 1:

Brazil: Heteroscedasticity Robust Test Statistics $Z^*(q)$

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23 Chow and Denning show that for a sample size of above and equal 512, the power of the multiple variance ratio test is comparable with the ADF and PP test for a unit root against an AR(1) process and much more powerful against an ARIMA (1,1,1) and ARIMA (1,1,0). Furthermore, choosing a larger sample size could mask important exchange rate dynamics and structural breaks.

24 Sensitivity tests were applied and lags above 20 were hardly ever significant. In addition, the decision to restrict results to three variables was motivated to maintain the clarity of results.
Graph 2:

Notes: X-Axis denotes the starting period of the moving sample; Results have been tested for robustness to outliers in the data; Large spikes in the results have been removed from the graph for clarity. Only heteroskedasticity robust critical values are reported; Standard Normal 0.05 critical value 1.96; Chow and Denning (1993) 0.1 critical value 2.23 and 0.05 critical value 2.49.

Graph 1 and 2 present our results. Several points are noteworthy.

First, there seems to be preliminary support for our hypothesis of differing exchange rate dynamics depending on the exchange rate regime in place. As can be seen from the variance ratio in Graph 2 a period of negative serial correlation during Brazil’s band systems is followed by positive serial correlation during the floating period. This evidence is especially strong for the short-run serial correlation separated by one lag (V(2)).

Second, it is evident that the that the inclusion of the crisis days in the moving sample results in a considerable jump in the test statistic and significant correlation in exchange rate returns. This in turn could point to the fact that the devaluation of the currency and increased risk environment drove stabilizing
fundamentalists from the market, while “irrational” feedback traders moved the currency away from its “fundamental” value.

Third, the current floating exchange rate regime is characterized by at least one period of significant positive autocorrelation. This provides strong preliminary support for the hypothesis of multiple equilibria. However, there are two main caveats to this result. First, they are incomplete. As outlined above, the analysis of time series behaviour detached from “fundamentals” or the risk environment has little explanatory power. Rather than knowing that there are changing equilibria, it would be crucial to analyze why and under what market conditions this change takes place. Second, there is a problem of identification. Although the methodology of a moving sub-sample can locate structural breaks and periods of different market behaviour, it is difficult to determine the exact switch between the equilibria.

Fourth, one has to be clear about how to interpret these results. Above presented methodology might not be able to discover noise traders or technical trading, which are based on exploiting short-term trends in the data and contribute to higher volatility in exchange rates. However, it shows that the interaction between heterogeneous traders in foreign exchange markets and/or the uncertainty about a “true” underlying value can give rise to speculative bubbles characterized by feedback trading (possibly the result of herding), driving the exchange rate away from its underlying value.

Table 2: Variance Ratio Tests for band and floating periods

<table>
<thead>
<tr>
<th></th>
<th>Excluding Crisis</th>
<th>Including Crisis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Band</td>
<td>V(q)</td>
<td>Z*(q)</td>
</tr>
<tr>
<td>V(q)</td>
<td>0.858</td>
<td>-1.659</td>
</tr>
<tr>
<td>Z*(q)</td>
<td>-1.370</td>
<td>-0.857</td>
</tr>
<tr>
<td>Floating</td>
<td>V(q)</td>
<td>Z*(q)</td>
</tr>
<tr>
<td>Z*(q)</td>
<td>-2.0757</td>
<td>0.112</td>
</tr>
<tr>
<td></td>
<td>Z*(q)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.0757</td>
<td></td>
</tr>
</tbody>
</table>

Table 2 confirms our results obtained from the moving sample application. First, although not significant, it shows that while variance ratios for the floating periods are all higher than one, indicating positive serial correlation, they are below one during the band systems. This in turn could confirm our hypothesis of mean reverting behaviour in target zones, as destabilising noise traders are deterred from the system. However, as also previously mentioned,

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25 The period of significant serial correlation seems to coincide with the financial turmoil around the election of President Lula and (unwarranted) fears about a change in economic policy “to the left”. In addition, concerns about the large domestic debt and the future of IMF assistance contributed to the uncertainty.

26 Attempts to locate such a “switching point” through the use of fixed endpoints have been made in another paper (cite working paper). Although this procedure helps to locate the switch more precisely, results are not robust, due to the varying sample size.

27 An identification of these phenomena would probably require higher frequency data and a more detailed study of “events”. 
this methodology cannot distinguish between stabilizing trading and “leaning against the wind” policies by the central bank. Hence, in order to obtain a full picture of exchange rate dynamics, above results would have to be seen in conjunction with foreign exchange intervention.

Second, it is interesting to note that the inclusion of the crisis days in the variance ratio tests leads to significant positive serial correlation in returns and a rejection of the null hypothesis of a unit root. In other words, if taking the crisis years under consideration positive serial correlation is followed by mean reverting behaviour. This in turn could serve as strong evidence that destabilising noise traders drove the exchange rate away from its underlying value, as the increasing risk drove stabilizing arbitrageurs from the market.

5. Concluding Remarks

There have been intense debates among policy makers as well as academics what could be appropriate exchange rate regimes for emerging market economies in a world of free capital mobility. The paper aims at contributing to this discourse by presenting the case for an intermediate exchange rate regime. While macroeconomic literature has so far conducted theoretical and empirical discussions in relation to the infamous proposition of ‘Impossible Trinity Thesis’, this paper attempted to examine the case for an intermediate regime from a microeconomic perspective, drawing on recent theoretical and empirical literatures on behavioural finance and currency market structures.

Thus, in this paper, exchange rate dynamics is analysed, not as a result of market equilibrating forces, but as one resulting from changing expectations and behaviour of heterogeneous traders in currency markets, in particular from complex, non-linear interactions of destabilising noise trading and stabilizing “fundamentalists”. In our analysis, a distinction between noise trading based on chartism/momentum trading (chartists) and trading based on economic fundamentals (fundamentalists) is made, not in terms of two distinct types of trading agents operating in markets, but more in terms of trading rules, which can be combined in one agent and can prevail depending on market conditions. Seen from this perspective, it is shown that markets are characterised by two different kinds of equilibria: a fundamental equilibrium, where the exchange rate is kept close to its fundamental value, and a bubble equilibrium, where destabilizing noise trading dominates. It is conjectured that as a market condition shifts from the former to the latter, the exchange rate becomes disconnected from its fundamental value and experiences higher short-term volatility than fundamentals warrant.

We argued in this context that the interaction between heterogenous trading strategies is not placed in a vacuum, but influenced by what we refer to as “objective” and “subjective” market conditions. Importantly, the exchange rate regime is viewed as the most important institutional setting, wherein subjectively and objectively perceived risk parameters are determined, which would in turn shape the interaction between stabilizing and destabilizing trading strategies. While leaving a fuller analysis of objective market conditions, i.e. “fundamentals” and their effects on exchange rate dynamics to our future
research agenda, this paper focused on the role of “subjective” market conditions in shaping the critical interface between heterogeneous traders. These in turn, we argued, will critically depend on the particular exchange rate regime in operation, which will shape the behaviour of foreign exchange market participants and effectively change market structure. For example, a credible exchange rate regime in the form of target zones or Williamson’s BBC regime (Basket, Band and Crawl) will impede destabilising noise traders to enter the market, and hence will stabilize exchange rates at no cost.

We applied our theoretical conjectures to an empirical study of Brazil’s foreign exchange markets. Brazil switched from a managed band regime to market-based floating after experiencing a speculative currency attack at the end of 1998. Since then the central bank has followed an inflation targeting regime, under which exchange rate movements should only enter the bank’s objective function if at odds with its inflation target. As a result, its current floating exchange rate regime has been characterised by substantial volatility. Thus, our comparative empirical analysis of Brazil’s foreign exchange market under different exchange rate regimes yielded some valuable insights into how foreign exchange markets are structured and performed in an era of financial globalization, as the outcome of interactive forces among heterogeneous market traders/participants as well as between market traders on the one hand and the Central Bank on the other.

Our analysis of exchange rate dynamics with explicitly endogenising market structures could have important implications for exchange rate policy. While mainstream economics has settled on the two corner consensus, policy makers in emerging countries acknowledge the need for an intermediate exchange rate regime, which provides stability while leaving enough flexibility to react to internal and external shocks and adjust to changing structural characteristics. However, although acknowledging the importance of stabilized exchange rates, policy makers shy away from any renewed institutional commitment to an exchange rate target due to the fear of speculative attack. Hence, existing de-facto pegs are supported by a war-chest of foreign exchange reserves which aim to prevent a run on the currency. However, as has been argued in this paper institutional commitment will be crucial to change foreign exchange market structures and effectively drive destabilising noise traders from the system. The credible commitment to an exchange rate band should make the holding of large reserves for self-insurance purposes unnecessary and allow investing valuable foreign exchange reserves into productive projects.

While this paper focused on the importance of “subjective” market conditions in shaping exchange rate dynamics, a deeper understanding of exchange rate behaviour will need a critical analysis of “objective” market conditions, or so called fundamentals. Although touched upon only briefly on this aspect in the present paper, we suggest that an analysis of motivations and behaviour of asset market players incorporating a fuller study of fundamentals will allow us to deepen further our knowledge how markets function under different exchange rate regimes. This question is the subject of our on-going research efforts.
References


Appendix Variance Ratio Tests

Lo and MacKinlay Variance Ratio Test

The variance ratio is given by

\[ VR(q) = \frac{\sigma^2_c(q)}{\sigma^2_a} \]

Lo and MacKinlay (1988) consider a sample size of \( nq+1 \) observations \((X_0, X_1, \ldots, X_{nq})\). Unbiased estimators of \( \sigma^2_c(q) \) and \( \sigma^2_a(q) \) are given by

\[
\hat{\sigma}^2_a = \frac{1}{nq-1} \sum_{k=1}^{nq} (X_k - X_{k-1} - \hat{\mu})^2
\]

And

\[
\hat{\sigma}^2_c(q) = \frac{1}{m} \sum_{k=q}^{nq} (X_k - X_{k-q} - q\hat{\mu})^2
\]

Where \( \hat{\mu} \) is the sample mean of \((X_t - X_{t-1})\) and

\[
m = q(nq - q + 1)(1 - \frac{q}{nq})
\]

The test-statistic is defined as

\[ \hat{M}_r(q) \equiv VR(q) - 1 \]

The asymptotic variance of the test-statistic under homoscedasticity is

\[
\hat{\sigma}^2_0(q) = \frac{2(2q-1)(q-1)}{3q}
\]

The standard normal test-statistic under homoscedasticity, \( Z(q) \), is then

\[
Z(q) = \sqrt{\frac{nq}{\hat{\sigma}^2_0(q)}} \tilde{\hat{M}}_r(q)^a \sim N(0,1)
\]

Using the result that \( \hat{M}_r(q) \) is asymptotically equal to a weighted sum of autocorrelation coefficient estimates,

\[
\hat{M}_r(q) = \sum_{j=1}^{q-1} \frac{2(q-j)}{q} \hat{\rho}(j)
\]

The asymptotic variance of the test statistic under heteroskedasticity is
\[ \hat{\sigma}^2 = \sum_{j=1}^{q-1} \left[ \frac{2(q-j)}{q} \right] \hat{\delta}(j) \]

Where
\[ \hat{\delta}(j) = \frac{\sum_{k=j+1}^{n_{q}} (X_k - X_{k-j} - \hat{\mu})^2 (X_{k-j} - X_{k-j-1} - \hat{\mu})^2}{\sum_{k=1}^{n_{q}} (X_k - X_{k-1} - \hat{\mu})^2} \]

The heteroskedasticity-consistent standard normal test-statistic, \( Z^*(q) \) is then given by
\[
Z^*(q) = \frac{\sqrt{nqM_r(q)} \alpha}{\hat{\sigma}} \sim N(0,1)
\]

**Chow and Denning’s Multiple Variance Ratio Tests**

The serial correlation tests presented in the paper are joint tests that no serial correlation is present at any lagged return under consideration. In essence, a set of multiple sub-hypotheses

\[(9) \quad H_{0i} : M_r(q_i) = 0 \quad \text{for } i=1,2,\ldots,m\]

\[(10) \quad H_{1i} : M_r(q_i) \neq 0 \quad \text{for any } i=1,2,\ldots,m\]

is tested.

In this context it has been argued that it is inappropriate to focus on the significance of individual variance ratios without controlling for the joint test size. This could give rise to the problem of multiple comparisons among test statistics, which in turn causes an inappropriately large probability of Type I error (Chow and Denning, 1993).

The authors propose a multiple variance ratio (MVR) test, based on the maximum absolute value of a set of Lo and MacKinlay’s test statistics, and Studentized Maximum Modulus (SMM) critical values to control for the overall test size and define a joint confidence interval for the variance ratio estimates.

The core of their test is based on the result

\[(11) \quad PR\left[ \max\{\left|Z(q_1)\right|, \ldots, \left|Z(q_m)\right|\} \leq SMM(\alpha; m; T) \right] \geq 1 - \alpha \]
in which $SMM(\alpha; m; T)$ is the upper $\alpha$ point of the SMM distribution with parameters $m$ and $T$ (sample size) degrees of freedom.

Asymptotically, when $T$ is finite

\begin{align*}
(12) \quad SMM(\alpha; m; \infty) &= Z_{\alpha/2}^*
\end{align*}

If the maximum absolute value of either $Z(q)$ or $Z^*(q)$ is greater than the SMM critical value at a predetermined significance level then the null hypothesis of no serial correlation in any of the returns considered is rejected (see also Smith et al. 2002).

**Critical Values 1**

<table>
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<th>$\alpha$</th>
<th>$3$</th>
<th>$4$</th>
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<td>$0.01$</td>
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</table>

*Source: Smith (2007)*