TEXTO PARA DISCUSSÃO

No. 623

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Abstract:

The estimation of the impact of macroeconomic announcements in the Brazilian futures markets is used to uncover the relationship between macroeconomic fundamentals and asset prices. Using intraday data from October 2008 to January 2011, we find that external macroeconomic announcements dominate price changes in the Foreign Exchange and Ibovespa futures markets, while the impact of the domestic ones is mainly restricted to Interest Rate futures contracts. We additionally propose an investment strategy based on the conditional price reaction of each market that showed promising results in an out-of-sample study, where we are able to correctly identify returns' signals, conditional on the surprise's signal, in approximately 70% of the cases. Finally, we provide evidence that price reactions are conditional on the state of the economy and document the impact on volume and bid-ask spreads.

Key Words: high frequency data, macroeconomic announcements, financial markets, investment strategy, futures markets, Brazil.

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We thank Marcelo Fernandes, Alan De Genaro, Marco Cavalcanti and Tiago Berriel for much helpful comments.

1. Introduction

The study of the behavior of asset returns is central for financial economists and a wide range of applications benefit from such interest, including risk management, market efficiency and asset pricing. It is far from clear how markets arrive at prices and, more specifically, how they incorporate news related to the state of the economy. In this sense, we want to shed light on the controversy over the relationship between macroeconomic fundamentals and asset price formation by estimating the impact of economic announcements in the Brazilian futures market. Previous studies have found it difficult to measure such effects, not only due to identification issues but also to data quality. The event study literature combined with the availability of intraday data offers a suitable approach to identify exogenous shocks, overcoming some difficulties inherent to the literature. Conversely, it brings econometric issues related to transaction microstructure that needs to be addressed.

We contribute to the existent literature by incorporating liquidity (trading volume) and informational (bid-ask spread) variables as opposed to the prevailing focus on prices and returns. We believe that market participants will benefit from a broader outlook of time periods surrounding macroeconomic announcements as there are a number of reasons why we should give importance to evaluate its impact on the financial market. At first place, it provides information on the timing of market interventions. We will investigate, for instance, return and liquidity parameters for different assets traded at the futures markets nearby an interest decision from the Federal Committee of Open Market (FOMC). The Central Bank of Brazil (CBB), as a regular participant in the market, could benefit from this valuable information in the process of deciding whether or not intervene in such instances. Since investors form expectations prior to scheduled

announcements, understanding the overall market reaction may help them rebalance portfolios after its release. Also, investors take into account broad market conditions in their decision to operate, not only prices. Informed agents, for instance, may prefer conditions that favor anonymity in order to hide its private information. In such a case, anticipating situations of decreasing or increasing volumes may support the choice for post-announcement operations.

In a highly integrated and electronic-based market, events that convey price information should be readily incorporated into prices. This is especially true in such a liquid market as the Brazilian futures one, where the presence of High Frequency Trading (HFT) is widely acknowledged. With that in mind, we compute the aggregate announcement effect by summing up the coefficient estimates of the regression analysis over progressive larger time windows. This procedure enables us to offer different dimensions on market´s reaction. For instance, we give an indication of how fast markets react to each announcement type, enabling us to discuss its relative efficiency. Persistence is another parameter to look carefully, since some news may impose only transitory effects on prices. But to what extent does it translate into movements in the financial market? Our third metric, the impact intensity on each market, should answer this question. Combined, they give support to investment strategies definition, an additional motivation for this work.

Finally, the event study literature concentrated its efforts in understanding market reactions and co-movements in central economies. In this sense, it will be particularly interesting to compare the results applied to an emerging market, in particular the Brazilian one, in which external factors supposedly exert great influence on the development path of the domestic economy. Andritzky et al (2007, 2011), for instance,

already studied first and second order effects of macroeconomic announcements for the most liquid emerging market bonds. Note, however, that both studies were restricted to the sovereign bond market as opposed to our study that focuses on the main domestic markets of an emerging country. Also, quite uniquely in the international arena, Brazilian futures markets are the most liquid ones, both for interest rates and for exchanges rates. Therefore, this study concentrates on the markets where price discovery is most likely to take place.

The transactions' data is provided by BM&FBovespa (BVMF), the Brazilian company responsible for clearing and trading futures and equity market transactions. The sample period starts at October 2008 until January 2011, totaling 513 days, and contains tick-by-tick information from the interest rate (IR), foreign exchange (FX) and stock index (Ibovespa) futures markets on prices, volume and bid and ask offers as well. In addition, we construct an announcement database with the surprise component of six economic indicators. The domestic announcements are the interest rate decision made by the monetary policy committee (COPOM), the monthly industrial sector production (PIM) and the consumer inflation (IPCA) while their external counterparts, all of them originated in the US, are the FOMC interest rate decision[2], non-farm payroll indicator (PR) and the consumer price one (CPI).

The main findings are as follows. First, our study provides evidence of the link between economic fundamentals and asset prices. We find that external macroeconomic announcements dominate price changes in the FX and Ibovespa futures markets where reactions are, in general, immediate and persistent relative to monetary (FOMC) and real economy (PR) surprises. We also conclude that the IR market is affected by events

[2] We also included Quantitative Easing (QE) announcements.

that potentially affect its monetary rule, based on the inflation targeting approach. This is the reason why the impact of announcements in the IR market is less intense and restricted to domestic events. State dependency, in turn, can interfere in the relative magnitude of the coefficients that measure the impact of announcements, occasionally cancelling out predicted impacts as shown by the estimates for the IPCA announcement.

In the IR market, we find an excess return of -0.107 p.p. in response to a 25 basis points' COPOM surprise and 0.041 p.p. in response to a 0.10 p.p. IPCA surprise. Both impacts are persistent only up to ten minutes after each release and holds in the expansion period. In the FX and Ibovespa futures markets, two features emerge. First, we conclude that the impact of each announcement, when significant, is more persistent, eventually reaching twenty minutes after its public release. Also, we find evidence that external events dominate both markets. Take the example of the FX market, where external monetary policy is the main factor driving returns where a 25 basis points' FOMC surprise raises FX returns in 0.191 p.p. and 0.089 p.p. in the full sample and expansion period, respectively, twenty minutes after its release. Ibovespa futures' analysis reveal an additional and important feature, related to the link between fundamentals and asset prices: reactions are more persistent and spread among all announcements, except for inflation-related ones. A COPOM surprise, for instance, amounting to 25 p.b., raise Ibovespa futures returns by 0.094 p.p. in the expansion period estimates, twenty minutes after its release. Also, a US monetary policy easing is related to positive stock returns in Brazil. Instead, non-farm payroll records are positively associated with domestic stock index returns suggesting that the dividend effect is higher than the cost of capital one and also that real economy shocks are correlated between Brazilian and US economies.

Actually, an investment strategy based on the conditional price reaction of each market showed promising results in an out-of-sample study. Under this approach, investors decide its trading position depending on the combination between sign impact and surprise direction. It presents promising results in an out-of-sample study since we are able to correctly identify returns' signals, conditional on the surprise's signal, in 70% of the cases. Besides, aggregate results show positive returns for all markets.

Finally, we assess trading volume impact and conclude that, contrary to price reaction, they are widespread among all announcements and business cycles. We also document large differences in the relative magnitude of trading volume reactions that theory attributes to each announcement's precision. The significant reaction from the IR market with respect to COPOM announcements and from FX and Ibovespa markets relative to FOMC and PR ones is an indication of differential levels of informational content. We find that bid-ask spreads often revert in face of external announcements what can be attributed to different trading phases.

In Section 2, we briefly present the main references on this subject, focusing on the recent developments in event studies. Section 3 explore the database and give details of its construction. Next, we present the methodology used in the paper, which will be based on the work of Andersen et al (2007) and discuss the results in Section 5 with an application to the real data. Finally, our concluding remarks are offered in Section 6.

2. Related work

The link between economic fundamentals and asset prices has been extensively studied in the financial economic literature. When working with daily data, the biggest issue is to identify structural shocks. An identification strategy based on the data heteroskedasticity is proposed by Ehrmann et al (2011) in a daily frequency study. The authors defined different variance regimes and assumed that some parameters were stable across them. Besides, some signal restrictions were employed to guarantee identification. This framework was used to identify the degree and direction of financial transmission between Euro area and the United Stated in the bond, stocks and exchange rate markets. The authors found that, although the causality runs in both directions, the US market had a higher impact. A similar approach has been applied by Rigobon & Sack (2003) in their study on the contemporaneous impact of stock and bond markets.

The use of high frequency data makes it possible to identify a structural shock by focusing on specific situations when a prevailing force moves the financial market. In the high frequency event study literature, the central hypothesis is that announcements have price relevant information that is quickly incorporated to prices through trading.

The high frequency association between returns and fundamentals has been acknowledged by Fleming & Remonela (1997). Using data from August 1993 to August 1994, the authors documented that the 25 largest price moves and trading surges in the US bond market were related to macroeconomic announcements. Fair (2003) also took advantage of the availability of intraday data and identified abnormal returns on the US stock market from 1982 to 1999. Such returns were, then, associated with economic news released at exactly the same time. Moreover, the author corroborated that each

market was moving according to what is expected from theory, depending on the announcement type studied.

On the same agenda, Faust et al (2007) evaluated the effect of macroeconomic announcements on the bond and exchange rate markets. Contrary to Fair (2003), the authors made a regression-type analysis where the dependent variable was the return on a 20-min window around each announcement and the independent one was its surprise component. In general, the authors found that stronger-than-expected releases[3] for real and nominal activity cause dollar appreciation and raise U.S. rates at all horizons.

Also based on a high frequency event-study analysis, Andersen et al (2003) proposed an alternative structure on the construction of the database of returns which will be explored more deeply in Sections 3 and 4. In short, each 5-min return is kept as a separate observation around a 100-minute window around announcements. The explanatory variable is the surprise component of each announcement that is put in place in synchrony with the exact time of its release. Using 5-min returns from January 1992 to December 1998, the authors analyzed the impact of macroeconomic announcements on the relationship between the dollar and major currencies (German Mark, Japanese Yen, British Pound, Swiss Franc and Euro), finding that that bad news has greater impact than good ones, the so-called asymmetric effect. Departing from the same framework, Andersen et al (2007) concluded for the existence of a state-dependent link from economic fundamentals to the bond, exchange and stock market in US, German and British markets. The authors also found that systematic effects are usually short-lived and restricted to the first 5-min interval.

[3] . Inflation surprises (CPI and PPI) were not significant to exchange rate returns at the 1% level.

Recent high frequency studies provided additional evidence of the link between economic fundamental and asset prices in different markets and sample periods. Using 5-min returns from September 2000 to September 2008, Hussain (2011) documented the significant influence of domestic monetary policy on the return and volatility of US and four European stocks (Germany, France, Switzerland and UK). Lapp & Pearce (2012), in turn, found that greater than expected inflation and employment rise futures bond prices. Beechey & Wright (2009) also confirmed the highly significant and immediate impact of macroeconomic announcements on long term US bonds and inflation-nominated ones between February 2004 and June 2008.

Rosa (2011) made the important distinction between policy decisions and statements in their study on the relationship between the US FX market and monetary announcements. Estimation results showed that both types of monetary announcements have economically large and highly significant effects on the FX market. Contrary to Andersen et al (2007), though, it shows that the impact of FOMC surprises takes more time to be absorbed, lasting between 30 and 40 minutes. Conrad & Lamla (2010) created communication indicators to deal with the issue of interpreting monetary statements in their analysis of first and second order effects of the European Central Bank (ECB) communications in the EUR-USD exchange rate. Due to the long memory property of the volatility, the option for a FIGARCH approach provided a good fit. The communication indicators were, then, used as explanatory variables in the FIGARCH model, providing the main conclusion of the article that price and risk paths are affected by monetary communications.

Melvin & Ahn (2007) adopted a different strategy for the estimation of the impact of FOMC days on the German Mark and Dollar between 1994 and 1995. Using 5-min

returns, the authors identified regime switches around ten FOMC meetings and associated them with informed or liquidity trading. They concluded that the switch to informed trading occurs during the meeting, suggesting an earlier adjustment of positions prior to its end.

3. Database construction

The futures market in Brazil is concentrated at BVMF, the company that manages the domestic derivatives transactions. We collected data from specific interest rate, stock index and exchange futures contracts from 1st October 2008 until 31st January 2011, or 513 days[4]. As any intraday database, it contains price, volume, quantity, date and time for every operation (closed deals, bid and ask offers).

Before getting into the details of the database construction, it is important to discuss the reason why did we opt for the futures market instead of the spot one. When it comes to interest rates, the secondary spot market is highly illiquid and does not provide a good price reference. When the Central Bank of Brazil performs auctions on federal bonds, for instance, the decision on which offers to accept are based on the nearest to maturity futures contract. The spot FX market, in turn, is approximately nine times smaller than the futures one since many operations that should be done in the spot market are performed in the futures market due to regulatory restrictions. Finally, at the sample period, BVMF released a product[5] whose reference is the Brazilian stock index, Ibovespa. However, its liquidity cannot be compared to that of Ibovespa futures contracts.

[4] There are 64 random missing days in our data.

[5] PIBB is an Exchange Traded Fund (ETF) that references Ibovespa and can be traded as a stock at BVMF.

3.1. Returns, trading volumes and spreads

In each market, there are contracts with different maturities traded at the same day. In the FX market, in particular, expiration date is in the first business day of the contract month. The shorter term ones, expiring in the subsequent month, are always the most liquid ones, concentrating approximately 90% of the FX trading volume. Two days before expiring, traders move to following contract month and the final database was selected by switching contracts according to liquidity. Ibovespa futures[6] market are similar to FX ones, where short term contracts concentrate most of the trading volume and, every two months, there is a switch to the nearest to maturity contract two days before expiring.

Although liquidity remained a choice criterion, the fact that the IR futures market works in a different way brings an additional element to its database construction. In a given trading day, there is a wider range of IR contract maturities with high trading volume, including medium and long term contracts. This feature implies a tradeoff between liquidity and risk premium since we must minimize large differences in risk premium as we switch between contracts. Given that that January contracts are the most traded ones, between October 2008 and December 2008, the selected contract is the one expiring in January 2010. In 2009 and 2010, the selected ones expired in January 2011 and January 2012, respectively. Finally, in January 2011, January 2013 contract has been the selected one. Such procedure leads to time to maturity contracts that share a medium term range, between one and two years ahead of the trading day. Since expiration dates

[6] BVMF codes have six digits. The first three identify the contract ("IND", for Ibovespa futures, "DOL", for exchange rate ones and "DI1" for interest rates). The final three digits identify month and year of contract maturity.

are fixed in the IR futures market, differences in time to maturity could be minimized if we expanded the range of contracts used. However, such decision would imply a change in the sampling frequency for all markets, since only January contracts present regular trades compatible with sampling each five minutes.

In terms of number of contracts, IR futures are the most traded ones, followed by FX and Ibovespa. However, when we look at the number of deals, the inverse is true as the FX contracts are the most frequently traded with at least one transaction in each three-second interval, followed by Ibovespa and IR ones which are traded every five and thirty seconds, respectively. Note that this is not a homogenous statistic as, nearby announcements, all markets trade more frequently than it does on average. Thus, we do not expect any problems concerning our database, because, as will be demonstrated, we will only work with selected observations around announcement release times.

Table 3.1.1: Daily average transaction volumes for each futures market between October 2008 and January 2011

		IR		FX		Ibovespa	
	# days on the database	# of transactions (in thousands)	Volume (in trillion Brazilian reais)	# of transactions (in thousands)	Volume (in trillion US dollars)	# of transactions (in thousands)	Volume (in trillion Brazilian reais)
2008 (October to December)	59	43.2	1.32	551.9	1.94	259.6	0.18
2009	233	164.1	9.30	2,793.4	6.62	1,311.5	0.89
2010	204	161.3	18.8	3,095.6	7.31	2,338.7	1.20
2011 (January)	17	14.7	1.09	169.2	0.46	141.7	0.08

All markets open at 09:00 AM and closes at 06:00 PM. The IR market has a trading interruption between 04;00 PM and 04:50 PM without transactions and we opt to consider that the price remained unchanged throughout this interval. This assumption will not impact our estimates since announcements did not coincide with such interruptions. Since all selected markets are highly liquid, we expect to minimize error measurement by considering the last price in a 5-min grid as the prevailing one. Considering only closed deals, returns for each contract were then computed at each 5-

min interval as the log-difference between consecutive 5-min prices. Taking order cancelation into account, spreads are derived as the relative difference between bid and ask values ($\frac{ask-bid}{bid}$) and are measured in percentage points (p.p.). Similarly, the last available spread is the prevailing one at each 5-min grid. Trading volume, in turn, refers to the sum of the number of traded contracts in each 5-min interval.

Table 3.1.2 provides information on the sample sizes and summary statistics for the 5-min return, trading volume and spread series. The average returns are, as expected, zero for all markets with the standard deviation ranging from 0.05% in the FX market to 4.3% in the Ibovespa one. The summary statistics for trading volume also indicate that the FX market is the most liquid one and spread's data have lower levels of dispersion for all markets. All distributions show excess kurtosis and are positively skewed, except the FX market return´s data. Negative first-order autocorrelation holds for all return's distribution. High first-order autocorrelation, as the one observed in the Ibovespa market's trading volume and spread, suggests that persistence is a dominant feature of both distributions.

Table 3.1.2: Summary statistics for 5-min returns, trading volumes and spreads

	IR	FX	Ibovespa
Sample size	55,504	55,504	55,504
Final sample	50,274	55,504	55,504
	Returns		
Mean	0.00%	0.00%	0.00%
Standard deviation	0.32%	0.05%	4.05%
Skewness	0.23	-0.13	0.61
Kurtosis	552.2	316.2	1123.4
First-order autocorrelation	-0.30	-0.01	-0.47
	Trading volumes		
	IR	FX	Ibovespa
Mean	973,3	2,586,0	541.9
Standard deviation	2,000.3	2,522.8	411.5
Skewness	5.1	2.7	2.1
Kurtosis	43.9	14.0	8.9
First-order autocorrelation	-0.07	0.51	0.63
	Spreads		
	IR	FX	Ibovespa
Mean	0.11%	0.06%	0.06%
Standard deviation	0.14%	0.08%	0.05%
Skewness	1.8	16.0	6.6
Kurtosis	289.1	553.2	166.6
First-order autocorrelation	-0.15	-0.15	0.64

Note: The table reports sample sizes and summary statistics for returns, trading volume and spreads.

3.2. The surprise data

Active traders form expectations over the state of the economy based on the release of macroeconomic indicators. The difference between the observed value and its expectation is called surprise and, according to its direction and intensity, can signal changes in the economy and alter portfolio weights. As our aim is to investigate short-term effects on the futures market, our choice of announcements gave preference to quantitative indicators as opposed to report analysis and policy statements, a kind of release that we would not be able to identify the exact time of the initial impact. In Brazil, it would be the case of the Inflation Report and COPOM minutes[7] whose impact on the domestic term structure of interest rates has been investigated by Janot & El-Jaick (2012). Using daily data and controlling for announcement surprises, the authors

[7] COPOM minutes (or "Ata do COPOM") are released one week after the target interest rate decision and subjected to deep revision by market participants in order to anticipate the interest rate path.

found a significant effect of the first on both the level and volatility of interest rates, but none for the latter. In such circumstance, the construction of communication indicators, as in Conrad & Lamla (2010), would be well suited.

In this sense, we have chosen the most important domestic and external indicators according to the following types of announcement: monetary, price and real economy. Both interest rate decisions made by COPOM and FOMC, respectively, are the most relevant monetary announcements and we included Quantitative Easing (QE) announcements for reasons that will be discussed soon. The choice for the price type is also straightforward as target inflation rules aim at consumer prices. With respect to the real economy, we refer to Fair (2003) to justify the use of non-farm payroll indicator as the author find evidences its superior impact in the US stock market. In Brazil, the domestic industrial production is not only the most reliable one, but is also the subject of many institutional forecasts and attracts the interest of the academy. In Table 3.2.1, we present details of the macroeconomic indicators, including its periodicity and additional information concerning the public releases.

Table 3.2.1: List of macro indicators, periodicity, time and day of the announcement release

Origin	Type	Indicator	Day of the week	Periodicity	Local Time	Brazilian Time	Source	# events in the sample
Domestic	Monetary	Interest rate decision (COPOM)	Wednesday	45 days	18:30	18:30	Central Bank of Brazil	15
	Price	Consumer price (IPCA)	Usually on Friday	Monthly	09:00	09:00	Brazilian Statistical authority (IBGE)	22
	Real Economy	Industrial Production (PIM)	Random	Monthly	09:00	09:00	Brazilian Statistical authority (IBGE)	26
External	Monetary	Interest rate decision (FOMC statements) and QE announcements	Usually on Tuesday**	45 days**	13:15**	15:15 or 16:15**	US Federal Reserve (FED)	22***
	Price	Consumer price (CPI)	Wednesday or Friday	Monthly	08:30	10:30 or 11:30*	Bureau of Labor Statistics	25
	Real Economy	Non-farm Payroll (PR)	Friday	Monthly	08:30	10:30 or 11:30*	Bureau of Labor Statistics	19

Note: FOMC and COPOM are the central bank committees responsible for the decision on the short-term interest rates.

IPCA and PIM are the initials for the consumer price index and monthly industrial production in Brazil.

QE: Quantitative Easing

* The difference is due to differences in saving lights times.

** The periodicity and time information refer only to interest rate decisions by FOMC.

*** Includes four QE announcements.

At times, the blind analysis of an indicator is a noisy picture of the real state of the economy. If an apparently positive indicator, for instance, is contaminated by a one-time event, the surprise component should reflect this. That is why it is not unusual to see that good indicators drive down the market and the reverse is also true. Our indicators' measures are not free from such concern. Although we recognize this potential problem, markets take time to absorb and do not correct instantaneously in these cases. In addition, we do not know the exact time of the reversal effect, if any. Consequently, as we focus on the immediate market reaction, the raw indicator is the most adequate.

As far as expectations are concerned, Rigobon & Sack (2008) pointed out that they are noisy and hard to measure. As much as possible, it is important to capture expectations

directly from market prices[8]. Otherwise, one should analyze carefully the survey's historical results; for instance, it is not a good signal if they always fail in one direction. In Brazil, the Central Bank releases a weekly survey (FOCUS Survey) that, besides showing the average perception of financial agents about some indicators, it also informs the average of the Top 5 agents, i.e., those who had the best recent forecasts. Hence, we will address this concern by using this specific indicator as we believe they provide better expectations measures.

Real economy and inflation surprise components will be calculated following Balduzzi, Elton & Green (2001), where the discrepancy between unit measures justifies the normalization procedure, also allowing a relative comparison between results.

$$S_{kt} = \frac{A_{kt} - E_{kt}}{\sigma_k} \qquad (3.2.1.)$$

Where A_{kt} is the released value for announcement k, E_{kt} denotes its expectation and σ_k is each announcement standard deviation´s surprise. Time t is a discrete variable that indexes each announcement date.

Monetary surprise deserves a special attention as our database starts at the onset of the financial crisis of 2008. Since September 2007, Federal Reserve (FED) started to lower short term interest rates in response to a deteriorating state of the economy. At this point, however, interest rates were already close to zero, reaching the zero-bound at the December 2008 meeting and remaining there until the end of the database period. Following Lehmann Brothers' bankruptcy, FED not only continued its monetary easing but also set up a policy known as Quantitative Easing (QE) in order to respond to the crisis' collateral effects. This unconventional type of monetary policy involved the

[8] Domestic and external interest rates expectations were measured from market prices.

expansion of central banks' balance sheets aimed at influencing long-term interest rates directly. In 25th November 2008[9], FED announced the first QE, or QE1, where it would purchase treasury bonds and mortgage-backed securities (MBS) providing not only liquidity to a dry market but also affecting the term structure of interest rates. Shortly after the first announcement, in 1st December 2008[10], FED's release provided additional details concerning the purchase operations. Then, QE1 information is spread in time and in different releases from FED. Gagnon et al (2011) and Krishnamurthy & Vissing-Jørgensen (2011) identified eight relevant communications related to QE1 assuming that markets are efficient and what really matters are the communications not the purchase operations. Besides the two events mentioned above, the other six are FOMC statements released after interest rate decisions that reveal QE1 information on volume, securities involved and purchasing period. Our sample period also encompasses the second round of QE, or QE2. We will follow Krishnamurthy & Vissing-Jørgensen (2011) and include two[11] dates concerning QE2: 21st September 2010[12] and 03rd November, 2010[13]. The second round of quantitative easing was distinct from the first in that the aim was to support economic activity by reinvesting principal payments from agency debt and agency mortgage-backed securities that it had acquired in QE1 in longer-term Treasury securities. Thus, despite keeping balance sheet reserves unaltered, it did not resort to purchases of different sort of asset like in QE1, whose aim was to provide credit easing through large scale asset purchases, including private ones.

[9] At 01:15 PM (GMT) or 11:15 AM(Local Time).

[10] At 06:45 PM (GMT) or 04:45 PM (Local Time).

[11] Krishnamurthy & Vissing-Jørgensen (2011) suggested three dates, but 10th October 2010 is a missing data in our sample.

[12] At 03:15 PM (GMT) or 06:15 PM (Local Time).

[13] At 04:15 PM (GMT) or 06:15 PM (Local Time).

Since there were no expectations of a reversion on monetary easing, (3.2.1) implies a monetary surprise very close to zero when the target rate is considered. Moreover, Treasury bills, the shortest-maturity debt obligations issued by the U.S. government, are historically lower than Fed funds rate and reached the zero-bound even before December 2008. But remember that we are interested in the announcement impact and, in fact, statements released by FOMC reveals more than just the target fund, giving insights of the state of the economic and also suggesting the future path of the target rate. In the meeting of January 28, 2009[14], for instance, Federal Reserve suggested that it would keep the target rate at the zero lower bound for a prolonged time, producing a widespread impact on the financial market. In this respect, Swanson & Williams (2013) investigated the effect of the zero lower bound on the term structure of interest rates and its responsiveness to macroeconomic announcements. The authors concluded that, between 2008 and 2010, monetary policy has been as effective as usual. Using study event methods with daily and intraday data, Neely (2010) also found that QE announcements substantially reduced long-term U.S. and foreign bond yields as well as the foreign exchange value of the dollar. In fact, FOMC meetings sustained its ability to impact long term maturity yields, producing daily variations in five and ten-year bonds compatible with sizeable "normal time" surprise changes in the federal funds rate, as calculated by Gürkaynak et al. (2005) and Glick & Leduc (2013).

Accordingly, shorter-term maturity bonds do not seem adequate to capture the monetary surprise component of a FOMC meeting, at least for the unconventional sample period under study. Moreover, QE announcements aimed at influencing long-term rates

[14] The FOMC stated: "The Federal Open Market Committee decided today to keep its target range for the federal funds rate at 0 to 1/4 percent. The Committee continues to anticipate that economic conditions are likely to warrant exceptionally low levels of the federal funds rate for some time."

directly. In Wright (2012), monetary shock has been computed based on the first principal component of a set of bond futures traded at the Chicago Mercantile Exchange (CME), ranging from two to thirty years to maturity. We opted for a more traditional strategy, based on robustness checks. In our reference scenario, we have chosen a long-term maturity, the constant maturity ten-year Treasury bill, to measure the impact of a FOMC meeting release. As a robustness check, we will provide the results for the one-year and two-year contracts, all of them provided by FED. As we have only daily data on US bonds, the surprise component will be calculated as the difference between the closing rate on the FOMC/QE day and the day before, resting on the assumption that it is the main factor driving interest rates and that the risk premia is constant in between. We analyzed the economic calendar from 2008 to 2011 and could not identify any concurrent macroeconomic announcements released on a regular basis. Although we cannot rule out the effect of non-regular events, we will refer to Faust et al (2003) to assume that the correlation between the surprise taken from daily and intraday futures data nearby FOMC meetings is very close to one.

Since the zero-bound constrain do not apply to domestic monetary surprises, it will be calculated taking the 30-day interest rate swap contract. In the same line of reasoning, we will check the results with a one-year to maturity contract to account for a broader[15] impact of a COPOM meeting. In Table 3.2.2, we show the most relevant information on each indicator´s expectation.

[15] In Brazil, interest rate term structure is severely limited by a shorter investment horizon. In this sense, a year-contract can act as a medium term yield.

Table 3.2.2: List of expectation by indicator

Indicator	Description	Standard deviation	Source
COPOM	Closing rate of the short term interest rate swap contract (30 days to maturity) in the last day before announcement.	0.11	BVMF
IPCA	Most recent survey	0.07	Central Bank of Brazil (FOCUS Survey)
PIM	Most recent survey	0.73	Central Bank of Brazil (FOCUS Survey)
FOMC	Closing rate of a long term Treasury bond (10-years to maturity) in the last day before announcement.	0.15	FED
CPI	Most recent survey	0.13	Bloomberg
PR	Most recent survey	94,438	Bloomberg

The FOCUS survey provides market expectations on a daily basis about the Brazilian main economic indicators, including inflation rate and industrial production. In terms of forecasting performance, Lima & Alves (2011) found no significant evidence of the superior ability of FOCUS survey when compared with univariate autoregressive models. We must bear in mind, though, that it exerts a prominent role in the conduction of monetary policy in Brazil. Besides, it provides a standard deviation comparable to the one based on Bloomberg forecasts[16].

Figure 3.1 presents the evolution of the normalized surprises for all the six announcements. In Brazil, the Central Bank did not cut interest rates immediately after the Lehmann Brothers' event and the coordinated interest rate cuts held by central banks worldwide, in the last quarter of 2008. Only in the beginning of 2009, it started to cut interest rates aggressively even when inflationary pressures indicated otherwise. Hence, domestic monetary surprises were mostly negative up to the meeting of March 2010, when COPOM started a contractionary monetary cycle that lasted until the middle of 2011. The abrupt shifts in the conduction of monetary policy in such a short period of time explain the erratic behavior of COPOM surprises and reveal a disagreement

[16] Most high frequency studies take announcements' expectations from Money Market Services (MMS) forecasts, which we do not possess. Publicly available Bloomberg data present market consensus for CPI only in the first decimal place, what partially explains its relative high standard deviation figure.

between market and Central Bank expectations over the duration and intensity of each monetary cycle. Moreover, the fact that surprises are mainly negative shows that the market expected a more hawkish monetary policy than the one actually employed.

Prior to the financial crisis, Brazilian economy experienced high growth rates led mostly by consumer expenditures. With the decline in commodity prices and in consumer credit availability, there was a consensus that the external scenario would imply a deflationary price pressure. On the other hand, federal governments and central banks worldwide, including the Brazilian one, responded to the crisis with aggressive expansion of fiscal and monetary balances. Thus, there were two opposing driving forces at work with an unpredictable combined outcome. In fact, until mid-2009, the fact that IPCA and PIM[17] surprises were high shows that inflation and real economy indicators were harder to predict immediately after the crisis. We can also conclude that surprises' signal are rather persistent, revealing that market forecasts fail to predict and recognize persistent shifts in the level of those economic indicators.

Until mid-2009, QE and FOMC statements promoted a reduction in long-term bonds and, by assumption, its surprise component. Note also that the highest negative surprises refer to QE-related announcements. In 25th November, for instance, QE1 was launched by FED. In 18th March 2009, FED's announcement that it would inject US$ 1 trillion to aid economy by buying treasury bonds and mortgage securities, generating a high negative surprise associated with a significant reduction in long term bonds. In the same period, CPI and PR surprises were mostly negative reflecting the uncertainties over the state of the economy and the difficulties surrounding the conduction of monetary policy.

[17] Remember that PIM announcement are lagged by two months. So, for instance, a January 2009 release refers to what happened in November 2008.

Since the second semester of 2009, as the economy started to present signs of recovery of the economy, all external announcements exhibited a well-behaved pattern, characterized by fewer outliers and constant shifts between positive and negative ones, displaying minor error persistence.

4. The model

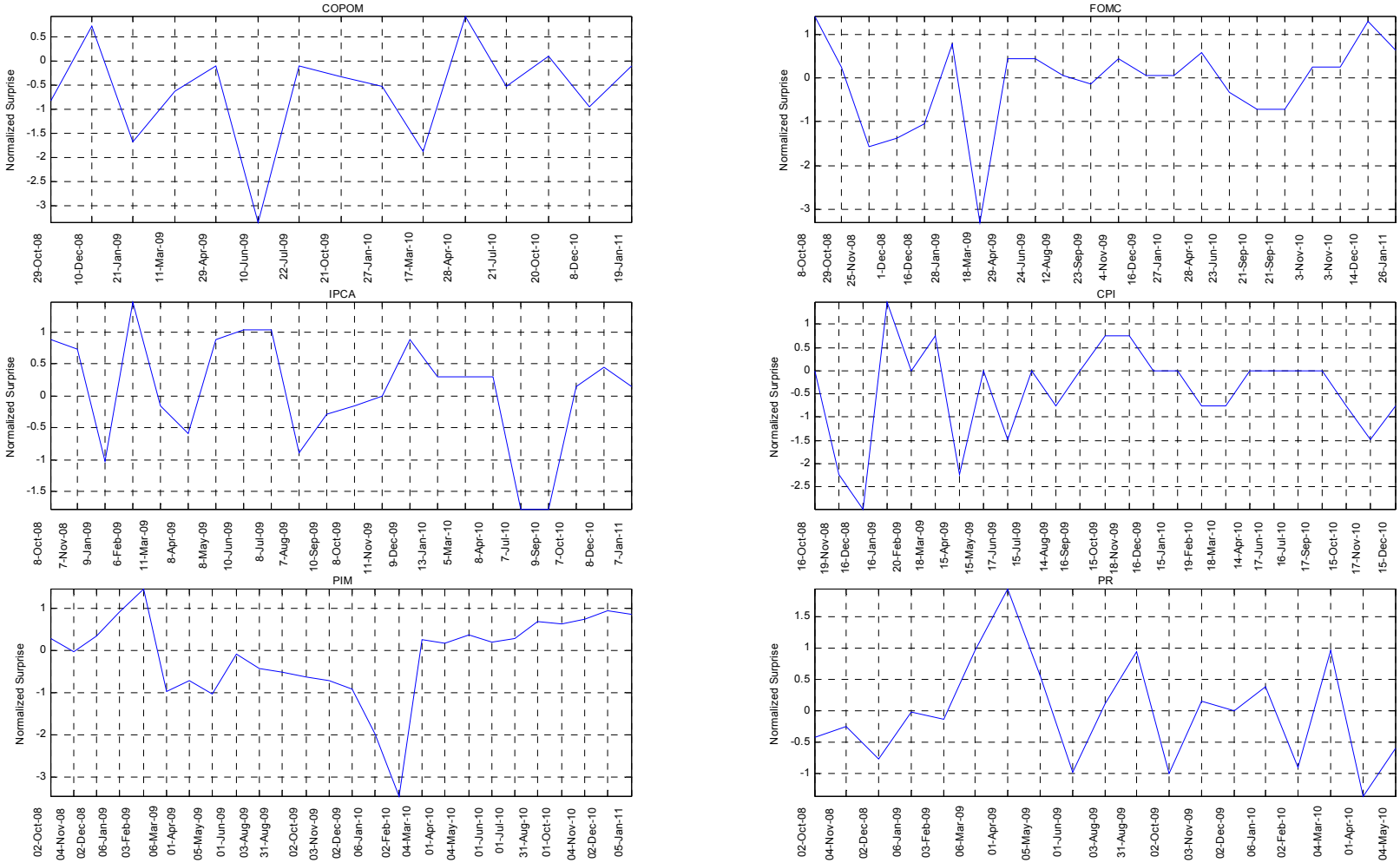
The original database has information on returns, trading volumes and bid-ask spreads of the entire sample period, totaling 55,404 observations (513 days x 108 5-min intervals per day). In the spirit of the event study literature, we must be able to identify time periods around announcements so as to avoid concurrent effects on returns. More precisely, we must define an estimation window that must be wide enough to capture announcement effects but not so wide to allow returns to be affected through other channels.

Accordingly, we collected twenty 5-min returns around each announcement, two of them before and eighteen after it. The small interval before announcements is needed to identify, if any, the relative impact on returns. When announcements are released after the market is closed[18], we opted to consider the last two 5-min interval of the current day as the pre-announcement period and the eighteen first ones of the following day as the post-announcement period. In this case, markets absorb the news during the night and there is no way to avoid a quicker adjustment in the morning. The same logic was applied to the cases when announcement is made at the first interval[19] of the day. With the selection procedure proposed above (see Figure 1 in Appendix for its graphical representation), the final database ended up with 2504 observations.

[18] COPOM announcements, for instance.

[19] IPCA and PIM are released at 09:00 AM, when markets are opening

Graph 3.1: Evolution of announcements' surprises



Let S_t^k be the surprise component of each announcement, our variable of interest. Following Andersen et al (2003, 2007), we propose a linear model in order to measure the short-term dynamics of the selected variables after macroeconomic announcements. We run different regressions, one for each market and independent variable, as follows:

$$R_t^h = \beta_0^h + \beta_1^1 . R_{t-1}^1 + \beta_1^2 . R_{t-1}^2 + \beta_1^3 . R_{t-1}^3 + \sum_{k=1}^{6} \sum_{j=0}^{3} \chi_{kj}^h . S_{t-j}^k + \varepsilon_t^h \qquad (4.1)$$

Where t refers to each 5-min interval, h refers to each market (IR=1, FX=2, Ibovespa=3) and k identify the six announcements described in Section 3.2. R_j^h are the returns of each market h. S_t^k takes the computed value at the first 5-min interval after the announcements and zero afterwards.

Andersen & Bollerslev (1998) already documented the existence of volatility spikes around macroeconomic announcements lasting approximately twenty minutes what validates the four-lag structure of the surprise variable S_{t-j}^k . We assume that surprise variables are exogenous. According to Christiano et al. (1998), monetary policy decisions can be viewed as the systematic response of policy makers to the state of the economy and the shock, its unaccounted or surprise component. Therefore, the exogeneity assumption also implies that both FOMC and COPOM meetings do not reveal any private information of the monetary authority. Note also that ARCH effects and cross market linkages[20] as long as we include lagged returns for all markets.

Since events are spaced in time, it is worth analyzing if the day breaks that arise from the selection procedure can cause any bias in the coefficient estimates. This would be true if we expected that observations outside the sample would bring information on the

[20] Andersen et al (2007) also calculated contemporaneous spillover over effects applying heteroskedasticity identifying restrictions.

surprise variables. But remember that we assumed that the impact on the returns is short-lived. In other words, unless one thinks that our estimation window is not adequate, there is no reason to believe that there will be any bias in the regression estimates.

Due to the time-varying nature of the innovations ε_t^h, the Ordinary Least Square (OLS) estimation of model (4.1) would produce consistent, but inefficient coefficient estimates. We again follow Andersen et al (2007) and apply a two-step correction procedure for heteroskedasticity based on Weighted Least Squares (WLS). In the first step, we perform an OLS regression of (4.1), whose absolute residuals are used to estimate (4.2) as shown below. Finally, equation (4.1) is recalculated through WLS using (4.2) as the volatility weighting.

$$\left|\widehat{\varepsilon_t^h}\right| = \sum_{i=1}^{9} \beta_i^h \left|\widehat{\varepsilon_{t-\iota}^h}\right| + \sum_{j=1}^{9} \lambda_j D_t^j + \sum_{k=1}^{6} \sum_{j=0}^{3} \chi_{kj}^h D_{t-j}^k + \mu_t^h \qquad (4.2)$$

Where $\widehat{\varepsilon_t^h}$ is the first-step residual for each market h, D_t^j is the dummy that identifies each observation's hour and D_{t-j}^k is the announcement dummy that sets to one when observations are related to macroeconomic announcement k.

The first term of (4.2) accounts for serial correlation or ARCH effects and the second one, for the intraday volatility. Note that, contrary to Andersen et al (2007), we opted to control for the hourly volatility (nine trading hours per days) instead of using each 5-min intervals to avoid overparametrization. The last term controls for announcement-specific volatility patterns.

When we replace the dependent variable in (4.1) by each market´s trading volume and spread, it is important to highlight that economic surprises are replaced by their dummy

counterparts, a key modification to the original model[21]. Consider a public authority planning a neutral market intervention, i.e., one that is aimed only at restore supply and demand equilibrium. Suppose it wants to avoid periods in which there is a drop in liquidity, when it could induce noise and excess volatility. In contrast to high frequency traders seeking return premiums, the most relevant decision criteria for this kind of agent is the average effect of each announcement, as they will not plan an intervention based on information that they do not possess ex-ante, i.e., the direction of the surprise. The parameters of equations (4.3) and (4.4) will be also estimated by WLS.

$$X_t^h = \beta_0^h + \beta_1^1 . X_{t-1}^1 + \beta_1^2 . X_{t-1}^2 + \beta_1^3 . X_{t-1}^3 + \sum_{k=1}^{2} \sum_{j=0}^{3} \chi_{kj}^h . D_{t-j}^k + \varepsilon_t^h \quad (4.3)$$

$$\left|\widehat{\varepsilon_t^h}\right| = \sum_{i=1}^{9} \beta_i^h \left|\widehat{\varepsilon_{t-\iota}^h}\right| + \sum_{j=1}^{9} \lambda_j D_t^j + \sum_{k=1}^{2} \sum_{j=1}^{3} \chi_{kj}^h D_{t-j}^k + \mu_t^h \quad (4.4)$$

Where X can either refer to the bid-ask spread or to trading volume.

Spreads are derived following the same procedure as described in Section 3 and 4 for the returns, i.e., it refers to the last available value for each 5-min interval. They are computed as the relative difference between bid and ask values and measured in percentage points (p.p.). Trading volume refers to the sum of the number of traded contracts in each 5-min interval, respectively.

However, as Table 1 of the Appendix shows, these variables present a pronounced seasonal pattern. Spreads reaches its peak in the first two hours of the trading section and are relative stable afterwards. With respect to volume, we can define three different

[21] Replicating model (4.1) to trading volumes and bid-ask spreads, with announcements' surprise as the independent variables instead of dummies, impact estimates were mainly insignificant. Given the persistent and widespread reactions observed in the latter case, we speculate that, although trading volume and bid-ask spread fluctuations are related to announcements, reactions are not correlated to the surprise components.

volume regimes. In the beginning of the trading session, we identify a high trading regime, followed by low volume in lunchtime and a new period of higher volume afterwards. Hence, we need to modify each 5-min variable in order to avoid bias in the results and we opt to compute spreads and volumes as a ratio relative to its correspondent hourly mean figures. According to this new definition, the coefficients must be interpreted correctly as the relative announcement impact to the hourly mean on spreads and volume.[22]

5. Results

According to equations (4.1) and (4.3), the effect of macroeconomic announcements in the futures market is measured within a twenty-minute post-release window, split in four 5-min intervals. We will derive our measures of interest based on the aggregate effect by summing up coefficient estimates in a progressive aggregation up to twenty minutes. In formal terms, as follows:

$$Five-minute\ aggregation: H0:\ \chi_{k0}^{h} = 0$$

$$Ten-minute\ aggregation: H0:\ \chi_{k0}^{h} + \chi_{k1}^{h} = 0$$

$$Fifteen-minute\ aggregation: H0: \chi_{k0}^{h} + \chi_{k1}^{h} + \chi_{k2}^{h} = 0$$

$$Twenty-minute\ aggregation: H0: \chi_{k0}^{h} + \chi_{k1}^{h} + \chi_{k2}^{h} + \chi_{k3}^{h} = 0 \qquad (5.1)$$

[22] We also modeled the intraday behavior of trading volume and bid-ask spreads using cubic splines with hourly knots. Under this alternative model, impact estimates were mainly insignificant. We attribute the contrasting results to the fact that splines potentially add noise to the high frequency observations, contrary to our proposed specification, that preserves the proportionality between sequential observations.

Where h refer to each market and k for the announcements. The indexes (0,1,2,3) refer to the five, ten, fifteen and twenty minute surprise coefficient estimates calculated as (4.1) and (4.3). The p-values will be computed by means of a Wald Test on each aggregate effect.

First of all, we want a measure of speed or how fast each market reacts to each announcement. The surprise component of an announcement is equivalent to the release of new public information. According to the semi-strong form of efficient market hypothesis, it should be instantaneously reflected in asset prices. We will derive this information by identifying the first joint coefficient that is significant at some pre-specified level of significance. Another important aspect to be assessed is the persistence effect, or how long[23] will the announcement be an explanatory factor. An overreacting market could respond instantaneously to a surprise and, in the next interval, adjust to the previous price level. More efficient markets are expected exhibit a more persistent pattern, i.e., once reacting to a surprise it will sustain its price levels until the 20-min aggregation. So, the last significant joint coefficient will be used to analyze this effect. Finally, the value of the last significant joint coefficient is a direct measure of intensity, or how much does the surprise affect each market.

The direction of the return changes deserve a particular attention in order to compare with what one could expect by applying basic economic thinking. For the sake of simplicity, it is important to highlight that we will take into account what we consider to be the dominant factors surrounding price determination in each market to derive the most likely impact of the announcement surprises.

[23] Persistency is frequently measured in the literature with the half-life criterion. Our first-order serial correlation, however, is not high enough to allow its application in the present study.

Since 1999, Brazilian monetary authority runs an inflation targeting approach for the conduction of monetary policy. Consider a general interest rule function:

$$i_t = \gamma_\pi E_t(\pi_{t+\tau}) + \gamma_y E_t(y^*_{t+\tau}) \quad (5.2)$$

Where γ_π and γ_y are positive weights on inflation and output gap expectations, respectively, and τ is the monetary policy horizon.

According to our definition, a positive monetary surprise is meant by a higher target rate than the one implied by (5.2). To derive the expected effect of a monetary surprise on futures interest rates, we must first understand its association with the yield curve. According to Litterman & Scheinkman (1991), there are three common sources driving the term structure of interest rates: level, steepness, and curvature. Since most part of the variation (89.5%) can be attributed to the level factor, an unexpected rise in the short run interest rate should, everything else constant, raise interest rates for all expiration dates. However, the authors showed examples where ignoring the other two factors' impact can lead to severe loss in hedged portfolios. Assuming that risk premium is not altered in our short interval window, the expectations hypothesis of the term structure of interest rates states that the yields on financial assets of different maturities are related primarily by market expectations of future yields. A negative monetary surprise, for instance, can reveal that BCB is less concerned about inflation (equivalent to a reduction in γ_π in equation 5.2) what will make short term rates to fall and long term ones to rise at some point so as to reverse the current expansionary effect. Such shocks may have the power to change the slope of the yield curve, corresponding to the steepness factor described by Litterman & Scheinkman (1991) as the one that is an increasing function of time to maturity. The effect on medium-term interest rates, our object of interest, depends on the extent of which the market expects the monetary

easing to last and, thus, we are not able to unambiguously determine the sign impact[24]. Instead, we will reverse the argument and infer the expectation of the market on the monetary cycle by the estimated impact in the IR market. Real economy surprises are expected to positively related to medium term interest rates since they can anticipate future reversals on the monetary cycle. In face of positive inflation surprises, we expect the level factor to be dominant and, hence, interest rates to rise. When we only consider the expansionary cycle, a positive monetary surprise can reveal a higher than expected weight on inflation[25] generating an asymmetric effect on interest rates but, once more, we also cannot determine ex-ante the inflexion point of the yield curve. On the other hand, positive real economy surprises raise interest rate as long as the decreasing output gap may potentially be converted into inflationary pressures.

It is true that, according to (5.2), external announcements should only affect the IR market as long as they produce changes in inflation or real economy expectations. But the instantaneous effect is better understood when one analyzes the effect of interest rate differentials on the demand for domestic bonds which we assume to be the main transmission channel in the short run. External investors have a large participation in the IR secondary and futures market in Brazil. A positive US monetary surprise, usually associated to a stronger than expected economy, trigger the reallocation of portfolio investments around the world to the US bonds. The drop in demand for domestic bonds

[24] Empirical studies on the Brazilian term structure showed conflicting results over the effect of steepness shocks. Luna (2006) showed that factor loadings, associated with medium-term contracts, were very close to zero. By contrast, Shousa (2008) and Bressan et al (2007) showed that factor loadings were already close to zero for short term contracts, with six months to maturity.

[25] We assume that no private information is revealed in COPOM meeting that could change market´s perception on inflation and output gap expectations.

reduces its prices and raise interest rates levels for all maturities with different intensities. The same impact is expected when inflation and output surprises are positive since they both raise the level of US interest rates.

In order to analyze the impact on the FX market, Engel & West (2006) and Engel (2013) provide a suitable framework. The authors set up a two-country specification where uncovered interest rate parity holds and both countries follow a general interest rule with an additional term to equation (5.2) that allows for interest rates to react to exchange rate misalignments. Within short time intervals, real exchange rates can be substituted by nominal ones, generating the following model:

$$s_{t+\Delta} - s_{t-\Delta} \approx -\sum_{j=0}^{\infty} \left(\frac{1}{1+\gamma_q}\right)^j (E_{t+\Delta} - E_{t-\Delta}) \left\{ \left(\frac{\gamma_\pi - 1}{1+\gamma_q}\right) (\pi_{d,t+j+1} - \pi_{e,t+j+1}) - \left(\frac{\gamma_y}{1+\gamma_q}\right) (y^*_{d,t+j} - y^*_{e,t+j}) \right\} \quad (5.3)$$

Where the time period is one-month, Δ is our 5-min interval and $(y^*_{d,t+j}, y^*_{e,t+j})$ and $(\pi_{d,t+j+1}, \pi_{e,t+j+1})$ are the domestic and external output gaps and consumer inflation indexes, respectively. The factor γ_q is the additional term in the home interest rule related to exchange rate misalignment.

Assuming that the central bank follows a sufficiently stabilizing monetary policy $(\gamma_\pi > 1, \gamma_q, \gamma_y > 0)$, model (5.3) implies a positive correlation between expected inflation and output gap in the home country to domestic currency appreciation. Also, higher inflation and higher output gap in the foreign country leads to domestic currency depreciation. The effect of interest rate surprises is equivalent to inflation or output gap one in that they are positively linked through the Taylor rule. These predictions are consistent with the analysis of the short-term equilibrium between dollar supply and

demand since positive prospects of the US economy that become evident from whatever the source (monetary, inflationary or from the real economy should lead to home currency depreciation as long as the dollar supply decreases. These theoretical considerations are validated by some empirical works on the high frequency impact of announcements. Clarida & Waldman (2008) found that the positive correlation between inflation expectations and exchange rates is stronger in countries that follow inflation targeting rules. Recent studies (Andersen et al (2007), Faust et al (2007)) related a stronger than expected economy with dollar appreciation, equivalent to home currency depreciation.

The relationship between economic news and stock prices are harder to predict. In the simple dividend model (5.4) where risk premium is assumed to be constant in short intervals, stock returns are a function of dividend flow and the cost of equity. Economic news can convey information on both factors and its relative importance can vary depending on the state of the economy. Accordingly, a rise in cost of equity originated by a monetary or inflation surprise should decrease the value of dividends and, everything else constant, reduce the amount invested in stocks to bonds. Positive real economy surprises increase future dividend returns, rising stock valuation and prices.

$$y = f(E_t\left(\sum_{j=1}^{\infty} d_{t+j}\right), i_t^e), \frac{\partial y}{\partial E_t\left(\sum_{j=1}^{\infty} d_{t+j}\right)} > 0 \frac{\partial y}{\partial i_t^e} < 0 \qquad (5.4)$$

Where $E_t(\sum_{j=1}^{\infty} d_{t+j})$ are the expected future dividends and i_t^e, the cost of equity.

Finally, the effect of external announcements on stock market has two opposing dimensions. On one hand, we have seen that a stronger than expected US economy raise both US and domestic interest rates drive investment flows to the central economy and reducing the present value of dividends. However, it has a positive effect on the

dividend flow provided that a wealthier international economy is a positive factor for domestic companies. Thus, the sign impact shall depend on the relative intensity of such dimensions. In Table 5 below, we summarize the theoretical predictions discussed above.

Table 5: Theoretical sign of impact per announcement on IR, FX and Ibovespa futures returns

	IR	FX	Ibovespa
COPOM	NA	-	-
IPCA	+	-	-
PIM	+	-	+
FOMC	+	+	NA
CPI	+	+	NA
PR	+	+	NA

Note: NA: Not assigned.

Although common sense points to a positive relationship between price and volume reactions, Bamber and Cheon (1995) find evidence of public announcement with small price changes and high trading volume. Actually, nearly a quarter of firm-specific earnings announcements generate divergent reactions in terms of magnitude. Accordingly, there is a literature aimed at providing answers of what can be inferred from public announcements by its trading volume.

Empirical studies already documented that announcements increase trading volume in different markets. Balduzzi, Elton & Green (2001), for instance, documented significant and persistent post-announcements increases in trading volume in the interdealer broker market for US bonds. Concerning the FX market, Chaboud et al (2004) also reported a sharp increase in trading volume after US announcements in the Global interdealer spot market. Basically, two factors were identified as important drivers to trading volume. The first one is that public announcement provides the grounds to uncertainty resolution implying that trading volume prompted by a public announcement is positively related to the announcement's precision. In some theoretical models of trade, such as Blume et

al (1994), information quality is deduced from volume and considered an informational advantage in investment strategies such as technical analysis. Barron & Karpoff (2004) note, however, that this interpretation does not always holds as transaction costs can interfere in this positive association. A more recent strand of the literature focus on the fact that markets are composed of heterogeneous agents with differential public announcements' interpretations. This divergence not only stimulates speculative trading but also gives rise to the "no price, high volume reaction" described in the literature. With that in mind, our main task will be to infer the microstructure of each market based on the regression results. Besides, the relative magnitudes can be used to determine the relative information content of each announcement.

As liquidity can be related to information asymmetry, the effect on spreads will be confronted to trading volume in order to assess this relationship. Kyle (1985) has shown that asymmetric information is positively related to illiquidity. Considering that spreads are a market maker´s protection from informed trading, informed traders lose the camouflage from noisy trading in low liquid markets. All else equal, though, profits based on inside information trading can be maximized in a frequently traded asset. So, according to Kyle´s model, market makers increases ask prices to protect from huge order flows from informed traders. BVMF order-to-order trading system, however, does not include market makers and the protection against the action of informed traders is possible through limit orders. In view of this framework, trading volume and spreads should present a negative association.

We additionally want to check for business cycle singularities. In the first months that followed the peak of the financial crisis, Brazil suffered a dramatic turnaround in its economic prospects. The first sign of recovery did not appear until the second quarter of

2009 with the release of a positive quarterly GDP after two consecutive positive industrial production indicators. The contraction period, thus, should comprise observations from October 2008 to March 2009, while the expansion one from April 2009 to January 2011. Note, however, that such definition would yield a very short contraction sub-sample, with few observations. We will partially circumvent this problem by running two regression sets, one for the full sample and another for the expansion period. Differences in the results will then be associated with state dependency.

5.1. The impact of macroeconomic announcements on returns

Rather than commenting on the regressions individually (see Appendix Table 2), I organize the most interesting aspects of the empirical results in terms of the three indicators mentioned in the beginning of Section 5: how fast (efficiency), how long (persistence) and how much (intensity). With that in mind, Table 5.1.1 displays the response of each market to the surprise component of the selected macroeconomic announcements. In general, when a significant impact is verified, markets react quickly at the first 5-min interval. In most cases, however, we observe price reversions given that only few announcements show persistent effects up to the twenty-minute estimation window.

At the IR market, in particular, responses are not only fast but short-lived as well. Reactions to FOMC and PR surprise components, for instance, vanish after five minutes. Even COPOM and IPCA, the most important domestic news related to monetary decisions, keep its influence only up to ten minutes time. At this point, it should be noted that COPOM´s releases happen when markets are closed what surely alter the dynamics of information absorption relative to other announcements. In

principle, it should increase the immediate impact and obscure potential changes in level attributed to COPOM, justifying the low persistence observed in the results. IPCA releases, which anchor COPOM decisions, mattered only in the expansion period, suggesting that the economic interpretation of macroeconomic news is ambiguous and depends on the cyclical position of the economy. The fact that expansion´s period R^2 is superior to full sample ones (see Table 2 of Appendix) for all market provides additional support to the procedure that splits sample according to the business cycle. Remember that our sample starts at the beginning of 2008's financial crisis. As such, expectation over the state of the US economy determined the evolution of long term interest rates. Moreover, policy makers expected a future deceleration of inflation indexes due to the colder economy and lower commodity prices. In the expansion period, however, domestic announcements were back on stage, since monetary authority decisions were not bounded by the external scenario.

FX and Ibovespa markets, in turn, react mostly to external indicators. The FX market display immediate reactions to the surprise components of COPOM, PR and FOMC, but only the latter is persistent up to twenty minutes. The results for Ibovespa reveal that it is the futures market that exhibits the most widespread reaction to announcements in terms of persistence as long as the impact of COPOM, FOMC and PR are significant at the 5% level up to twenty minutes.

By contrast, PIM and CPI have negligible impact on the futures markets for all announcements and at all perspectives. Take the example of PIM, which is a one-month lagged industrial production announcement and we assumed that its surprises could induce changes in market´s expectations over the output gap and real economy prospects. The "no impact" of PIM, thus, can be attributed to a fail in this assumption.

CPI's lack of impact has another interpretation and rests on the fact our sample period covered a period in which US policy makers assigned a relative low importance to inflation due to the financial crisis.

In addition to identifying the existence of a measurable announcement effect, it is important to clarify the direction of such effects and compare it with the theoretical expected signs of Table 5.1. In the IR market, we find an excess return of -0.107 p.p. in response to a 25 basis points' COPOM surprise and 0.041 p.p. in response to a 0.10 p.p. IPCA surprise. Both impacts are persistent up to ten minutes in the expansion period. Suppose Central Bank underreacts to inflation expectations, medium-term interest rates are expected to rise because the financial market expects inflation figures to rise accordingly imposing a new monetary contraction cycle to start earlier than previously expected. Until mid-2010, domestic monetary policy experienced a shift in the reaction function while Central Bank implemented a progressive decline in the prime interest rate, Selic. At this period, it was less reactive to current inflation pressures and confident that a deflationary external scenario would bring inflation expectations down, as extensively documented by COPOM minutes and quarterly inflation reports.

Table 5.1.1: Impact of macroeconomic announcements on each futures market on returns

How fast						
	IR		FX		Ibovespa	
	Full sample	Expansion period	Full sample	Expansion period	Full sample	Expansion period
COPOM	5 min	5 min	5 min	5 min	5 min	5 min
IPCA	No impact	5 min	5 min	No impact	No impact	No impact
PIM	No impact	No impact	No impact	No impact	5 min	5 min
FOMC	5 min	5 min	5 min	5 min	5 min	5 min
CPI	No impact	No impact	No impact	No impact	No impact	No impact
PR	5 min	5 min	5 min	5 min	5 min	5 min
How long						
	IR		FX		Ibovespa	
	Full sample	Expansion period	Full sample	Expansion period	Full sample	Expansion period
COPOM	10 min	10 min	5 min	5 min	20 min	20 min
IPCA	No impact	10 min	5 min	No impact	No impact	No impact
PIM	No impact	No impact	No impact	No impact	5 min	5 min
FOMC	5 min	5 min	20 min	20 min	20 min	20 min
CPI	No impact	No impact	No impact	No impact	No impact	No impact
PR	5 min	5 min	5 min	5 min	20 min	20 min
How much (Reported coefficients are expressed in percentage points for a unit shock. A unit shock from COPOM and FOMC is equal to 25 basis points; IPCA and CPI: 0.10 p.p.; PIM: 1.0 p.p.; PR: 100,000 jobs.)						
	IR		FX		Ibovespa	
	Full sample	Expansion period	Full sample	Expansion period	Full sample	Expansion period
COPOM	-0.128	-0.107	-0.055	-0.071	0.173	0.094
IPCA	No impact	0.041	0.047	No impact	No impact	No impact
PIM	No impact	No impact	No impact	No impact	0.023	0.046
FOMC	0.029	0.029	0.191	0.089	-0.329	-0.313
CPI	No impact	No impact	No impact	No impact	No impact	No impact
PR	0.032	0.028	-0.045	-0.051	0.151	0.182

Note: All the estimates consider a 5% level of significance.

Coefficients were normalized to facilitate interpretation.

There are several ways that under reacting to inflation expectations could negatively affect medium-term yields, as implied by our results. Investors possess long-term bonds and, according to its portfolio composition, are subjected to various degrees of duration risk. Duration generally refers to the approximate percentage change in a security's price that will result from a change in its yield. Since futures interest rates directly affect bond yields, the longer a bond's duration, the more sensitive its price is to changes in the IR futures market. In such a case that the IR market does not totally agree with the scenario proposed by monetary authorities, rising inflation expectations deteriorates

medium and long term bond prices, while the opposite happens in terms of yields. Liquidity is another transmission channel that may offer a suitable explanation. In periods characterized by high uncertainty levels, investors usually shift portfolio composition towards short-term bonds. The resulting lower demand for longer term bonds produces higher interest rates. Also, another potential driving factor is Brazilian financial market´s perception that the worldwide commitment to keep interest rates low prevailing at the sample period could induce a low interest rate regime in Brazil, for more time than would be recommended in view of the domestic inflation figures and expectations.

The same rationality applies to a higher than expected IPCA when IR futures rates rise anticipating a tighter stance of monetary policy by COPOM. Both FOMC and PR surprise component estimates reveal an increase in futures interest rates when subjected to a positive shock, suggesting that a better than expected US economy drive interest rates up. But both impacts are short-lived reinforcing the dominance of domestic factors in the IR market.

Taking into account previous studies (Kolscheen (2011, 2012)[26]), it is not surprising to find that the FX market is sensitive only to FOMC announcements while the domestic ones showed only transitory or non-existent impacts probably due to the important role

[26] Using event study based on daily data for Mexico, Brazil and Chile, Kolscheen (2011) also finds no significant relation between monetary surprises and exchange rates around monetary policy committee meetings. In a regression-based analysis, taking order flow and a set of economic variables as exogenous variables, Kolscheen (2012) have found no significant effect of interest rate differentials on exchange rate.

of external investors[27]. In effect, Fratzscher (2011) finds that domestic interest rate changes have no significant effect for explaining capital flow to Latin America both during the crisis period or afterwards. In both samples, FOMC is the main factor driving returns when a 25 basis points' surprise raises FX returns in 0.191 p.p. and 0.089 p.p. in the full sample and expansion period, respectively. So, an unexpected increase in US long-term interest rates appreciates the dollar relative to the domestic currency (BRL). External announcements are primarily responsible for changing the volume and direction of investment flow to the domestic economy. In this sense, higher interest rates or a better state of the economy takes liquidity away from emerging countries and leads to dollar appreciation, agreeing with Andersen et al (2007) and Faust et al (2007) findings. If we extrapolate this conclusion to the most recent monetary events, our results show that news related to the tapering of the stimulative quantitative easing policy by Federal Reserve shall appreciate dollar. That is exactly what Aizenman et al (2014) found, applying a panel framework using daily data between November 2012 and October 2013, for a group of 26 emerging countries.

In the same line of reasoning[28], Ibovespa futures are directly and persistently affected by two external announcements: FOMC and PR. A 25 basis points' FOMC surprise impacts stock futures returns by -0.329 p.p. and -0.313 p.p. in the full sample and expansion periods, respectively. Hence, a monetary policy easing is related to positive returns in Brazil, consistent with Aizenman et al (2014) which found that FOMC QE news were strongly associated with positive stock market returns in countries experiencing current account deficits, Brazil included. Non-farm payroll figures emerge

[27] In general, external investor account for approximately 15% of the FX traded futures contracts. However, their importance grows considerably when we net investors' position with the spot market.

[28] Approximately 50% of the Ibovespa futures contracts belong to external investors.

as an important announcement and its surprise component is positively associated with domestic stock index returns. PR is persistent at both periods, when a 100,000 jobs' surprise increase returns in the stock market by 0.151 p.p. and 0.182 in the full sample and expansion period, respectively. It suggests not only that the dividend effect is higher than the cost of capital one but also that real economy shocks are correlated between Brazilian and US economies. This is in contrast with the results of Boyd, Hu & Jagannathan (2005) which found that unemployment rising is good news for the US stock market at the expansion period. We find support to our results when we take the study of Elder et al (2012), which find positive effects of an unexpected improvement of the US economy on copper prices using intraday data from 2002 to 2008, together with the high weight of commodity-related stocks in the composition of Ibovespa. Finally, a COPOM surprise amounting to 25 p.b. raises Ibovespa futures returns by 0.173 p.p. and 0.094 p.p. in the full sample and expansion period estimates, respectively. The positive correlation is at odds with the theoretical results in Table 5.1. Our interpretation is that the sensitivity of Ibovespa futures to a domestic monetary shock may owe to more than just the adjustment of the cost of capital: revision of expectations over central bank independency and commitment to policy rules may play an even more important role, assigning a greater impact of monetary decisions to the dividend effect of equation (5.4). More importantly, impact is found to be highly persistent up to twenty minutes after market opening. In view of to this prolonged effect if compared to the one observed in the IR market, we can conjecture that a COPOM shock primarily affects the IR Market and, after stabilizing it, it is then transmitted to Ibovespa futures contracts.

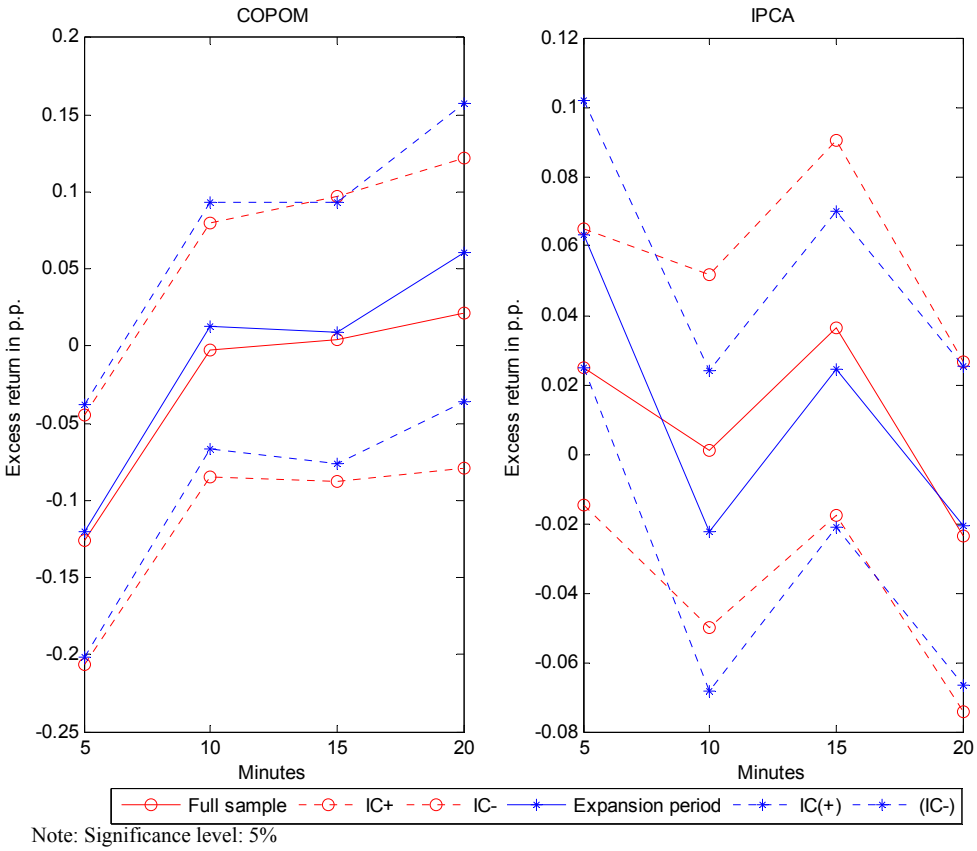
To sum up, focusing our attention to the most persistent announcements, we conclude that results match those predicted by theory and are robust to sample changes, as there are no sign reversals and minor differences in the intensity coefficients. Despite this

general conclusion holds, state dependency can interfere in its relative magnitude and cancel out predicted impacts. The fact that IPCA estimates are conflicting over different samples is an indication of such effect, exactly as reported by Andersen et al (2007). By forming the full sample by adding observations from the contraction period to the expansion period, the coefficient that measures the impact of IPCA announcements is not significant at the 5% level. This is in contrast with the result obtained by restricting the sample to the expansion period, where the IPCA coefficient is positive and persistent up to ten minutes after the release. This result suggests that the contraction period, not included as a separate sub-sample only due to the small amount of observations, can generate sufficient noise so as to eliminate the significance of this coefficient. In fact, from October 2008 to March 2009, considering that worldwide financial systems experienced severe liquidity shocks, monetary authorities were less concerned about inflation and directed monetary policy instruments mainly towards preserving the functionality of the banking system.

In addition to the aggregate effect, it is worth analyzing the behavior of the 5-min coefficients in some selected situations. The general pattern is of an immediate conditional mean adjustment, characterized by a jump immediately following the announcement release, and no significant reaction thereafter. Aggregate effects, computed as the sum of the coefficient estimates, are persistent providing that quick reactions are not overturned in the remaining intervals. Graph 5.1 displays that COPOM surprises are significant only in the first 5-min interval for both sample estimates in the IR market. Adjustment to IPCA surprise, instead, occurs only in the expansion period, also limited to the first 5-min interval.

Graph 5.1: Estimated impact of Copom and IPCA on the IR futures market in each 5-min interval after announcement release per unit shock

(A unit shock from COPOM and FOMC is equal to 25 basis points; IPCA and CPI: 0.10 p.p.; PIM: 1.0 p.p.; PR: 100,000 jobs.)

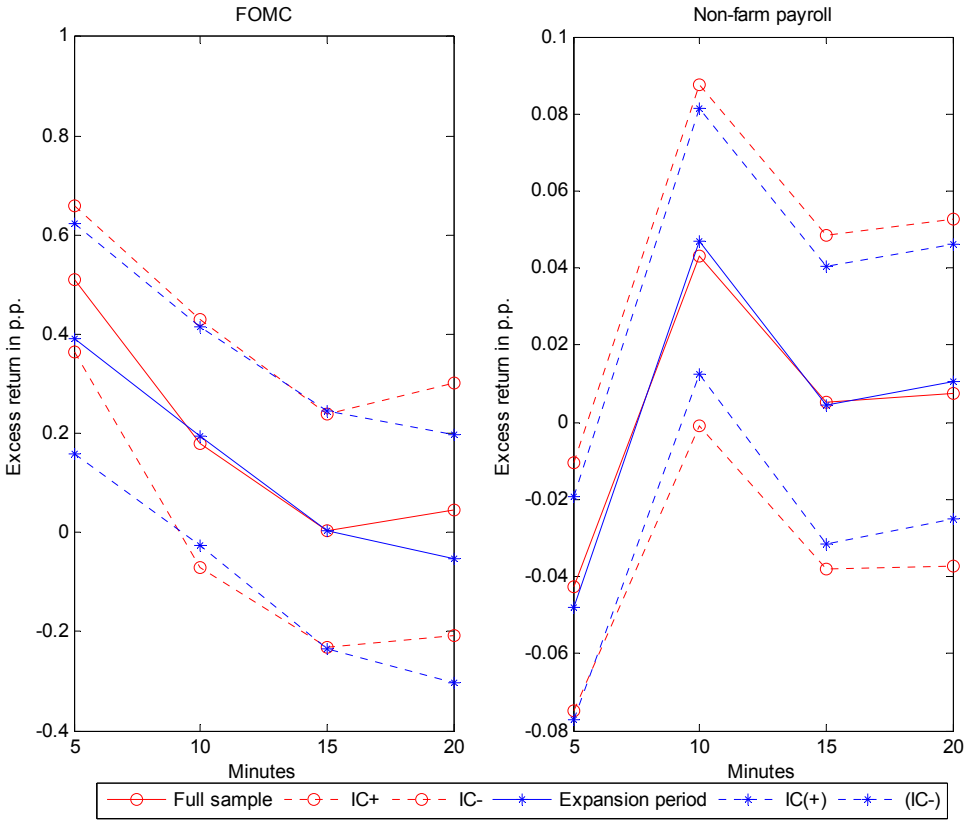


Note: Significance level: 5%

In the FX futures market, FOMC surprises are immediately incorporated into prices in both sample estimates, where the sign coefficient is meant by a positive correlation between 10-year US Treasury yields and USD appreciation (or BRL depreciation). As far as PR is concerned, we see that in both samples, the first reaction of the market is to appreciate dollar in response to a positive PR surprise, which means that a stronger economy with higher payroll figures appreciate dollar, exactly as implied by theory. But this effect is transitory as the FX market immediately reverse this trend it in the next interval.

Graph 5.2: Estimated Impact of FOMC and PR on the FX futures market in each 5-min interval after announcement release per unit shock

(A unit shock from COPOM and FOMC is equal to 25 basis points; IPCA and CPI: 0.10 p.p.; PIM: 1.0 p.p.; PR: 100,000 jobs.)

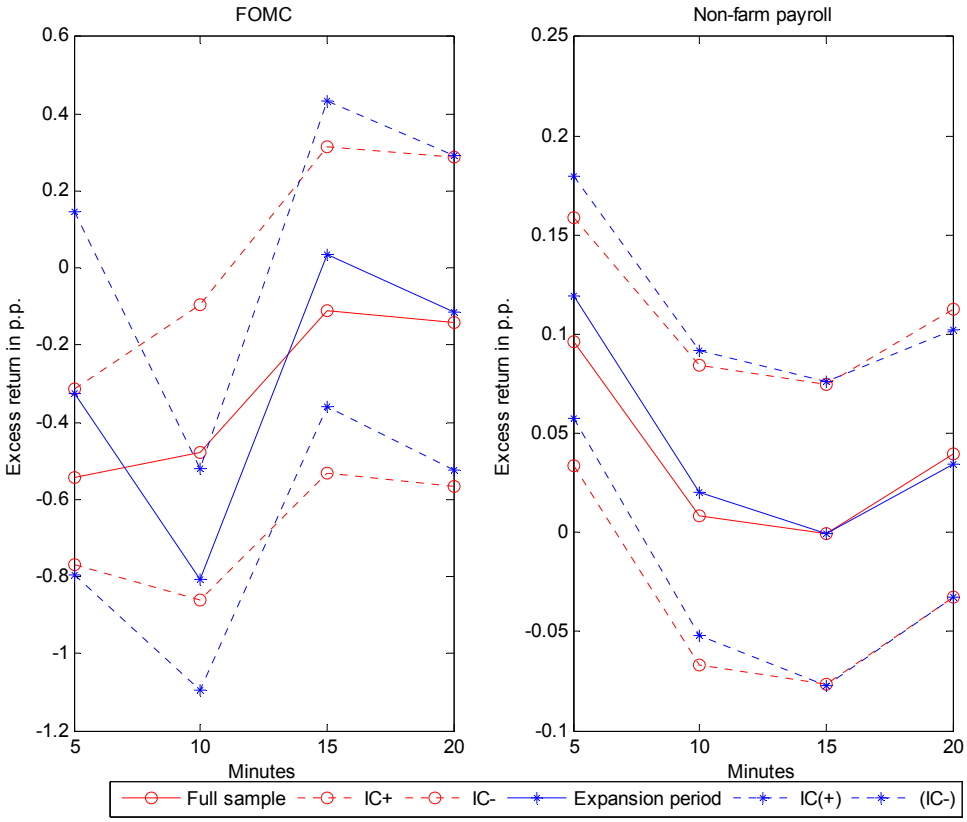


Note: Significance level: 5%

At Ibovespa market, a negative FOMC surprise, or conversely, financial market´s expectation that lower external interest rates will hold for a prolonged time is positive to domestic stock index returns. Its individual coefficient estimates are significant up to ten minutes after the announcement release, in contrast to the other markets. PR surprise affects the stock market in both samples with a similar pattern as the one observed in the previous examples, where adjustment occurs in the first 5-min interval.

Graph 5.3: Estimated impact of FOMC and PR on the Ibovespa futures market in each 5-min interval after announcement release per unit shock

(A unit shock from COPOM and FOMC is equal to 25 basis points; IPCA and CPI: 0.10 p.p.; PIM: 1.0 p.p.; PR: 100,000 jobs.)



Note: Significance level: 5%

5.2. Impact of macroeconomic announcements on trading volume and spreads

Consistent with previous results in the literature, there is no straightforward connection between trading volume and returns changes since there are announcements that do not impact returns at all but impact trading volume, and vice-versa. PIM and CPI, for instance, have an important overall effect on trading volume with no corresponding impact on returns. In the FX and Ibovespa markets, trading volume is affected by all external announcements in the first 5-min interval for both estimates. Impact on the IR trading volume, in turn, is dominated by domestic announcements although CPI and PR produce changes in terms of trading volume. Macroeconomic announcements are also

economically important in explaining trading volume as we can infer by analyzing goodness of fit through its R^2 levels presented in Table 3 of Appendix.

From Table, 5.2.1, it is also noteworthy to determine that impacts, when significant, are highly persistent up to twenty minutes after the release. Due to agent heterogeneity, liquidity trading shall occur in stages, with investors performing trades at different times leading to an impact on trading volume that is spread over the post-announcement window.

Table 5.2.1: Impact of macroeconomic announcements on each futures market on trading volume

	IR		FX		Ibovespa	
How fast						
	Full sample	Expansion period	Full sample	Expansion period	Full sample	Expansion period
COPOM	5 min	5 min	5 min	5 min	5 min	5 min
IPCA	5 min	5 min	No impact	No impact	5 min	5 min
PIM	5 min	5 min	5 min	5 min	No impact	No impact
FOMC	No impact	No impact	5 min	5 min	5 min	5 min
CPI	5 min	5 min	5 min	5 min	5 min	5 min
PR	5 min	5 min	5 min	5 min	5 min	5 min
How long						
	IR		FX		Ibovespa	
	Full sample	Expansion period	Full sample	Expansion period	Full sample	Expansion period
COPOM	20 min	20 min	20 min	20 min	5 min	5 min
IPCA	20 min	20 min	No impact	No impact	5 min	5 min
PIM	20 min	20 min	20 min	20 min	No impact	No impact
FOMC	No impact	No impact	20 min	20 min	20 min	20 min
CPI	20 min	20 min	15 min	20 min	5 min	5 min
PR	20 min	20 min	20 min	20 min	20 min	20 min
How much (Reported coefficients are expressed considering the seasonal adjustment proposed in Section 4. The coefficient unit, thus, is the hourly average trading volume prevailing at the time of the announcement release.)						
	IR		FX		Ibovespa	
	Full sample	Expansion period	Full sample	Expansion period	Full sample	Expansion period
COPOM	3.34	3.92	0.95	1.61	0.25	0.38
IPCA	2.05	1.64	No impact	No impact	-0.19	-0.23
PIM	0.99	1.11	1.05	1.39	No impact	No impact
FOMC	No impact	No impact	1.55	1.88	2.25	2.43
CPI	0.17	1.4	0.53	0.66	0.32	0.32
PR	1.27	3.13	2.04	2.13	1.56	1.79

Note: All the estimates consider a 5% level of significance.

Note that the surprise component of COPOM increases the number of traded contracts in the IR market by 3.34 and 3.92 relatively to the hourly average, respectively, in the full sample and expansion period estimates. If we deseasonalize the data, the increase in the number of traded contracts amounts to 4,880 and 5,730, respectively. If we refer back to theory, one can associate such remarkable result to COPOM's high information precision and its success in solving agents' uncertainty. One caveat, however, is that FOMC surprises are largely insignificant during the observation period, a counterintuitive finding when confronted with the importance of FOMC-related news that deserves further investigation. As far as the FX and Ibovespa markets are concerned, the dominant role is performed by FOMC and PR surprises. In the expansion estimates, FOMC raises FX and Stock trading volumes by 1.88 and 2.43 times relatively to the hourly average, respectively, while PR impact is in the same order of magnitude. Besides market microstructure considerations, the superior informational quality of the dominant announcements can also stimulate trading.

From Table 5.2.2, we can see that spreads are affected mainly by domestic announcements where impact is immediate in the vast majority of situations. Taking trading volume as a proxy for liquidity, the association between liquidity and spreads is not confirmed as the increase in spreads is not accompanied by a reduction on trading volume.

Equally important is the fact that external announcements have little, if any, impact on spreads. We refer to Balduzzi, Elton & Green (2001) in order to provide an explanation for this finding. The quick reversion of bid-ask spreads, not captured by our 5-min data frequency, can be attributed to the dominance of informed trading in an initial trading phase. Such view can be reconciled with price impact figures (Graphs 5.2 and 5.3),

where coefficients are only significant in the first interval. The persistence of trading volume beyond spreads' reversion is an evidence of a second trading phase where liquidity trading is prevailing, what supposedly occurs when markets face domestic announcements.

Table 5.2.2: Impact of macroeconomic announcements on each futures market on spread

	IR		FX		Ibovespa	
How fast						
	Full sample	Expansion period	Full sample	Expansion period	Full sample	Expansion period
COPOM	5 min	5 min	5 min	5 min	5 min	20 min
IPCA	5 min	5 min	5 min	5 min	5 min	5 min
PIM	5 min	5 min	5 min	5 min	5 min	5 min
FOMC	5 min	10 min	5 min	5 min	No impact	No impact
CPI	No impact	No impact	No impact	No impact	No impact	No impact
PR	5 min	5 min	5 min	5 min	5 min	No impact
How long						
	IR		FX		Ibovespa	
	Full sample	Expansion period	Full sample	Expansion period	Full sample	Expansion period
COPOM	20 min	No impact	20 min	20 min	20 min	20 min
IPCA	20 min	20 min	20 min	20 min	20 min	20 min
PIM	20 min	20 min	20 min	20 min	20 min	20 min
FOMC	20 min	10 min	20 min	20 min	No impact	No impact
CPI	No impact	No impact	No impact	No impact	No impact	No impact
PR	20 min	20 min	20 min	20 min	5 min	No impact
How much (Excess returns are expressed in percentage points. Reported coefficients are adjusted to the fact that volume is expressed in logarithms and the explanatory variable is a dummy.)						
	IR		FX		Ibovespa	
	Full sample	Expansion period	Full sample	Expansion period	Full sample	Expansion period
COPOM	0.61	No impact	1.77	0.58	2.29	0.86
IPCA	1.19	1.14	2.00	1.93	0.95	0.63
PIM	1.21	1.30	1.76	1.76	0.19	0.86
FOMC	0.54	0.13	0.31	0.36	No impact	No impact
CPI	No impact	No impact	No impact	No impact	No impact	No impact
PR	0.41	0.43	0.39	0.44	0.31	No impact

Note: All the estimates consider a 5% level of significance.

Assuming that spread increases are related to the presence of informed traders, why should this informational advantage be persistent for domestic announcements? It is realistic to infer that external announcements are more difficult to forecast and interpret by domestic traders, reducing the proportion of informed traders in relative terms. At the full sample, COPOM, IPCA and PIM raise IR market spreads by 0.61, 1.19 and 1.21

times[29]. In the FX and Ibovespa markets, estimates share the same signals and orders of magnitude. Individual regression results are shown in Table 4 of Appendix.

5.3. Robustness to changes in the monetary surprise

We proceed by outlining that the use of longer term bonds as a proxy for the monetary surprise is justified by the fact that FOMC releases reveals more than the prime rate and give hints on the future decision which impacts the term structure of interest rates, even at the zero-bound. However, this is far from obvious, since using daily changes in longer term bonds imply additional assumptions concerning time-varying risk premiums and additional factors driving rates other than the FOMC announcements. The best way to assess robustness is by changing the baseline contract and to analyze changes in the results.

Our reference scenario bases its monetary surprise in a long-term treasury bond, with 10 years to maturity. If, instead, we take a medium-term contract, for instance, 2 years to maturity, there are no changes in the impact signals and only one change in our persistence indicator: the impact of a 25 basis points' FOMC surprise at the FX market , in the expansion period, is faster (15 minutes as opposed to 20 minutes). If we change of the contract to a shorter one, with 1 year to maturity, FOMC's surprise impact on Ibovespa market vanishes at the expansion period. We can state that the use of a shorter term contract implies a lesser impact on Brazilian futures markets. In contrast, when we use a longer maturity contract in the domestic surprise calculus, a 1-year SWAP contract, COPOM surprises displays higher point estimate reactions when returns are taken as the dependent variable. In the expansion period, for instance, stock markets are positively related to a 25 basis points COPOM monetary surprise, raising returns by

[29] Again, relative to the hourly average spread.

0.25%. In general, thus, it is fair to say that the use of longer maturities amplify the impact of the monetary surprise.

In terms of volume, the change in monetary surprises' definition does not alter the results. Apart from minor changes in the intensity coefficients, COPOM's influence on volume is more pronounced in the IR market while FOMC's is in the Ibovespa one. COPOM preserves its impact on spreads over all markets, while the use of a shorter term contract do not change the fact that FOMC has no impact on the IR market trading volume.

5.4. Application: Out-of-sample performance based on an announcement-timing strategy

To provide a sense of the practical application of the returns' model, we describe an approach for measuring the potential gains associated with the methodology described in Section 4. The interpretation of the returns' impact for each announcement provides the tools to devise a simple strategy where one takes a portfolio position immediately after the announcement is public, i.e., as soon as its surprise is known. In this framework, investors take a long or short position depending on the combination between sign impact and surprise direction, as shown in the table below.

We restrain our analysis to the expansion period as we believe markets were better behaved away from the extreme events of the last quarter of 2008 and the first quarter of 2009, leading to more stable and structural estimates. We separate 80% of the observations for the in-sample estimates, shown in the table below, and the remaining 20% for the out-of-sample exercise. We also define persistent announcement as those with significant aggregate coefficients up to twenty minutes after announcement's

releases. The exceptions to the persistency rule are the estimated impact of COPOM and IPCA on the IR market whose aggregation window has been reduced to ten minutes providing that such announcements are publicly available while markets are closed leading to differential informational absorption as Table 5.1.1 shows.

Table 5.4.1: In-sample estimates of the persistent impact based on regression results for each market and announcement in the expansion period
(Reported coefficients are expressed in percentage points for a unit shock. A unit shock from COPOM and FOMC: 25 basis points; IPCA and CPI: 0.10 p.p.; PIM: 1.0 p.p.; PR: 100,000 jobs.)

	IR	FX	Ibovespa
COPOM	-0.078	No impact	0.059
IPCA	0.033	No impact	No impact
PIM	No impact	No impact	No impact
FOMC	No impact	0.149	-0.224
CPI	No impact	No impact	No position
PR	No impact	No impact	0.042

The results in Table 5.4.1 generate the following high frequency trading strategy, as in Table 5.4.2. In order to take advantage of the information contained in macroeconomic announcements, investors should trade immediately after identifying its surprise component and revert to a neutral position shortly after. Note that the investment holding period varies according to the previous persistency definition (ten minutes for investments in the IR market after COPOM and IPCA announcements and twenty minutes for the remaining ones).

Table 5.4.2: Summary of the announcement-timing strategy based on regression results

	IR	FX	Ibovespa
COPOM	Sell, if surprise is positive. Buy, otherwise.	No position	Buy, if surprise is positive. Sell, otherwise.
IPCA	Buy, if surprise is positive. Sell, otherwise.	No position	No position
PIM	No position	No position	No position
FOMC	No position	Buy, if surprise is positive. Sell, otherwise	Sell, if surprise is positive. Buy, otherwise.
CPI	No position	No position	No position
PR	No position	No position	Buy, if surprise is positive. Sell, otherwise

The above strategy will be tested in 23 announcement releases from October 2010 to January 2011, a 4-month period. Transactions costs, including registration and exchange

fees, are taken directly from BVMF which offers special conditions for investors registered as high frequency traders. It adopts a pricing model of differentiated and decreasing fees based on the volume executed by investors. Our results can be labeled conservative since the worst case scenario will be applied, that is, the one of highest proportional fees compatible with the initial investment proposed.

As we will see, the out-of-sample results of this strategy are encouraging. In Table 5.4.3, the consolidated results are summarized considering a USD 5 million initial investment in the FX market, and BRL 5 million in the IR and Ibovespa markets. It is clear that the consolidated results are positive for all announcements, except for investments in the Ibovespa futures market after COPOM interest rate decisions. It turns out that 16 out of 23 recommended positions generate positive returns, resulting in a 70% success rate. Note, however, that performance across announcements is not homogenous. While all FOMC-related positions matched the anticipated market directions for all markets, COPOM influence specifically on the stock market shows the lowest success rate, with 1 positive return out of 3 announcements.

Table 5.4.3: Results of the strategies based on regression results, in nominal terms and in percentage points.

	IR (in Brazilian reais)	FX (in US dollars)	Ibovespa (in Brazilian reais)
COPOM	BRL 5.281,24		-BRL 6.500,91
IPCA	BRL 2.197,64		
PIM			
FOMC		USD 12.435,64	BRL 13.834,84
CPI			
PR			BRL 5.835,10
Total	BRL 7.478,88	USD 12.435,64	BRL 13.105,01
Excess return as a percentage of the initial investment	0.15%	0.25%	0.26%

6. Conclusion

This paper explores the role of macroeconomic announcements in the Brazilian futures market in order to assess the link between economic fundamentals and asset pricing. Although it has been the subject of many empirical studies, the issue is far from resolved. With a few exceptions, event studies using daily data found little evidence of this connection. The main issue is that returns are affected by a number of factors that are not easily identifiable in low frequency. Intraday data allowed us to separate the effect of announcements properly and we are able to find robust evidence of this impact in specific announcements and states of the economy.

This study contributes to the literature on the impact of macroeconomic announcements in emerging markets. Testing six announcements over the period between October 2008 and January 2011, we find that external monetary policy (FOMC) is not only the main factor driving returns in the FX market but also the single persistent one, where a 25 basis points' surprise raises FX returns in 0.191 p.p. and 0.089 p.p. in the full sample and expansion period, respectively, twenty minutes after its release. A more widespread reaction to macroeconomic announcements is observed in the Ibovespa futures market. A negative association between FOMC surprises and stock returns has been identified implying that a US monetary policy easing is related to positive stock returns in Brazil. In contrast, non-farm payroll records are positively associated with domestic stock index returns suggesting that the dividend effect is higher than the cost of capital one and also that real economy shocks are correlated between Brazilian and US economies. PR is persistent up to twenty minutes at both sample periods, when a 100,000 jobs' surprise increase returns in the stock market by 0.151 p.p. and 0.182 in the full sample and expansion period, respectively. In the IR market, we find a negative correlation

between COPOM surprises and returns that can be credited to the misalignment between financial market and central bank expectations over inflation during the sample period. IPCA surprises, exactly as anticipated by theory, are positively related to futures interest rates.

We also offer a practical application of the study by constructing an announcement-timing investment strategy, where investors take a long or short position depending on the combination between sign impact and surprise direction. This approach enables us to directly assess the potential gains associated to our methodological framework. As a matter of fact, it showed promising results in an out-of-sample study as we are able to correctly anticipate the direction of the returns, conditional on the surprise's signal, in 70% of the cases. State dependency is found to be a potential factor driving market returns by changing the magnitude of the coefficients that measure the impact of announcements, occasionally eliminating predicted impacts as implied by the non-significance of estimates for the IPCA announcement in the full sample which is in contrast to the persistent results that holds in the expansion period.

Overall, our results point to large differences in the relative weight of domestic and external announcements. In Andersen et al (2007), for instance, domestic events (in this case, taking US as domestic country) play a central role in asset pricing. In our study, domestic dominance is restricted the IR market while external announcements govern price changes in the FX and Ibovespa futures markets. It is somewhat surprising, though, that the domestic real economy announcement (PIM) has negligible effect on returns. In theory, the level of information content of a data release is proportional to the effect on the financial market, triggering portfolio reallocation and influencing asset pricing. In this particular case, financial market probably faces data issues that prevent it

from correctly interpreting and resolving uncertainty in the post-announcement release period. Enhancing economic data availability could be a good start in order to handle this problem.

Similarly, we contribute to the literature by finding that announcements are followed by greater trading volume, suggesting that uncertainty resolution triggers transactions in all markets irrespective of the business cycle. More important, contrary to price reaction, the effect on trading volume is widespread, showing that the absence of price reaction is not a sufficient condition to overrule the announcement importance. We also document large differences in the relative magnitude of trading volume reactions attributing it to differential levels of informational content between announcements. We finally find that bid-ask spreads often quickly revert when external announcements are released that, form a microstructure viewpoint, can indicate the prevalence of different kinds of investors and trading phases.

Finally, we show that the impact of IPCA announcements in the IR market returns vary according to the sample period. In contrast to full sample results, point estimates are significant when database is restricted to the expansion cycle. In this regard, previous theoretical work (Blanchard (1981), Veronesi (1999)) showed that asset price response to news is state-dependent, suggesting that the context may define the way financial markets process information. Due to data availability, though, state-dependency could not be properly assessed. Further research can bring light to this issue as long as one is able to split sub-samples according to the economic cycle. There are other open questions that can orient future research. In particular, the investigation of correlation across markets could indicate common factors that make them move together. The impact on volatility is another important issue that comes up naturally.

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Appendix

Figure 1. Framework for the database construction

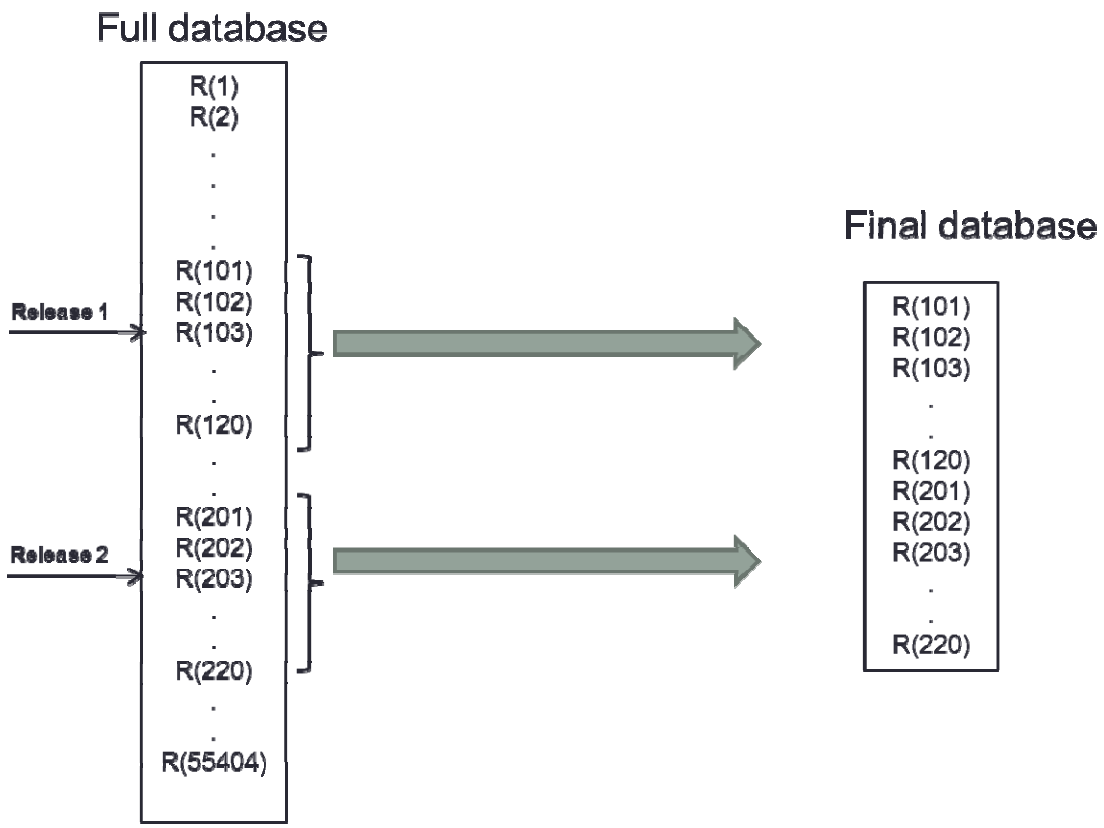

Table 1: Hourly average trading volume (number of traded contracts) and spread per futures market

	Spread			Trading Volume		
	IR	FX	Ibovespa	IR	FX	Ibovespa
1st hour	0.00176	0.16118	0.08254	1461	2406	365
2nd hour	0.00141	0.00181	0.00064	1122	2768	602
3rd hour	0.00136	0.00067	0.00061	1089	3120	657
4th hour	0.00135	0.00128	0.00059	828	2701	507
5th hour	0.00137	0.00140	0.00057	275	1552	364
6th hour	0.00135	0.00101	0.00057	675	1822	392
7th hour	0.00124	0.00057	0.00057	1345	2977	473
8th hour	0.00175	0.00166	0.00060	497	1914	498
9th hour	0.00122	0.01683	0.00066	496	1392	515

Table 2: Regression results for returns

The table shows WLS estimation's results for models (4.1) and (4.2), one for each futures market and sample period. The coefficients and t-stats are reported. Surprises are normalized according to (3.2.1).

		IR		FX		Ibovespa	
		Full sample	Expansion period	Full sample	Expansion period	Full sample	Expansion period
IR Return (t-1)	point estimate	-0.04600	-0.07780**	0.02340	0.02570	-0.07900**	0.00013
	standard deviation	(0.02860)	(0.03240)	(0.02170)	(0.02210)	(0.03140)	(0.03880)
FX Return (t-1)	point estimate	-0.01080	-0.01340	0.02220	0.01120	-0.07940**	0.23000**
	standard deviation	(0.01590)	(0.01890)	(0.02860)	(0.03010)	(0.03350)	(0.04720)
Ibovespa Return (t-1)	point estimate	-0.00842	-0.00108	-0.00025	-0.01910	-0.01850	0.05610
	standard deviation	(0.00950)	(0.01280)	(0.01380)	(0.01620)	(0.02860)	(0.03800)
COPOM surprise (t)	point estimate	-0.00055***	-0.00053***	-0.00024***	-0.00031***	0.00067***	0.00061***
	standard deviation	(0.00018)	(0.00018)	(0.0009)	(0.00008)	(0.00015)	(0.00015)
COPOM surprise (t-1)	point estimate	-0.00001	0.00006	0.00023**	0.00032***	-0.00037*	-0.00014
	standard deviation	(0.00018)	(0.00018)	(0.00011)	(0.00009)	(0.00019)	(0.00018)
COPOM surprise (t-2)	point estimate	0.00002	0.00004	-0.00007	0.00001	0.00011	-0.00005
	standard deviation	(0.00020)	(0.00019)	(0.00014)	(0.00009)	(0.00020)	(0.00018)
COPOM surprise (t-3)	point estimate	0.00009	0.00027	-0.00028**	-0.00015*	0.00035	0.00057***
	standard deviation	(0.00023)	(0.00022)	(0.00014)	(0.00009)	(0.00023)	(0.00019)
IPCA surprise (t)	point estimate	0.00017	0.00044***	0.00033**	0.00015	-0.00018	0.00020
	standard deviation	(0.00014)	(0.00014)	(0.00013)	(0.00012)	(0.00018)	(0.00025)
IPCA surprise (t-1)	point estimate	0.00001	-0.00016	-0.00018	-0.00006	-0.00010	-0.00001
	standard deviation	(0.00018)	(0.00017)	(0.00017)	(0.00012)	(0.00023)	(0.00025)
IPCA surprise (t-2)	point estimate	0.00025	0.00017	-0.00009	-0.00014	0.00016	0.00027
	standard deviation	(0.00019)	(0.00016)	(0.00017)	(0.00012)	(0.00021)	(0.00022)
IPCA surprise (t-3)	point estimate	-0.00017	-0.00014	0.00021	0.00014	-0.00017*	-0.00006
	standard deviation	(0.00018)	(0.00016)	(0.00017)	(0.00011)	(0.00023)	(0.00023)
PIM surprise (t)	point estimate	-0.00014	-0.00014	0.00008	0.00014	0.00017	0.00034***
	standard deviation	(0.00011)	(0.00010)	(0.00011)	(0.00009)	(0.00010)	(0.00012)
PIM surprise (t-1)	point estimate	0.00011	-0.00013	-0.00012	-0.00002	-0.00017	-0.00024*
	standard deviation	(0.00014)	(0.00014)	(0.00012)	(0.00009)	(0.00011)	(0.00015)
PIM surprise (t-2)	point estimate	0.00002	-0.00001	0.00004	0.00002	-0.00011	-0.00002
	standard deviation	(0.00017)	(0.00015)	(0.00012)	(0.00009)	(0.00013)	(0.00013)
PIM surprise (t-3)	point estimate	-0.00006	-0.00007	-0.00009	-0.00008	0.00017	0.00022*
	standard deviation	(0.00015)	(0.00013)	(0.00011)	(0.00009)	(0.00012)	(0.00012)

FOMC surprise (t)	point estimate	0.00017*	0.00018*	0.00079***	0.00061***	-0.00084***	-0.00050***
	standard deviation	(0.00009)	(0.00009)	(0.00012)	(0.00010)	(0.00018)	(0.00019)
FOMC surprise (t-1)	point estimate	0.00005	-0.00003	0.00028	0.00030***	-0.00074**	-0.00125***
	standard deviation	(0.00011)	(0.00009)	(0.00020)	(0.00011)	(0.00030)	(0.00015)
FOMC surprise (t-2)	point estimate	-0.00014	-0.00021**	0.00001	0.00001	-0.00017	0.00006
	standard deviation	(0.00013)	(0.00010)	(0.00019)	(0.00012)	(0.00034)	(0.00021)
FOMC surprise (t-3)	point estimate	0.00002	-0.00003	0.00007	-0.00008	-0.00022	-0.00018
	standard deviation	(0.00013)	(0.00009)	(0.00020)	(0.00013)	(0.00034)	(0.00021)
CPI surprise (t)	point estimate	-0.00004	-0.00002	0.00007	0.00001	-0.00007	0.00003
	standard deviation	(0.00008)	(0.00013)	(0.00010)	(0.00013)	(0.00016)	(0.00022)
CPI surprise (t-1)	point estimate	-0.00015	-0.00024*	0.00001	-0.00004	0.00028*	0.00040***
	standard deviation	(0.00009)	(0.00014)	(0.00011)	(0.00012)	(0.00015)	(0.00020)
CPI surprise (t-2)	point estimate	0.00011	-0.00007	0.00017*	0.00035***	-0.00035**	-0.00016
	standard deviation	(0.00010)	(0.00014)	(0.00009)	(0.00012)	(0.00016)	(0.00021)
CPI surprise (t-3)	point estimate	0.00007	0.00006	-0.00006	-0.00001	0.00008	0.00003
	standard deviation	(0.00009)	(0.00012)	(0.00010)	(0.00010)	(0.00015)	(0.00019)
PR surprise (t)	point estimate	0.00030***	0.00027**	-0.00042***	-0.00048***	0.00096***	0.00118***
	standard deviation	(0.00013)	(0.00012)	(0.00016)	(0.00014)	(0.00032)	(0.00033)
PR surprise (t-1)	point estimate	-0.00010	-0.00013	0.00043*	0.00047**	0.00008	0.00020
	standard deviation	(0.00015)	(0.00013)	(0.00022)	(0.00019)	(0.00038)	(0.00041)
PR surprise (t-2)	point estimate	0.00006	0.00004	0.00005	0.00004	-0.00001	-0.00001
	standard deviation	(0.00014)	(0.00014)	(0.00022)	(0.00019)	(0.00038)	(0.00042)
PR surprise (t-3)	point estimate	-0.00013	-0.00011	0.00007	0.00011	0.00039	0.00035
	standard deviation	(0.00014)	(0.00013)	(0.00023)	(0.00020)	(0.00037)	(0.00039)
Intercept	point estimate	-0.00001	-0.00001	-0.00003***	-0.00003***	0.00004***	0.00025***
	standard deviation	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00002)	(0.00001)
Observations		2,482	1,788	2,482	1,788	2,482	1,788
R-squared		0.015	0.030	0.037	0.060	0.038	0.080

Note: standard errors in brackets. * Significance at 90% levels. ** Significance at 95% levels. *** Significance at 99% levels.

Table 3: Regression results for trading volume

The table shows WLS estimation's results for models (4.3) and (4.4), one for each futures market and sample period, where. Variable X refers to trading volume. The coefficients and t-stats are reported.

		IR		FX		Ibovespa	
		Full sample	Expansion period	Full sample	Expansion period	Full sample	Expansion period
IR Volume (t-1)	point estimate	0.104***	0.106***	0.007	0.012	0.008	0.014
	standard deviation	(0.022)	(0.026)	(0.013)	(0.016)	(0.009)	(0.011)
FX Volume (t-1)	point estimate	-0.025	0.003	0.236***	0.225***	0.015	0.021
	standard deviation	(0.030)	(0.033)	(0.025)	(0.029)	(0.014)	(0.016)
Ibovespa Volume (t-1)	point estimate	0.036	0.030	0.011	0.017	0.278***	0.279***
	standard deviation	(0.042)	(0.045)	(0.028)	(0.031)	(0.022)	(0.025)
COPOM dummy (t)	point estimate	1.137***	1.268***	0.463**	0.784***	0.249**	0.384***
	standard deviation	(0.245)	(0.278)	(0.199)	(0.236)	(0.125)	(0.151)
COPOM dummy (t-1)	point estimate	0.909***	0.816***	0.034	0.126	0.025	-0.069
	standard deviation	(0.247)	(0.282)	(0.190)	(0.233)	(0.125)	(0.153)
COPOM dummy (t-2)	point estimate	0.955***	1.477***	0.156	0.358	-0.019	-0.103
	standard deviation	(0.246)	(0.284)	(0.179)	(0.222)	(0.123)	(0.149)
COPOM dummy (t-3)	point estimate	0.343	0.361	0.298	0.340	0.005	0.086
	standard deviation	(0.243)	(0.279)	(0.189)	(0.231)	(0.125)	(0.154)
IPCA dummy (t)	point estimate	0.881***	1.086***	0.116	0.197	-0.191*	-0.228*
	standard deviation	(0.237)	(0.255)	(0.166)	(0.183)	(0.101)	(0.115)
IPCA dummy (t-1)	point estimate	0.246	0.176	0.247	0.140	0.213**	0.196*
	standard deviation	(0.247)	(0.269)	(0.153)	(0.171)	(0.104)	(0.118)
IPCA dummy (t-2)	point estimate	0.404	0.135	-0.077	-0.041	-0.250**	-0.215*
	standard deviation	(0.231)	(0.245)	(0.153)	(0.173)	(0.100)	(0.113)
IPCA dummy (t-3)	point estimate	0.518	0.246	-0.188	-0.241	-0.038	-0.054
	standard deviation	(0.227)	(0.237)	(0.157)	(0.177)	(0.099)	(0.114)
PIM dummy (t)	point estimate	0.407*	0.533**	0.615***	0.869***	-0.020	0.006
	standard deviation	(0.224)	(0.244)	(0.160)	(0.185)	(0.096)	(0.111)
PIM dummy (t-1)	point estimate	0.142	0.096	0.113	0.076	0.055	0.052
	standard deviation	(0.228)	(0.250)	(0.162)	(0.192)	(0.095)	(0.110)
PIM dummy (t-2)	point estimate	0.283	0.262	0.169	0.157	-0.106	-0.188*
	standard deviation	(0.218)	(0.234)	(0.149)	(0.169)	(0.095)	(0.109)
PIM dummy (t-3)	point estimate	0.154	0.224	0.175	0.289*	-0.042	-0.095
	standard deviation	(0.215)	(0.230)	(0.151)	(0.174)	(0.093)	(0.105)

FOMC dummy (t)	point estimate	-0.254	-0.178	0.584***	0.717***	0.767***	0.980***
	standard deviation	(0.267)	(0.293)	(0.169)	(0.183)	(0.134)	(0.155)
FOMC dummy (t-1)	point estimate	0.459*	0.489*	0.478***	0.568***	0.778***	0.746***
	standard deviation	(0.259)	(0.282)	(0.171)	(0.187)	(0.141)	(0.162)
FOMC dummy (t-2)	point estimate	-0.136	-0.098	0.181	0.240	0.234*	0.249*
	standard deviation	(0.264)	(0.287)	(0.161)	(0.175)	(0.132)	(0.151)
FOMC dummy (t-3)	point estimate	0.099	0.104	0.305*	0.359**	0.466***	0.454***
	standard deviation	(0.262)	(0.285)	(0.165)	(0.180)	(0.131)	(0.150)
CPI dummy (t)	point estimate	0.582**	0.744***	0.633***	0.732***	0.324***	0.321***
	standard deviation	(0.238)	(0.257)	(0.125)	(0.145)	(0.099)	(0.113)
CPI dummy (t-1)	point estimate	0.407*	0.357	-0.00175	0.062	-0.065	-0.093
	standard deviation	(0.239)	(0.258)	(0.131)	(0.151)	(0.098)	(0.114)
CPI dummy (t-2)	point estimate	0.069	0.127	-0.0979	-0.072	-0.190**	-0.220**
	standard deviation	(0.229)	(0.250)	(0.123)	(0.146)	(0.095)	(0.112)
CPI dummy (t-3)	point estimate	0.217	0.167	-0.0952	-0.061	-0.055	-0.028
	standard deviation	(0.223)	(0.247)	(0.123)	(0.146)	(0.093)	(0.109)
PR dummy (t)	point estimate	2.082***	2.468***	1.729***	1.688***	1.406***	1.619***
	standard deviation	(0.238)	(0.259)	(0.132)	(0.152)	(0.096)	(0.109)
PR dummy (t-1)	point estimate	0.731***	1.011***	-0.0292	0.022	0.147	0.132
	standard deviation	(0.269)	(0.303)	(0.146)	(0.172)	(0.111)	(0.126)
PR dummy (t-2)	point estimate	0.229	-0.094	0.177	0.203	0.003	0.039
	standard deviation	(0.237)	(0.258)	(0.129)	(0.149)	(0.098)	(0.112)
PR dummy (t-3)	point estimate	-0.123	-0.256	0.164	0.214	0.001	0.002
	standard deviation	(0.222)	(0.235)	(0.135)	(0.155)	(0.099)	(0.111)
Intercept	point estimate	0.759***	0.727***	0.695***	0.685***	0.661***	0.644***
	standard deviation	(0.054)	(0.059)	(0.0365)	(0.041)	((0.026)	(0.030)
Observations		2,482	1,788	2,482	1,788	2,482	1,788
R-squared		0.081	0.112	0.132	0.143	0.184	0.213

Note: standard errors in brackets. * Significance at 90% levels. ** Significance at 95% levels. *** Significance at 99% levels.

Table 4: Regression results for spreads

The table shows WLS estimation's results for models (4.3) and (4.4), one for each futures market and sample period, where. Variable X refers to bid-ask spread. The coefficients and t-stats are reported.

		IR		FX		Ibovespa	
		Full sample	Expansion period	Full sample	Expansion period	Full sample	Expansion period
IR Spread (t-1)	point estimate	0.08450***	0.06290*	0.02370	0.02610	-0.04220	-0.01230
	standard deviation	(0.02740)	(0.03130)	(0.02450)	(0.02110)	(0.03440)	(0.03360)
FX Spread (t-1)	point estimate	0.01100	0.06690***	0.05310*	0.05360*	-0.03600	-0.04190
	standard deviation	(0.01730)	(0.02470)	(0.02940)	(0.03090)	(0.02790)	(0.03240)
Ibovespa Spread (t-1)	point estimate	0.01790	0.03060	0.03930**	0.04020**	-0.00315	0.00968
	standard deviation	(0.01310)	(0.01900)	(0.01550)	(0.01580)	(0.02720)	(0.03150)
COPOM dummy (t)	point estimate	0.63300***	0.19700	1.76400***	0.62900***	1.58900***	0.40900
	standard deviation	(0.13200)	(0.20200)	(0.14700)	(0.16100)	(0.20100)	(0.25800)
COPOM dummy (t-1)	point estimate	-0.08070	-0.19500	-0.09340	-0.06530	0.19800	0.13500
	standard deviation	(0.12800)	(0.16200)	(0.17800)	(0.17700)	(0.19700)	(0.20400)
COPOM dummy (t-2)	point estimate	-0.00751	0.03480	0.00686	-0.10200	0.32500*	0.11300
	standard deviation	(0.11000)	(0.14400)	(0.17300)	(0.18800)	(0.18900)	(0.18100)
COPOM dummy (t-3)	point estimate	0.06530	0.10100	0.09650	0.11500	0.17900	0.20000
	standard deviation	(0.10200)	(0.12500)	(0.13300)	(0.13200)	(0.15800)	(0.15500)
IPCA dummy (t)	point estimate	0.71000***	0.66300***	1.88300***	1.74000***	0.88200***	0.44600***
	standard deviation	(0.10800)	(0.12000)	(0.13200)	(0.11300)	(0.19000)	(0.17300)
IPCA dummy (t-1)	point estimate	0.39700***	0.31900**	-0.02620	-0.02020	0.06450	0.05930
	standard deviation	(0.12000)	(0.13300)	(0.15500)	(0.13100)	(0.18500)	(0.16500)
IPCA dummy (t-2)	point estimate	0.07000	0.11000	0.15100	0.14400	-0.11300*	-0.08000
	standard deviation	(0.10900)	(0.12900)	(0.14700)	(0.13200)	(0.17700)	(0.15500)
IPCA dummy (t-3)	point estimate	0.01160	0.05250	-0.00654	0.06700	0.11200	0.20400
	standard deviation	(0.09490)	(0.11200)	(0.12800)	(0.11400)	(0.15100)	(0.14100)
PIM dummy (t)	point estimate	0.95300***	1.05400***	1.72000***	1.75700***	0.77500***	0.50100***
	standard deviation	(0.10600)	(0.11800)	(0.11900)	(0.10200)	(0.14100)	(0.13500)
PIM dummy (t-1)	point estimate	0.08360	0.05040	-0.05240	-0.03260	0.34000**	0.35400**
	standard deviation	(0.10700)	(0.12900)	(0.13200)	(0.11600)	(0.15400)	(0.15000)
PIM dummy (t-2)	point estimate	0.07680	0.11800	0.05990	0.04830	0.07340	-0.03250
	standard deviation	(0.09040)	(0.10400)	(0.11300)	(0.09800)	(0.14200)	(0.13100)
PIM dummy (t-3)	point estimate	0.09970	0.08130	0.03070	-0.01120	0.00371	0.04160
	standard deviation	(0.08620)	(0.09810)	(0.09680)	(0.08440)	(0.12300)	(0.11400)

FOMC dummy (t)	point estimate	0.24200**	0.13000	0.21200**	0.22100***	-0.03200	-0.05690
	standard deviation	(0.10900)	(0.12400)	(0.08580)	(0.06710)	(0.10700)	(0.09900)
FOMC dummy (t-1)	point estimate	0.27400**	0.25100**	0.13800	0.14500**	-0.08470	-0.09670
	standard deviation	(0.10700)	(0.11700)	(0.09010)	(0.07230)	(0.10700)	(0.09760)
FOMC dummy (t-2)	point estimate	-0.02500	-0.01940	-0.01280	0.00302	-0.16900*	-0.20500**
	standard deviation	(0.09810)	(0.10600)	(0.07730)	(0.05910)	(0.09360)	(0.08440)
FOMC dummy (t-3)	point estimate	0.04680	-0.05160	-0.02460	-0.00982	0.03740	0.05260
	standard deviation	(0.09330)	(0.10300)	(0.07170)	(0.05430)	(0.09190)	(0.08140)
CPI dummy (t)	point estimate	0.14000	0.08700	0.09120	0.06670	0.03610	0.01010
	standard deviation	(0.08780)	(0.10400)	(0.07540)	(0.06690)	(0.12500)	(0.11700)
CPI dummy (t-1)	point estimate	-0.03710	-0.06810	-0.00304	0.05590	0.05160	0.03830
	standard deviation	(0.08520)	(0.10000)	(0.07800)	(0.06950)	(0.11700)	(0.10700)
CPI dummy (t-2)	point estimate	0.02010	0.00590	0.00623	0.04640	0.13500	0.13400
	standard deviation	(0.07530)	(0.09020)	(0.06880)	(0.06300)	(0.10500)	(0.09960)
CPI dummy (t-3)	point estimate	0.04290	0.04080	-0.02440	0.01630	0.08900	0.07660
	standard deviation	(0.07580)	(0.09070)	(0.06520)	(0.05880)	(0.10500)	(0.09990)
PR dummy (t)	point estimate	0.41000***	0.45400***	0.22200**	0.25800***	0.31400**	0.11400
	standard deviation	(0.09050)	(0.10200)	(0.10200)	(0.08530)	(0.13500)	(0.12500)
PR dummy (t-1)	point estimate	-0.03450	-0.03120	0.06350	0.07880	-0.00728	0.00512
	standard deviation	(0.08180)	(0.09230)	(0.10400)	(0.08740)	(0.13300)	(0.12000)
PR dummy (t-2)	point estimate	-0.00839	0.03300	0.14500	0.11700	0.07540	0.02680
	standard deviation	(0.08250)	(0.09310)	(0.09270)	(0.07920)	(0.12800)	(0.11200)
PR dummy (t-3)	point estimate	0.04120	-0.02780	-0.03950	-0.01050	-0.08650	-0.11200
	standard deviation	(0.07880)	(0.08760)	(0.08280)	(0.07070)	(0.12500)	(0.11200)
Intercept	point estimate	0.84400***	0.79900***	0.83800***	0.83600***	1.03200***	1.00700***
	standard deviation	(0.03290)	(0.04100)	(0.03840)	(0.03750)	(0.04980)	(0.05300)
Observations		2,482	1,788	2,482	1,788	2,482	1,788
R-squared		0.110	0.117	0.245	0.302	0.074	0.034

Note: standard errors in brackets. * Significance at 90% levels. ** Significance at 95% levels. *** Significance at 99% levels.

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