Articles

Fundamentals, the Net Positions of Speculators, and the Exchange Rate in Brazil

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Abstract:
This paper analyzes the role of fundamentals and the net positions of speculators in determining the Brazilian exchange rate from April 2002 to August 2012. Based on a cointegrated SVAR model, we found empirical evidence to support our hypothesis that the microeconomic approach (Evans and Lyons, 2002) and the monetary model (Bilson, 1978) to determine the exchange rate are consistent with one another. Unlike in other empirical studies, our analysis demonstrates that the net positions of speculators and economic fundamentals constitute two channels (one liquidity-related, the other information-related) that can contribute to explaining the dynamics of the Brazilian exchange rate in the short and long term.
Key Words: Exchange rate, cointegration, SVAR, monetary models, speculators

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So long as the world continues to be divided amongst sovereign states, each of which regards the interest of its own citizens as its first priority, universal free trade may not be compatible with that objective in the long run any more than in the short run – whether the world is under a regime of fixed rates or under a regime of floating rates.

Nicholas Kaldor, 1978: 113

INTRODUCTION

The objective of this paper is to analyze the dynamics of the nominal exchange rate in the Brazilian economy as a function of its determinants, using two approaches: 1) the macroeconomic or monetary approach, which we use to analyze the interest rate and monetary aggregate differentials between Brazil and the United States, and 2) the microstructure approach, which we use to analyze the net positions of speculators. Both approaches consider the short and long term.

We aim to demonstrate the hypothesis that the exchange rate dynamics obey macroeconomic and microeconomic variables. On the one hand, the influence of the monetary aggregates differential and/or an increase in the interest rate differential is positive; that means it will spur an increase (depreciation) in the nominal exchange rate (Bilson, 1978); on the other, the influence of the net positions of speculators on the exchange rate should be positive (Evans and Lyons, 2002).

Froot and Ramadorai (2005) distinguished between two forms of relationships between the exchange rate and speculators' net positions. The first, the strong flow-centric version, holds that the net positions of speculators are correlated with changes in the value of the fundamental variables of a currency, in other words, with the transmission of the fundamental macroeconomic information to the market. The second, the weak flow-centric version, asserts that speculators' net positions are correlated with a temporary deviation in the exchange rate with respect to its fundamental value. A deviation from the exchange rate vis-à-vis its fundamental value can arise due to a change in demand, or due to liquidity effects or the overreaction of investors.

The "information channel" is the term used for the case in which the net positions of speculators have a permanent effect on the exchange rate and provide fundamental macroeconomic information to the market, and the "liquidity channel" is the term used for the situation in which the net positions of speculators are related to temporary deviations in the exchange rate vis-à-vis its fundamental value.

The strong flow-centric version implies that speculators' net positions and the exchange rate are non-stationary series, but cointegrate, such that there is a stable and long-term equilibrium relationship between the time series. Although the weak flow-centric version does not necessarily imply cointegration (Froot and Ramadorai, 2005).

In this paper, unlike in other studies that have analyzed speculators' net positions, we used a cointegrated SVAR method in the presence of non-stationary variables, which allowed us to distinguish between the two mechanisms, the informational and the liquidity mechanisms, to analyze the behavior of the Brazilian real exchange rate with respect to the United States dollar. The empirical results suggest that including the net positions of speculators in a standard monetary model increases its explanatory power and the predictive accuracy of the model. But what is most important is that speculators' net positions were correlated both with the fundamental variables of the monetary model in Bilson's version, the information channel, as well as with the monetary policy news version, the liquidity channel. We can therefore say that the relationship between the exchange rate and speculators' net positions is not inconsistent with the macroeconomic approach (MAER) and the effect of these positions on prices is permanent.

Below, we analyze the role played by fundamentals and the microstructure in determining the exchange rate in Brazil in the time period 2002-2012. Following this introduction, we include: a review of the literature relevant to these two models; an analysis of the speculators' net positions approach and the monetary paradigm in determining the exchange rate; the SVAR method used; an empirical scrutiny of the net positions of speculators and the exchange rate in Brazil, and, finally, our conclusions.

REVIEW OF THE DEBATE ON THE MONETARY APPROACH

This section introduces literature pertaining to the behavior of the exchange rate from a macroeconomic perspective (the monetary or fundamentals model: interest rate differential, product, and money supply) and the counterposing point of view, the microstructure approach, that explains the exchange rate based on the net positions taken by speculators.

Empirical Analysis of the Monetary Approach

The monetary model for the exchange rate assumes perfect capital mobility, perfect substitution among different financial assets, perfect integration of the goods and financial markets, and the validity of purchasing power parity (PPP). In monetary models with flexible prices, it moreover assumes uncovered interest rate parity, with which the exchange rate responds to the fundamentals, where the most important variable is the relative quantity of money (Mussa, 1982). On the other hand, in monetary models with rigid prices, the exchange rate dynamics do not match with the PPP in the short term; the financial and goods markets have different adjustment speeds, which gives rise to overshooting the exchange rate vis-à-vis the long-term equilibrium value (Dornbusch, 1976).

Among the empirical analyses, Gardeazabal et al. (1997) found important evidence of cointegration between the exchange rate of the British pound sterling, the German Deutsche mark, the Italian lira, and the Spanish peseta with respect to the United States dollar and its fundamentals; MacDonald and Taylor (1992) analyzed the long-term behavior of the exchange rate of the sterling pound and the United States dollar using multivariate cointegration techniques in an unrestricted monetary model and were able to validate the monetary approach. In summary, these authors asserted that the monetary model does indeed explain exchange rate dynamics in the long term, particularly when the model is complemented with the Balassa-Samuelson effect.

The Microstructure Approach: Speculators' Net Positions

The microstructure approach highlights other variables not considered in the monetary model. Among the most relevant, the order flow that measures the net purchasing pressure (Lyons, 2001: 7), the conduct of the heterogeneous stabilizing and destabilizing agents that take part in the foreign exchange market with different expectations not necessarily consistent with the fundamental macroeconomic variables, asymmetrical sharing of information, and the net positions of speculators that balance the markets and transmit information (Torre Cepeda and Provorova Panteleyeva, 2007: 15-18).

In their pioneering study on the microstructure of the exchange rate market, Evans and Lyons (2002), based on data from Reuters D 2000-1 on the net positions held by speculators, analyzed the daily variation between the dollar, the mark, and the yen during a four-month period (May-August 1996) and found substantial correlation between the negotiations of the net positions held by speculators and the published exchange rates. This conclusion was proven again by Danielsson, Luo, and Payne (2012), although the latter concluded that, lacking a perfect forecast of the future explanatory variables, the net positions of speculators have little or practically no explanatory power at all when it comes to the exchange rate.

Various studies have underscored the explanatory significance of the net positions of speculators. Bjønnes, Rime et al. (2005) concluded that these positions could explain one third of the daily volatility in the Swedish krona and the euro. This conclusion is consistent with others. Osler (2002, 2003) and Bates, Dempster et al. (2003) examined the ledger of daily orders made at HSBC Bank. Torre Cepeda and Provorova Panteleyeva (2007) conducted an excellent and pioneering analysis of the microstructure of the influence of the net positions of speculators in the Mexican peso futures market to determine the exchange rate with respect to the United States dollar in the time period 1999-2005; they found that due to the accelerated growth of this market, the relationship between the two currencies has not been constant.

Based on the foregoing, we can say the following: the monetary model explains the exchange rate in the long term; the net positions of speculators determine the behavior of the exchange rate in the short term; finally, a combination of the two approaches could better capture the dynamics of an exchange rate, given that the net positions of speculators requires prior information that could be provided by the monetary model.

THE NET POSITIONS OF SPECULATORS AND THE MONETARY APPROACH IN DETERMINING THE EXCHANGE RATE

Evans and Lyons (2002) added a few variables from the monetary model in determining the exchange rate (MAER), of which one classic version was developed by Bilson (1978).[2] The equation proposed by Evans and Lyons is:

$$\Delta e_t = \Delta m_t + \lambda \Delta x_t \quad (1)$$

Where Δe_t is the exchange rate, Δm_t refers to macroeconomic information innovations (the fundamentals), λ is a positive constant, and Δx_t denotes the net positions of speculators. In this model, public information augments the association between the fundamentals, Δm_t, defined as the change in the interest rate differential (i.e., $\Delta m_t = (i-i^*)$). Given that Δm_t can be a function of other macroeconomic variables, we use the following monetary model proposed by Bilson:

$$\Delta e_t = \Delta(m - m^*) + \lambda \Delta(i - i^*) + \phi \Delta(y - y^*), \quad \phi < 0 \quad (2)$$

Where *(m - m)*, *(i - i*)*, and *(y - y*)* are the differentials of the money supply, the interest rate, and national and international income, respectively, typically used as macroeconomic determinants of the exchange rate.

By augmenting the equation (1) proposed by Evans and Lyons, we include the monetary model variables and the net positions of speculators (*x*), thereby integrating the macroeconomic approach and the microfinancial variable that transmits important information about the exchange rate:

$$\Delta e_t = \Delta(m - m^*) + \lambda\Delta(i - i^*) + \phi\Delta(y - y^*) + \delta\Delta x, \quad \phi < 0 \qquad (3)$$

Equation (3) shows the transmission mechanism that keeps the money market in balance through variations in the nominal exchange rate in the following fashion: an increase in the net positions of speculators (*x*), the money supply (*m*), or the interest rate differential will generate a depreciation of the nominal exchange rate, $\Delta e_t > 0$; contrarily, an increase in the income differential will provoke an appreciation. As observed, a positive relationship is expected between the exchange rate and the net positions of speculators, $\delta > 0$, given that an increase in net payments in foreign currency will result in a higher price for the foreign currency in terms of the national currency. It is important to highlight that speculators' net positions can affect the exchange rate directly by way of an impact on prices, transmitting non-public information; they can also affect the informational and liquidity-related mechanisms in the market, and by extension, the nominal exchange rate.

Equation (3) could be taken to mean that the relationship between the exchange rate and speculators' net positions is not consistent with the macroeconomic approach. However, speculators' net positions transmit non-public information (information that is not common knowledge) and can play a fundamental aggregate information role for uncovering prices in the currency exchange markets. The way in which these transmission mechanisms play out is an empirical matter that we will tackle below.

ECONOMETRIC METHOD

The Sims (1987) SVAR method is useful in analyzing the relationships between the net positions held by speculators and the nominal exchange rate. The main objective of this method is to determine the dynamic responses of economic variables distinct from independent impacts. The SVAR approach is an alternative to the traditional, non-theoretical VAR approach (Sims, 1980; Juselius, 2006). The classic VAR approach assumes that the variables are stationary and includes only lags for all of the variables. The reduced form of the model with one lag can be represented as follows:

$$y_t = d_t + Cy_{t-1} + u_t \qquad (4)$$

Where y_t is a vector of endogenous variables; d_t is a vector of deterministic components, such as the constant, the trend, and stationary or intervention dummies; and u_t is an error vector.

Equation (4) does not appear to offer any explanation for instantaneous relationships (contemporaneous effects) between the variables, as it contains only the lags of the endogenous variables. However, each contemporaneous component is concealed in the correlation structure of the variance and covariance matrix that comes from u_t. This fact implies that the innovations in u_t are correlated. A more meticulous examination of the primitive VAR helps elucidate this difficulty (Enders, 1995):

$$By_t = d_t + Ay_{t-1} + \varepsilon_t \quad (5)$$

In Equation (5), the errors in ε_t are not correlated due to the fact that matrix B contains the contemporaneous interactions among the variables. Matrix A captures all of the lagged interactions between the same variables. As such, the reduced VAR model (4) can be seen as a reparameterization of the more general form of the primitive VAR model (5). Essentially, it can easily be observed that $C = B^{-1} A$ and $u_t = B^{-1} \varepsilon$. This means that the errors of the reduced VAR model u_t are a linear combination of the non-correlated impacts of ε_t.

As such, the contemporaneous interactions of interest contained in matrix B can be recovered, as long as we are willing to impose different restrictions on a triangular structure given by the Cholesky decomposition. This decomposition is used to calculate the impulse-response functions in the classic VAR analysis,[3] which will give us the conditions needed for the identification. This means that the number of coefficients different from zero in matrix A must be equal to or less than $\left((n^2 - n)/2\right)$. However, we can impose a different decomposition, in other words, a matrix that contains restrictions to identify the contemporaneous interactions in the errors in the reduced VAR model. This procedure is known as structural VAR (SVAR) analysis.

Amisano and Giannini (1997) suggest a more general vision of the SVAR that admits a representation of the VAR with non-stationary series as the starting point for the specification of the SVAR model. In the presence of cointegration, the model must take shape in two different phases: the first is to identify the long-term equilibrium relations and the second is to identify short-term interactions. The final structure of the instantaneous equations is achieved through two matrices (A and B):

$$AA(L)y_t = A\mu + A\varepsilon_t \quad (6)$$

$$A\varepsilon_t = Bu_t \quad (7)$$

Where ε_t is the error vector of the reduced VAR and u_t is the error vector of the primitive VAR. Moreover, we know that $E(u_t) = 0$ and $E(u_t u_t) = I_t$. The identification of the contemporaneous relationships among the variables in equation (7) requires a set of restrictions based on theoretical assumptions. Matrix B is a diagonal matrix that normalizes the variance of the structural errors u_t, and matrix A contains the relevant contemporaneous relationships. The final structure is obtained from a precisely identified model (matrix A correctly identified) and the over-identification, imposing statistically valid theoretical constraints. The validation of these restrictions was confirmed using the likelihood ratio test.

The SVAR methodology can be implemented in three steps: first, estimate the reduced VAR and calculate the residuals matrix; second, use the residuals to estimate matrices A and B using the full information maximum likelihood (FIML) approach, and, finally, estimate the immediate reaction of the system for the individual impacts and draw up the impulse-response graphs, combining the information from the first two steps.

THE NET POSITIONS OF SPECULATORS AND THE EXCHANGE RATE IN BRAZIL

Stylized Facts

In the presence of non-stationary variables, we must look for robust empirical evidence as to the role played by the net positions of speculators in the exchange rate in a flexible regime. First, we discuss some of the main stylized facts pertaining to the exchange rate (Brazilian real/dollar) and its cardinal determinants, including the net positions of speculators and a few fundamental variables.

The data consisted of monthly, non-adjusted observations taken during the time period 2002.4-2012.8. The variables considered were as follows: the nominal exchange rate (Brazilian real/dollar); net positions of speculators; the difference between the log of the interest rate and M1 of Brazil and the United States. We did not consider the product, given that we could not find monthly data on this factor for Brazil. The following graphs display the behavior of each of the series:

Source: Created by the authors using data from the Applied Economics Research Institute (IPEA).

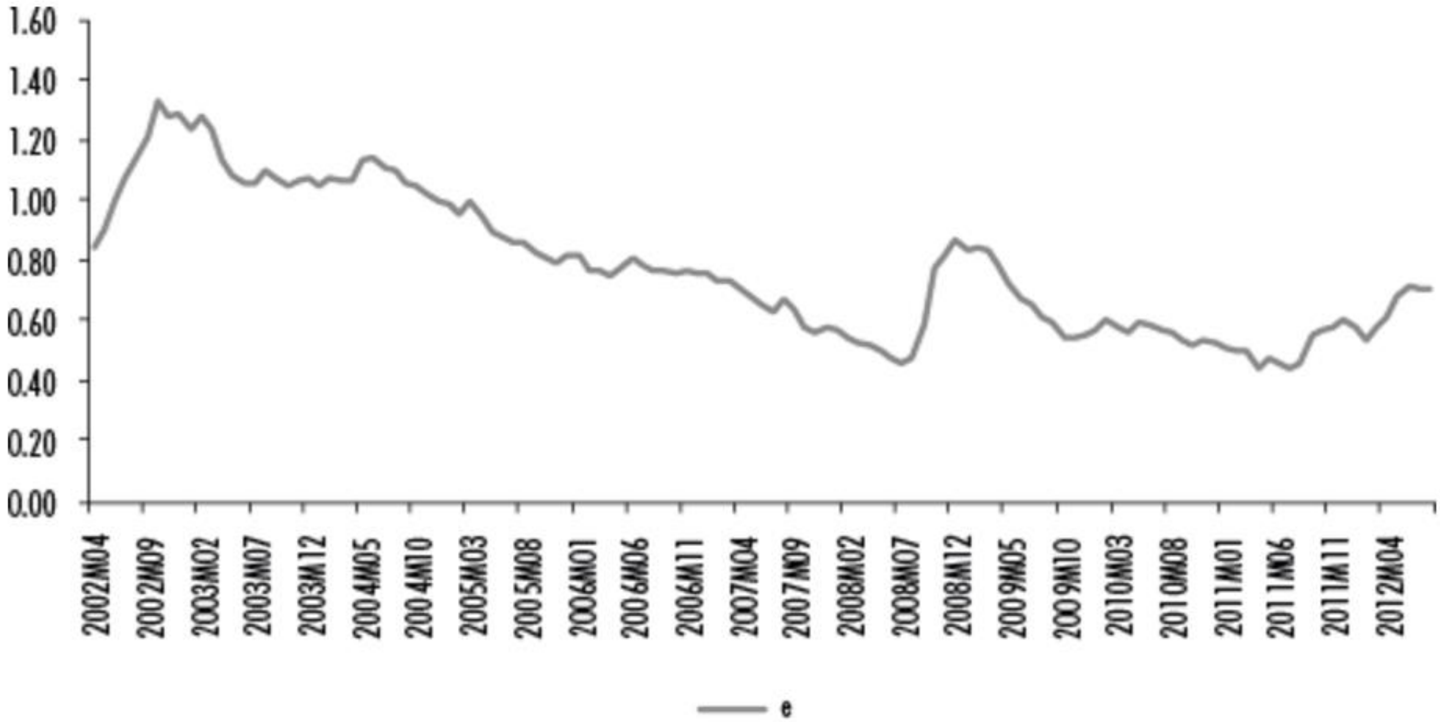

Figure 1. Logarithm of the Nominal Exchange Rate (Brazilian Real/Dollar), Quarterly Data

Source: Created by the authors using data from the IPEA.

Figure 2. Logarithm of the Nominal Exchange Rate and Logarithm of Speculators' Net Positions

Source: Created by the authors using data from the IPEA.

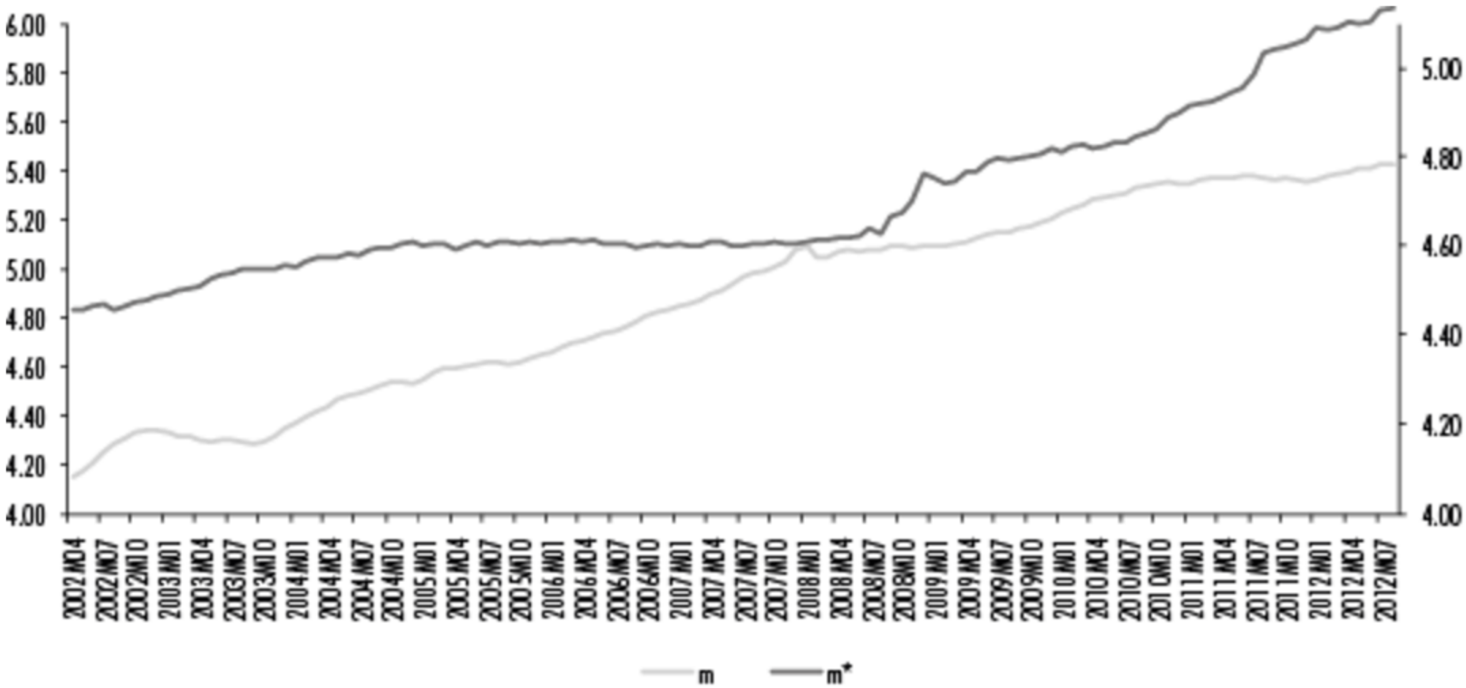

Figure 3. Brazil (m) and the United States (m*): Logarithm of M1.

Source: Created by the authors using data from the IPEA.

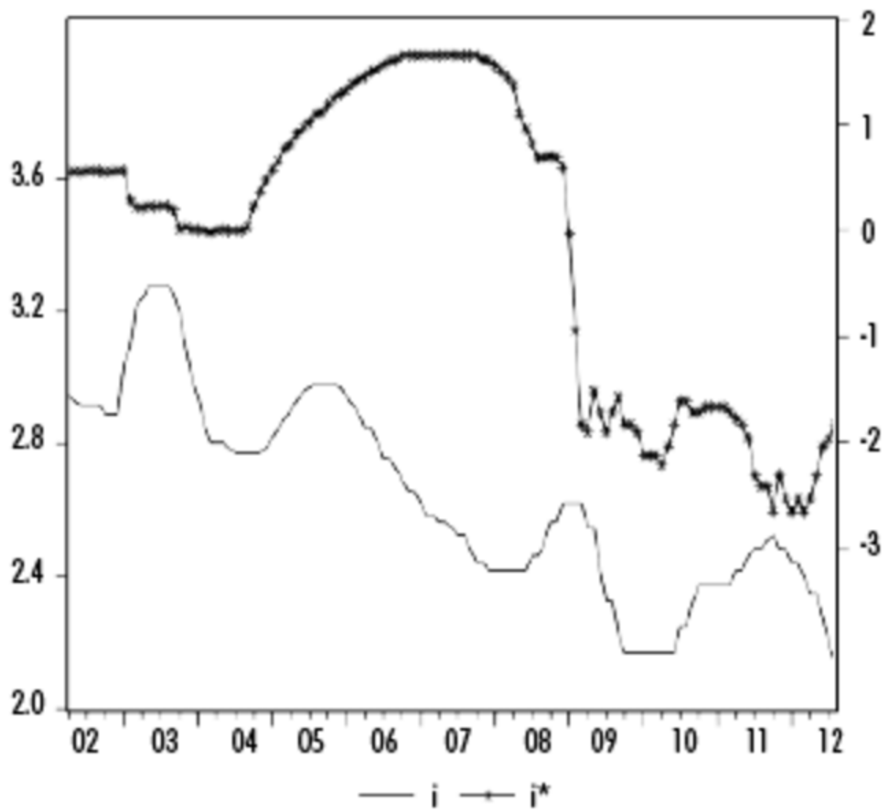

Figure 4. Logarithm of the Interest Rates of Brazil (i) and the United States (i*).

In Figure 1, we see that from 2002.4 to 2002.12, the exchange rate rose, as competitiveness was sought via depreciation of the nominal exchange rate. However, starting in 2003-1 and up until 2007-12, the Brazilian real appreciated, due to the inflow of foreign capital, as well as an improved balance of payments, in this way prompting an increase in the international reserves. The devaluation observed in 2008 was due to the global financial crisis that year. Following the crisis, foreign capital began to flow in again and, once more, the balance of payments improved. As a result, the nominal exchange rate continued to appreciate, exceeding pre-crisis levels (both in real and nominal terms); the Brazilian currency – together with that of Colombia and Uruguay – is the currency that has appreciated the most since the end of 2009.

Below, we examine the presence of unit roots in the nominal exchange rate, the net positions held by speculators, the interest rate, and the M1, in both Brazil and the rest of the world. Table 1a, in the Appendix, suggests that all of the variables are integration order I(1), which means that the estimation of the series in levels could lead to spurious conclusions, unless the series cointegrate.

Figure 2 exhibits the positive relationship between the nominal exchange and speculators' net positions beginning in 2006; this is because when there are buying pressures (exerted by the net positions), the exchange rate price rises. On the other hand, Figures 3 and 4 show that the trends between the various national rates and the rest of the world (m - $m*$, i - $i*$) have the same behavior, which indicates the existence of more than one cointegration vector.

Table 1b, in the Appendix, shows that the differences between the variables for Brazil and the United States are stationary. As such, it is possible to find cointegration between the variables. In this way, the cointegrated VAR model could be our point of departure for the structural analysis, in other words, for the SVAR. This not only would permit us to determine if the explanatory power of the macroeconomic model is enhanced when the net positions of speculators are included, but also the structure of how the net positions of speculators transmit information to the price in a multivariate set.

Method

In this section, we describe the empirical method that shows the relevance of the net positions of speculators in determining the exchange rate and its role in the transmission of information to price, using a cointegrated SVAR model. First, we show how the SVAR model is used to detail how the net positions of speculators transmit non-public information to prices in the monetary model context.

The analysis shows not only the estimation of the long-term cointegration equation associated with the theoretical exchange rate equation (3), but also the impulse-responses associated with the variance and covariance matrix of the cointegrated VAR model of the structural form to calculate the contemporaneous correlations between the variations in the net positions of speculators and the variations in the exchange rate. At the same time, we derive the short- and long-term transmission mechanisms.

In the presence of unit roots, the structure of the VAR model can be shaped in three stages: the first, specify a VAR representation that is adequate for the set of variables, including a selection of the order of lags, the cointegration range, the type of deterministic polynomial analyzed, and a specification sensitive to the cointegration space. If one of the cointegration relationships identified is consistent with the coefficient suggested by (3), we can conclude that the net positions of speculators plays an important role in explaining the long-term behavior of price. More specifically, we analyze the existence of a statistically solid cointegration relationship, which includes the net positions held by speculators, which are related to the cointegration equation in the following manner:

$$e_{t-1} = \beta_1 (m - m^*)_{t-1} + \beta_2 (i - i^*)_{t-1} + \beta_3 x_{t-1} \quad (8)$$

If speculators' net positions have a permanent influence on determining the exchange rate, in this long-term specification, β_3 should be positive. On the other hand, the determination in the Bilson model in the monetary approach to determining the exchange rate is given when the expected coefficients are $\beta_1 > 0$ and $\beta_2 > 0$.
The second stage is the "structural" step; the VAR model is used in its vector error correction model (VECM) version to identify the association between the exchange rate and speculators' net positions in the short term, which is hidden in the covariance matrix of the residuals of each multivariate model. This is the point of departure for structuring the VAR representation of the exchange rate equation:

$$\Gamma(L)\Delta z_t = \mu + \alpha \beta' z_{t-1} + \varepsilon_t \quad (9)$$

Where

$$z_t = \left[e_t, (m - m^*), (i - i^*), \; x_t \right] \text{ y } \Gamma(L) = I_p - \Gamma_1 L - \Gamma_2 L^2, \ldots, \; \Gamma_{p-1} L^{p-1}$$

To recover the coefficients of the short-term model, we use the variance and covariance matrix of the VAR in their error correction form (9); to verify the statistical validity of the various transmission channels between the net positions of speculators and the exchange rate, we work based off of equation (7). For example, to validate the short-term version of equation (3), we use the decomposition of the following variance and covariance matrix (which will be analyzed in the next section).

Restrictions on the Short-Term SVAR

$$\begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ a_{31} & 0 & 1 & 0 \\ a_{41} & a_{42} & a_{43} & 1 \end{pmatrix} \begin{pmatrix} \varepsilon_{(m-m^*)_t} \\ \varepsilon_{(i-i^*)_t} \\ \varepsilon_{x_t} \\ \varepsilon_{e_t} \end{pmatrix} = \begin{pmatrix} b_{11} & 0 & 0 & 0 \\ 0 & b_{22} & 0 & 0 \\ 0 & 0 & b_{33} & 0 \\ 0 & 0 & 0 & b_{44} \end{pmatrix} \begin{pmatrix} u_{(m-m^*)_t} \\ u_{(i-i^*)_t} \\ u_{x_t} \\ u_{e_t} \end{pmatrix} \quad (10)$$

This set of restrictions corresponds to the following short-term transmission mechanism:

Source: Created by the authors.

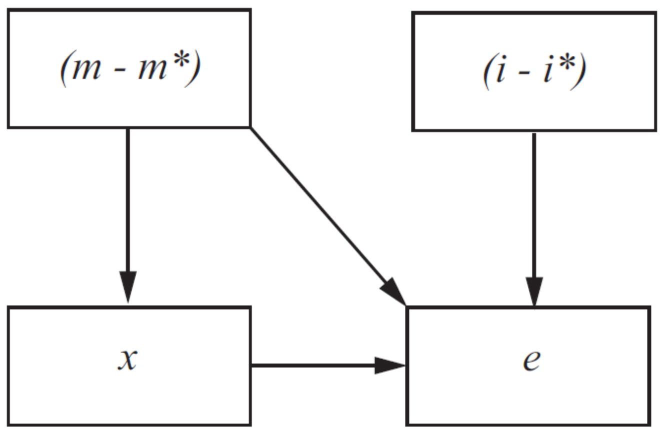

Chart 1. Instantaneous Links in the Exchange Rate Model

The structure of the matrix can be rewritten as the following equations related with the monetary model that includes the net positions of speculators:

$$\varepsilon_{(m-m^*)} = b_{11} u_{(m-m^*)} \quad (11)$$

$$\varepsilon_{(i-i^*)} = b_{22} u_{(i-i^*)} \quad (12)$$

$$\varepsilon_{X} - a_{31} \varepsilon_{(m-m^*)} = b_{33} u_{X} \quad (13)$$

$$\varepsilon_{e} - a_{41} \varepsilon_{(m-m^*)} - a_{42} \varepsilon_{(i-i^*)} - a_{43} \varepsilon_{X} = b_{44} u_{e} \quad (14)$$

If the monetary model plays a relevant role in uncovering the expected price in the short term, it means that the coefficients have to be: $\partial\varepsilon_e / \partial\varepsilon_{(m\text{-}m^*)} = a_{41} > 0$ and $\partial\varepsilon_e / \partial\varepsilon_{(i\text{-}i^*)} = a_{42} > 0$, according to Chin et al. (2007). Moreover, a short-term impact exerted by the net positions of speculators on the price, for example, $\partial\varepsilon_e / \partial\varepsilon_{(m\text{-}m^*)} = a_{31} * a_{43} > 0$, implies that the temporary monetary shock transmits information to the price by way of the net positions of speculators. It is important to emphasize that the monetary model must be identified or over-identified and the short- and long-term restrictions must be validated by way of the likelihood ratio test.
Finally, the third phase is the short- and medium-term validation of the monetary model by way of plausible modeling of the instantaneous correlations via the impulse-response functions.

Empirical Results and Discussion

In the econometric analysis, we estimated a correctly specified VAR model with non-stationary variables for the time period 2002.4 to 2012.8. The data have monthly periodicity; all of the variables are in their logarithmic form. The series used were: the nominal exchange rate Brazilian real/dollar (*e*), the net positions of speculators (*x*), and the national and external interest rate differentials (*i, i**) and M1 (*m, m**). The VAR model includes a restricted constant, two lags, and dummy variables to capture the financial shocks of 2002, 2008, 2009, and 2011. The unit root tests, with correct individual and joint specification, are shown in Tables 1a, 1b, 1c, and 1d in the Statistical Appendix. The number of lags was chosen based on the adequate model with correct specification. Other tests were also used, such as the Schwartz information criteria test, the Godfrey Portmanteau test, and the LR test (the latter is suggested by Sims (1980)). All of the correct specification tests are reported in the Appendix.
We began by analyzing the range of cointegration, using Johansen's reduced range method. The trace statistic, in Table 1, suggests the existence of at least three cointegration vectors.

Table 1. Johansen's Cointegration Range Test (Trace Test)

R	*Statistic*	*99%*
0	147.26	54.46
1	67.71	35.65
2	28.99	20.04
3	5.08	6.65

Note: R is the cointegration range.

Source: Created by the authors based on data from IPEA.

To test further evidence, a sequential test was conducted for the joint determination of the cointegration range and the polynomial trend [4] (Johansen, 1995; see Table 2). First, we report the deterministic (constant and trend) tests, and then the joint test (the statistic).

The results suggest the existence of at least three cointegration vectors at a confidence level of 99% and indicate that a sensible model implies the existence of a linear trend in the cointegration vector and a constant in the series of the model. To ensure a robust model for the cointegration range over time, we used the Hansen and Johansen (1992) iterative process. Figure 5 shows the results of the test. The test reinforced the hypothesis of the existence of three cointegration vectors over time at a 99% confidence level. However, the test indicated that only two of them are stable over time (R Model).

Table 2..Johansen's Sequential Test (1995) Used for the Joint Determination of the Cointegration Range and the Deterministic Polynomial

Model	*R*	*Trace*	*99%*
I(0) Intercept, I(1) Nothing	0	184.93	60.16
I(0) Intercept, I(1) Linear Trend	0	147.26	54.96
I(0) Intercept, I(1) Nothing	1	90.05	41.07
I(0) Intercept, I(1) Linear Trend	1	67.71	35.65
I(0) Intercept, I(1) Nothing	2	49.31	24.6
I(0) Intercept, I(1) Linear Trend	2	28.99	20.04
I(0) Intercept, I(1) Nothing	3	10.61	12.97
I(0) Intercept, I(1) Linear Trend	3	5.08	6.65

Note: R=range of cointegration

Source: Created by the author based on IPEA data.

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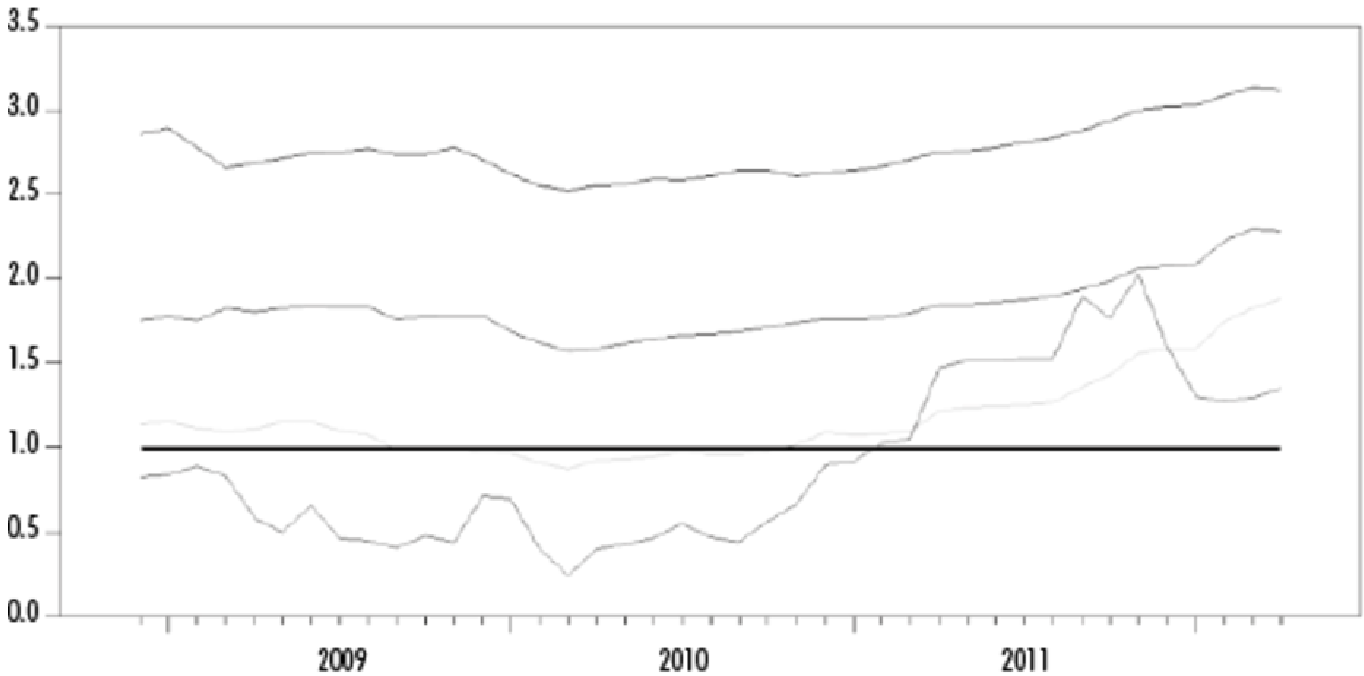

Figure 5. Hansen and Johansen Test. Stability of the Cointegration Range: R Model (Size=5%)

The Johansen maximum likelihood procedure estimates a base for the cointegration space; the problem of identification remains open. One treatment used for identification is to impose a set of sensible a priori restrictions in the space of the parameters. In this case, the first cointegration vector is normalized as a long-term exchange rate equation and we consider the hypothesis where the differences between the national variables and the rest of the world are stationary; those restrictions permit a sensible identification of the space for the cointegration vector. Below, we report the equation of the cointegration vector:

Source: Created by the authors.

$e_{t-1} = -0.754(m - m^*)_{t-1} - 0.016(i - i^*)_{t-1} - 0.023X_{t-1}$
Over-identification test LR- CHISQR(2) = 3.272 [0.195]

Table 3. Normalized Cointegration Vector

This is one of the ways to write the cointegration vector, which implies that there is a long-term relationship associated with the monetary model suggested by Bilson, but which includes the net positions of speculators in determining price in the long term. In this particular interpretation of the cointegration space, we can see a positive relationship between net positions of speculators and the exchange rate in the long term. Figure 6 also confirms that the long-term equation – which is a linear combination of the exchange rate and its determinants – has stationary behavior, just as the monetary model suggests. The long-term relationship confirms that the net positions of speculators have a permanent effect and transmit fundamental macroeconomic information to the market, as the strong flow-centric version suggests. We can conclude, therefore, that the net positions of speculators are correlated with the fundamental future variables, like in the Bilson version of the monetary model, and that the relationship between exchange rate and speculators' net positions is not inconsistent with the macroeconomic approach in determining the exchange rate.

Source: Created by the authors based on data from IPEA.

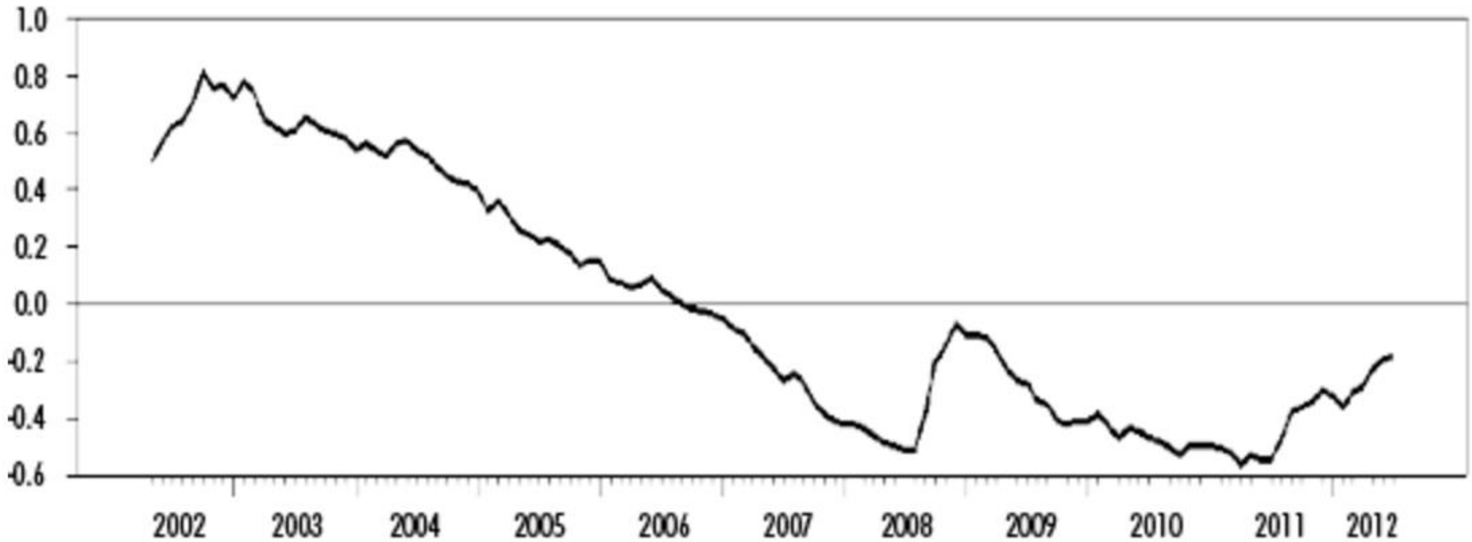

Figure 6. Impulse-Response for the Structural Effects

To estimate the contemporaneous relationships in which we were interested, associated with the coefficients of equation (3), we used the restrictions suggested by equation (10), included in matrices A and B, to obtain the structure suggested by equations (11), (12), (13), and (14). It is important to emphasize that to find each restriction, we begin with an exact identification structure given by the decomposition of the lower triangle of the variance and covariance matrix of errors of the estimated VAR. Then, in matrix A, we save the coefficients to identify the monetary model (MAER), as long as the variables are statistically significant, and restrict to zero the parameters that are not significant, with which we arrive to a situation of over-identification. Finally, we secure the validity of the previously imposed restrictions through the LR test. The coefficients estimated for the contemporaneous interactions that represent the short-term version of the monetary model are shown in equations 15 to 18. The final estimate supports the graphical representation of the instantaneous relationships among the variables shown in Figure 5.

Source: Created by the authors based on data from IPEA.

$$\begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ a_{31} & 0 & 1 & 0 \\ a_{41} & a_{42} & a_{43} & 1 \end{pmatrix} \begin{pmatrix} \varepsilon_{(m-m^*)_t} \\ \varepsilon_{(i-i^*)_t} \\ \varepsilon_{x_t} \\ \varepsilon_{e_t} \end{pmatrix} = \begin{pmatrix} b_{11} & 0 & 0 & 0 \\ 0 & b_{22} & 0 & 0 \\ 0 & 0 & b_{33} & 0 \\ 0 & 0 & 0 & b_{44} \end{pmatrix} \begin{pmatrix} u_{(m-m^*)_t} \\ u_{(i-i^*)_t} \\ u_{x_t} \\ u_{e_t} \end{pmatrix}$$

$$\varepsilon_{(m-m^*)} = \underset{(0.0007)}{0.0113}\ u_{(m-m^*)} \tag{15}$$

$$\varepsilon_{(i-i^*)} = \underset{(0.0061)}{0.0957}\ u_{(i-i^*)} \tag{16}$$

$$\varepsilon_X - \underset{(1.2785)}{3.4887}\, \varepsilon_{(m-m^*)} = \underset{(0.0102)}{0.1604}\ u_X \tag{17}$$

$$\varepsilon_e - \underset{(0.2254)}{0.1846}\ \varepsilon_{(m-m^*)} - \underset{(0.0258)}{0.0037}\, \varepsilon_{(i-i^*)} - \underset{(0.0154)}{0.0226}\, \varepsilon_X = \underset{(0.0275)}{0.0275}\ u_e \tag{18}$$

LR Test: Chi^2(2.0000): 2.9715, Prob: 0.2263

$$\partial \varepsilon_e / \partial \varepsilon_{(m-m^*)} = a_{41} = 0.1846 \tag{19}$$

$$\partial \varepsilon_e / \partial \varepsilon_x = a_{31} * a_{43} = 3.4887 * 0.0226 = 0.07884 \tag{20}$$

$$\partial \varepsilon_e / \partial \varepsilon_{(i-i^*)} = a_{42} = 0.0037 \tag{21}$$

Table 4. Estimated Contemporaneous Effects. Estimates of the SVAR Parameters

The statistical validity of the mechanism in Table 4 confirms the a priori assumptions of the short-term connections between the fundamental variables and the exchange rate. The impacts of the structural shocks of money and the interest rate on the nominal exchange rate are positive. Finally, monetary shocks also

have a positive influence on the exchange rate via speculators' net positions. The simulation shows that the latter have a substantial contemporaneous effect on the exchange rate because the money supply shock affects the exchange rate through the net positions of speculators. As such, speculators' net positions are correlated with monetary policy news, the liquidity channel, which confirms that temporary monetary shocks are transmitted to prices via the net positions held by speculators.
The evidence on the mechanisms can be proven using typical simulation techniques, such as impulse-response functions (IRF), based on the estimated VAR model and restricted to satisfy the cointegration range restrictions. The IRFs and their asymptotically valid intervals are shown below:

Source: Created by the authors based on data from IPEA.

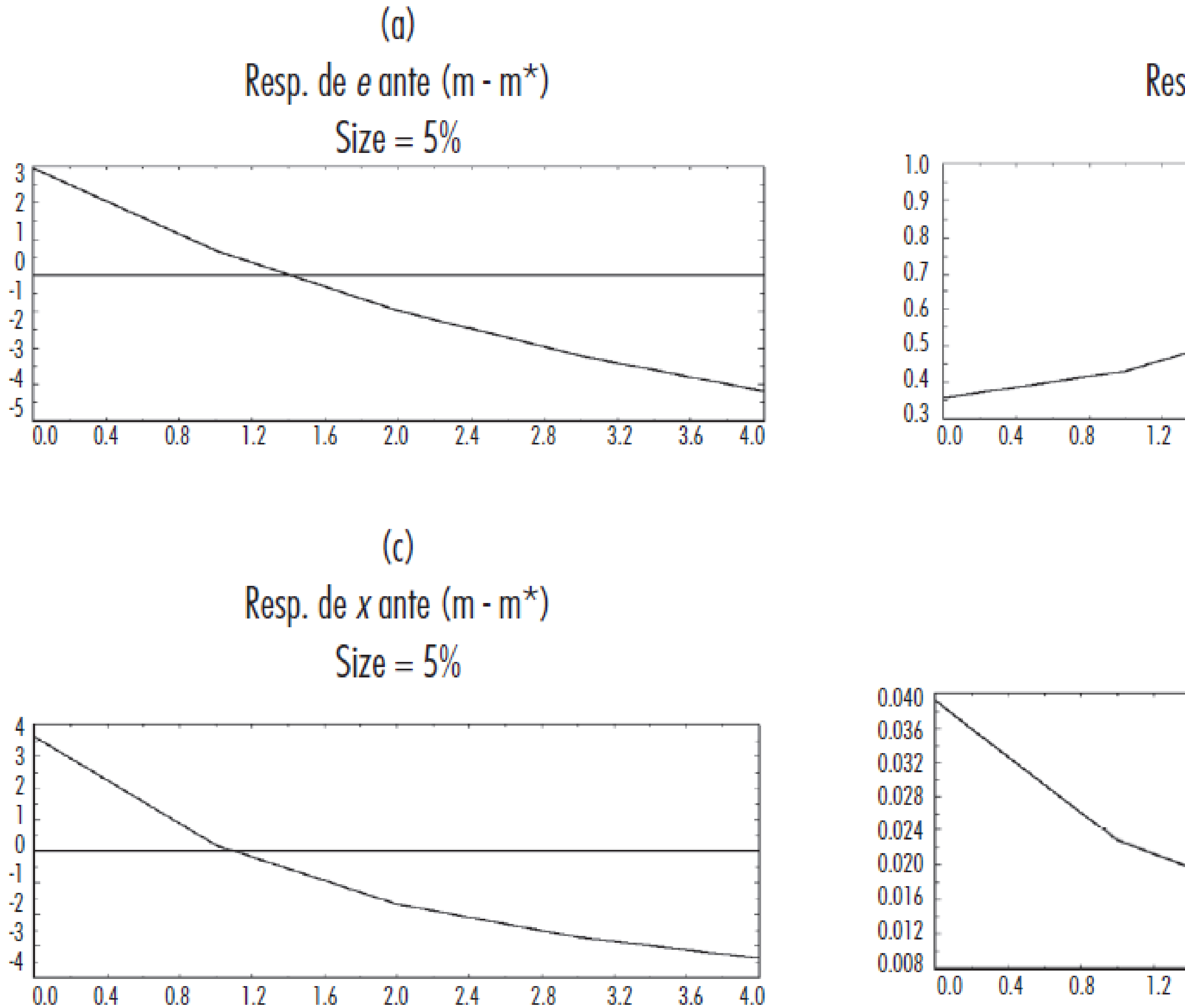

Figure 7. Impulse-Response for Structural Effects

Figure 7 shows the responses of the exchange rate to the shocks of the money supply and the interest rate differential, respectively, in graphs (a) and (b). As can be observed, both have a positive effect in the short term. This confirms the search for contemporaneous shocks and allows us to say that the MAER is a good approach to understanding the behavior of the currency in Brazil. In summary, the empirical results reveal that exchange rate movements respond to the shocks of the variables in the monetary model proposed by Bilson. On the one hand, pursuant to graph (c), we can see that the net positions of speculators have had a positive effect on the exchange rate, as mentioned in the initial hypothesis. This reflects the effect of the net positions of speculators on the exchange rate in the short term.

Finally, Table 5 shows the explanatory power of the net positions held by speculators. Although they are not the strongest, it is important to include them in the model, as the F test indicated that they should not be excluded from the SVAR model, as they help the model on fit. [5] Table 6 shows that the precision of the forecast improves once the net positions of speculators are introduced into the VAR model. This means that the net positions held by speculators are necessary to explain the long-term behavior of the exchange rate in Brazil.

Table 5. Analysis of R2 for Each Equation in the VAR Model

Variable	R^2
X	0.88946
(m-m*)	0.99978
(i-i*)	0.9867
E	0.98704

Source: Created by the author based on data from IPEA.

Table 6. Forecasts for Errors Outside the Sample (Root of average quadratic error)

	RW	*Cointegrated VAR*	*Differences*
E	0.041	0.026	0.037

Source: Created by the authors based on data from IPEA.

CONCLUSIONS

The empirical evidence offers an explicit characterization of how the net positions of speculators transmit non-public information to prices, and the channels through which the net positions of speculators contribute to the allocation of this information.

In this study, we used an SVAR model to show an appropriate description of the relationship between speculators' net positions and the exchange rate in Brazil. This microstructure approach is consistent with the monetary model, and encompasses two mechanisms, information and liquidity. In other words, by adding the net positions held by speculators into the monetary model, the specification is enhanced, and so is the explanatory power and predictive accuracy. Moreover, the long-term estimates show that the net positions of speculators have a permanent effect and transmit fundamental macroeconomic information to the market, which is incorporated to prices via the net positions of speculators.

The simulations also demonstrate that the net positions held by speculators have a substantial contemporaneous effect on the exchange rate, because the shocks of the money supply affect the exchange rate through the net positions held by speculators. In other words, these net positions are correlated with the variables of the monetary model known as MAER (information channel), but also with the monetary policy news (liquidity channel). The results confirm that the relationship between the exchange rate and speculators' net positions is not inconsistent with the macroeconomic approach to determining the exchange rate in Brazil, and that monetary shocks are transmitted via the net positions of speculators.

[1]Hallwood and MacDonald (2000) proved this model for various economies.
[2]Matrix A contains parametrical constraints derived from economic theory.
[3]Matrix A contains parametrical constraints derived from economic theory.
[4]The null hypothesis was that the net positions of speculators would be zero in each of the VAR model equations. This test suggests that the net positions of speculators must not be excluded from the model Chi^2(23))=3.0088e+005[0.0000].

APPENDIX

Note: The asterisks indicate series for the United States; m, i, e, and x refer to M1, the interest rate, the nominal exchange rate, and the net positions of speculators, respectively. The first difference in the series is denoted by Δ.

Source: Created by the authors based on data from IPEA.

Variables	Model	ADF	PP	DF-GLS	KPSS
I	Intercept	-1.374999	-0.840006	-0.340922	1.142752
	Trend and intercept	-5.010332	-2.822602	-4.34108	0.088069
	None	-1.843627	-1.146077	-	-
Δi	Intercept	-4.555431	-6.969818	-4.515314	0.066227
	Trend and intercept	-4.512505	-7.015597	-4.406877	0.046803
	None	-4.263958	-6.838548	-	-
i*	Intercept	-0.694528	-0.565876	-0.442705	0.805899
	Trend and intercept	-1.612773	-1.441045	-1.375953	0.255461
	None	-0.604949	-0.48183	-	-
Δi*	Intercept	-6.522783	-6.491635	-6.539083	0.203909
	Trend and intercept	-6.54342	-6.512193	-6.569031	0.122593
	None	-6.473123	-6.434835	-	-
m2	Intercept	-0.612458	-1.487832	1.54992	1.344897
	Trend and intercept	-2.213852	-1.659906	-2.352766	0.197566
	None	2.76722	5.291885	-	-
Δm2	Intercept	-4.322442	-5.855913	-3.56463	0.190531
	Trend and intercept	-4.26956	-5.973267	-4.141311	0.048643
	None	-3.181736	-4.138125	-	-
m2*	Intercept	2.981122	2.912675	5.86954	1.188221
	Trend and intercept	0.566082	0.401067	0.244	0.292496
	None	5.828401	4.704796	-	-
Δm2*	Intercept	-9.78686	-10.00817	-4.169529	0.711214
	Trend and intercept	-10.40635	-10.45094	-10.39651	0.176737
	None	-3.179077	-8.869337	-	-
E	Intercept	-1.531418	-1.404349	-1.460236	1.102269
	Trend and intercept	-2.808389	-3.001415	-2.104411	0.192935
	None	-0.771947	-0.596142	-	-

Table 1a. Unit Root Tests 2002.4-2012.8

Note: Test at 95% confidence.
Source: Created by the authors based on data from IPEA.

Variables	*Model*	*ADF*	*PP*	*DF-GLS*	*KPSS*
$(i\text{-}i^*)$	Intercept	-1.09967	-0.920769	-0.991555	0.630393
	Trend and intercept	-1.646131	-1.429115	-1.499829	0.259778
	None	0.006665	0.128537	-	-
$\Delta(i\text{-}i^*)$	Intercept	-6.256057	-6.166428	-6.278163	0.169425
	Trend and intercept	-6.252301	-6.15976	-6.292789	0.121558
	None	-6.252445	-6.193926	-	-
$(m\text{-}m^*)$	Intercept	-1.349487	-1.944678	-0.042333	1.152242
	Trend and intercept	-0.94795	-0.507211	-1.236225	0.261935
	None	-0.486496	-0.665279	-	-
$\Delta(m\text{-}m^*)$	Intercept	-3.927826	-6.064227	-3.384192	0.400814
	Trend and intercept	-4.040147	-6.405607	-4.056189	0.087274
	None	-3.831464	-5.80868	-	-

Table 1b. Unit Root Tests for the Logarithm of the Differences of the Series for Brazil and the United States

Note: Level of significance at 5%.
Source: Created by the authors based on data from IPEA.

Variables	Autocorrelation		Normality		Heteroscedasticity	
	F Statistic	Prob	Chi^2-Statistic	Prob	F statistic	Prob
E	1.5951	[0.1450]	6.0645	[0.0482]	0.70597	[0.6669]
(m-m*)	2.679	[0.0137]	0.98458	[0.6112]	1.3198	[0.2492]
(i-i*)	1.8876	[0.0789]	4.8997	[0.0863]	2.5652	[0.0181]
X	0.68109	[0.6877]	0.74412	[0.6893]	0.56355	[0.7838]

Table 1c. Individual Correct Specification Tests for the VAR(1) Model

Note: Level of significance at 5%.
Source: Created by the authors based on data from IPEA.

Test	Statistic	Prob
AR	1.2723	[0.0545]
Normality	12.7460	[0.1209]
Hetero	1.1336	[0.2122]
Hetero-X	1.0911	[0.2407]

Table 1d. Joint Correct Specification Tests

Note: LR [L(kmax)/L(h)]= The LR test determines the optimal number of lags for the VAR model. LR[L(h)/L(h-1)]= The corrected LR test determines the optimal number of lags for the VAR model.
Source: Created by the authors based on data from IPEA.

LAG	LOG_L	LR(kmax/k)	DGF	Prob.	LR(kmax/k)COR	DGF	Prob.	SCHWARZ
1	1441.514	110.515	48	0.000	89.208	48	0.000	-22.694
2	1468.831	55.881	32	0.006	45.107	32	0.062	-22.510
3	1476.816	39.911	16	0.001	32.216	16	0.009	-21.999
4	1496.771	NA	0	NA	NA	0	NA	-21.690

Table 1e. Determining the Order of Lags

Source: Created by the authors based on data from IPEA.

Correlation	GODFREYCORR	GL	Prob.
1	58.821	16	0.00000
1,2	64.372	32	0.00100
1,2,3	76.670	48	0.00500
1,2,3,4	63.495	64	0.49400

Table 1f. The Godfrey Portamanteau Test for the Order of Determining the Lags

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