

The Brazilian Foreign Exchange Market through the Microstructure Perspective

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Resumo

The objective of this study is to investigate whether the relationship between order flow and the spot exchange rate stems from the fact that the flow aggregates information on dispersed economic fundamentals in the economy. To perform this test, a database that includes all transactions of the commercial and financial segments of the Brazilian primary foreign exchange market between January of 1999 and May of 2008 was used. We show that the order flow was partly responsible for variations in inflation expectations over the time period and that this relationship did not remain robust, drawing comparisons with other fundamentals such as GDP and Industrial Production.

Key words: Exchange Rate Dynamics, Market Microstructure.

JEL Code: F31, G17

1 Introduction

The traditional model of open macroeconomics based on the asset market has existed for over three decades. Despite its intellectually intuitive appeal, no empirical evidence exists that corroborates the model. In this study, while we assume the existence of uncovered interest rate parity and risk neutrality, the interest rate differential between two countries should be fully offset by changes in the exchange rate. However, in practice, we observe that the carry trade¹ is not only lucrative but presents superior returns to the interest rate differential. In the 1980s, Meese and Rogoff (1983) showed that a simple random walk possesses greater predictive power than a variety of models based on macroeconomic fundamentals, and the task of explaining exchange rate determinants remains one of the greatest empirical challenges facing researchers of open macroeconomics.

In the last decade, a new micro-founded approach called the microstructural approach was developed to address this problem. Evans and Lyon's (2002) study is currently the most representative study in this new line of research, and this article also focuses on this area with a specific focus on information structure. The novelty of this approach lies in the fact that three hypotheses of traditional models are relaxed: (i) not all relevant information for exchange rate formation is public; (ii) heterogeneity between agents (either with respect to the mapping of public information or motivation to operate) affects prices; and (iii) institutional arrangements (e.g. lack of transparency) affect prices. In this analysis, one variable is crucial: order flow. This variable is indicative of selling or buying pressure, that is, it is concerned with negotiated volume with a positive (negative) sign if the order that occurred in the market was a purchase (sale).

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¹Operation in which one borrows in a low interest currency and applies to financial instruments with high interest currencies.

After confirming the existence of a statistically significant relationship between order flow and exchange rates for the Brazilian case (a result already established in Wu (2007) and Fernandes (2008)), this article attempts to move the discussion forward by investigating the factors that determine the flow. By conciliating microstructure elements through Macroeconomic Theory and based on the theoretical model developed in Evans and Lyons (2007), this article empirically investigates whether exchange rates respond to order flow according to the latter and thus induce changes in market expectations on future economic fundamentals.

To answer this question, the original basis of Wu (2007) was updated to account for all transactions between the business and financial sector customers of Brazil's primary foreign exchange market from January of 1999 to May of 2008. Moreover, high frequency estimates were used for the macroeconomic variables (expectations of financial institutions collected daily by the Central Bank), which are derived from current and publicly available information. In turn, a high level of accuracy is ensured on ex-ante market expectations on fundamentals rather than ex-post realisations about the own variables.

The remainder of this article is organised as follows. Section 2 describes the market microstructure approach and reviews past empirical studies focused on the foreign exchange market, which provide the basis for this article. Section 3 provides a brief summary on the characteristics of the Brazilian foreign exchange market. Section 4 describes the database employed, and Section 5 elaborates on the theoretical model. Section 6 presents the empirical analysis, and Section 7 concludes the study.

2 Market Microstructure

A major challenge faced by empiricists in international economics is the task of relating exchange rate movements to macroeconomic fundamentals such as money supply, economic activity and interest rates. Though theory suggests that exchange rates are determined by such fundamentals, with the publication of Meese and Rogoff (1983) it has since been accepted that the exchange rate between two countries with similar inflation rates can be approximated by a random walk.

Overall, in traditional macroeconomic models, the exchange rate is equal to the present value minus the fundamentals, as shown below:

$$s_t = (1 - b) \sum_{i=0}^{\infty} b^i E[f_{t+i} | \Omega_t] \quad (1)$$

where s_t represents the logarithm of the spot exchange rate, $0 < b < 1$ represents the discount rate, Ω_t denotes current public information at time t and f_t represents macroeconomic fundamentals. Although intellectually intuitive, these models cannot empirically explain a large fraction of the movements that occur in the exchange rate. Flood and Rose (1995), for example, were "led to conclude that the most critical determinants of the exchange rate volatility are not macroeconomics". Lyons (1991) attempted to fill this gap by unifying elements of Microstructure Theory, which was initially limited to the Theory of Finance (asset pricing, corporate finance, etc.) that concerns itself with foreign exchange market analysis.

Market Microstructure Theory is concerned with the mechanism through which agent demand becomes reflected in asset prices and traded volumes. The most influential studies in this area include Kyle (1985), Glosten and Milgrom (1985), Stoll (1978), and Amihud and Mendelson (1980). Madhavan (2000) provides a strong introductory examination of this topic.

This literature introduces an alternative line of reasoning to Walrasian auction models, which typically assume perfect competition and free entry, that is, a market without friction. As the central focus of this approach is related to the process in which prices incorporate new information, previous studies are related to agent operators known as market makers, who are operators that are willing to buy and sell assets at pre-established prices.

The difference in prices at which these agents buy or sell a particular asset, known as the bid-ask spread comprises one of the simplest forms of friction that arises from asset trading. In microstructure models, variants of the general specifications described below are designed to explain changes in prices quoted by dealers (Δp_t) as a function of the order flow received (Δx_t) and as a function of the change in net exposure by price setters (ΔI_t):

$$\Delta p_t = f(\Delta x_t, \Delta I_t, \dots) + \varepsilon_t \quad (2)$$

The order flow is positive (negative) when the counterparty buys (sells) the asset at the price quoted by the dealers. The inventory cost can be understood as the risk attributed to the maintenance of an unwanted position in custody. To retrieve ideal carrying levels, market makers alter prices to those that they are willing to pay or receive for the purchase or sale of assets to prompt the market to take their position. However, this study does not focus on the relationship between Δp_t and ΔI_t .

Another area of concern among microstructure models is related to private information and its influence on prices. Information heterogeneity between agents can be illustrated by the varying operating motivations. Certain agents trade for liquidity purposes, smoothing their intertemporal consumption habits by adjusting their portfolios with no information advantage over other agents.

In contrast, informed traders² have access to some form of private information. The market maker does not know, a priori, under which category its counterparty falls. However, these individuals know, on average, that because they experience losses when operating with the latter group, it is advantageous to offset this loss with profits made in dealings with the first group.

The learning processes of dealers are thus critical to the determination of asset prices. The difference between the intertemporal behaviours of informed and uninformed traders lies in the fact that the former will establish positions based on ex-ante beliefs on the fundamentals until ex-post information is revealed. Therefore, the direction of transactions (purchase or sale) and traded volume provide information for market makers, and these individuals update their beliefs based on this information. The existence of dispersed private information within the economy and its transmission through the order flow is the mechanism that explains the positive relationship between Δp_t and Δx_t ³.

The microstructure approach to the foreign exchange market is based, in short, on two central ideas: (i) only part of the macroeconomic information relevant to the exchange rate is publicly known at a given point in time. The remainder of this information remains dispersed and owned by agents privately. (ii) Because the exchange rate constitutes nothing more than the foreign currency price quoted by dealers in terms of the domestic currency, this rate may only reflect information known by dealers. Consequently, the exchange rate will only reflect information dispersed in the economy when it is assimilated by the dealers - a process that occurs through negotiation.

It is important to note that the fact that the order flow constitutes a proximate cause for exchange rate movements does not contradict the notion that macroeconomic fundamentals are the

²The concept of an informed trader differ from an insider, which generally refers to a corporate officer who has fiduciary obligations to its shareholders. There are no insiders in the foreign exchange market.

³The work of Easley and O'Hara (1987) shows that the adjustment path of prices need not necessarily converge immediately to the true price, since this trajectory is detgermined by the history of business, which in turn also reflects actions of uninformed trades.

real cause of such movements. According to Evans and Lyons (2002), this interpretation is quite plausible given that empirical forecasting on the expected value of future fundamentals are fairly inaccurate. Orders, on the other hand, reflect bets on future fundamentals that are backed by money.

2.1 Empirical Literature Review: Microstructure Applied to Exchange⁴

Using data from the interdealer market, Evans and Lyons (2002) successfully explain an astonishing 60% of the variation in the Deutsche Mark/dollar exchange rate primarily through order flow. Furthermore, the study shows that buying pressure for dollars worth \$1 billion depreciates the dollar price (according to the Deutsch Mark) by 0.5%. In contrast, Evans and Lyons (2005) analyse the relationship between order flows in the interdealer market, as well as flows in the primary market (end-user/dealer)

Evans and Lyons (2007), who are referenced as a theoretical and empirical basis for this article and who therefore will be discussed extensively in other sections, attempt to analyse the relationship between macroeconomic fundamentals, order flow and exchange rate dynamics⁵. Their results show that the flow exerts significant predictive power over macroeconomic fundamentals in addition to those contained in the exchange rate and in other variables. Moreover, they show that the ability of the order flow to predict future exchange rate fluctuations is consistent with its ability to predict market reactions to information flows on macroeconomic variables.

By qualifying the discussion on the relationship between fundamentals and exchange rates, Froot and Ramadorai (2005) identify three lines of reasoning. In the "strong" view of the order flow, the order flow induces exchange rate fluctuations due to its ability to aggregate private information, which, when revealed, positively and permanently impacts the exchange rate. In the "weak" view of the order flow, the order flow carries information on deviations in fundamentals rather than the actual values of fundamentals and, therefore, impacts the exchange rate only temporarily. Finally, according to the "solely focused on the fundamentals" view, the flow may respond passively to fundamentals or may simply not contain information on fundamentals or fundamental deviations.

The authors examine the relationship between excess currency return⁶, transaction flows of institutional investors and macroeconomic fundamentals (actual exchange rate and actual interest rate differentials) and find evidence that the flow helps to predict temporary variations in the interest rate differential, which supports the "weak" view of the flow. Evans and Lyons (2007) justify this result on basis of (i) the choice of the fundamentals; (ii) lack of representativeness in the institutional flow (when viewed exclusively); and, most importantly, (iii) the fact that the order flow is not controlled by fundamental variations but by variations in expectations about fundamentals.

Wu (2007) was the first study these processes in relation to the Brazilian foreign exchange market. The author's database is similar to that used for this article, as can be seen in Section 5, and it includes all domestic primary exchange market transactions between July of 1999 and June of 2003, aggregated daily by counterparty type: business, financial clients and the Central Bank of Brazil. To identify and control bias that may occur with endogeneity between exchange rate movements and foreign currency demands, the author estimates a structural VAR. The results show that due to a buying pressure of \$1 billion, dealers depreciate the exchange rate at 2.7%. At the same time, a depreciation of 1% decreases the financial sector buying flow by \$111 million and the commercial sector by \$46 million.

⁴The empirical literature on the ability to forecast out of sample will be discussed in section 6.2.

⁵See also Engel e West (2005).

⁶Exchange rate variations in excess on the interest rate differential.

The objective of Fernandes (2008) was to compare the Brazilian cash market to its forward exchange rate market. The empirical results show that the forward market demonstrates tighter spreads and lower-order flow impact on the exchange rate price: The buy (sell) flow of \$1 billion depreciates (appreciates) forward exchange rates at 0.99% and depreciates the spot exchange rate at 1.12%. Furthermore, whereas the future dollar rate adjusts the order flow in less than three minutes, the spot price achieves this result in four to five minutes. Finally, the author shows that (i) for the prices of the previous ten minutes, (ii) the order flow of the forward market informs the prompt dollar, but the opposite does not occur. This finding indicates that the forward market is the locus of the exchange rate formation, and then transmitted by arbitration to the spot market.

Laurini et al. (2008) evaluated various empirical properties of the Brazilian foreign exchange market microstructure. Due to the inability to identify, from the obtained database, completed transactions and hence the order flow, the authors instead focused on the bid-ask spread, which can be understood as the inventory carrying cost and/or the liquidity provisions by dealers. For the sample period, it was found that the incorporation of new information into prices is not immediate, which contradicts the efficient market hypothesis and corroborating model developed by Easley and O'Hara (1987).

Another interesting aspect of this study included the use of quantile regressions to address the asymmetric process through which the spread becomes related to the market state, measured from uncertainty (volatility) and liquidity (time between two orders in seconds) variables. Spreads above their equilibrium values showed a high degree of persistence and reacted positively in proportion to the quantile with respect to volatility and liquidity. For spreads below their equilibrium value, an opposite relationship was found, denoting a non-linear relationship of mean reversion in the spreads.

3 The Brazilian Foreign Exchange Market

In Brazil, the exchange for physical is split between the primary and secondary market, a system referred to as the interbank. Another relevant locus for exchange rate formation is the derivatives market of the BM&FBOVESPA (São Paulo Stock Exchange). The primary market operation implies effective inputs or outputs of foreign currency within the country. This is the case for transactions between overseas exporters, importers, investors and recipients of funds, interest-paying borrowers and creditors collecting interest from previous debts, travellers etc. In the secondary market, foreign exchange simply migrates from the assets of one bank to another, and these movements are referred to as interbank transactions.

Only those banks authorised by the Central Bank of Brazil perform operations in the secondary market. As in most countries, Brazil has adopted a decentralised market system with multiple dealers. However, as this could not be fully realised, the system possesses certain particularities in practise ⁷. If negotiations between banks in the international market take place through electronic systems, the interbank market is largely mediated by brokers who administer their trading desks and real trading sessions by phone. Given its opacity, the learning process for this market, in the words of operators, involves an even greater focus on what Goodhart (1988) called the reading ability of counterparties' transactions, as well as issues such as reputation and leadership.

Once negotiated, transactions must undergo compulsorily registration and confirmation in the electronic information system of the Central Bank of Brazil: the Sisbacen. In the forward exchange market, buy-and-sell transactions are administered directly with the Derivatives Clearinghouse of BM&FBOVESPA, which acts as the central counterparty for buyers and sellers. Participants are

⁷For a survey of the Brazilian Exchange Rate Market see Garcia e Urban (2004).

required to deposit a bank guarantee, against which daily rate fluctuations are charged or credited and multiplied by the value of the contracts to maintain a minimum margin.

The legislation surrounding the forward market is much less restrictive than that of the cash market. While only banks authorised by the Central Bank of Brazil (BACEN) may carry foreign currency in cash, all institutions, as well as individual investors, can carry future positions provided that conditions imposed by the broker and the BM&FBOVESPA are fulfilled. This institutional arrangement causes several unusual spot market transactions to be transferred to the forward market, which creates a more fluid system and, consequently, making the forward market the main locus of exchange rate formation, as is argued by Garcia and Urban (2004).

Operations with financial assets are generally targeted at hedging, arbitrage and speculation. In the case of exchange, the most common operation carried out in this market involves arbitrage between interest rates. The bank obtains overseas money located in countries where the interest rate is low - the United States (or Japan) - sells dollars (or yen) over the interbank market and invests in the Brazilian real over the domestic market. In Brazil, we observed that the carry trade is not only lucrative but provides superior returns than the interest rate differential given that the Brazilian real has undergone an appreciation process from the pre-electoral crisis of 2002 until the outbreak of the 2008 financial crisis. Another common practice in the interbank market involves arbitrage between the exchange rate traded on the secondary market and the rate offered to the customer on the primary market. When buying foreign currency from its customers, for example, the bank attempts to sell that same position over the secondary market with a degree of arbitrage profit.

From a practical perspective, numerous issues that the Brazilian exchange market currently faces or has recently experienced are related to information structures. The introduction of prompt dollar open outcry trading at the BM&FBOVESPA in February of 2006, which was established through Brazilian Payment System restructuring in 2002, raised doubts over whether order flow fragmentation between various markets would affect information efficiency. The introduction of the electronic trading later on has generated similar issues. With this development, discussions focused on whether the order book should be open to the public, on whether originating institutions should be identified and on the requirements of appropriate order depth.

4 Theoretical Model

4.1 Intuition

Consider a firm that is willing to pay interest on a liability contracted in dollars from an international funding organisation. This operation affects the Balance of Payments and, therefore, represents a fundamental that should affect the exchange rate. On the other hand, this fact only becomes public after a delay period, which is revealed as a negative item in the Current Account.

The company shall approach a bank (dealer A) to exchange Brazilian reals for dollars in order to complete this transaction. At this time, the company's private information was transmitted with some degree of accuracy to dealer A through the buy order flow (positive). In general, in the second step of this transaction, the bank uses either the prompt dollar or forward market interbank market to buy dollars and reduce its exposure while profiting from the spread between markets ⁸. This successive order flow continues until the exchange rate has reached a new level of equilibrium.

⁸The mechanism by which the banks; to avoid a mismatch between their current and desired exchange position; give an order on the primary market to other dealers in the secondary market was called by Lyons (1997) as a "hot potato".

The asymmetry of the information set between agents allows the order flow between primary customers and the dealer, and later among dealers, to impact prices. This is true because the transmission of private information is the primary factor that causes the selling or buying pressure to impact prices permanently.

4.2 Dealers

The theoretical model follows the framework provided by Evans and Lyons (2007). We consider the optimal choice of M market makers engaged in the foreign exchange market over two negotiation rounds. In both phases, the prices traded are publicly observed and valid for any dollar amount. In the beginning, the dealer sets prices, $S_{m,t}^I$, at which he is willing to sell (or buy) dollars to (from) primary customers. The orders from primary customers are only observed by the dealer involved in the negotiation and are configured as private sources of information.

In the second phase, the dealers set prices, $S_{m,t}^{II}$, at which they are willing to negotiate over the interdealer market. At this time, dealers also initiate businesses using prices provided by other market makers $S_{m,t}^{II}$. The net result of orders received by the market maker m at stage I is denoted by $T_{m,t}^I$. In the second phase, the orders initiated by the dealer m are denoted by $\Gamma_{m,t}^{II}$, and those that are received are denoted by $T_{m,t}^{II}$.

The total value of the orders received by M dealers in round I is equal to the total order flow for primary customers, Δx_t . The reasoning behind this process is analogous to the next round of interdealer trading. The total order values received by the dealers are equal to the total order values that the dealers had initiated.

$$\sum_{m=1}^M S_{m,t}^I T_{m,t}^I = \Delta x_t \quad (3)$$

$$\sum_{m=1}^M S_{m,t}^{II} \Gamma_{m,t}^{II} = \sum_{m=1}^M S_{m,t}^{II} T_{m,t}^{II} \quad (4)$$

Each quotation must be simultaneously chosen at the beginning of each round, so that:

$$S_{m,t}^I = S_{m,t}^{II} = S_t = f(\Omega_t^M) \quad (5)$$

where $\Omega_t^M = \bigcap_m \Omega_{m,t}^I$ is the common information set of all dealers at the beginning of round I in period t . The balance possesses three basic characteristics: (i) each dealer quotes the same price in both rounds; (ii) all dealers provide the same pricing; (iii) all quotations set a common information function that is available at the beginning of the period t .

The possibility of parallel trading between multiple counterparties and the fact that the quotation is valid for any foreign currency amount excludes the existence of a quote that differs from S_t^I in the second round given that, in this case, dealers would be exposing themselves to arbitrage. The reasoning behind this process is analogous to round I . The primary customer is free to choose with whom they will negotiate, implying that dealers should set the same prices, i.e., $S_{m,t}^I = S_{m',t}^I = S_t^I$. Finally, while we require incentive compatibility, i.e., that all dealers wish to participate in the first round, we discard any difference between S_t^I and S_t^{II} , because each dealer should use the same price for both rounds to avoid operating losses.

Finally, the prices of the first round will be common across all market makers only if they depend on information that is common to everyone, that is, Ω_t^M . This however, does not imply that Ω_t^m is equal across all markets makers. A market maker m may possess private information at the beginning of period t on the future spot exchange rate, that is, $E_t^m[S_{t+1}] \neq E_t^M[S_{t+1}]$, but he or she cannot use this information to inform quoted exchange rate choices without risking arbitrage loss. The agent instead applies this information in second-round allocation decisions, that is, when buying or selling dollars according to the quote S_t .

The spot exchange rate is given by the following basic expression:

$$s_t = \ln(S_t) = (1 - b)E_t^M \left[\sum_{i=0}^{\infty} b^i f_{t+i} \right] \quad (6)$$

where E_t^M is the expectation conditional in Ω_t^M . The precise definition of fundamentals and the specific parameter form b depend on the macroeconomic model in question and are not the focus of this study.

For dealers to agree to buy and sell dollars at the exchange rate that they quote, s_t should be valued so that excess expected returns offset operation risk, Ψ .

$$E_t^M [\Delta s_{t+i}] + r_{t+i} - \hat{r}_{t+i} = \psi \quad (7)$$

in which $r_{t+i} - \hat{r}_{t+i}$ is the interest rate differential and Ψ is the risk premium.

Equation (6) shows that the dollar price quoted by dealers in Brazilian reals is equal to the expectation and conditioned to dealers' common beliefs, which is the present fundamentals value. This feature differentiates this variable from (1). The natural consequence of this formulation is the fact that information on the current and future state of the economy will only affect the exchange rate when and if it results in a review of dealer beliefs.

In rewriting (6), we conclude:

$$s_t = E_t^M [f_t] + \frac{b}{(1-b)} E_t^M [\Delta s_{t+i}] \quad (8)$$

$$\Delta s_{t+1} = E_t^M [\Delta s_{t+i}] + \varepsilon_{t+1}^M = \frac{1-b}{b} (s_t - E_t^M [f_t]) + \varepsilon_{t+1}^M \quad (9)$$

$$\varepsilon_{t+1}^M \equiv (1-b) \sum_{i=0}^{\infty} b^i (E_{t+1}^M [f_{t+i+1}] - E_t^M [f_{t+i+1}]) \quad (10)$$

Equation (8) demonstrates that the evolution of the dealers' information set can affect the exchange rate through two channels. First, it alters the difference between dealer estimates on the current fundamentals value and the spot exchange rate, $s_t - E_t^M [f_t]$. Second, it suggests the occurrence of new reviews on future fundamentals $E_{t+1}^M [f_{t+i+1}] - E_t^M [f_{t+i+1}]$ for $i \geq 0$, which contributes to dealer prediction errors on spot exchange rates in the future, $\varepsilon_{t+1}^M \equiv s_{t+1} - E_t^M [s_{t+i}]$. Therefore, any variable correlated with the arrival of new information that allows market makers to revise their beliefs on future fundamentals, such as the order flow of period t , must also be correlated with exchange rate innovation.

Remember that the order flow received in round I includes private dealer information that is used by dealers to negotiate with other dealers (that is, when choosing $\Gamma_{m,t}^{II}$). As a result, round

II aggregates (although partially) information held by the primary customer, or dealer order flow, which increases the common information set of period $t + 1$, Ω_{t+1}^M , and thus affects the choice of s_{t+1} .

4.3 Order Flow

Without loss of generality, we will analyse the case of a representative primary customer. With this simplification, we disregard the information difference between primary agents. In notation, we require that $\Omega_t^P = \Omega_t^D = \Omega_t^P$. However, we allow for information heterogeneity between dealers and customers.

The primary agent receives a private signal, represented by the fundamentals, but the information contains noise. This form of information can be obtained through searching in the case of investment funds or through the demand for goods and services in the case of firms. Based on this signal, the agent will begin a transaction through hedging, speculation or arbitrage to profit from an information advantage. The total order flow will, therefore, be related to differences between primary customer and dealer estimates on spot exchange rates in the future.

$$\Delta x_t = \beta \left((E_t^P [s_{t+1}] - E_t^M [s_{t+1}]) \right) \quad (11)$$

where β is a positive constant and E_t^P is the conditional expectation of primary customer belief sets. If the primary customers are more optimistic than the market makers on s_{t+1} , i.e., $E_t^P [s_{t+1}] > E_t^M [s_{t+1}]$, buying pressure will develop ($\Delta x_t > 0$).

Starting from a very general characterisation of the fundamentals dynamics given in (12), we can draw a direct connection between these dynamics and the order flow, as shown in (21).

$$\Delta f_{t+1} = A \Delta f_t + u_{t+1} \quad (12)$$

In which u_{t+1} is a vector of shocks with zero mean. When dealers choose the price of the spot exchange rate according to (6), we can rewrite this last equation as follows:

$$s_t = \varphi E_t^M \left[\vec{f}_t \right] \quad (13)$$

where:

$$\vec{f}_t = \left[f_t', \Delta f_t' \right] \quad \text{e } \varphi = \vec{i}_1 + b(I - bA)^{-1} A \vec{i}_2$$

then:

$$\begin{aligned} E_t^P [s_{t+1}] - E_t^M [s_{t+1}] &= \varphi \left(E_t^P E_{t+1}^M \left[\vec{f}_{t+1} \right] - E_t^M E_{t+1}^M \left[\vec{f}_{t+1} \right] \right) \\ &= \varphi \left(E_t^P E_{t+1}^M \left[\vec{f}_{t+1} \right] - E_t^M \left[\vec{f}_{t+1} \right] \right) \end{aligned} \quad (14)$$

Suppose that the primary customers in instant t collectively know at least as much about the economy as the market makers do, that is $\Omega_t^M \subset \Omega_t^P$.

Thus, the right hand side of (14) can be rewritten as $\varphi \left(E_t^P E_{t+1}^M \left[\vec{f}_{t+1} \right] - E_t^P E_t^M \left[\vec{f}_{t+1} \right] \right)$ and will depend upon customer perceptions on how market makers revise their beliefs on future economic fundamentals.

When $\Omega_t^M = \Omega_t^P$, the difference between expectations on the future exchange rate spot price will be null because $E_{t+1}^M \left[\vec{f}_{t+1} \right] - E_t^M \left[\vec{f}_{t+1} \right]$ shall be caused by information that is not contained in

Ω_t^M . Alternatively, assume that primary customers collectively possess superior information on a certain variable v_t , i.e., $\Omega_t^P = \{\Omega_t^M, v_t\}$. If dealers review their estimates on \vec{f}_{t+1} using elements of v_t , then certain elements of $E_{t+1}^M [\vec{f}_{t+1}] - E_t^M [\vec{f}_{t+1}]$ will be estimated based on Ω_t^P . Therefore, the order flow should be correlated with variations in fundamentals estimates. Formally, we have:

$$\begin{aligned} E \left[E \left[\vec{f}_{t+1} \mid \Omega_{t+1}^M \right] \mid \Omega_t^P \right] &= E \left[E \left[\vec{f}_{t+1} \mid \Omega_{t+1}^M \right] \mid \Omega_t^M, v_t \right] \\ &= E \left[E \left[\vec{f}_{t+1} \mid \Omega_{t+1}^M \right] \mid \Omega_t^M \right] + B_{E_{t+1}^M [\vec{f}_{t+1}], v_t} (v_t - E [v_t \mid \Omega_t^M]) \end{aligned} \quad (15)$$

where

$$B_{E_{t+1}^M [\vec{f}_{t+1}], v_t} = \frac{Cov \left(E \left[\vec{f}_{t+1} \mid \Omega_{t+1}^M \right], v_t \right)}{Var(v_t)} \quad (16)$$

$$E_t^P E_{t+1}^M [\vec{f}_{t+1}] - E_t^M [\vec{f}_{t+1}] = B_{E_{t+1}^M [\vec{f}_{t+1}], v_t} (v_t - E [v_t \mid \Omega_t^M]) \quad (17)$$

$$E_t^P E_{t+1}^M [\vec{f}_{t+1}] - E_t^M [\vec{f}_{t+1}] = \kappa \left(E_t^P [\vec{f}_{t+1}] - E_t^M [\vec{f}_{t+1}] \right) \quad (18)$$

$$\kappa \equiv B_{E_{t+1}^M [\vec{f}_{t+1}], v_t} \left(B_{E_t^P [\vec{f}_{t+1}], v_t} B_{E_t^M [\vec{f}_{t+1}], v_t} \right)^{-1} B_{E_t^P [\vec{f}_{t+1}], v_t} \quad (19)$$

for a given κ , which Evans and Lyons (2007) called "pace of information aggregation". If the dealers do not add new information at t , $E_{t+1}^M [\vec{f}_{t+1}] = E_t^M [\vec{f}_{t+1}]$, or if customers expect dealers not to be able to incorporate new information during period t , $E_t^P E_{t+1}^M [\vec{f}_{t+1}] - E_t^P E_t^M [\vec{f}_{t+1}] = 0$, κ will be null⁹. If period t is completely revealing in such way that $\Omega_{t+1}^M = \Omega_t^P$, $\kappa = 1$ ¹⁰. $E_{t+1}^M [\vec{f}_{t+1}] - E_t^M [\vec{f}_{t+1}]$ will be equal to $E_{t+1}^P [\vec{f}_{t+1}] - E_t^M [\vec{f}_{t+1}]$. Finally, in intermediary cases where the pace of aggregation and the incorporation of new information is slower, $0 < \kappa < 1$. In this case, the order flow and difference between expectations of future spot exchange rates between primary customers and dealers, $E_t^P [s_{t+1}] - E_t^M [s_{t+1}]$ will be given by the following expressions:

$$\nabla E_t^P [s_{t+1}] = E_t^P [s_{t+1}] - E_t^M [s_{t+1}] = \varphi \kappa \left(E_t^P [\vec{f}_{t+1}] - E_t^M [\vec{f}_{t+1}] \right) \quad (20)$$

$$\Delta x_t = \beta \varphi \kappa \left(E_t^P [\vec{f}_{t+1}] - E_t^M [\vec{f}_{t+1}] \right) \quad (21)$$

The basic reasoning of the model suggests that if primary customers possess more information on the economy than dealers and if dealers can assimilate segments of order flow information at each period, the order flow should partly explain variations in differential predictions (between dealers and primary customers) on economic fundamentals.

⁹ $Cov \left(E \left[\vec{f}_{t+1} \mid \Omega_{t+1}^M \right], v_t \right) = 0$

¹⁰ $B_{E_{t+1}^M [\vec{f}_{t+1}], v_t} = B_{E_t^P [\vec{f}_{t+1}], v_t}$

5 Database

The database provided in this article contributes information on transactions between dealers and end users over the primary exchange market, the Real/dollar spot exchange rate, a collection of control variables and a proxy for agent belief changes on macroeconomic fundamentals.

5.1 Flows

Information on foreign exchange transactions was taken from the information system of the Central Bank of Brazil, Sisbace¹¹, added at daily intervals and measured in billions of dollars; it is calculated as the difference between the total value of buy orders and total value of sell orders in US dollars.

These data are advantageous, as they provide 100% coverage of primary market transactions involving the financial and commercial sectors. The series identifies the counterparty type for each transaction, which allows us to determine whether the behaviour of each agent segment is similar and whether the review process of dealer beliefs differs for each type of end user. As transactions over the primary market capture the primitive exchange needs of the economy, the database allows for an analysis that is better aligned with modern macroeconomic theory.

These data also provide an extensive time window, covering the period from January of 1999 to May of 2008. Moreover, due to the paperwork involved in negotiations over the primary market, the use of algorithms to identify originators/initiators of transactions is not required, as transactions are carried out directly.

Criticisms of Laurini et al. (2008) about this database are invalidated by the model shown in the previous section. According to the authors, the delay in the disclosure of such information by the Central Bank of Brazil to market agents would imply that such information would not affect trading. The theoretical model, however, clarifies that trading over the primary market involves private information provided to the dealer and that the relationship between the exchange rate and primary flow will be given by the portion of this information to be transmitted to the entire market through interdealer negotiation at t .

5.2 Expectations

An explanation is appropriate to clarify the difference between the macroeconomic fundamental and expectations surrounding it. Assume that fundamental f , occurs during the period τ , that ends on day $T(\tau)$, with a value of $f_{T(\tau)}$. The disclosure of data regarding $f_{T(\tau)}$ only occurs in $D(\tau)$, after period τ ends and with a delay of $D(\tau) - T(\tau)$ days. The expectation q of f appraised on day t belonging to period τ is the expected value of $f_{T(\tau)}$ based on the available information set to dealers earlier on day t , Ω_t^M , i.e.:

$$q_{T(\tau)|t} = E [f_{T(\tau)} | \Omega_t^M] \quad (22)$$

This expectation specification, which occurs on the condition of information available at t , ensures that the variable can be assumed to affect the market on day t . Traditional macroeconomic

¹¹It is mandatory to register all exchange transactions carried out in Brazil through the Sisbacen, an information collection, storage and exchange systems that connects the Central Bank to all agents operating in the domestic financial market. The information generated by dealers in Sisbacen can only be observed by the Central Bank, and only with some delay is disclosed to the market in a summary in a lower frequency.

models, in contrast, use series containing information that is not available to market participants on day t . Another advantageous attribute of this approach is concerned with data frequency. While fundamentals are added on a quarterly (in the case of GDP) or monthly (industrial production and inflation) basis, expectations vary from day to day, which is illustrated in figure 1¹² and figure 2.

Evans and Lyons (2007) develop estimates in real time for expectations on fundamentals based on publicly available information until the date in question. For example, using the disclosed data for the period until the second week of August (which includes inflation in July, the second quarter GDP, etc.), the authors build an estimate for U.S. GDP growth in the third quarter. The estimate is recalculated every time an update on the state (public disclosure) of an explanatory variable of U.S. quarterly GDP is provided.

This study adopts a simpler approach. We directly apply market expectations on several macroeconomic variables that are updated daily by the Central Bank of Brazil from financial institutions. "Currently, the research follows market expectations for different price indices, GDP and industrial production growth, exchange rates, Special Systems for Settlement and Custody (SELIC) rates, tax variables and foreign sector indicators."¹³

¹²Only as illustrative, disclosure of the series was artificially computed as on the last working day of the reference period.

¹³<http://www4.bcb.gov.br/?FOCUSINTRO>

We used four sets of expectations disclosed by the Central Bank (Banco Central - BACEN): (i) Monthly inflation; (ii) twelve-month ahead inflation; (iii) monthly industrial production; and (iv) quarterly GDP. We also measured variations in beliefs on these variables at weekly intervals. When two weeks belong to the same period τ , the development of beliefs is given by the formula:

$$q_{T(\tau)|S(j)} - q_{T(\tau)|S(j-1)} = E \left[f_{T(\tau)} \mid \Omega_{S(j)}^M \right] - E \left[f_{T(\tau)} \mid \Omega_{S(j-1)}^M \right] \quad (23)$$

In which $S(j)$ denotes the last day of the week j and $\Omega_{S(j)}^M$ contains only information known at the beginning of $S(j)$. In this case, expectation development should only include new information on the value of f in the current period, $f_{T(\tau)}$, which denotes that it will not be correlated with $\Omega_{S(j-1)}^M$. When weekly variations occur in different periods, we follow:

$$\begin{aligned} q_{T(\tau+1)|S(j)} - q_{T(\tau)|S(j-1)} &= \left\{ E \left[f_{T(\tau+1)} \mid \Omega_{S(j)}^M \right] - E \left[f_{T(\tau+1)} \mid \Omega_{S(j-1)}^M \right] \right\} \\ &+ \left\{ E \left[f_{T(\tau+1)} \mid \Omega_{S(j-1)}^M \right] - E \left[f_{T(\tau)} \mid \Omega_{S(j-1)}^M \right] \right\} \end{aligned} \quad (24)$$

The first element on the right side of (24) contains new information $f_{T(\tau+1)}$ and, therefore, should not be correlated with $\Omega_{S(j-1)}^M$. The second element identifies ex-ante expectations of variations in f between periods τ and $\tau + 1$. This term is a function of $\Omega_{S(j-1)}^M$ and, therefore, can be correlated to past belief changes.

5.3 Control Variables

Three standard macroeconomic controls are considered in the literature: the interest rate differential measured by the difference between the SELIC and LIBOR rate in dollars (both in % p.a.) over one month; the country risk premium measured by the EMBI + Brazil and IBovespa. All variables were calculated based on the final-day closing value of each period. The series were differentiated using:

$$\Delta difjur_t = \ln(selic_t/libor_t) - \ln(selic_{t-1}/libor_{t-1})$$

$$\Delta embi_t = \ln(embi_t) - \ln(embi_{t-1})$$

$$\Delta ibov_t = \ln(ibovespa_t) - \ln(ibovespa_{t-1})$$

Table 1 shows the descriptive statistics of data gathered at monthly intervals. The table demonstrates that the variation in the exchange rate logarithm has a mean close to zero. Moreover, the series has no significant correlation, indicating that the generating process of can be adequately represented by a random walk, as was demonstrated by Messe and Rogoff (1983).

Figura 1: Market Expectations IPCA for the current month and disclosed IPCA (percentage pm): 04/2001 to 04/2008

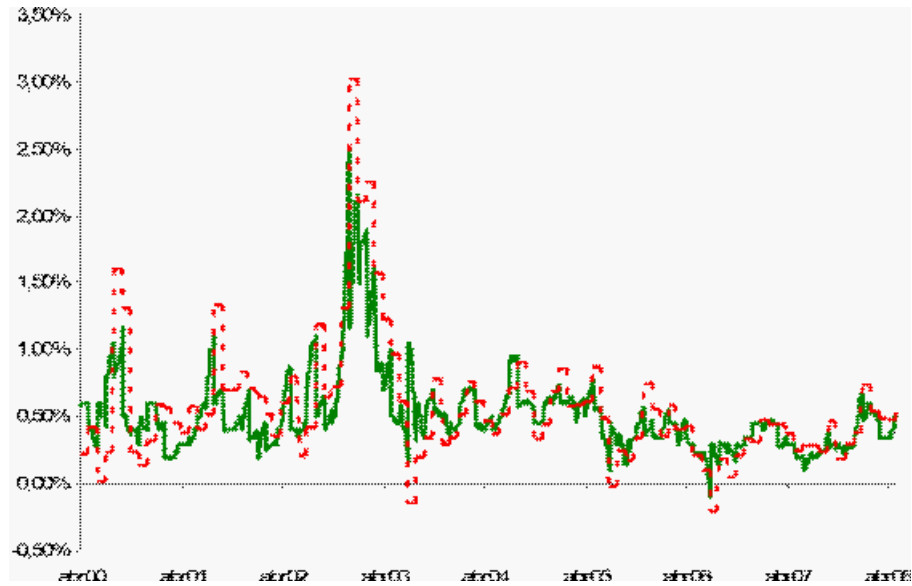


Figura 2: Market GDP Expectations for the current quarter and reported GDP (percentage growth over the same period in the previous year): November of 2001 to June of 2008

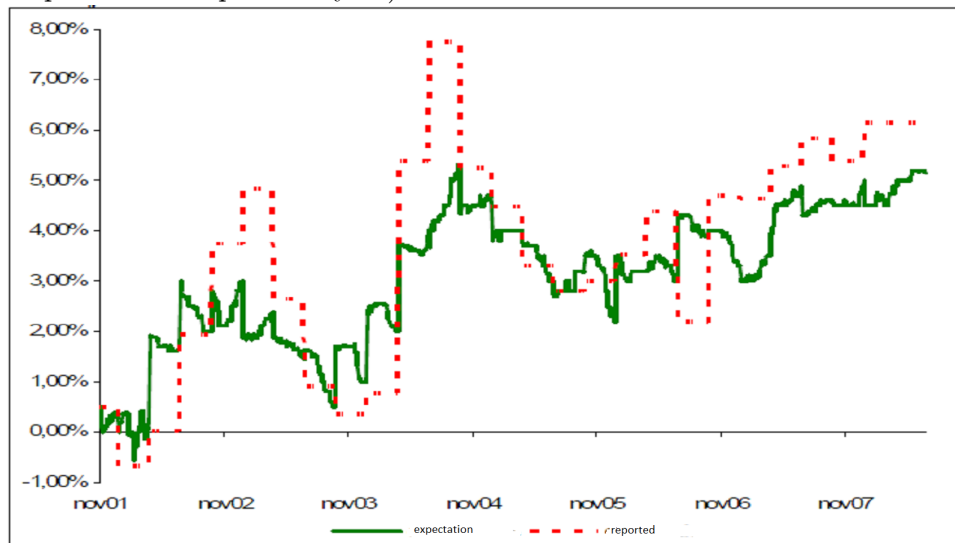


Tabela 1: Descriptive Statistics

	Mean	Median	Minimum	Maximum	Stand. Dev.	Asymmetry	Kurtoses	Autocorrelation*	
						$\mu_3/\mu_2^{3/2}$	μ_4/μ_2^2	ρ_1	ρ_2
Δs_t	0,0028	-0,0021	-0,1816	0,4952	0,0712	3,2262	23,2920	-0,0430	-0,0412
Controls									
$\Delta ibov_t$	0,0207	0,0207	-0,1925	0,2155	0,0808	-0,2088	2,8946	0,0902	0,0139
$\Delta embi_t$	-0,0154	-0,0284	-0,3620	0,4562	0,1413	0,6721	4,1618	-0,0174	0,1001
$\Delta difjur_t$	-0,0022	-0,0153	-0,3218	0,3806	0,1007	0,6499	5,6096	0,4848	0,3327
Expectation									
<i>prodind</i>	-0,0183	0,0000	-0,8000	0,7000	0,3007	-0,3327	3,3035	0,4036	0,0952
<i>ipca</i>	0,0723	0,0350	-0,7500	1,7000	0,2672	2,4893	17,4530	0,5922	0,2516
Order Flow									
<i>total</i>	-1,6155	-0,7809	-16,5650	6,1333	3,2485	-1,5312	6,8785	0,4732	0,4156
<i>comercial</i>	-3,0386	-2,3182	-10,4410	0,5309	2,4691	-0,9876	3,4903	0,6975	0,6910
<i>financeiro</i>	1,4231	1,1710	-6,3789	11,6440	2,4616	0,3633	5,8053	0,3141	0,1145

Notes: All variables are collected at monthly intervals.

*critical value of 5% is 0,18438

All the analysed series are leptokurtic¹⁴ with the exception of the geometric return of IBOVESPA. This last result was not repeated for the daily series, which produced a sample kurtosis of 22.9 (unreported result). Whereas exchange rate fluctuations and inflation expectation exhibited a strong trend of right asymmetry, total and commercial order flows demonstrated a clear left asymmetry pattern.

The autocorrelations are positive and significant for the order flow and for the review proxies of dealer expectations. As is shown in figure 3, the trade flow is constantly negative, which indicates selling pressures on foreign currency. This fact depicts a condition of positive balances within the Trade Balance that was experienced in Brazil during this period. Among the months 113 included in the sample, only two showed a positive flow. In the financial segment, the series is more volatile, but ρ_1 is also significant (other lags are not significant). For this segment, the pressure is opposite, and thus dollars are being bought.

The autocorrelation of expectation variables by dealers demonstrates that growth projections of industrial production or inflation are positively related to their respective lags. This implies that a review of dealer beliefs on a particular variable reflects the arrival of new information on that variable. Hence, our proxies allow us to capture variations in perceptions on the state of the economy and not on the economy's actual evolution.

6 Empirical Analysis

To avoid spurious results, ADF and Philips-Perron unit root tests were performed on variables. The results presented in the table (2-4) demonstrate that the series of order flow is $I(0)$. On the other hand, the dollar, embi, difjur and ibovespa series are $I(1)$. These were thus used to ensure consistent results. Below, the temporal precedence is tested between the disaggregated order flow and the exchange variation.

As shown in table 5 below, the hypothesis that, exchange rate depreciation does not Granger cause commercial order flows is rejected for all frequencies of aggregation. The null hypothesis that trade and financial flows are not mutually Granger caused in daily aggregations, is also rejected. For all other combinations of order flows, including commercial and financial order flows and exchange rate depreciation, the null hypothesis of no Granger causality, is not rejected.

¹⁴Compared to a normal distribution, a leptokurtic distribution has a higher peak (higher probability of events around the mean) and heavier tails (higher probability of extreme events).

Tabela 2: Unit Root Tests - Daily Frequency

		ADF			Phillips-Perron		
daily	variable	nothing	constant	trend	nothing	constant	trend
frequency	commercial	0.052	0.006	0.000	0.000	0.000	0.000
	financial	0.000	0.000	0.000	0.000	0.000	0.000
	total	0.000	0.000	0.000	0.000	0.000	0.000
	dollar	0.652	0.096	0.405	0.631	0.093	0.395
	1st dif	0.000	0.000	0.000	0.000	0.000	0.000
	embi	0.202	0.785	0.598	0.180	0.786	0.638
	1st dif	0.000	0.000	0.000	0.000	0.000	0.000
	difjur	0.514	0.866	0.975	0.507	0.822	0.961
	1st dif	0.000	0.000	0.000	0.000	0.000	0.000
	IBOVESPA	0.996	0.876	0.771	0.997	0.885	0.797
	1st dif	0.000	0.000	0.000	0.000	0.000	0.000

Note: The null hypothesis of non-stationarity range from the most general test to the most specific one, and the most suitable option is highlighted in bold. The reported values are p-values

Tabela 3: Unit Root Tests - Weekly Frequency

		ADF			Phillips-Perron		
weekly	variable	nothing	constant	trend	nothing	constant	trend
frequency	commercial	0.082	0.014	0.000	0.0000	0.000	0.000
	financial	0.000	0.000	0.000	0.000	0.000	0.000
	total	0.000	0.000	0.000	0.000	0.000	0.000
	dollar	0.661	0.086	0.366	0.621	0.078	0.334
	1st dif	0.000	0.000	0.000	0.000	0.000	0.000
	embi	0.144	0.767	0.688	0.146	0.760	0.647
	1st dif	0.000	0.000	0.000	0.000	0.000	0.000
	difjur	0.351	0.633	0.902	0.477	0.736	0.928
	1st dif	0.000	0.000	0.000	0.000	0.000	0.000
	IBOVESPA	0.997	0.867	0.788	0.997	0.861	0.752
	1st dif	0.000	0.000	0.000	0.000	0.000	0.000

Note: The null hypothesis of non-stationarity range from the most general test to the most specific one, and the most suitable option is highlighted in bold. The reported values are p-values

Tabela 4: Unit Root Tests - Monthly Frequency

		ADF			Phillips-Perron		
Monthly Frequency	variable	nothing	constant	trend	nothing	constant	trend
	commercial	0,717	0.731	0.000	0.045	0.000	0.000
	financial	0.000	0.000	0.000	0.000	0.000	0.000
	total	0.000	0.000	0.000	0.000	0.000	0.000
	dollar	0.481	0.638	0.916	0.480	0.735	0.954
	1st dif	0.000	0.000	0.000	0.000	0.000	0.000
	embi	0.193	0.753	0.577	0.203	0.740	0.577
	1st dif	0.000	0.000	0.000	0.000	0.000	0.000
	difjur	0.311	0.494	0.812	0.431	0.647	0.881
	1st dif	0.000	0.000	0.000	0.000	0.000	0.000
	IBOVESPA	0.998	0.874	0.813	0.997	0.860	0.813
	1st dif	0.000	0.000	0.000	0.000	0.000	0.000

Note: The null hypothesis of non-stationarity range from the most general test to the most specific one, and the most suitable option is highlighted in bold. The reported values are p-values

Tabela 5: Granger Causality Test

Frequency	Variable 1	Variable 2	p-value
Daily	financial	depreciation	0.197
	depreciation	financial	0.056
	commercial	depreciation	0.138
	depreciation	commercial	0.001
Weekly	commercial	financial	0.024
	financial	commercial	0.000
	financial	depreciation	0.926
	depreciation	financial	0.336
Monthly	commercial	depreciation	0.159
	depreciation	commercial	0.000
	commercial	financial	0.386
	financial	commercial	0.113
Monthly	financial	depreciation	0.665
	depreciation	financial	0.193
	commercial	depreciation	0.277
	depreciation	commercial	0.033
Monthly	commercial	financial	0.841
	financial	commercial	0.535

6.1 Correlation Between Flow and Depreciation

In Section 4, we noted that the spot exchange rate quoted by dealers must satisfy $E_t^M [\Delta s_{t+i}] + r_{t+i} - \hat{r}_{t+i} = \psi$. Combining this equation with identity $\Delta s_{t+1} = E_t^M [\Delta s_{t+1}] + s_{t+1} - E_t^M [s_{t+1}]$ and to equation (13), we have:

$$\begin{aligned} \Delta s_{t+1} &= s_{t+1} - E_t^M [s_{t+1}] + \Phi Z_t \\ &= \varphi \left(E_{t+1}^M [\vec{f}_{t+1}] - E_t^M [\vec{f}_{t+1}] \right) + \Phi Z_t \end{aligned} \quad (25)$$

Where $\Phi Z_t = \hat{r}_{t+i} - r_{t+i} + \psi$. The risk premium, ψ , is captured by the return of the stock market and the country-risk premium as measured by Embi+.

In (25) depreciation rates and control variables can be made explicit to review dealer belief sets on the state of the economy.

There are two channels through which dealer belief sets are updated: (i) public information announced at the start of $t + 1$, that is, before dealers quote s_{t+1} ; (ii) dispersed private information contained in the order flow between t and $t + 1$ and the latter represents the channel that we are interested in exploring. Assume that v_t is the vector denoting new information obtained by dealers from the start of t and $t + 1$, i. e., $\Omega_{t+1}^M = \{\Omega_t^M, v_t\}$. Hence:

$$E_{t+1}^M [\vec{f}_{t+1}] - E_t^M [\vec{f}_{t+1}] = B_{f_{t+1}, v_t} (v_t - E[v_t | \Omega_t^M]) \quad (26)$$

Because the order flow is an element of v_t . when the order flow follows (21), the depreciation rate can be rewritten as follows:

$$\Delta s_{t+1} = \delta (\Delta x_t - E_t^M [\Delta x_t]) + \Phi Z_t + \xi_t \quad (27)$$

in which $\delta = \varphi B_{f_{t+1}, v_t}$ and ξ_t comprise the portion of $\varphi (E_{t+1}^M [\vec{f}_{t+1}] - E_t^M [\vec{f}_{t+1}])$ that is not correlated with order flow, Δx_t . As an empirical strategy, we use the order flows of financial and commercial sectors as a proxy for $(\Delta x_t - E_t^M [\Delta x_t])$, and the results are presented in table 6 below. Note that the depreciation rate will be correlated with the order flow not only because primary agent and dealer expectations differ with respect to economic fundamentals but also because there is a belief that agents that dealers should assimilate a portion of the information through the order flow. In this context, Evans and Lyons (2007) reported that this correlation provides information on: (i) the existence of dispersed information and (ii) the pace at which this information is aggregated.

Different interpretations can be drawn from the observations provided in table 6 above. First, despite having the expected sign, we note that none of the coefficients of the interest rate differentials are statistically significant, which is was expected given the extensive empirical literature that examines uncovered parity in interest rates.¹⁵

¹⁵Phenomenon known as forward premium puzzle or uncovered parity puzzle. At a theoretical level, there is no consensus in this regard, and explanations include the existence of a risk premium, the inefficiency of markets, learning, the peso problem and the irrational behaviour of agents, see Taylor (1995), Fama (1984), Froot, Thaler (1990) e Garcia e Olivares (2001).

Tabela 6: Order Flow Impact in the Exchange Rate Fluctuation

Frequency	$\Delta difjur_t$	$\Delta embi_t$	$\Delta ibov_t$	commercial	financial	R^2
daily	0.012 (0.49)	0.148*** (7.62)	0.004 (0.08)	-0.322*** (-3.96)		0.191
	0.010 (0.42)	0.156*** (8.16)	-0.005 (-0.09)		0.015 (0.55)	0.168
	0.012 (0.50)	0.148*** (7.58)	0.004 (0.08)	-0.327*** (-4.18)	-0.020 (0.63)	0.191
weekly	0.016 (0.30)	0.211*** (4.37)	0.035 (0.45)	-0.134*** (-2.07)		0.332
	0.012 (0.24)	0.217*** (8.15)	-0.037 (-0.50)		0.288* (1.66)	0.343
	0.013 (0.25)	0.216*** (4.33)	-0.037 (-0.50)	-0.042 (-0.48)	0.272 (1.39)	0.343
monthly	0.064 (1.27)	0.415*** (8.34)	0.224*** (2.57)	0.261 (1.27)		0.467
	0.061 (1.23)	0.418*** (8.52)	0.215*** (2.51)		0.455** (2.25)	0.483
	0.047 (0.95)	0.423*** (8.68)	0.216*** (2.55)	0.341*** (1.68)	0.509** (2.50)	0.497
Note: Student t-statistics are listed between parentheses. The order flow						
coefficients were multiplied by 100. Standard errors were corrected through						
autocorrelation and heteroskedasticity using Newey-West.						

Thus, as was reported in Evans and Lyons (2007), the portion of exchange rate fluctuations explained by the variables increases with decreases in the aggregation frequency: the model in which both primary market segments are addressed where the R^2 increases from 19% when shifting from a daily aggregation horizon to one that is weekly, 34% , and finally to one that is monthly, 50% .]

We now present a technical question. As the coefficients of order flows were multiplied by 100, a buying pressure of \$1 billion depreciates the exchange rate in $\beta\%$. It is evident that the order flow impacts within the two segments differ considerably. Some impacts are positive, others are negative, and some are statistically significant while others are not. Moreover, it is unclear why the customer order flow apparently contains information on temporal frequency while the other does not.

When aggregation is conducted daily (or weekly for the first specification), for example, the coefficient measuring the buying pressure impact in the commercial segment is negative and statistically significant, which is counterintuitive. According to market makers, a commercial segment buy flow is interpreted as an overvaluing of the dollar. On the other hand, the positive flow from the financial sector is positive (that is, the domestic currency is depreciated) in five out of six possible scenarios (with the exception of the more complete specification for daily aggregation) and statistically significant in three cases: for the weekly aggregation where only the financial flow is considered and for the monthly aggregation for two specifications.

The key to interpreting negative coefficients that differ considerably among themselves lies in the distinction between non-expected order flow, $\Delta x_t - E_t^M [\Delta x_t]$, as imposed by the model, and the adopted empirical counterparty, or the primary customer dealer flow. According to the theoretical formulation constructed in this article, the realised exchange rate fluctuation reflects dealer price reviews, which were induced with the arrival of new information on the state of the economy.

This information arrives by means of public announcements on economic indicators and via interdealer order flows. Private information contained in an order between end customers and a

dealer will only affect the exchange rate when it can be inferred through interdealer flows observed by all dealers. Evans and Lyons (2005) show that the coefficients of each segment do not offer a structural interpretation but, instead, depict how the reviewed set of dealer beliefs influence changes in order flows for each type of end user.

It should be noted that the negative and statistically significant coefficient for the commercial sector order flow used in the daily series was also obtained by Wu (2007). According to the author, this phenomenon is caused by endogeneity between the variables, which invalidates the use of the least squares estimation method. On one hand, exchange rate fluctuations alter foreign goods and assets prices (as well as perceptions of primary agent impacts on the state of the economy), which affects the order flow; on the other hand, buying pressures on foreign currency contain private information that is perceived by dealers to some degree, which affects the exchange rates that dealers quote. To enhance the comparative analysis, we estimate structural *VAR* according to the framework provided by Wu (2007). The results of this analysis are provided in the appendix of this study.

6.2 Out-of Sample Forecast

The purpose of this section is to assess the predictive power of the out-of-sample model. We propose a method that is based on a study by Meese and Rogoff (1983). We then identify whether this power is consistent with the capacity for flows to predict fundamentals that affect exchange rates.

Three models will be compared to a random walk (RW) given in (28), which is used as the benchmark. The other models employed include: (i) a pure microstructure model given in (29), in which the explanatory variables comprise order flows from the financial and commercial sectors; (ii) a macroeconomic/financial model given in (30), which uses the interest rate differential, country-risk premium and Ibovespa as independent variables; (iii) a hybrid model given in (31) that, as developed in this article, incorporates macroeconomic and microstructure elements. The predictive power levels of periods one, two and five are compared at several aggregation frequencies (daily, weekly and monthly).

The empirical strategy adopted is the procedure known as rolling regressions, which is commonly used in the literature.¹⁶ This method involves estimating model parameters based on a chosen sample window (e.g. 100 periods) to produce p - out-of-sample forecasts. Subsequently, the sample window rolls up p -forward periods, and the procedure is repeated. This process is repeated until all out-of-sample forecasts are generated. This method is advantageous in that the testing power remains constant once the sample window has a fixed size. Models (29), (30) and (31), which are described below, are estimated using the Ordinary Least Squares method.

$$s_{t+1} - s_t = \varepsilon_{t+1} \tag{28}$$

$$s_{t+1} - s_t = \alpha + \beta_1 \Delta x_{commercial,t} + \beta_2 \Delta x_{financial,t} + \varepsilon_{t+1} \tag{29}$$

$$s_{t+1} - s_t = \alpha + \beta_3 \Delta difjur_t + \beta_4 \Delta embi_t + \beta_5 \Delta IBOVESPA_t + \varepsilon_{t+1} \tag{30}$$

$$s_{t+1} - s_t = \alpha + \beta_1 \Delta x_{commercial,t} + \beta_2 \Delta x_{fin,t} + \beta_3 \Delta difjur_t + \beta_4 \Delta embi_t + \beta_5 \Delta IBOVESPA_t + \varepsilon_{t+1} \tag{31}$$

¹⁶Meese and Rogoff (1983), Cheung, Chinn, Pascual (2002), Evans and Lyons (2005), Fernandes (2008).

Tabela 7: Mean Squared Error

Model		Macro	Microstructure	Hybrid
Sample frequency	Forecast Horizon			
daily	1 day	0.722***	0.845***	0.666**
	2 days	0.481***	0.604***	0.451*
	5 dias	0.345***	0.520***	0.347***
weekly	1 day	0.617***	0.858*	0.622**
	2 days	0.483***	0.638***	0.474***
	5 days	0.420***	0.683**	0.527***
monthly	1 day	0.535*	1.752	0.721***
	2 days	0.483*	1.354	0.705***
	5 days	0.614**	0.636	0.957
Note: Statistical significance of the Diebold-Mariano test is				
H_0 : there is no differentiation in the predictive accuracy of ***1%, **5% and *10%				

Two metrics will be used to compare the models: (i) the ratio between the Mean Squared Error of the model in question and random walk –values lower than 1 indicate greater predictive power (compared to RW) and (ii) a direction change statistic, which denotes the number of correct predictions on the exchange rate change direction over the total number of predictions. (The prediction reaches the change direction if $\Delta s_{t+p} > 0$ occurs simultaneously with $\Delta \hat{s}_{t+p} > 0$ or if $\Delta s_{t+p} < 0$ occurs simultaneously with $\Delta \hat{s}_{t+p} < 0$). For both of these calculations, Diebold-Mariano statistics, which is defined as the ratio between the sample mean of the loss differential and its asymptotic variance, allows us to test the non-differentiation null hypothesis of predictive power (between the model and RW). The difference in loss for the first case is calculated as the difference between the model MSE in question and the RW value. In the second case, the difference in loss, d_t takes on a value of 1 when the prediction reaches the exchange rate direction of change. Otherwise, it assumes a null value. Hence, we expect to find values of \bar{d} higher than 50%. In large samples, the Diebold-Mariano statistic, $\frac{\bar{d}-0,5}{\sqrt{0,25/T}}$, follows a normal distribution¹⁷.

As shown in tables 7 and 8 above, in the frequencies of daily and weekly aggregations for both metrics proposed, the out-of-sample forecast power of the microstructure model is superior to that of the random walk, and this result complements the findings of Evans and Lyons (2002) and Fernandes (2008). This result demonstrates that private sources of information are essential for predicting fluctuations in exchange rates at high frequencies. Furthermore, we realise that the forecast power of the macroeconomic model is also superior to the RW, which opposes empirical results for pairs of the most heavily traded currencies using high frequency data (Meese and Rogoff 1983). As the aggregation frequency is reduced, macroeconomic models can perform more effectively than the RW, as was demonstrated in Chinn and Meredith (2004).

The strong empirical performance of macroeconomic models (compared to RW) is due to the high correlation real/dollar exchange rate fluctuations and country-risk premium fluctuations, even

¹⁷Cheung, Chinn e Pascual (2002), Diebold and Mariano (1995).

Tabela 8: Variation Change Direction Hit

Model		Macro	Microstructure	Hybrid
Sample frequency	Forecast Horizon			
daily	1 day	58.1%***	59.8%***	61.1%***
	2 days	61.4%***	61.2%***	64.3%***
	5 days	63.8%***	63.2%***	66.7%***
weekly	1 day	63.9%***	57.6%***	66.2%***
	2 days	65.8%***	63.4%***	68.0%***
	5 days	67.8%***	63.0%***	72.6%***
monthly	1 day	60.4%**	54.5%	62.4%***
	2 days	67.3%***	55.4%	65.3%***
	5 days	72.3%***	55.4%	69.3%***

Note: Statistical significance of the Diebold-Mariano test is
 H_0 : there is no differentiation in the predictive accuracy of ***1%, **5% and *10%

in cases where the aggregation frequency is high. According to the Central Bank of Brazil¹⁸, "variations in perceptions of sovereign risk are generally followed by variations in net capital inflows, which contribute to appreciation or depreciation in the exchange rate". Lowenkron and Garcia (2005) empirically show that the phenomenon of prime risk¹⁹ is associated with: (i) currency mismatch with the government (measured by the ratio between external debt and international reserves) and (ii) low depth of the financial market (measured by the ratio between private credit and GDP). When these two factors are latent, an increase in the expected depreciation rate or of the exchange rate risk raises fears surrounding government solvency, which affects perceptions of country-risk. This phenomenon is linked to the inability of certain countries to borrow funds on the international market in their own currencies. This phenomenon was coined as ‘original sin’ by Eichengreen, Hausmann and Panizza (2003).

The hybrid model generates stronger results than the RW for short horizons (daily and weekly). This illustrates the importance of using microstructure elements to capture dispersed private information as a complement to publicly known information when predicting future exchange rate fluctuations.

In practical terms, the capacity for a currency trader to predict the exchange rate change direction of with higher accuracy can be useful for formulating a more lucrative market input rule. As is demonstrated in table 8, the accuracy of the hybrid model increases with a decrease in aggregation frequency and an increase in the prediction window, which changes from 61% to a daily series with the prediction of one period ahead 72,6% in weekly frequency and with the prediction of 5 periods ahead. This method generates the highest level of accuracy of all of the models.

6.3 Fundamentals

The theoretical model developed in Section 4 shows that if primary customers collectively possess a set of information that is at least as comprehensive as that of the market makers, that is, $\Omega_t^M \subset \Omega_t^P$, exchange rate variations should be correlated with order flows because they contain dispersed

¹⁸<http://www4.bcb.gov.br/pec/gci/port/focus/FAQ09-Risco-Pa%C3%ADs.pdf>

¹⁹The positive correlation between foreign exchange rate risk and country risk is known in the literature as “cousin risks”.

information on economic fundamentals. If this mechanism drove the results of 6 and 7, the order flow should also explain variations in economic fundamentals. To demonstrate this proposition, we extend the theoretical model by rewriting equation (8) as follows:

$$s_t = E_t^M [f_t] + E_t^M \left[\sum_{i=0}^{\infty} b^i \Delta f_{t+i} \right] \quad (32)$$

It is evident that the difference between the spot exchange rate and current dealer expectations on economic fundamental values, $s_t - E_t^M [f_t]$, is given by the present value of future changes in fundamentals.

Empirically, this proposition can be tested using the following projection:

$$\Delta f_{t+\tau} = \beta_s (s_t - E_t^M [f_t]) + \varepsilon_{t+\tau} \quad (33)$$

where $\varepsilon_{t+\tau}$ is the projection error that is not correlated with $s_t - E_t^M [f_t]$. Returning to the correlation between the order flow and fundamentals, (22), proved that the flow is partly explained by the difference between dealer and end-customer beliefs on future fundamentals. Therefore, if end agents possess a set of information that is superior to dealers, the order flow must offer incremental predictive power over $\Delta f_{t+\tau}$, in addition to that contained in $s_t - E_t^M [f_t]$. In formalising this reasoning, we show the following:

$$\Delta f_{t+\tau} = \beta_{s^*} (s_t - E_t^M [f_t]) + \beta_x (\Delta x_t - E_t^M [\Delta x_t]) + \eta_{t+\tau}^{20} \quad (34)$$

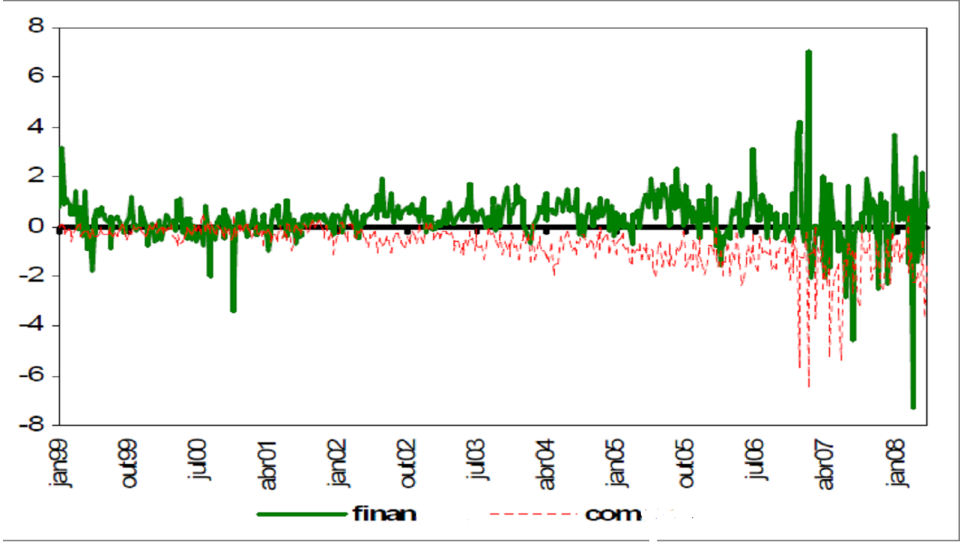
The order flow of period t will have incremental predictive power over $\Delta f_{t+\tau}$ when: (i) dispersed information exists on future economic fundamentals contained therein; (ii) a portion of information aggregation occurs through negotiation during period t . As $s_t - E_t^M [f_t]$ cannot be measured directly, we use two known variables at beginning of period t as proxies: $\Delta^\tau q_t$ and $\Delta^\tau s_t$. The empirical strategy to for analysing this prediction has the following form:

$$\Delta^\tau q_{t+\tau} = \alpha + \beta_1 \Delta^\tau q_t + \beta_2 \Delta^\tau s_t + \beta_3 \Delta^\tau x_{commercial,t} + \beta_4 \Delta^\tau x_{financial,t} + \eta_{t+\tau} \quad (35)$$

where $q_t = E_t^M [f_t]$; $\Delta^\tau q_{t+\tau}$ denotes dealer belief reviews on fundamentals accumulated between periods t and $t + \tau$; $\Delta^\tau q_t$ denotes the review that occurs between instances $t - \tau$ and t ; $\Delta^\tau s_t$ represents the exchange rate variation value accumulated between $t - \tau$ and t ; $e \Delta^\tau x_{j,t}$, denotes the order flow for each segment between instances $t - \tau$ and t . The empirical counterpart of q_t is the market expectation of various macroeconomic variables, which updated daily by the Central Bank of Brazil from financial institutions and which is disclosed through its website and the Focus newsletter. Coefficients β_3 and β_4 reveal whether the primary customer order flow in instance t has predictive power over future changes in fundamentals in addition to those contained in the spot exchange rate and in past beliefs. .

²⁰Because $v_t - E [v_t | \Omega_t^M]$ is not correlated to Ω_t^M which leads to $Cov(\Delta x_t - E_t^M [\Delta x_t], s_t - E_t^M [f_t]) = 0$ implying that $\beta_x (\Delta x_t - E_t^M [\Delta x_t]) + \eta_{t+\tau} = \varepsilon_{t+\tau}$ implying that $\beta_{s^*} = \beta_s$

Figura 3: Weekly order flow (in USD Billions) in the primary market: commercial and financial segment - January of 1999 to May of 2008.



Remembering that:

$$q_{T(2)|S(\tau+13)} - q_{T(1)|S(\tau)} = E [\Delta^T q_{T(2)} | \Omega_{S(\tau)}] + \{q_{T(2)|S(\tau+13)} - q_{T(2)|S(\tau)}\} \quad (36)$$

where $\Delta^T q_{T(\tau+1)} = q_{T(\tau+1)} - q_{T(\tau)}$.

If the change in belief is calculated in weeks belonging to different periods, this will include the expected ex-ante variation between f_τ and $f_{\tau+1}$, $E [\Delta^T q_{T(2)} | \Omega_{S(\tau)}]$, or the first element to the right of (36), which shall be captured by $\Delta^\tau q_t$ and $\Delta^\tau s_t$; and the information flow that is related to $f_{\tau+1}$ to be disclosed between periods τ and $\tau + 13$, are denoted by the second element to the right of (36).

The sample size varies for each series and based on the prediction horizon chosen. For inflation 12 months ahead, industrial production and GDP, the samples vary from 314 to 336 observations. Therefore, for the longest prediction horizon (2 quarters), 12 observations exhibit no overlapping behaviour. The statistics were corrected for the presence of heteroskedasticity and serial correlation using the Newey-West estimator.

For each regression, we performed two types of Wald tests for the exclusion of coefficients, which possessed null hypotheses of (i) $\beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$ and (ii) $\beta_3 = \beta_4 = 0$, respectively.

First, we observe that the exchange rate variation contains information on the future values of certain fundamentals. Table 9 above shows that the depreciation coefficient for the reviewed inflation beliefs (monthly or 12 months) is positive and statistically significant for all prediction horizons. On the other hand, the exchange rate variation did not offer the same explanatory power for industrial production and GDP, and it was only statistically significant for GDP projections with a prediction horizon of two months.

With respect to the order flow, it is important to note that orders between primary customers and dealers represent a private source of information. Thus, the predictive power that this interaction has on future dealer belief reviews cannot arise from known ex-ante information. Rather, orders must be correlated with information flows on fundamentals to be released during the prediction horizon. The results shown in table 9 are only minimally satisfactory. In seven of the sixteen cases analysed, at least one statistically significant flow coefficient was identified (commercial or financial): four for monthly inflation, two for inflation in 12 months ahead and only one for industrial production. In addition, the null hypothesis that both flow coefficients are jointly significant was rejected for only four cases: two for monthly inflation and two for inflation 12 months ahead.

This lack of robustness in the results may be attributable to the non-optimal manner in which market agents respond to the Focus survey, which would imply certain limitations of the data used. Carvalho and Minella (2009) analyse the behaviour of market expectations collected by the BACEN and conclude that, among other factors, (i) research respondents tend to align their predictions with those of their peers, which implies that a large portion of the prediction error for each agent is common to all agents; (ii) the responses of top-five institutions tend to influence the estimates of other agents; and (iii) the hypothesis of the efficient use of all available information for inflation forecasts is rejected.

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forecasts is rejected.

7 Conclusion

From the study conducted by Evans and Lyons (2007), we sought to build a theoretical model, distinct from the Economic Theory that dominates this area of research, to explain the relationship between order flows, macroeconomic fundamentals and exchange rates. The primary relaxed assumption of the model assumes that not all information affecting the exchange rate is public. A significant portion of this information is dispersed across the economy, and the market uses this information only after a period of time. As was shown in the final analysis, the exchange rate represents the price at which dealers are willing to buy and sell foreign currencies in terms of domestic currency, and this information will only affect the exchange rate when it is transmitted to dealers. This process, as argued in this article, occurs by means of order flow.

We showed in Section 6 that a statistically significant and contemporaneous correlation exists between the order flow of primary customers and the exchange rate, and the relationship signal varies for each counterpart type. The buying pressure of primary customers is observed by dealers as an indication that the exchange rate is overvalued while the opposite occurs for the financial segment.

Furthermore, we performed out-of-sample prediction exercises on exchange rates at various horizons using hybrid models. These models contained both microstructure elements (order flow) and traditional macroeconomic variables, demonstrating the superiority of these variables compared to random walk for shorter prediction horizons (daily and weekly).

On the other hand, two facts demonstrate weaknesses in the Theory on Fundamentals (Froot and Ramadorai, 2005), as the flow only explains short-term changes in fundamentals. As was shown through the out-of-sample prediction exercise of the exchange rate, the pure macroeconomic model was the only model that showed statistically higher performance than the random walk for the longest prediction horizon. Additionally, while attempting to establish a relationship between order flow and expectations on macroeconomic fundamentals, the null hypothesis for the lack of predictive power of the flow on fundamentals was only rejected in four of the eight cases in which the dependent variable was the inflation expectation. Finally, we showed that the results were not robust for expectations regarding other fundamentals such as GDP and industrial production. Although we acknowledge that the manner in which the agents develop expectations disclosed in the Focus survey may limit the proxy used, as was argued in Section 6.3, we leave room for other interpretations.

It is worth noting that the availability of high frequency data on order flows is still developing, and especially in Brazil, where insufficient access to information has been a recurring issue. Therefore, it is reasonable to assume that further studies will have a similar focus to that which was proposed in this article, that is, the attempt to reconcile microstructure elements with Macroeconomic Theory. We believe that once a contemporaneous relationship between order flows and exchange rates is established, future studies should then focus on the determinant elements of flows. This task can be divided into studies on order flow uses within the Brazilian forward foreign exchange market and on the construction of alternative theoretical models and/or improvements to the market expectation series.

8 Referências

- Amihud, Y.; Mendelson, H. (1980), “Dealership Markets: Market-Making with Inventory”, *Journal of Financial Economics*, **8**, 31-53.
- Carvalho, F.; Minella, A (2009) “Market Forecasts in Brazil: Performance and Determinants” *Banco Central do Brasil Trabalhos para Discussão*, 185.
- Cheung, Y.; Chinn, M.; Pascual, A. (2002) “Empirical Exchange Rate Models of the Nineties: Are Any Fit to Survive?” *NBER Working Paper* No. 9393.
- Chinn, M.; Meredith, G. (2004) “Monetary Policy and Long-Horizon Uncovered Interest Parity” *IMF Staff Papers*, **51** (3), 409-430.
- Diebold, F.; Mariano, R. (1995), “Comparing Predictive Accuracy”, *Journal of Business and Economic Statistics*, **13** (20), 134-44.
- Easley, D.; O’Hara, M. (1987), “Price, Trade Size, and Information in Securities Markets”, *Journal of Financial Economics*, **19**, 69-90.
- Eichengreen, B.; Hausmann, R.; Panizza, U. (2003) “Currency Mismatches, Debt Intolerance and Original Sin: Why They Are Not the Same and Why it Matters” *NBER Working Papers* 10036.
- Engel, C., and K. West (2005), “Exchange Rates and Fundamentals” *Journal of Political Economy*, **113**, 485-517.
- Evans, M.; Lyons, R. (2002) “Order Flow and Exchange-Rate Dynamics”, *Journal of Political Economy*, **110**, 170–180.
- Evans, M.; Lyons, R. (2005) “Understanding Order Flow”, *NBER Working Paper* No. 11748.
- Evans, M.; Lyons, R. (2007) “Exchange Rate Fundamentals and Order Flow”, *NBER Working Paper* No. 13151.
- Fama, E. (1984) “Forward and Spot Exchange Rates” *Journal of Monetary Economics*, **14** (3), 319–338.
- Fernandes, A. (2008), “Microestrutura do Mercado Cambial Brasileiro: Comparação do Mercado à Vista e Futuro”. *Dissertação de Mestrado PUC-Rio*
- Flood, R.; Rose, A. (1995) “Fixing Exchange Rates: A Virtual Quest for Fundamentals”, *Journal of Monetary Economics*, **36** 3-37.
- Froot, K.; Ramadorai, T. (2005) “Currency Returns, Institutional Investors Flows and Exchange Rate Fundamentals” *Journal of Finance*, **60**, 1535-1566.
- Froot, K.; Thaler, R. (1990) “Anomalies: Foreign Exchange” *The Journal of Economic Perspectives*, **4** (3), 179-192.
- Garcia, M.; Urban, F. (2004) “O Mercado Interbancário de Câmbio no Brasil”, *PUC-Rio Texto para Discussão*, 509.
- Garcia, M.; Olivares, G. (2001) “O Prêmio de Risco da Taxa de Câmbio no Brasil durante o Plano Real”, *Revista Brasileira de Economia*, **55**(2), 151-182.
- Glosten, L.; Milgrom, P. (1985), “Bid, Ask, and Transaction Prices in a Specialist Market with Heterogeneously Informed Traders” *Journal of Financial Economics*, **14**, 71-100.
- Goodhart, C. (1988) “The Foreign Exchange Market: A Random Walk with a Dragging Anchor”, *Economica*, **55** (220), 437-460.
- Kyle, A. (1985) “Continuous Auctions and Insider Trading”, *Econometrica* **53**, 1315-1336.
- Laurini, M.; Furlani, L.; Portugal, M. (2008) “Microestrutura Empírica e Mercado - Uma Análise Para a Taxa de Câmbio BRL/US\$ Usando Dados de Alta Freqüência” *IBMEC Working Paper*, WPE 43.
- Lowenkron, A.; Garcia, M. (2005) “Cousin Risks: the Extent and the Causes of Positive Correlation between Country and Currency Risks, *PUC-Rio Texto para Discussão*, 507.

Lyons, R. (1991) “Private Beliefs and Information Externalities in the Foreign Exchange Market”, *NBER Working Paper* 3889.

Lyons, R. (1997): “Simultaneous Trade Model of the Foreign Exchange Hot Potato”, *Journal of International Economics*, **42**, 275-298.

Lyons, R. (2001), *The Microstructure Approach to Exchange Rates*, MIT Press.

Madhavan, A. (2000) “Market microstructure: A survey”, *Journal of Financial Markets*, **3**, 205-258.

Messe, R.; Rogoff, K. (1983). “Empirical Exchange Rate Models of the Seventies”. *Journal of International Economics*, **14**, 3-24.

Stoll, H. (1978) “The Supply of Dealer Services in Securities Markets”, *Journal of Finance*, **33**, 1133-1151.

Taylor, M. (1995) “The Economics of Exchange Rates”, *Journal of Economic Literature*, **XXXIII**, 13-47.

Wu, Thomas (2007) “Order Flow in the South: Anatomy of the Brazilian FX Market”, *SCCIE Working Paper* No. 06-13.

9 Appendix

According to the theoretical model developed in this article, the ability of the order flow to aggregate information/expectations dispersed in the economy clarifies that the causality moves from the flow toward the exchange rate as a rule in canonical microstructure models (Glosten & Milgrom 1985, Kyle 1985, Stoll 1978, Amihud & Mendelson 1980). This does not imply that the temporal precedence should follow the same direction.

In the hypothesis raised by Wu (2007), an endogenous relationship exists between order flow and exchange. The buying pressure on foreign currency leads dealers to increase the quoted price of the exchange rate. On the customer side, as the exchange rate depreciates, the demand for foreign currency decreases slowly, and this would explain the negative coefficients of the order flow in the linear regression of the spot exchange rate. As was shown in Section 6, Evans and Lyons (2005) highlight that the coefficients of each segment do not have a structural interpretation. Rather, the authors instead map out how the reviewed set of dealer beliefs reflects changes in order flows for each type of end user.

The solution found by Wu (2007) for avoiding possible endogeneity problems between order flows and exchange rate variations involves the modelling of a structural VAR as a restriction on model identification. This assumes that the contemporaneous effects of the financial flow and trade flow on the exchange rate are equal, that is, $\alpha_{12} = \alpha_{13}$ and that financial and trade flows do not affect one another contemporaneously, that is, $\alpha_{23} = \alpha_{32} = 0$.

$$\begin{bmatrix} 1 & \alpha_{12} & \alpha_{12} \\ \alpha_{21} & 1 & 0 \\ \alpha_{31} & 0 & 1 \end{bmatrix} \begin{bmatrix} \Delta s_t \\ \Delta x_{financial,t} \\ \Delta x_{commercial,t} \end{bmatrix} = \Phi Z_t + \begin{bmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \\ \varepsilon_{3,t} \end{bmatrix}$$

By adopting this strategy, we found the following results for the daily frequency:

$$\Delta s_t = -0.0379(\Delta x_{financial,t} + \Delta x_{commercial,t})$$

$$\Delta x_{financial,t} = -30.9\Delta s_t$$

$$\Delta x_{commercial,t} = -13.7\Delta s_t$$

We find that before a buying pressure for dollars of US\$ 1 billion occurs, dealers increase the price of foreign currency in reais in 3.8%. Wu found an impact of 2.7% for the period from July of 1999 to June of 2003. The coefficient demonstrates that an exchange rate depreciation of 1% reduces demands from financial clients of US\$ 309 million and shows that the same depreciation level also reduces demands from commercial clients of US\$ 137 milhões. Tmillion. All coefficients were significant to a significance level of 1%.