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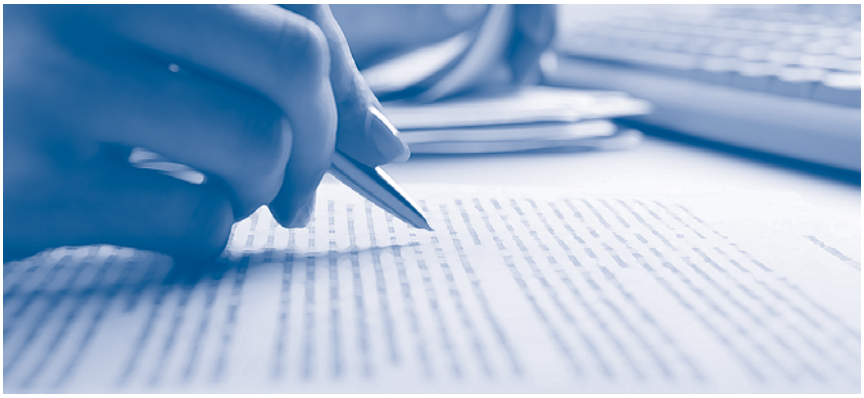

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Official Interventions through Derivatives: Affecting the Demand for Foreign Exchange*

Emanuel Kohlscheen† and Sandro C. Andrade‡

Abstract

We use high-frequency data to study the effects of currency swaps auctions by the Brazilian Central Bank on the BRL/USD spot exchange rate. We find that official currency swap auctions impact the level of the exchange rate, even though they do not directly alter the supply of foreign currency in the market. The maximum impact occurs 60 to 70 minutes after the initial official announcement of an auction, and typically shortly after the results of the auctions are made public. The official supply of currency swaps to the market provides an alternative for traders that demand foreign currency for financial (speculative or hedging) rather than transactional reasons, and thus affects the demand for foreign currency and its price. This mechanism is likely to be particularly relevant when forecasters extrapolate exchange rate trends at short-term horizons.

Keywords: intervention; exchange rate; derivatives; Brazil
JEL Classification: F30

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1 Introduction

A recent survey article by Lukas Menkhoff (2012) has noted that, to the extent that interventions in emerging markets tend to occur regularly and central banks in these countries have considerable leverage, interventions in emerging markets are significantly different from those that have occurred in advanced economies. Nevertheless, interventions in these markets have not received their fair share of attention in the academic literature. Menkhoff notes that "*when it comes to empirical studies on foreign exchange interventions, established surveys indicate a severe lack of consideration [for emerging economies]. For example, Sarno and Taylor (2001) do not cover a single study which would specifically address emerging markets and Neely's (2005) comprehensive survey about empirical work has a share of 2 out of 41 studies which are based on evidence from emerging markets.*" (p.3). His study concludes that much more research on interventions in emerging markets is needed. Indeed, he goes as far as stating that "*when we talk about foreign exchange interventions today we should talk about emerging markets.*" [1]

Once an observer has established that most emerging economies do engage in direct or indirect interventions in the foreign exchange market, an important question that ensues is which policy tools should optimally be

[1] In terms of macroeconomic theory, some promising recent research efforts have tried to close the large gap that exists between actual practices in monetary and exchange rate policies in emerging economies and textbook models (see for instance the studies by Ostry, Ghosh and Chamon (2012) and by Benes, Berg, Portillo and Vavra (2013) at the IMF).

used by a monetary authority if it decides to intervene. As a matter of fact, the instruments that have been used to conduct exchange rate policy, and to ensure the smooth functioning of the exchange rate market, have typically developed in sync with the increasing sophistication of exchange rate markets. Indeed, in some countries derivative contracts have come to the forefront of the exchange rate policy toolkit of Central Banks. In the case of Brazil, for instance, *Banco Central do Brasil* carried out a total of 12 currency swap auctions in the second half of 2012 - at the same time that it did not resort to any plain vanilla spot market auctions. [2] Yet, somewhat surprisingly, the use of such instruments has not received the appropriate attention in the economic literature.

A well known advantage of issuing such contingent liabilities as currency swaps is that authorities become able to intervene in the exchange market indirectly, without affecting the money supply or varying the stock of foreign exchange reserves. Alternatively, a Central Bank might also want to engage in derivative operations to deepen the market for instruments for risk management or to act as an automatic stabilizer of the foreign exchange market (Blejer and Schumacher (2000)). The caveat, of course, is that the use of such instruments requires much more careful risk assessments than traditional instruments. In the case that we analyze in this paper, however, it is important to bear in mind that the notional amount of the total BCB exposure in the

[2] The Central Bank also performed USD sales with repurchase agreements in late November and December.

currency swap market - that was below US$ 2 bn at the end of the period that we investigate [3] - was dwarfed by international reserve holdings that fluctuated between US$ 346 bn and US$ 379 bn. In other words, to some extent, the large holdings of international reserves provided an insurance, as well as the means to fight eventual adverse movements for the Central Bank. [4]

This study shows that currency swap contracts, that trade the exchange rate variation (plus a local onshore US$ interest rate) for the cumulative domestic interest rate, can have a significant impact on the level of the exchange rate without altering the supply of foreign currency in the market in any direct way. The rationale for such effect is that the supply of currency swaps to the market provides an alternative for traders that are demanding foreign currency for speculative or hedging reasons. In other words, altering the supply of these contracts will ultimately affect the demand for foreign currency and therefore, also its price. This mechanism is particularly potent if, as Frankel and Froot (1990) and Taylor and Allen (1992) already confirmed, forecasters tend to extrapolate the exchange rate trends at short-term horizons. More recently, also Menkhoff and Taylor's (2007) survey established the widespread use of technical analysis in the foreign exchange market. They argue that such practice informs traders on non-fundamental forces. Using

[3] That is, from July 1st, 2011 to December 31st, 2012.

[4] Conversely, when it is receiving exchange rate variation, a Central Bank could issue more domestic currency to cause a depreciation of the currency.

high-frequency data, we find that the currency swap auctions that were carried out by the Brazilian Central Bank in the second half of 2011 and during 2012 indeed had a significant effect on the BRL/USD exchange rate. As we show, our findings are robust to a number of alternative specifications, and to the inclusion of macroeconomic control variables as well as time-stamped news effects, and persists if we treat the data for the possibility of intraday endogeneity.

The present article adds to the existent literature in at least two ways. First, our study represents a contribution to the small set of studies on the effects of interventions in emerging markets that is based on high-frequency data. Most existing studies on the subject were not able to make use of intraday data. Second, our contribution represents an important innovation in that we analyze the effects of indirect interventions in the foreign exchange market, *i.e.* interventions via currency swaps. To the best of our knowledge, the official use of such exchange rate derivatives to attain exchange rate policy objectives had not been the subject of a systematic analysis in the academic literature before. We find that, even though these operations do not involve direct exchanges of foreign currency, they clearly do have a significant impact on the level of the exchange rate on their own.

Relation to the literature. A few papers of the existing intervention literature can be related to the present article. For comprehensive surveys of the literature, we refer the reader to the studies of Sarno and Taylor (2001),

Neely (2005) and Menkhoff (2012). In terms of the empirical strategy that we follow, the paper that lies closest to ours is the seminal contribution of Dominguez (2003). As we do, Fatum and Pedersen (2009) and Dominguez, Fatum and Vacek (2012) have also used a reaction function that is based on intraday data to analyze the effects of "unexpected interventions". [5] One important difference from these studies, however, is that we base exchange rate return computations on actual trade data, instead of indicative quotes.

Within the group of emerging economies, Disyatat and Galati (2007) have pointed out that if emerging markets can be characterized by lower asset substitutability and greater size of interventions relative to market turnover, (direct) interventions should be more likely to be successful due to the portfolio balance channel or to the microstructure/order flow channel. Nevertheless, they find that intervention in the Czech Republic had only small and weakly significant impacts on the spot rate and on the risk reversal. Earlier, however, Tapia and Tokman (2004) had found that interventions via direct spot market transactions and via US Dollar denominated papers did not have significant effects in the case of Chile. Our results, however, indicate that even indirect interventions - *i.e.* those that do not involve direct transactions of foreign exchange - can have economically and statistically significant effects on the exchange rate. To some extent then, our findings resonate with those of Guimarães and Karacadag (2004), that found that direct interventions

[5] The latter study concludes that reserve sales by the *Czech National Bank* had a significant impact on the exchange rate.

had a lagged impact on the value of the Mexican Peso. Also Adler and Tovar (2011) report evidence of significant effects of direct interventions. The analysis of these two studies, however, was based respectively on daily and weekly data. Using intraday data, we are able to demonstrate a much faster response of indirect interventions - with maximum impact occurring about one hour after the announcement of currency swap auctions.

Outline. The paper proceeds as follows. Section 2 briefly presents some background information on the recent Brazilian policy framework and on the use currency swap auctions. Section 3 presents the intraday data that is used in the analysis. Section 4 then outlines the econometric specification that was employed for estimation. The following section presents the estimation results, addressing the issue of intraday endogeneity. Section 5 also shows the robustness of the results when an alternative intervention variable is used. The paper closes with some concluding remarks.

2 Currency Swap Auctions in Brazil

After the abandonment of the currency peg against the US Dollar, in January 1999, the Brazilian Central Bank has operated a managed floating exchange rate regime. Since mid 1999, the main objective of the monetary authority has been to meet the explicit inflation target that is set in advance by the

Conselho Monetário Nacional (CMN). [6] Even though interventions in the foreign exchange market have been common - as in most other emerging economies - the volatility of the Brazilian Real has typically been larger or comparable to the volatility of G-3 currencies in both, bilateral and effective terms. [7]

In March 2002, the Brazilian Central Bank started to use public currency swap auctions as an instrument that is aimed at ensuring the smooth functioning of the foreign exchange market and supply a source for hedge operations. These swap contracts, to some extent, replaced domestic government bonds that were linked to the exchange rate. Bevilaqua and Azevedo (2005) provide a detailed discussion about the (re-)introduction of this type of contracts, as well as the replacement of US$ linked Treasury Notes (NTN-Ds).

Swap contracts are registered at the *BM&FBovespa* exchange as "*SCC - Contrato de Swap Cambial com Ajuste Periódico*". [8] Auctions are always announced through the Central Bank's communication system, establishing the exact time of the auction - typically a few minutes after the announcement, the maximum quantity of contracts that the Central Bank is offering to buy or sell, and the maturities that are on offer. [9] After bids are placed,

[6] Indeed, consumer price inflation has stayed within the allowed +/- 2% deviation from the target in each and every year between 2004 and 2012.

[7] For a direct comparison of the exchange rate volatilities of "emerging floaters" vis-à-vis G-3 currencies the reader is referred to Kohlscheen (2010).

[8] The contract can be found at http://www.bmfbovespa.com.br.

[9] Each participating institution is allowed to place up to five bids, specifying the quantity

the Central Bank has the discretion to accept any volume of contracts up to the maximum that is on offer. If the Central Bank is offering to buy these derivative contracts the financial institution receives the equivalent of the exchange rate variation over the time of the contract plus a local onshore US$ interest rate, *all paid in Brazilian Reais*. At the same time, the Central Bank receives the cumulative interbank interest rate.

Table 1 lists all 36 currency swap operations that were carried out by the BCB between July 1st, 2011 and December 31st, 2012. The local market convention has been to label auctions as *traditional swaps* when the Central Bank is buying contracts to limit the depreciation of the Brazilian Real, and as *reverse swaps* when the Central Bank is selling contracts to limit appreciation of the currency. Even though there is no exchange of foreign currency involved and the Central Bank does not alter the supply of foreign exchange, market participants typically see *traditional swaps* as being the financial equivalent to a sale of USD Dollars in the futures market by the BCB.

To the extent that a change in the supply of *SCC* derivatives alters the supply of hedging instruments that are available in the market, such auctions will have an affect on the demand for USD dollars in the marketplace and, as a consequence, the prevailing BRL/USD exchange rate. To illustrate this point, Figure 1 shows the daily evolution of the BRL/USD rate between Sep-

and price (i.e. the implicit interest rate) for each.

tember 1st, 2011 and mid-October - a period in which the Central Bank did not perform any direct USD auctions. Between September 1st and the 21st, the BRL/USD exchange rate moved from 1.62 to 1.88. This rapid movement prompted the Central Bank to announce a traditional swap auction on the morning of September 22nd, offering the exchange rate variation to market participants in exchange for an agreed interest rate. [10] As the auction provided an alternative for traders and trend extrapolators that were acquiring USD for speculative reasons (as well as those that needed to hedge their position), the speculative demand for USD dropped and the Brazilian Real recovered some ground. The figure shows that similar developments prompted new BCB action in the beginning of October.

Of course one could always argue that, while the anecdotal evidence presented above is very suggestive, other conditions that affect the BRL/USD market may also have varied during the time period in question, making it difficult to infer which part of the variation is directly attributable to the swap auctions. In what follows, we aim to establish whether a thorough analysis that is based on intraday variation, and that includes the proper control variables, supports the view that BCB currency swap operations indeed had a significant and systematic effect on the exchange rate.

[10] The notional amount of the contracts that were eventually sold amounted to $ 2.7 billion.

3 Data

To compute the systematic impact of currency swap auctions on the spot BRL/USD exchange rate we use *tick-by-tick* trade data provided by *Bloomberg*. This selection carries the advantage that we base our main variable of interest on price data that are derived from transactions that were effectively carried out. We discretize the time interval to *10 minute* intervals by matching each time to the nearest available transaction price. We then restrict our analysis to actual foreign exchange trading times at *BM&FBovespa*, which extends from 9:00 a.m. to 4:15 p.m local time. [11] This gives us a total of 16,500 observations that cover the 18 month period between July 2011 and December 2012, after excluding weekends and holidays.

Our main interest is to establish the effect of an *event* of a currency swap auction on the exchange rate. Figure 2 shows the frequency distribution of the announcement times of the currency swaps. It is clear that most announcements were made while local currency markets were open. Indeed, as the Figure shows, 80% of the operations were announced between 9:15 a.m. and 12:45 a.m. As we analyze the effects during a time window around the announcement of the intervention, we drop the 5 swap operations in Table 1 that were preceded by a public swap demand survey and disregard the 4 operations that were announced less than 4 hours after a previous

[11] The conversion of *Bloomberg* (i.e. NY) time to local time took proper account of the changes due to Summer time zones in both countries.

swap operation. This leaves us with a sample of 27 "clean" *events* to study. Throughout, our signed dummy variable takes the value 1 if the BCB is buying contracts and -1 if it acts as a seller.

We control for intraday commodity price variations (as measured by the variations of the *Commodity Research Bureau*'s index) and changes in the VIX rate, as reported by *Bloomberg*, as these variables have been shown to be important determinants of the value of the Brazilian Real (see Kohlscheen (2013)). We also control for direct USD auctions that were carried out by the BCB during this period. [12]

Finally, we also control for time-stamped macroeconomic news announcements. More precisely, we control for official announcements of GDP and consumer price inflation figures in Brazil and the United States. We follow Andersen, Bollerslev, Diebold and Vega (2003, 2007) as well as Dominguez, Fatum and Vacek (2012) in that we define each news surprise variable as the difference between the announced figure and prior survey expectations (taken from *Agência Estado Broadcast*), divided by the sample standard deviation of the variable in question.

[12] The exact timing of BCB operations was obtained through *BC Correio*.

4 Econometric Specification

In what follows, we employ the econometric specification that is shown in equation (1). If h represents the length of the discrete time interval that is used (i.e. *10 minutes*), we estimate the expression

$$\begin{aligned}\Delta s_t &= \beta_0 + \sum_{i=1}^{I} \beta_i \Delta s_{t-ih} + \sum_{j=-N}^{N} \beta_j D_{t+jh} + \sum_{k=-N}^{N} \beta_k USD_{t+kh} + \\ &+ \sum_{l=1}^{L+1} \beta_l Macro_{t-(l-1)h} + \sum_{m=1}^{M+1} \beta_m News_{t-(m-1)h} + \varepsilon_t \end{aligned} \quad (1)$$

where s_t represents the log of the BRL/USD exchange rate and β_0 a constant that may capture any eventual trend. D_t is a signed dummy variable that indicates the occurrence of a currency swap operation, USD_t is a signed dummy that flags eventual USD Dollar auctions, $Macro_t$ stands for a vector of macroeconomic control variables, $News_t$ is a vector of standardized macro news announcements and ε_t represents the error term. Throughout, we allow macroeconomic control variables, as well as official announcements of macroeconomic indicators, to impact the exchange rate up to *2 hours* after the initial realization of the variable. In other words, we set L and M to 12, allowing these variables to impact the exchange rate with relatively long time delays.

We assess whether swap auctions that are carried out by the BCB impact the exchange rate in a systematic way by evaluating the estimated sequence of β_js. In particular, if currency swaps are effective, we would expect nega-

tive β_js to dominate as *traditional swaps* should reduce the BRL/USD rate and *reverse swaps* increase it. N is also set to 12, so that the we effectively evaluate the intraday exchange rate impacts for the time window from $-2h$ to $+2h$ around each intervention episode. The least squares estimation of the betas is based on 16,500 observations and inference is based on robust (Newey-West) standard errors. In other words, we take account of the possibility of heteroskedasticity or serial correlation in the residuals.

5 Estimation Results

5.1 A First Pass

Table 2 reports the estimation results for equation (1) under 3 alternative models. Model I reports the estimates when we use only the signed intervention dummies as explanatory variables, without any controls for macroeconomic conditions or news announcements. Model II adds the macro controls that were found to be relevant in previous studies, current and lagged, to the specification of model I. Finally, Model III includes both, macro controls, as well as (current and lagged) macro news variables.

While we deliberately chose the relative long *2 hour* windows to allow the right hand side variables in the equation to impact the exchange rate, we selected the number of lags I that were included for the lagged dependent variable using the Akaike and the Schwartz Information Criteria. This led

us to focus on the model with 3 lags of exchange rate returns. [13] Table 2 shows that the return lags are all significant at 1%, and negatively signed, indicating a strong mean-reverting pattern for exchange rate variations.

The results for Model II and III show that the intraday market volatility index VIX and the intraday CRB commodity price index are also highly significant determinants of the value of the Real at intraday frequencies, confirming earlier findings that were based on daily frequency (Kohlscheen (2013)). Note that these are global variables, so that reverse causality here is highly unlikely.

For all 3 specifications the coefficients of the $t + 1$ lead intervention variable, as well as the coefficients for the lagged $t - 1$, $t - 6$ and $t - 7$ are all found to be significant at 5%. The maximum impact occurs 60 to 70 minutes after the announcement of the currency swap. As the median time for the publication of the auction results during the sample period is 48 minutes, the results suggest that the maximum impact typically occurs shortly after the results of the auction become known to the market. Note that this result is roughly comparable to that found by Dominguez (2003) for Fed interventions. That author had found that the maximal effect of Fed interventions on the USD/JPY rate occurred 55 minutes after the Reuter's report of intervention. In our case, the hypothesis that the significant β_j coefficients in Table 3 add up to zero is usually rejected by the appropriate Wald tests.

[13] The model with no lagged dependent variable was clearly inferior and delivered Durbin-Watson statistics around 2.40, indicating auto-correlation of the residuals.

The χ^2 statistic for the null of a zero cumulative effect attains the values 3.810 [*p-value=0.0510*], 5.528 [*p-value=0.0187*] and 5.514 [*p-value=0.0189*], respectively, for models I, II and III.

5.2 Effects of Unexpected Auctions

Even though we are working with intraday data - which normally tends to diminish the risk of simultaneity bias - there is the possibility that, in discretionary intervention regimes as the one that is practised by the BCB, currency swap auctions are a consequence rather than the cause of exchange rate movements. One indication that this factor might be at play comes from the fact that the coefficients of the signed intervention dummy that are closest to the time of the announcement t of an intervention in Table 2 are actually positive, and not negative. This pattern of the event window coefficients could in principle be a consequence of an intervention strategy that reacts to revert the development of eventual unfavorable trends in the exchange rate.

Because of the above, we proceed to obtain an estimated reaction function of the Central Bank, as a function of lagged exchange rate movements. The results of this exercise are shown in Table 3 for three alternative specifications. In particular, the specification in the last column includes hour of the day dummy variables, in order to take account of the intervention timing pattern for the sample period, which had been shown in Figure 2. We do find

some indications that the Central Bank is indeed more prone to perform a *traditional swap* right after the currency has depreciated against the US Dollar. It should be noted, however, that the low adjusted R2 statistics indicate that mechanic reaction functions do not seem to explain a very significant portion of BCB action.

Next, we re-estimated equation (1) using the difference between the intervention dummy and the fitted intervention variable that was estimated based on a parsimonious reaction function - that included a constant and the two lags of the (log) exchange rate variation that were found to be significant in Table 3. As Table 4 shows, the lead intervention variables now lose their significance. This could be taken to indicate that the evidence for price effects ahead of the time-stamped announcements, as found in other studies (e.g. Dominguez (2003)) is very weak in the Brazilian case. The lagged coefficients of the *unexpected* auction variable however continue to be economically and statistically significant at 5% for all 3 model specifications.

Two further aspects stand out from the estimation results. First, the magnitude and the significance of the coefficients of the currency swap auctions does not change very much when we move from Model I to Models II and III. Between the two, the change that is more significant is that from Model I to Model II, that is, the inclusion of (current and lagged) macroeconomic control variables. When we extend the model further to include controls for macroeconomic news, the coefficients are barely affected. All in

all, the coefficients of interest seem robust to alternative specifications - a conclusion that can also be drawn from the previous estimates in Table 2. [14] Secondly, note that at least in principle the (relatively small) positive coefficient on the $t-1$ intervention variable could potentially be taken as an indication that the reaction function that we estimate is not being entirely able to account for the fact that the central bank might be more likely to buy (sell) currency swap contracts when the BRL/USD exchange rate is high (low). This could be a consequence of the observation that estimating a reliable and stable reaction function at high-frequencies represents a rather tall order. It is certainly much easier to predict the day of an intervention based on an econometric model than the minute of intervention. (Nevertheless, the coefficients of the first and third log exchange rate changes are significant.) Indeed, as ours, the Central Bank reaction function that is estimated in Dominguez, Fatum and Vacek (2012) attains R2 values that are also well below 1%. This is the main reason that we consider the conclusions of the results of Table 2 and Table 4 in conjunction. In any case, the positive coefficient would make it less likely that we should find any cumulative effect of interventions. Nevertheless, Table 5 shows that the Wald tests now reject the null of no cumulative effect even more strongly than before, with χ^2 statistics between 6.2 and 7.8. All in all, the point estimates of Model III show that, once we take proper control factors into account, the BRL/USD depreciates

[14] As in Fatum and Pedersen (2009), one could argue that the simultaneity bias is too small to affect the results in a significant way.

33 basis points in the two hours that follow the announcement of a currency swap auction.

5.3 Robustness

We have also re-estimated all models of the previous sections using an intervention variable that took intervention amounts into account. More precisely, we substituted the signed intervention variable that was used previously for the product between the signed intervention dummy and the log of one plus the number of swap contracts that were offered by the BCB (see Table 1). [15] Note that, the number of contracts that the BCB offered is always made public at the time of the announcement of an auction. This variable was also highly correlated with the number of contracts that were eventually accepted during the sample period (the correlation is 0.574). Tables A1 to A4 in the Appendix show that the pattern of the results that were found in the previous sections is clearly maintained: the maximum impact of swap auctions occurs 60 to 70 min after the initial announcement of the interventions in all specifications. The fit of the estimated reaction function however deteriorates, compared to those that were based on interventions dummies alone. Not surprisingly, predicting the time and the magnitude of intervention within the day appears more difficult than to predict the timing alone. The Wald tests however reject the hypothesis of zero cumulative effect of interventions

[15] The notional amount of each contract is USD 50,000.

again, with *p-values* varying between 0.0049 and 0.0112, depending on the specification.

6 Concluding Remarks

This study analyzed the effect of currency swap auctions on the level of the exchange rate. We posited that, even though these contracts do not directly affect the supply of foreign currency in the market, they are likely to affect exchange rates as they alter the demand for foreign exchange - particularly if traders extrapolate exchange rate trends at short-term horizons.

Using high-frequency data and information on time-stamped official currency swap auctions in Brazil, we have shown that such public auctions do indeed have an economically and statistically significant effect on the level of the exchange rate. The point estimates suggest, for instance, that the swap auctions that the BCB carried out in May and June of 2012 had the effect of strenghtening the currency by 3.6% on their own.

We have found that the maximum impact occurs 60 to 70 minutes after the official announcement of an auction (and typically shortly after the result of the auctions are made public). The estimated time lags for the maximal effect of interventions are similar to those found earlier for direct interventions in advanced economies (e.g. Dominguez (2003)). Our findings are robust to the inclusion of relevant macroeconomic control variables, macroeconomic news and the treatment for possible intraday endogeneity.

Future research projects could aim to investigate whether currency swap auctions in emerging economies also have a systematic effect on variables such as the risk reversal or on onshore USD interest rates.

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Fig. 1 - Swap Auctions and the Exchange Rate

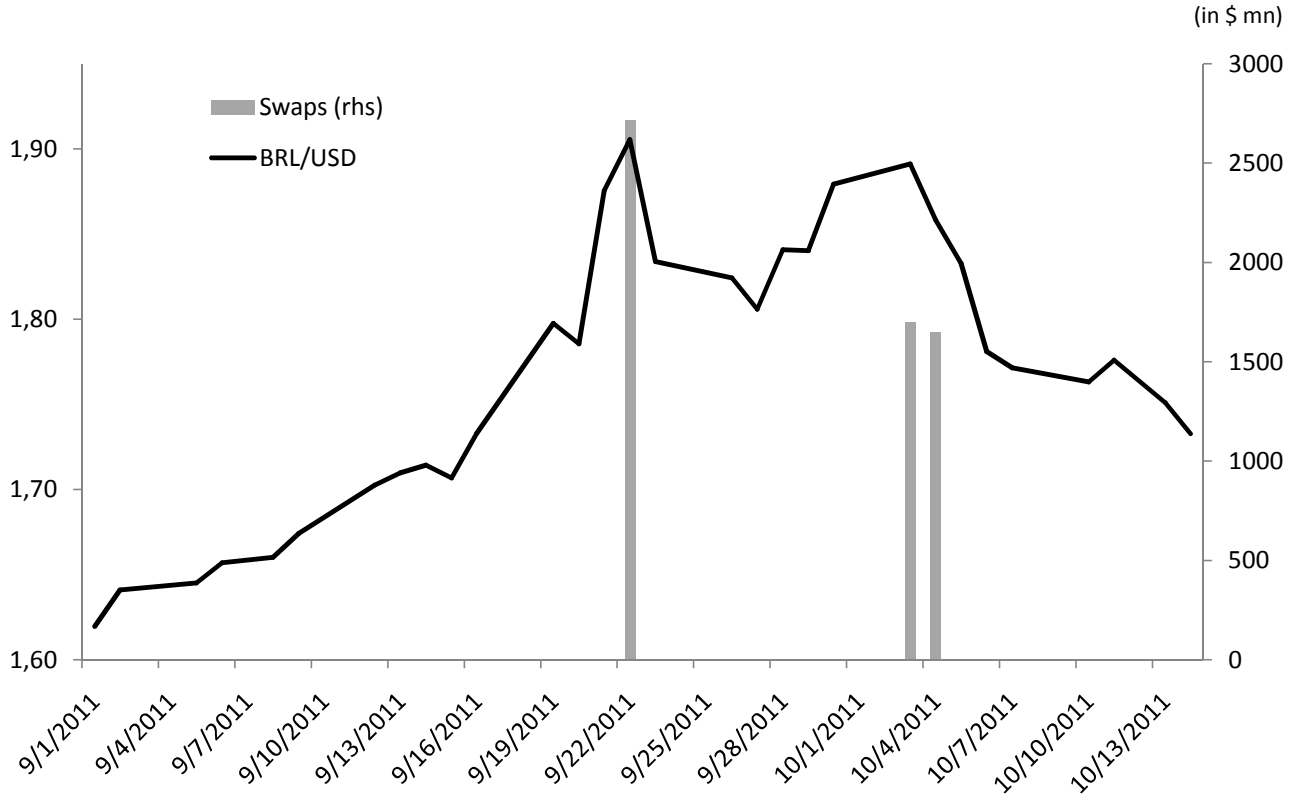

Table 1 - Currency Swap Operations of the BCB

Operation Nr.	Date	Announcement (BCB)	Bidding Time	Results	Traditional	Contracts Sold	Contracts Offered	Market Survey
1	08/07/2011	10:35	11:15-11:30	11:51	-1	9850	30000	0
2	13/07/2011	11:41	14:30-14:45	15:04	-1	11450	30000	0
3	27/07/2011	11:34	12:15-12:30	12:50	-1	10000	26000	1
4	30/08/2011	10:34	10:45-11:00	11:19	-1	13000	37400	1
5	31/08/2011	10:45	11:30-11:45	12:09	-1	0	24400	0
6	22/09/2011	10:06	10:45-11:00	11:31	1	55075	112290	0
7	03/10/2011	15:28	15:45-16:00	16:28	1	34150	106975	0
7b	04/10/2011	17:49 (day before)	11:15-11:30	11:55	1	33150	90525	0
8	28/10/2011	08:31	11:15-11:30	12:03	1	16000	30000	1
9	23/02/2012	12:13	12:15-12:30	12:53	-1	3500	40000	0
10	29/02/2012	09:53	10:15-10:30	10:47	-1	30500	40000	0
11	27/03/2012	18:00 (day before)	11:15-11:30	11:50	-1	41200	41200	0
12	18/05/2012	15:42	15:45-16:00	16:15	1	13000	13000	0
13	22/05/2012	11:12	11:30-11:45	12:02	1	30300	49400	0
13b	22/05/2012	12:20	12:30-12:45	13:03	1	13600	19100	0
14	23/05/2012	12:07	12:15-12:30	12:49	1	26400	80000	0
15	24/05/2012	11:45	12:00-12:15	12:34	1	11300	40000	0
16	25/05/2012	09:45	10:00-10:15	10:33	1	14000	40000	0
17	05/06/2012	09:29	10:15-10:30	10:48	1	20300	40000	0
18	08/06/2012	12:14	12:30-12:45	13:04	1	20400	30000	0
19	11/06/2012	12:41	12:45-13:00	13:17	1	8000	20000	0
20	27/06/2012	11:22 (day before)	11:15-11:30	12:11	1	60000	60000	0
21	28/06/2012	16:15 (day before)	10:15-10:30	11:54	1	25000	60000	0
22	29/06/2012	15:52 (day before)	10:15-10:30	10:46	1	60000	60000	0
23	21/08/2012	11:21	11:30-11:40	12:00	-1	7000	50000	1
24	12/09/2012	10:11	10:20-10:30	10:47	-1	27500	36000	1
25	14/09/2012	10:11	10:20-10:30	10:53	-1	35700	36000	0
25b	14/09/2012	12:18	14:30-14:40	14:56	-1	7400	70000	0
26	17/09/2012	09:26	09:40-09:50	10:02	-1	43500	70000	0
27	05/10/2012	10:42	10:45-10:55	11:07	-1	25800	50000	0
28	23/10/2012	09:36	09:40-09:50	10:06	-1	33000	60000	0
29	25/10/2012	09:25	09:30-09:40	09:56	-1	28300	30000	0
30	23/11/2012	11:39	11:45-11:55	12:07	1	32500	62800	0
31	03/12/2012	09:29	09:40-09:50	10:02	1	21800	40000	0
32	26/12/2012	10:31	10:40-10:50	11:03	1	27500	40000	0
32b	26/12/2012	11:16	11:40-11:50	12:02	1	9000	40000	0

Fig. 2. Time of Announcement of Swap Auctions - Frequency Distribution

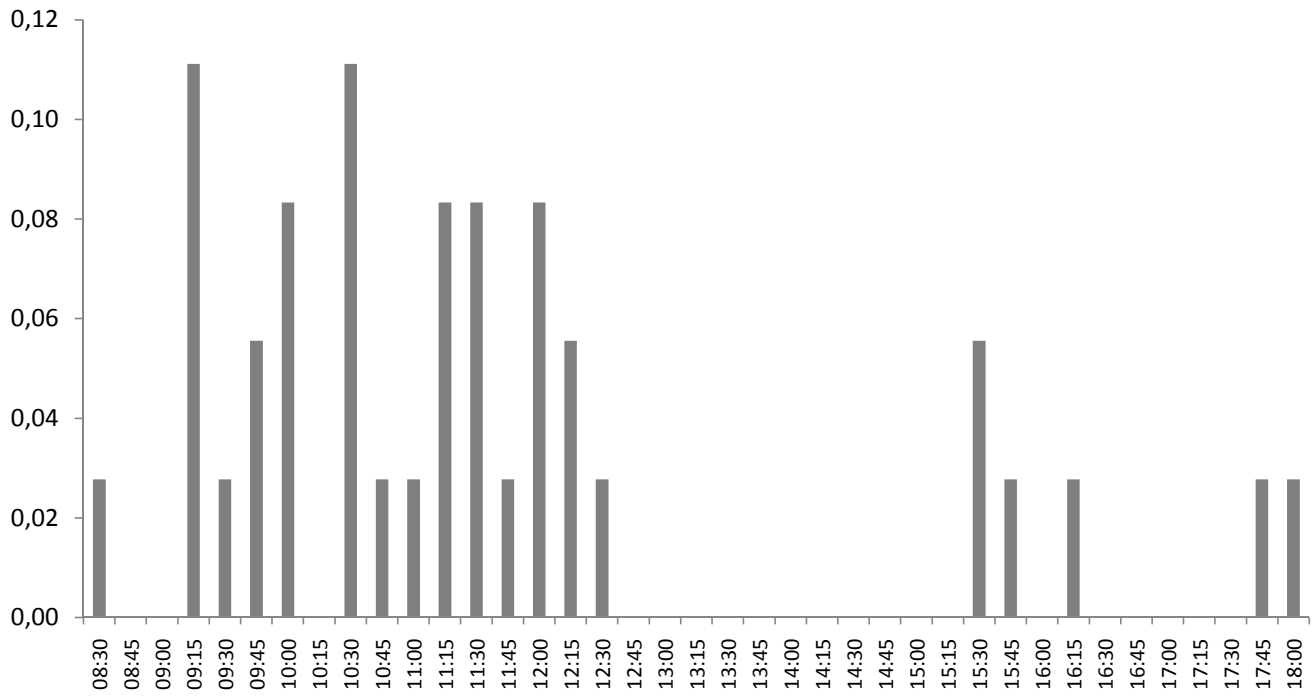

Table 2 - Impact of Swap Operations on BRL/USD Returns

log change in BRL/USD rate

	I	II	III
currency swap auction t+1	0.661**	0.564**	0.569**
	3.36	3.04	3.07
currency swap auction t-1	0.867*	0.832*	0.827*
	2.08	2.01	2.00
currency swap auction t-6	-1.733**	-1.892**	-1.889**
	2.57	2.88	2.87
currency swap auction t-7	-1.958**	-2.012**	-2.017**
	3.07	3.28	3.28
d (VIX)	-	1.028**	0.933**
		9.78	8.03
d (log commodity price index)	-	-0.263 E3**	-0.256 E3**
		13.59	13.49
d (log BRL/USD rate) t-1	-0.221 E3**	-0.237 E3**	-0.235 E3**
	8.74	8.89	8.77
d (log BRL/USD rate) t-2	-0.177 E3**	-0.193 E3**	-0.194 E3**
	2.76	2.94	2.94
d (log BRL/USD rate) t-3	-0.064 E3**	-0.074 E3**	-0.071 E3**
	2.68	2.88	2.76
Constant	Yes	Yes	Yes
Control for current and lagged USD interventions	Yes	Yes	Yes
Lagged macro controls	No	Yes	Yes
Current and lagged news variables	No	No	Yes
Significant news variables (at 5%)			GDP
			US GDP
			US CPI
no. of observations	16,500	16,500	16,500
Adjusted R2	0.0736	0.1144	0.1172
Log-likelihood	82619.6	83004.4	83056.6
F	25.735**	27.986**	17.724**
Durbin-Watson	1.992	1.993	1.992

Note: t-statistics based on HAC standard errors are reported. †, * and ** denote statistical significance at the 10%, 5% and 1% confidence levels, respectively. All coefficients were multiplied by 1,000. The sample covers data from 01/07/2011 to 12/31/2012. Only significant coefficients are displayed (5%).

Table 3 - Estimated Reaction Functions

swap operation announcement dummy

	I	II	III
d (log BRL/USD rate) t-1	0.319*	0.300†	0.296†
	1.99	1.88	1.86
d (log BRL/USD rate) t-3	0.235*	0.201†	0.208†
	2.31	1.88	1.94
Constant	Yes	Yes	Yes
Current and lagged macro controls	No	Yes	Yes
macro controls significant (at 5%)	-	No	No
Hour dummies	No	No	Yes
no. of observations	16,500	16,500	16,500
Adjusted R2	0.0034	0.0041	0.0046
Log-likelihood	30513.2	30519.9	30523.5
F	4.644**	1.815**	1.696**
Durbin-Watson	2.049	2.048	2.049

Note: t-statistics based on HAC standard errors are reported. †, * and ** denote statistical significance at the 10%, 5% and 1% confidence levels, respectively. All coefficients were multiplied by 1,000. The sample covers data from 01/07/2011 to 12/31/2012. Only significant coefficients are displayed (10%).

Table 4 - Impact of Unexpected Swap Operations on BRL/USD Returns

log change in BRL/USD rate

	I	II	III
unexpected currency swap auction t-1	0.859*	0.827*	0.822*
	2.07	2.01	2.00
unexpected currency swap auction t-6	-1.710*	-1.867**	-1.866**
	2.52	2.84	2.83
unexpected currency swap auction t-7	-1.939**	-1.995**	-1.998**
	3.06	3.27	3.26
d (VIX)	-	1.029**	1.033**
		9.79	9.82
d (log commodity price index)	-	-0.263 E3**	-0.261 E3**
		13.58	13.52
d (log BRL/USD rate) t-1	-0.221 E3**	-0.236 E3**	-0.235 E3**
	8.64	8.80	8.68
d (log BRL/USD rate) t-2	-0.176 E3**	-0.192 E3**	-0.193 E3**
	2.76	2.94	2.94
d (log BRL/USD rate) t-3	-0.064 E3**	-0.074 E3**	-0.071 E3**
	2.67	2.86	2.74
Constant	Yes	Yes	Yes
Control for current and lagged USD interventions	Yes	Yes	Yes
Lagged macro controls	No	Yes	Yes
Current and lagged news variables	No	No	Yes
Significant news variables (at 5%)			GDP
			US GDP
			US CPI
no. of observations	16,500	16,500	16,500
Adjusted R2	0.0732	0.1140	0.1168
Log-likelihood	82615.8	83000.9	83053.0
F	25.581**	27.885**	17.662**
Durbin-Watson	1.992	1.993	1.992

Note: t-statistics based on HAC standard errors are reported. †, * and ** denote statistical significance at the 10%, 5% and 1% confidence levels, respectively. All coefficients were multiplied by 1,000. The sample covers data from 01/07/2011 to 12/31/2012. Only significant coefficients are displayed (5%).

Table 5 - Wald Tests

	Model		
	I	II	III
Chi-square	6.245	7.787	7.795
[*p-value*]	[0.0125]	[0.0053]	[0.0052]

H_0: Sum of significant currency swap auction coefficients is zero

Table A1 - Impact of Swap Operations on BRL/USD Returns

log change in BRL/USD rate

	I	II	III
currency swap auction t+1	6.14 E-02**	5.22 E-02**	5.26 E-02**
	3.30	2.94	2.98
currency swap auction t-1	8.39 E-02*	8.02 E-02†	7.97 E-02†
	2.03	1.96	1.95
currency swap auction t-6	-16.7 E-02**	-18.1 E-02**	-18.1 E-02**
	2.60	2.90	2.90
currency swap auction t-7	-18.8 E-02**	-19.3 E-02**	-19.3 E-02**
	3.18	3.38	3.38
d (VIX)	-	1.027**	1.031**
		9.79	9.82
d (log commodity price index)	-	-0.263 E3**	-0.261 E3**
		13.61	13.54
d (log BRL/USD rate) t-1	-0.222 E3**	-0.237 E3**	-0.236 E3**
	8.81	8.96	8.84
d (log BRL/USD rate) t-2	-0.176 E3**	-0.192 E3**	-0.193 E3**
	2.79	2.97	2.97
d (log BRL/USD rate) t-3	-0.064 E3**	-0.073 E3**	-0.070 E3**
	2.71	2.91	2.78
Constant	Yes	Yes	Yes
Control for current and lagged USD interventions	Yes	Yes	Yes
Lagged macro controls	No	Yes	Yes
Current and lagged news variables	No	No	Yes
Significant news variables (at 5%)			GDP
			US GDP
			US CPI
no. of observations	16,500	16,500	16,500
Adjusted R2	0.0751	0.1159	0.1187
Log-likelihood	82633.0	83018.2	83070.6
F	26.283**	28.382**	17.965**
Durbin-Watson	1.992	1.993	1.992

Note: t-statistics based on HAC standard errors are reported. †, * and ** denote statistical significance at the 10%, 5% and 1% confidence levels, respectively. All coefficients were multiplied by 1,000. The sample covers data from 01/07/2011 to 12/31/2012. Only significant coefficients are displayed (5%).

Table A2 - Estimated Reaction Functions

swap operation announcement dummy * (ln (1 + no. of contracts on offer))

	I	II	III
d (log BRL/USD rate) t-1	3.368†	3.145†	3.099†
	1.95	1.82	1.80
d (log BRL/USD rate) t-3	2.572*	2.225†	2.293*
	2.34	1.93	1.98
Constant	Yes	Yes	Yes
Current and Lagged macro controls	No	Yes	Yes
macro controls significant (at 5%)	-	No	No
Hour dummies	No	No	Yes
no. of observations	16,500	16,500	16,500
Adjusted R2	0.0030	0.0022	0.0023
Log-likelihood	-8589.6	-8582.9	-8579.4
F	5.172**	1.983**	1.831**
Durbin-Watson	2.049	2.048	2.050

Note: t-statistics based on HAC standard errors are reported. †, * and ** denote statistical significance at the 10%, 5% and 1% confidence levels, respectively. All coefficients were multiplied by 1,000. The sample covers data from 01/07/2011 to 12/31/2012. Only significant coefficients are displayed (10%).

Table A3 - Impact of Unexpected Swap Operations on BRL/USD Returns

log change in BRL/USD rate

	I	II	III
unexpected currency swap auction t-1	8.33 E-02*	7.97 E-02†	7.93 E-02†
	2.03	1.95	1.95
unexpected currency swap auction t-6	-16.5 E-02**	-17.9 E-02**	-17.9 E-02**
	2.57	2.87	2.85
unexpected currency swap auction t-7	-18.6 E-02**	-19.1 E-02**	-19.2 E-02**
	3.16	3.36	3.36
d (VIX)	-	1.028**	1.032**
		9.79	9.83
d (log commodity price index)	-	-0.263 E3**	-0.261 E3**
		13.61	13.54
d (log BRL/USD rate) t-1	-0.221 E3**	-0.236 E3**	-0.235 E3**
	8.71	8.87	8.75
d (log BRL/USD rate) t-2	-0.176 E3**	-0.192 E3**	-0.193 E3**
	2.80	2.97	2.98
d (log BRL/USD rate) t-3	-0.064 E3**	-0.074 E3**	-0.070 E3**
	2.69	2.89	2.77
Constant	Yes	Yes	Yes
Control for current and lagged USD interventions	Yes	Yes	Yes
Lagged macro controls	No	Yes	Yes
Current and lagged news variables	No	No	Yes
Significant news variables (at 5%)			GDP
			US GDP
			US CPI
no. of observations	16,500	16,500	16,500
Adjusted R2	0.0746	0.1155	0.1183
Log-likelihood	82629.2	83014.7	83066.9
F	26.127**	28.279**	17.901**
Durbin-Watson	1.992	1.993	1.993

Note: t-statistics based on HAC standard errors are reported. †, * and ** denote statistical significance at the 10%, 5% and 1% confidence levels, respectively. All coefficients were multiplied by 1,000. The sample covers data from 01/07/2011 to 12/31/2012. Only significant coefficients are displayed (5%).

Table A4 - Wald Tests

	Model		
	I	II	III
Chi-square	6.437	7.901	7.911
[*p-value*]	[0.0112]	[0.0049]	[0.0049]

H_0: Sum of significant currency swap auction coefficients is zero

DETAILED Table 2 - Impact of Swap Operations on BRL/USD Returns

log change in BRL/USD rate

	I	II	III
currency swap auction t+12	0.364	0.404†	0.404†
	1.47	1.72	1.71
currency swap auction t+11	0.590	0.642	0.642
	0.89	0.96	0.96
currency swap auction t+10	0.346	0.431	0.430
	0.75	0.95	0.94
currency swap auction t+9	-0.124	0.005	-0.004
	0.29	0.02	0.01
currency swap auction t+8	0.062	0.018	0.019
	0.13	0.04	0.04
currency swap auction t+7	0.352	0.308	0.306
	0.97	0.84	0.84
currency swap auction t+6	2.840	2.777	2.774
	1.10	1.07	1.07
currency swap auction t+5	1.093†	1.099†	1.095†
	1.87	1.79	1.79
currency swap auction t+4	-0.971	-1.027†	-1.030†
	1.51	1.68	1.69
currency swap auction t+3	0.246	0.207	0.206
	1.04	0.83	0.84
currency swap auction t+2	0.234	0.101	0.099
	0.75	0.33	0.32
currency swap auction t+1	**0.661****	**0.564****	**0.569****
	3.36	**3.04**	**3.07**
currency swap auction t	2.049	2.064	2.064
	1.37	1.40	1.39
currency swap auction t-1	**0.867***	**0.832***	**0.827***
	2.08	**2.01**	**2.00**
currency swap auction t-2	-0.984	-0.982	-0.983
	0.80	0.79	0.79
currency swap auction t-3	0.263	0.102	0.098
	0.65	0.27	0.26
currency swap auction t-4	2.166	2.129	2.125
	1.17	1.19	1.19
currency swap auction t-5	0.479	0.464	0.466
	0.70	0.69	0.69
currency swap auction t-6	**-1.733****	**-1.892****	**-1.889****
	2.57	**2.88**	**2.87**
currency swap auction t-7	**-1.958****	**-2.012****	**-2.017****
	3.07	**3.28**	**3.28**
currency swap auction t-8	-0.393	-0.467	-0.468
	1.34	1.48	1.48
currency swap auction t-9	-0.589	-0.601	-0.597
	1.33	1.46	1.45
currency swap auction t-10	-0.028	0.006	0.011
	0.11	0.27	0.04
currency swap auction t-11	-0.064	-0.164	-0.164
	0.23	0.64	0.64
currency swap auction t-12	-0.914	-0.904†	-0.903†
	1.55	1.77	1.76
d (VIX)	-	1.028**	0.933**
		9.78	8.03
d (log commodity price index)	-	-0.263 E3**	-0.256 E3**
		13.59	13.49
d (log BRL/USD rate) t-1	-0.221 E3**	-0.237 E3**	-0.235 E3**
	8.74	8.89	8.77
d (log BRL/USD rate) t-2	-0.177 E3**	-0.193 E3**	-0.194 E3**
	2.76	2.94	2.94
d (log BRL/USD rate) t-3	-0.064 E3**	-0.074 E3**	-0.071 E3**
	2.68	2.88	2.76
Constant	Yes	Yes	Yes
Control for current and lagged USD interventions	Yes	Yes	Yes
Lagged macro controls	No	Yes	Yes
Current and lagged news variables	No	No	Yes
Significant news variables (at 5%)			GDP
			US GDP
			US CPI
no. of observations	16,500	16,500	16,500
Adjusted R2	0.0736	0.1144	0.1172
Log-likelihood	82619.6	83004.4	83056.6
F	25.735**	27.986**	17.724**
Durbin-Watson	1.992	1.993	1.992

Note: t-statistics based on HAC standard errors are reported. †, * and ** denote statistical significance at the 10%, 5% and 1% confidence levels, respectively. All coefficients were multiplied by 1,000. The sample covers data from 01/07/2011 to 12/31/2012.

DETAILED Table 3 - Estimated Reaction Functions

swap operation announcement dummy

	I	II	III
d (log BRL/USD rate) t-1	0.319*	0.300†	0.296†
	1.99	1.88	1.86
d (log BRL/USD rate) t-2	0.209	0.145	0.147
	0.90	0.64	0.64
d (log BRL/USD rate) t-3	0.235*	0.201†	0.208†
	2.31	1.88	1.94
d (log BRL/USD rate) t-4	-0.408	-0.467	-0.460
	1.36	1.51	1.50
d (log BRL/USD rate) t-5	0.386	0.392	0.398
	1.54	1.46	1.47
d (log BRL/USD rate) t-6	1.082	1.102	1.107
	1.09	1.06	1.06
d (log BRL/USD rate) t-7	0.390	0.396	0.403
	1.13	1.06	1.07
d (log BRL/USD rate) t-8	0.182	0.187	0.191
	0.78	0.73	0.74
d (log BRL/USD rate) t-9	0.114	0.151	0.153
	0.68	0.89	0.91
d (log BRL/USD rate) t-10	0.231	0.226	0.230
	1.21	1.14	1.15
d (log BRL/USD rate) t-11	0.180	0.184	0.184
	0.80	0.79	0.79
d (log BRL/USD rate) t-12	-0.010	-0.026	-0.026
	0.08	0.19	0.19
Constant	Yes	Yes	Yes
Current and lagged macro controls	No	Yes	Yes
macro controls significant (at 5%)	-	No	No
Hour dummies	No	No	Yes
no. of observations	16,500	16,500	16,500
Adjusted R2	0.0034	0.0041	0.0046
Log-likelihood	30513.2	30519.9	30523.5
F	4.644**	1.815**	1.696**
Durbin-Watson	2.049	2.048	2.049

Note: t-statistics based on HAC standard errors are reported. †, * and ** denote statistical significance at the 10%, 5% and 1% confidence levels, respectively. All coefficients were multiplied by 1,000. The sample covers data from 01/07/2011 to 12/31/2012.

DETAILED Table 4 - Impact of Unexpected Swap Operations on BRL/USD Returns

log change in BRL/USD rate

	I	II	III
unexpected currency swap auction t+12	0.361	0.400†	0.400†
	1.46	1.70	1.69
unexpected currency swap auction t+11	0.584	0.635	0.635
	0.88	0.95	0.95
unexpected currency swap auction t+10	0.353	0.436	0.433
	0.77	0.96	0.95
unexpected currency swap auction t+9	-0.089	0.037	0.037
	0.21	0.10	0.10
unexpected currency swap auction t+8	0.060	0.015	0.014
	0.12	0.03	0.03
unexpected currency swap auction t+7	0.306	0.259	0.259
	0.87	0.73	0.73
unexpected currency swap auction t+6	2.829	2.765	2.761
	1.09	1.07	1.06
unexpected currency swap auction t+5	1.125†	1.131†	1.128†
	1.89	1.81	1.81
unexpected currency swap auction t+4	-0.878	-0.932	-0.938
	1.37	1.53	1.53
unexpected currency swap auction t+3	-0.088	-0.108	-0.107
	0.36	0.42	0.42
unexpected currency swap auction t+2	0.347	0.216	0.213
	1.12	0.71	0.70
unexpected currency swap auction t+1	0.129	0.055	0.063
	0.53	0.24	0.27
unexpected currency swap auction t	2.050	2.065	2.065
	1.37	1.39	1.39
unexpected currency swap auction t-1	**0.859***	**0.827***	**0.822***
	2.07	**2.01**	**2.00**
unexpected currency swap auction t-2	-0.985	-0.982	-0.984
	0.80	0.79	0.79
unexpected currency swap auction t-3	0.231	0.072	0.071
	0.56	0.18	0.18
unexpected currency swap auction t-4	2.149	2.113	2.107
	1.17	1.19	1.18
unexpected currency swap auction t-5	0.481	0.463	0.467
	0.70	0.69	0.69
unexpected currency swap auction t-6	**-1.710***	**-1.867****	**-1.866****
	2.52	**2.84**	**2.83**
unexpected currency swap auction t-7	**-1.939****	**-1.995****	**-1.998****
	3.06	**3.27**	**3.26**
unexpected currency swap auction t-8	-0.346	-0.417	-0.418
	1.18	1.32	1.33
unexpected currency swap auction t-9	-0.622	-0.632	-0.627
	1.36	1.48	1.47
unexpected currency swap auction t-10	-0.028	0.007	0.012
	0.11	0.03	0.05
unexpected currency swap auction t-11	-0.062	-0.160	-0.160
	0.22	0.63	0.63
unexpected currency swap auction t-12	-0.880	-0.873†	-0.872†
	1.50	1.71	1.71
d (VIX)	-	1.029**	1.033**
		9.79	9.82
d (log commodity price index)	-	-0.263 E3**	-0.261 E3**
		13.58	13.52
d (log BRL/USD rate) t-1	-0.221 E3**	-0.236 E3**	-0.235 E3**
	8.64	8.80	8.68
d (log BRL/USD rate) t-2	-0.176 E3**	-0.192 E3**	-0.193 E3**
	2.76	2.94	2.94
d (log BRL/USD rate) t-3	-0.064 E3**	-0.074 E3**	-0.071 E3**
	2.67	2.86	2.74
Constant	Yes	Yes	Yes
Control for current and lagged USD interventions	Yes	Yes	Yes
Lagged macro controls	No	Yes	Yes
Current and lagged news variables	No	No	Yes
Significant news variables (at 5%)			GDP
			US GDP
			US CPI
no. of observations	16,500	16,500	16,500
Adjusted R2	0.0732	0.1140	0.1168
Log-likelihood	82615.8	83000.9	83053.0
F	25.581**	27.885**	17.662**
Durbin-Watson	1.992	1.993	1.992

Note: t-statistics based on HAC standard errors are reported. †, * and ** denote statistical significance at the 10%, 5% and 1% confidence levels, respectively. All coefficients were multiplied by 1,000. The sample covers data from 01/07/2011 to 12/31/2012.

DETAILED Table A1 - Impact of Swap Operations on BRL/USD Returns

log change in BRL/USD rate

	I	II	III
currency swap auction t+12	3.34 E-02	3.85 E-02†	3.85 E-02†
	1.43	1.65	1.65
currency swap auction t+11	5.19 E-02	5.78 E-02	5.77 E-02
	0.86	0.94	0.94
currency swap auction t+10	2.73 E-02	3.58 E-02	3.56 E-02
	0.63	0.84	0.84
currency swap auction t+9	-1.54 E-02	-2.73 E-02	-2.81 E-02
	0.37	0.07	0.08
currency swap auction t+8	5.02 E-02	0.06 E-02	0.07 E-02
	0.11	0.02	0.02
currency swap auction t+7	3.46 E-02	2.96 E-02	2.95 E-02
	0.99	0.84	0.83
currency swap auction t+6	28.6 E-02	28.0 E-02	28.0 E-02
	1.10	1.08	1.08
currency swap auction t+5	10.4 E-02†	10.5 E-02†	10.4 E-02†
	1.82	1.74	1.73
currency swap auction t+4	-9.03 E-02	-9.55 E-02†	-9.58 E-02†
	1.53	1.71	1.71
currency swap auction t+3	2.41 E-02	2.07 E-02	2.06 E-02
	1.08	0.88	0.88
currency swap auction t+2	2.27 E-02	0.99 E-02	0.98 E-02
	0.75	0.33	0.33
currency swap auction t+1	**6.14 E-02****	**5.22 E-02****	**5.26 E-02****
	3.30	**2.94**	**2.98**
currency swap auction t	20.5 E-02	20.7 E-02	20.7 E-02
	1.37	1.39	1.39
currency swap auction t-1	**8.39 E-02***	8.02 E-02†	7.97 E-02†
	2.03	1.96	1.95
currency swap auction t-2	-10.4 E-02	-10.4 E-02	-10.4 E-02
	0.84	0.83	0.83
currency swap auction t-3	2.28 E-02	0.75 E-02	0.71 E-02
	0.58	0.20	0.19
currency swap auction t-4	21.6 E-02	21.3 E-02	21.2 E-02
	1.17	1.19	1.18
currency swap auction t-5	4.91 E-02	4.83 E-02	4.85 E-02
	0.71	0.72	0.72
currency swap auction t-6	**-16.7 E-02****	**-18.1 E-02****	**-18.1 E-02****
	2.60	**2.90**	**2.90**
currency swap auction t-7	**-18.8 E-02****	**-19.3 E-02****	**-19.3 E-02****
	3.18	**3.38**	**3.38**
currency swap auction t-8	-3.73 E-02	-4.40 E-02†	-4.40 E-02
	1.33	1.46	1.47
currency swap auction t-9	-5.81 E-02	-5.90 E-02	-5.86 E-02
	1.37	1.50	1.49
currency swap auction t-10	-0.395 E-02	-0.112 E-02	-0.06 E-02
	0.17	0.05	0.03
currency swap auction t-11	-0.579 E-02	-1.57 E-02	-1.57 E-03
	0.22	0.66	0.66
currency swap auction t-12	-8.96 E-02	-8.82 E-02†	-8.81 E-02†
	1.51	1.73	1.72
d (VIX)	-	1.027**	1.031**
		9.79	9.82
d (log commodity price index)	-	-0.263 E3**	-0.261 E3**
		13.61	13.54
d (log BRL/USD rate) t-1	-0.222 E3**	-0.237 E3**	-0.236 E3**
	8.81	8.96	8.84
d (log BRL/USD rate) t-2	-0.176 E3**	-0.192 E3**	-0.193 E3**
	2.79	2.97	2.97
d (log BRL/USD rate) t-3	-0.064 E3**	-0.073 E3**	-0.070 E3**
	2.71	2.91	2.78
Constant	Yes	Yes	Yes
Control for current and lagged USD interventions	Yes	Yes	Yes
Lagged macro controls	No	Yes	Yes
Current and lagged news variables	No	No	Yes
Significant news variables (at 5%)			GDP
			US GDP
			US CPI
no. of observations	16,500	16,500	16,500
Adjusted R2	0.0751	0.1159	0.1187
Log-likelihood	82633.0	83018.2	83070.6
F	26.283**	28.382**	17.965**
Durbin-Watson	1.992	1.993	1.992

Note: t-statistics based on HAC standard errors are reported. †, * and ** denote statistical significance at the 10%, 5% and 1% confidence levels, respectively. All coefficients were multiplied by 1,000. The sample covers data from 01/07/2011 to 12/31/2012.

DETAILED Table A2 - Estimated Reaction Functions

swap operation announcement dummy * (ln (1 + no. of contracts on offer))

	I	II	III
d (log BRL/USD rate) t-1	3.368†	3.145†	3.099†
	1.95	1.82	1.80
d (log BRL/USD rate) t-2	2.246	1.537	1.551
	0.86	0.60	0.60
d (log BRL/USD rate) t-3	2.572*	2.225†	2.293*
	2.34	1.93	1.98
d (log BRL/USD rate) t-4	-4.355	-4.972	-4.907
	1.39	1.55	1.53
d (log BRL/USD rate) t-5	4.303	4.376	4.436
	1.52	1.43	1.44
d (log BRL/USD rate) t-6	12.568	12.837	12.886
	1.08	1.06	1.06
d (log BRL/USD rate) t-7	4.493	4.559	4.635
	1.13	1.05	1.06
d (log BRL/USD rate) t-8	2.050	2.110	2.155
	0.78	0.73	0.74
d (log BRL/USD rate) t-9	1.194	1.590	1.617
	0.63	0.84	0.86
d (log BRL/USD rate) t-10	2.387	2.328	2.368
	1.17	1.09	1.11
d (log BRL/USD rate) t-11	1.698	1.747	1.745
	0.73	0.71	0.71
d (log BRL/USD rate) t-12	-0.256	-0.407	-0.398
	0.18	0.27	0.26
Constant	Yes	Yes	Yes
Current and Lagged macro controls	No	Yes	Yes
macro controls significant (at 5%)	-	No	No
Hour dummies	No	No	Yes
no. of observations	16,500	16,500	16,500
Adjusted R2	0.0030	0.0022	0.0023
Log-likelihood	-8589.6	-8582.9	-8579.4
F	5.172**	1.983**	1.831**
Durbin-Watson	2.049	2.048	2.050

Note: t-statistics based on HAC standard errors are reported. †, * and ** denote statistical significance at the 10%, 5% and 1% confidence levels, respectively. All coefficients were multiplied by 1,000. The sample covers data from 01/07/2011 to 12/31/2012.

DETAILED Table A3 - Impact of Unexpected Swap Operations on BRL/USD Re

log change in BRL/USD rate

	I	II	III
unexpected currency swap auction t+12	3.31 E-02	3.81 E-02	3.81 E-02
	1.42	1.63	1.63
unexpected currency swap auction t+11	5.15 E-02	5.73 E-02	5.73 E-02
	0.85	0.93	0.94
unexpected currency swap auction t+10	2.79 E-02	3.62 E-02	3.60 E-02
	0.64	0.86	0.85
unexpected currency swap auction t+9	-1.24 E-02	0.02 E-02	0.01 E-02
	0.30	0.00	0.00
unexpected currency swap auction t+8	0.48 E-02	0.03 E-02	0.02 E-02
	0.11	0.01	0.01
unexpected currency swap auction t+7	3.03 E-02	2.51 E-02	2.51 E-02
	0.89	0.73	0.73
unexpected currency swap auction t+6	28.5 E-02	27.9 E-02	27.9 E-02
	1.10	1.08	1.07
unexpected currency swap auction t+5	10.7 E-02†	10.8 E-02†	10.8 E-02†
	1.84	1.76	1.76
unexpected currency swap auction t+4	-8.13 E-02	-8.64 E-02	-8.69 E-02
	1.38	1.54	1.55
unexpected currency swap auction t+3	-0.81 E-02	-0.97 E-02	-0.96 E-02
	0.34	0.40	0.39
unexpected currency swap auction t+2	3.31 E-02	2.05 E-02	2.02 E-02
	1.10	0.70	0.69
unexpected currency swap auction t+1	1.25 E-02	0.54 E-02	0.62 E-02
	0.55	0.25	0.28
unexpected currency swap auction t	20.6 E-02	20.7 E-02	20.7 E-02
	1.37	1.40	1.39
unexpected currency swap auction t-1	**8.33 E-02***	7.97 E-02†	7.93 E-02†
	2.03	1.95	1.95
unexpected currency swap auction t-2	-10.4 E-02	-10.4 E-02	-10.4 E-02
	0.84	0.83	0.83
unexpected currency swap auction t-3	1.97 E-02	0.47 E-02	0.45 E-02
	0.48	0.12	0.11
unexpected currency swap auction t-4	21.4 E-02	21.1 E-02	21.1 E-02
	1.16	1.18	1.18
unexpected currency swap auction t-5	4.94 E-02	4.84 E-02	4.88 E-02
	0.71	0.72	0.72
unexpected currency swap auction t-6	**-16.5 E-02****	**-17.9 E-02****	**-17.9 E-02****
	2.57	**2.87**	**2.85**
unexpected currency swap auction t-7	**-18.6 E-02****	**-19.1 E-02****	**-19.2 E-02****
	3.16	**3.36**	**3.36**
unexpected currency swap auction t-8	-3.31 E-02	-3.94 E-02	-3.95 E-02
	1.19	1.32	1.32
unexpected currency swap auction t-9	-6.11 E-02	-6.19 E-02	-6.14 E-02
	1.40	1.53	1.51
unexpected currency swap auction t-10	-0.39 E-02	-0.09 E-02	-0.05 E-02
	0.17	0.04	0.02
unexpected currency swap auction t-11	-0.56 E-02	-1.53 E-02	-1.53 E-02
	0.22	0.64	0.64
unexpected currency swap auction t-12	-8.64 E-02	-8.53 E-02†	-8.52 E-02†
	1.47	1.68	1.67
d (VIX)	-	1.028**	1.032**
		9.79	9.83
d (log commodity price index)	-	-0.263 E3**	-0.261 E3**
		13.61	13.54
d (log BRL/USD rate) t-1	-0.221 E3**	-0.236 E3**	-0.235 E3**
	8.71	8.87	8.75
d (log BRL/USD rate) t-2	-0.176 E3**	-0.192 E3**	-0.193 E3**
	2.80	2.97	2.98
d (log BRL/USD rate) t-3	-0.064 E3**	-0.074 E3**	-0.070 E3**
	2.69	2.89	2.77
Constant	Yes	Yes	Yes
Control for current and lagged USD interventions	Yes	Yes	Yes
Lagged macro controls	No	Yes	Yes
Current and lagged news variables	No	No	Yes
Significant news variables (at 5%)			GDP
			US GDP
			US CPI
no. of observations	16,500	16,500	16,500
Adjusted R2	0.0746	0.1155	0.1183
Log-likelihood	82629.2	83014.7	83066.9
F	26.127**	28.279**	17.901**
Durbin-Watson	1.992	1.993	1.993

Note: t-statistics based on HAC standard errors are reported. †, * and ** denote statistical significance at the 10%, 5% and 1% confidence levels, respectively. All coefficients were multiplied by 1,000. The sample covers data from 01/07/2011 to 12/31/2012.

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