Impact of macroeconomic surprises on the Brazilian yield curve and expected inflation

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Abstract

Announcements of macroeconomic data can contain surprises that impact the term structure of interest rates, a highly relevant topic for market agents and monetary authorities. The present study investigates how unexpected variations in Brazilian and U.S. macroeconomic indicators affect the term structure of interest rates and expected inflation in Brazil. Among the nine Brazilian indicators tested, surprises in monetary policy decisions, in the consumer and general price indexes and in industrial production affect the nominal yield curve, the real yield curve and expected inflation. In general, macroeconomic announcement surprises that lead the market to believe that there might be a higher risk of inflation or an overheated economy rise all the yield curves and the expected short-term inflation. The seven U.S. indicators show evidence that surprises in the activity index, in job creation and in monetary policy FOMC decisions have a significant impact in nominal and real yield curves, indicating that the U.S. economy also influences Brazilian yield curve and expected inflation.

Key words: Nominal and real yield curve, expected inflation, macroeconomic surprises.

Resumo

Anúncios de dados macroeconômicos podem conter surpresas que impactam a estrutura a termo das taxas de juros, um tema muito relevante para agentes de mercado e autoridades monetárias. O presente estudo investiga como as variações inesperadas em indicadores macroeconômicos brasileiros e dos Estados Unidos afetam a estrutura a termo das taxas de juro e a inflação esperada no Brasil. Entre os nove indicadores brasileiros testados, surpresas nas decisões política monetária, no índice de preços ao consumidor, no índice geral de preços e na produção industrial afetam a curva de juros nominal, a curva de juros real e a inflação esperada. De forma geral, surpresas que levam o mercado a acreditar que pode haver um alto risco de inflação ou uma economia superaquecida faz com que todas as curvas de juros e de inflação esperada aumentem. Os sete indicadores dos Estados Unidos mostram que surpresas no índice de atividade, na criação de postos de trabalho e nas decisões de política monetária do FOMC apresentam coeficientes significativos em curvas de juros nominais e reais, indicando que a economia dos Estados Unidos também influencia o estabelecimento a curva de juros e a inflação esperada na economia brasileira.

Palavras-chave: curva de juros nominal e real, inflação esperada, surpresas macroeconômicas.

JEL: E43, E44

Área 3 - Macroeconomia, Economia Monetária e Finanças

1 - Introduction

According to the efficient-market hypothesis proposed by Fama (1970), asset prices are instantly influenced by the arrival of new information. This allows us to ask how the Brazilian interest market responds to surprises[1] in macroeconomic indicators.

For example, how does the yield curve respond to surprises in the data and does the response occur through expected inflation or real yield? Which of the announcements has the greatest influence? Is the data response exaggerated, with a correction occurring on the following day? Additionally, in a globalized market, does the Brazilian market react to U.S. announcements?

The purpose of this paper is to find answers to those important questions by analyzing the impact of the unexpected components of macroeconomic variables on the Brazilian yield curve. More specifically, the objective is to determine how surprises in Brazilian and U.S. macroeconomic indicators, defined as differences between the median market expectations and the announced value, affect the Brazilian nominal interest rate, expected inflation and real interest rate term structure.

Unlike previously published studies on the subject, this analysis is not restricted to the nominal yield curve; it also considers the real yield curve and market inflation expectations. One of the advantages of the adopted methodology is that it enables us to evaluate how the market reacts to unanticipated macroeconomic announcements, in particular, if the nominal and real yield curve as well as inflation expectations reacts to those surprises.

Thus, this study contributes to the literature by attempting to understand how the Brazilian curve of future yield is established and by studying the origin of variability caused by macroeconomic surprises. Specifically we innovate by evaluating whether responses appear in market expected inflation or in nominal or real interest rates. Additionally, we studied which announcements lead to a larger market response and which create an exaggerated response that is later corrected.

The rest of the study is organized as follows. The second section briefly reviews the literature. The third section describes the data and the model used. The results are presented in the fourth section, and the fifth section presents the conclusions of this study.

2 - Literature review

Several studies have attempted to quantify and evaluate the impact of macroeconomic surprises on different financial instruments, such as the future yield curve, exchange rate and the stock market; see for instance Kuttner (2001), Fatum and Scholnick (2008) and Bernanke and Kuttner (2005). However, most of those studies have focused on the U.S. market and its response to unexpected FOMC[2] decisions and to the disclosure of unanticipated macroeconomic information.

In one of the first studies on the subject, Kuttner (2001) estimated the impact of Federal Reserve monetary policies on future interest rates, decomposing the monetary authorities' decisions into an expected component (market expectations extracted from the future yield curve) and an unexpected component (difference between announced and expected decisions). As predicted, the response of the yield curve to surprises was high and significant; however, the expected component was small and lacked statistical significance.

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[1] A surprise is a component of the announced data that is not expected by the market. For example, if the expectation for the IPCA is 0.50%, but the reported value is 0.57%, the surprise or unexpected component is 0.07%.
[2] The FOMC is the monetary policy committee of the Federal Reserve (the Fed) and is responsible for conducting the U.S. monetary policy and decide about the monetary policy interest rate (Fed Funds rate).

The reactions of the exchange rate and stock market to unexpected information have also been studied. Fatum and Scholnick (2008) estimated the change in the exchange rate in response to changes in the interest rate by the FOMC and concluded that the unexpected component of the decision is associated with a variation in the value of the dollar on the same day. Unexpected tightening leads to an American dollar appreciation, whereas unexpected loosening leads to dollar depreciation. Bernanke and Kuttner (2005), in turn, estimated the influence of FOMC decisions on the U.S. stock market and found that surprises in decisions made by the committee are followed by a consistent response from the U.S. stock market. On average, an unexpected 25 basis point decrease in the Federal Funds Rate Target is associated with a 1% increase in broad stock indexes.

Other studies have proposed that U.S. macroeconomic surprises produce global shocks. Craine and Martin (2008) described evidence that unexpected movements in both domestic monetary policy and U.S. monetary policy affect the Australian yield curve, while surprises in Australian announcements do not affect the U.S. curve. Ehrmann, Fratzscher and Rigobon (2005) showed that surprises in European macroeconomic data have no significant effect on American markets; however, Ehrmann and Fratzscher (2005) found evidence of an influence of surprises in North American macroeconomic announcements on European financial markets. Extending the range of those analyses, a panel study by Hausman and Wongswan (2011) has provided evidence that surprises in U.S. monetary policy directly affect the financial markets of 49 studied countries and, consequently, their economies.

Balduzzi, Elton and Green (2001) and Taylor (2010) estimated the effects of unanticipated information in announcements of major U.S. macroeconomic data on the variation in the United States yield curve. The median value expected by a panel of several economists was used as the expected data value. The articles concluded that in addition to the FOMC decisions, several indicators affect the variability of the yield curve, with Non-farm Payrolls and Civilian Unemployment as the other indicators with the most significant effects.

Also focusing on the study of the effect of surprises in macroeconomic indicators, Ramchander, Simpson and Chaudhry (2003) tested five instruments (treasury bill, certificates of deposit, bankers acceptances, dealer-placed commercial paper and directly placed commercial paper) within three months of the maturity date. Unlike the previously mentioned studies, a vector error correction model (VECM) was used to estimate the impact of surprises on each instrument. Three results were found: (1) the effect of surprises was confirmed in all instruments; (2) an increase in instrument volatility was observed on the days of surprises in macroeconomic announcements; and (3) movements common to all instruments occur on the days of surprises, such that the volatilities of the instruments cannot be considered significantly different from each other. Ramchander, Simpson and Chaudhry (2005) complemented the previous study using different maturities and a greater number of macroeconomic indicators. The yield curve was significantly affected by surprises in 17 of the 23 announcement types studied.

While the studies presented until now have considered the effects of U.S. data, some studies in the literature have addressed the effects of surprises in other countries. For example, Soderlind (2010) studied the effect of surprises in Swiss monetary policy on the Swiss yield curve and concluded that an unexpected increase in the base rate cause an increase of the same magnitude in short-term rates (shorter maturity), whereas the longer-term rates show a less intense drop, thereby decreasing the risk premium. Larrain (2007) examined this question in emerging economies and found a positive and significant correlation between the surprise component of decisions made by Chile's Central Bank and variations in Chilean interest rates. Finally, Reid (2010) measured the response of South African expected inflation to unanticipated shocks in local macroeconomic indicators, and their results indicate that South African expected inflation responds less to unexpected variations in current inflation than was previously observed, suggesting a consistent improvement in Central Bank credibility over the last few years.

Tabak (2004) studied the Brazilian market but did not study the effects of surprises. Instead, Tabak estimated the variability of future interest rates relative to variations in the Selic[3] rate, regardless of the expected and unexpected components. Therefore, because a significant portion of the variation is anticipated by the market, there is no significant response from the future yield curve to changes in the basic Selic interest rate. Still, for the Brazilian case, Robitailleand and Roush (2006) found a positive correlation between the Brazilian C-Bond[4] rate and surprises in American monetary policy and a negative correlation between the Brazilian stock market and the same American surprises. Nevertheless, this study did not analyze the effect of surprises in Brazilian macroeconomic indicators on the instruments.

In short, to the best of our knowledge the literature to date has established three principal results: (1) there is no significant response from any of the studied financial instruments to variations in macroeconomic data anticipated by the market; (2) macroeconomic surprises are followed by significant movements in the yield curve, exchange rates and stock markets; and (3) U.S. economic shocks cause reactions in the markets of several other countries and may be considered global shocks. However, no studies have demonstrated the effect of surprises in domestic and U.S. macroeconomic indicators on the Brazilian yield curve. Moreover, a vast majority of studies have used the nominal yield curve without checking whether the responses occur because of variations in expected inflation or variations in the real yield.

Thus, we highlight four contributions of this study to the literature. First, we studied the impact of macroeconomic surprises on the Brazilian economy, an emerging market that was the seventh largest economy in the world in 2010 according to data from the IMF and World Bank. Second, we considered not only the impact of domestic surprises on the domestic yield curve but also the impact of unanticipated information from the U.S. economy. Third, our methodology accounted for the possible long-term cointegration relationship among the vertices of the yield curve when estimating the VECM model to distinguish the impact of macroeconomic surprises. Finally, this study introduced the innovation of separately analyzing the impact on nominal rates in terms of real yield and implicit expectations of inflation for different maturities.

3 - Methodology and data description

3.1 - Methodology

The next part of the study focuses on the analysis of the behavior of Brazilian curves for nominal yield, real yield and market expected inflation in response to surprises in macroeconomic indicators.

Interest rates of the same securities with different maturities usually move together and are considered substitutes for one another. Therefore, interdependence exists among the several vertices that provide a great deal of information and consequently cannot be disregarded. For this reason, the statistical process is conducted within a framework that preserves the strong effect of substitution and the equilibrium among the several vertices of the yield curve. Specifically, the cointegration methodology is applied to analyze the long-term equilibrium among variables.

The cointegration methodology is implemented through three vector error corrections (VECs), one for the nominal interest rates, one for expected inflation and one for the real interest rates. Unanticipated shocks are inserted into the VECs as a vector of exogenous variables.

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[3]Selic rate: the weighted and adjusted average rate of financing operations for one day backed by federal public securities. This is a Brazilian reference interest rate determined by the Monetary Policy Committee (COPOM) of the Central Bank.
[4] C-Bond: Capitalization-bond, a Brazilian external debt bond, currently the most liquid one with the highest turnover. These bonds will mature in 2014 and have paid half yearly installments since 2004.

This methodology enabled flexible and functional modeling of the behavior of interest rates, thus enabling differentiation of short-term relationships and long-term balance while estimating the impact of each macroeconomic announcement on the yield curve.

To estimate the VECs, we first tested whether there were unit roots in each of the vertices of nominal yield, inflation and real yield curves through the Dickey-Fuller test. The cointegration tests were conducted after testing for unit roots in the series integrated in the same order, i.e., requiring the series from the same number of differentiations to become stationary.

Before estimating vector error corrections, the Hannan-Quinn criterion was adopted to select the number of lags to be considered in the model. This method was performed by estimating a VAR model and applying a test to choose the number of lags.

The Johansen (1988) procedure was used to identify the existence of cointegration. Unlike other methods, it uses the Maximum Likelihood method to estimate vectors, which enables the analysis and estimation of the presence of various vectors rather than a single cointegration vector.

When cointegration relationships exist among series, the series are said to show a stable long-term linear relationship. The test aims to determine the number of cointegration vectors required for the system.

When a long-term balance relationship exists, a vector error correction (VEC) is used to obtain the impact of shocks by inserting surprises as exogenous variables, giving the system below:

$$\Delta Y_{1.t} = \alpha_1 + \sum_{j=1}^{n}\sum_{i=1}^{p}\beta_{1.j,i}\Delta Y_{j,t-i} + \sum_{k=1}^{r}\omega_{1.k}Y_{k,t-1} + \sum_{k=1}^{m}\varphi_{1.k}A_{k,t} + \varepsilon_{1.t}$$

$$\Delta Y_{2.t} = \alpha_2 + \sum_{j=1}^{n}\sum_{i=1}^{p}\beta_{2.j,i}\Delta Y_{j,t-i} + \sum_{k=1}^{r}\omega_{2.k}Y_{k,t-1} + \sum_{k=1}^{m}\varphi_{2.k}A_{k,t} + \varepsilon_{2.t} \quad (1)$$

$$\vdots$$

$$\Delta Y_{n,t} = \alpha_n + \sum_{j=1}^{n}\sum_{i=1}^{p}\beta_{n,j,i}\Delta Y_{j,t-i} + \sum_{k=1}^{r}\omega_{n,k}Y_{k,t-1} + \sum_{k=1}^{m}\varphi_{n,k}A_{k,t} + \varepsilon_{n,t}$$

where Δ is the first difference operator, $Y_{n,t}$ is the rate of interest or inflation for each of the vertices n on day t, n is the number of vertices, p is the number of lags obtained by the Hannan-Quinn test, r is the number of cointegration relationships obtained by the Johansen test, m is the number of macroeconomic announcements, A_k is the vector of surprises for each indicator k, α_n, β_n and ω_n and $\varphi_{n,k}$ are coefficients and $\varepsilon_{n,t}$ is the residual.

More specifically, our interest is on the coefficients $\varphi_{n,k}$, which measure the impact of each macroeconomic surprise on the vertice n of the yield curve (nominal and real) and inflation expectations. Consequently, this model enabled us to estimate the effect of each announcement on each of the specific vertices without losing the relationships among each maturity of the yield curve (nominal and real) and inflation expectations.

3.2 – Data description

This study examined the behavior of the curves for nominal yield, expected inflation and real yield in response to surprises in the announcement of nine Brazilian macroeconomic indicators and seven U.S. indicators. Specifically, we analyzed the response of rates from 1, 3, 6, 12, 18, 24, 30 and 36 month contracts from BM&FBovespa[5] Pre x DI and IPCA x DI swaps to unanticipated shocks to the main

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[5] Pré x DI swap: a swap that is active in fixed rate and passive in CDI (Interbank Deposit Certificate – post fixed rate) registered at the Brazilian Mercantile and Futures Exchange (BM&F Bovespa). IPCA x DI swap: a swap that is active in the

Brazilian economic indicators. Namely, these indicators include the monthly National Consumer Price Index – broad (Índice de Preços ao Consumidor — IPCA), the monthly Market General Price Index (Índice Geral de Preços do mercado — IGPM), the GDP, the trade balance, the monthly unemployment rate, the monthly retail sales index and the industrial production, all of them released by the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística — IBGE). We also consider the basic interest rate (Selic) announced by the Monetary Policy Committee of the Brazilian Central Bank (COPOM) and the number jobs creation released by the General Register of Employed and Unemployed (Caged) from the Ministry of labor and employment. We also examined whether the unexpected components of American inflation indicators (CPI – Consumer Price Index), industrial activity (ISM), new home sales, retail sales, volume of orders and deliveries for durable goods, number of jobs created and the Fed Funds rate decisions by the FOMC (The Federal Open Market Committee of the Federal Reserve) impact Brazilian yield curves.

The first step of the analysis was to construct curves for nominal yield, expected inflation and real yield. According to Kozicki and Sellon (2005) the future nominal interest rate may be defined as:

$$(1 + i_j) = (1 + r_j) \times (1 + \pi_j^e) \tag{2}$$

where j is the rate's maturity, i is the nominal interest rate, r is the real interest rate, π^e is the expected inflation for the period. The above defined IPCA x DI swap curve supplies the real interest rates, and the Pre x DI swap curve provides the nominal interest rates. Therefore, the expected inflation may be obtained by equation (2) rewritten as follows:

$$(1 + \pi_j^e) = \frac{(1 + i_j)}{(1 + r_j)} \tag{3}$$

The vertices of the yield curve were obtained from the daily data from the period between March 2005 and July 2011, a total of 1580 observations. For each of the macroeconomic announcements, we obtained not only the effectively disclosed amount but also a proxy of the market consensus represented by the median of expectations collected by the Bloomberg survey together with a sample of market analysts. These data were extracted from Bloomberg announcements and the rates of swaps from the BM&FBovespa database.

The surprise in each announcement is defined as the difference between the disclosed data and the survey's median[6]:

$$S_k = D_k - Md_k \tag{4}$$

where S_k is the surprise component, D_k is the disclosed amount and Md_k is the median of the Bloomberg survey for the announcement of indicator k. The descriptive analysis of surprises for each of the macroeconomic indicators is provided in tables 1 and 2.

Because most of the macroeconomic data considered were disclosed on a monthly or quarterly basis and the survey database contains data on a daily basis, we assigned the disclosed macroeconomic indicator value (more precisely, its surprise component) to the first trading session where the information was available and assigned a zero value to the other working days. Sixteen vectors were created in this way for use as regressors in our VEC model, equation (1).

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variation of inflation index IPCA and passive in CDI registered at the Brazilian Mercantile and Futures Exchange (BM&F Bovespa)

[6] Except for the COPOM and FOMC meetings, where the Bloomberg survey average was used. As the committee movements are usually multiples of 25 basis points, the expectations of economists are also multiples of 25 basis points. Because of this characteristic, the average provides more information about the division of expectations than the median, as the latter will also be a multiple of 25 basis points.

Of the announcements studied here, only Brazilian job creation was not captured in a Bloomberg survey for the analyzed period. The collections for that indicator started on 28th February 2009; therefore, we set the Brazilian series of surprises for job creation before this date equal to zero.

Due to large differences in the values of observed macroeconomic variables, the value of each surprise was normalized by the standard deviation of its own series, as proposed by Ramchander, Simpson and Chaudhry (2005).

$$S_k^n = \frac{S_k}{\sigma_{S_k}} \tag{5}$$

where S_k^n is the normalized surprise, S_k is the surprise and σ_{S_k} is the standard deviation of the series of surprises for indicator k. Because the standard deviation is constant for all observations of each announcement k, the significance of the estimates is not affected. Figures 1 and 2 show a series of normalized surprises used for estimation.

Table 1 – Descriptive statistics of surprises in Brazilian announcements

	COPOM	GDP	IPCA	IGPM	Trade Balance	Unemployment	Job Creation	Retail Sales	Industrial Production
Observations	41	25	66	77	76	67	19	89	7 0
Average	- 0.02	0.08	0.00	- 0.01	104.40	- 0.04	11,908	0.30	- 0.29
Median	- 0.01	0.14	0.01	0.01	78.50	- 0.10	12.547	0.09	0.09
Maximum	0.21	1.10	0.20	0.26	1.25 1.90	0.80	96.700	4.08	2.40
Minimum	- 0.29	- 1.90	- 0.15	- 0.39	-893.00	- 0.80	-115.192	-3.68	-6.27
Standard deviation	0.12	0.69	0.06	0.11	488.72	0.34	53.351	1.31	1.49
Asymmetry	- 0.45	- 0.69	0.18	- 0.42	0.22	0.12	- 0.61	0.23	- 1.39
Kurtosis	2.73	3.93	4.04	4.03	2.56	2.53	3.02	3.58	5.84

Note: This table presents the descriptive statistics for the series of surprises in the announcements of each of the Brazilian macroeconomic indicators. On days without an announcement, no observations were considered.

Table 2 – Descriptive statistics of surprises in American announcements

|	CPI	ISM	New Homes Sold	Retail Sales	Orders of Durable Goods	Jobs	FOMC
Observations	62	69	76	70	73	73	21
Average	- 0.00	- 0.29	-2 1.58	- 0.01	- 0.03	-32.58	- 0.02
Median	- 0.10	- 0.30	-17.00	0.10	- 0.10	-22.00	0.00
Maximum	0.50	4.50	169.00	1.70	9.50	213.00	0.07
Minimum	- 0.50	-5.40	-189.00	- 1.70	-1 0.70	-467.00	- 0.23
Standard deviation	0.17	2.10	62.94	0.72	3.16	118.23	0.08
Asymmetry	0.35	0.10	0.18	- 0.04	- 0.14	- 0.84	- 1.43
Kurtosis	4.07	2.46	4.18	2.96	4.27	4.87	4.10

Note: This table presents the descriptive statistics for the series of surprises in the announcements of each of the American macroeconomic indicators. On days without an announcement, no observations were considered.

Figure 1 – Normalized surprises in Brazilian indicators.
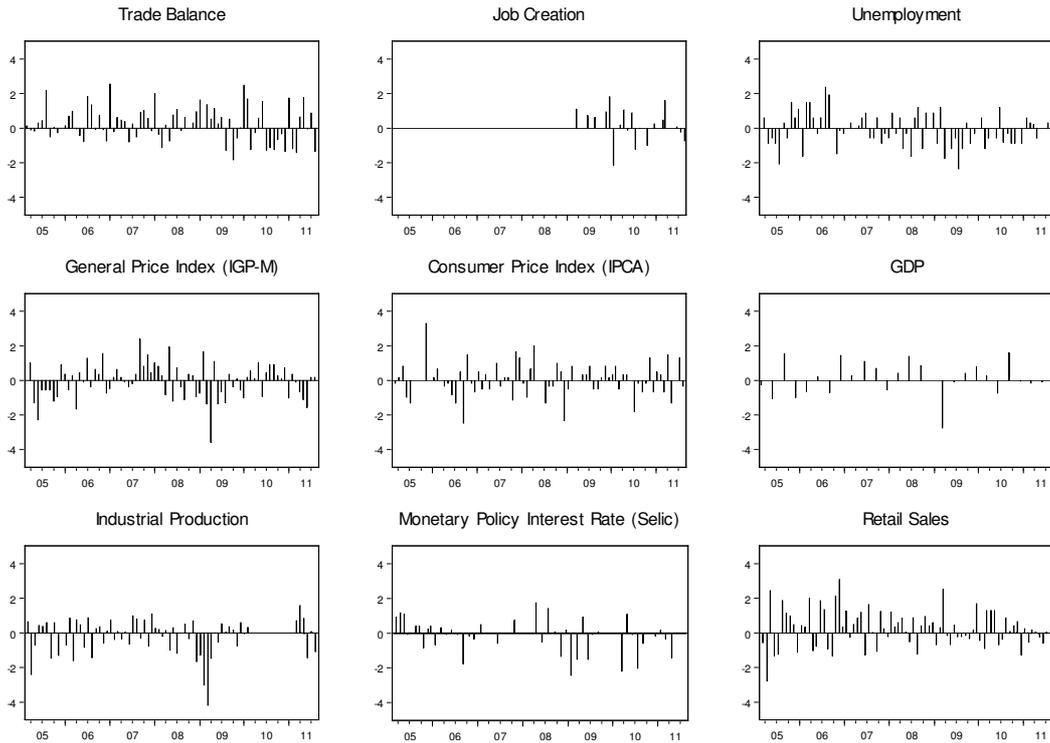
Note: This figure shows a series of surprises in terms of numbers of standard deviations for each of the Brazilian economic indicators studied. The y-axis of each graph indicates the number of standard deviations of the surprise, and the x-axis indicates on which trading day the surprise occurred, with the data encompassing 1580 trading days from 1st March 2005 to 29th July 2011. The series of surprises from job creation announcements starts on 28th February 2009 because Bloomberg survey data were not available before this date.

Figure 2 – Normalized surprises in American indicators.
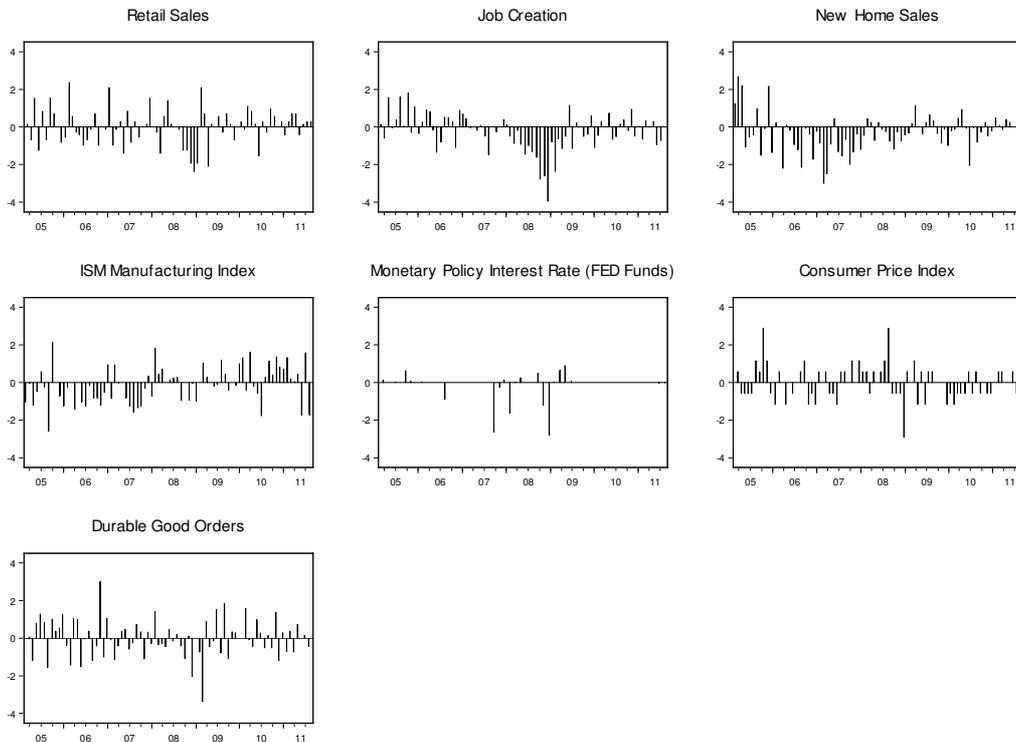
Note: This figure shows the series of surprises in numbers of standard deviations for each of the American economic indicators studied. The y-axis of the graph indicates the number of surprise standard deviations, and the x-axis indicates on which trading day the surprise occurred, from the 1st trading day of 1st March 2005 to the 1580th trading day of 29th July 2011.

4 - Results

4.1 - Unit root test and cointegration

We began the data analysis by checking the temporal characteristics of each series. Table 3 shows the results of the ADF unit root test. The evidence suggests that the rates are first order integrated - I(1).

Table 3 – ADF unit root test

Maturity (months)	Level			First Difference		
	Nominal Yield	Expected Inflation	Real Yield	Nominal Yield	Expected Inflation	Real Yield
1	-2.17	0.68	-1.14	-40.28*	-51.45*	-50.97*
3	-2.12	1.60	-0.84	-40.12*	-51.24*	-50.1*
6	-2.14	1.48	-1.26	-39.90*	-46.26*	-46.28*
12	-2.02	1.34	-1.54	-42.17*	-45.13*	-43.29*
18	-1.95	1.03	-1.59	-42.24*	-45.56*	-44.44*
24	-1.90	0.85	-1.51	-41.43*	-47.04*	-45.31*
30	-1.88	0.62	-1.53	-40.26*	-44.82*	-43.65*
36	-1.93	-0.06	-0.91	-40.99*	-45.78*	-43.83*

Note: This table shows the results of the augmented Dickey-Fuller (ADF) root unit test for the level and first difference for each of the vertices of the curves for nominal yield, expected inflation and real yield. The null hypothesis of the test is that there is a unit root in the series. The * indicates rejection of the null hypothesis with a statistical significance of 1%.

Table 4 presents the results of Johansen cointegration tests. A test was conducted for each group of rates, nominal yield, real yield and expected inflation. In all of the three groups we found evidence of more than one cointegration relationships among the numerous vertices analyzed.

Table 4 - Johansen cointegration test

Nominal Yield			
Number of cointegration equations	Statistics	Critical value	P-value
None *	809.19	169.60	0.00
Maximum 1*	669.79	134.68	0.00
Maximum 2*	372.58	103.85	0.00
Maximum 3*	215.45	76.97	0.00
Maximum 4*	130.77	54.08	0.00
Maximum 5*	53.68	35.19	0.00
Maximum 6	18.46	20.26	0.00
Maximum 7	4.73	9.16	0.31

Expected Inflation				Real Yield			
Number of cointegration equations	Statistics	Critical Value	P-value	Number of cointegration equations	Statistics	Critical value	P-value
None *	424.21	187.47	0.00	None *	416.01	187.47	0.00
Maximum 1*	263.47	150.56	0.00	Maximum 1*	260.64	150.56	0.00
Maximum 2*	160.55	117.71	0.00	Maximum 2*	182.99	117.71	0.00
Maximum 3*	104.07	88.80	0.00	Maximum 3*	120.82	88.80	0.00
Maximum 4	54.48	63.88	0.01	Maximum 4*	71.80	63.88	0.00
Maximum 5	31.69	42.92	0.35	Maximum 5	42.23	42.92	0.02
Maximum 6	16.69	25.87	0.56	Maximum 6	19.17	25.87	0.13
Maximum 7	6.74	12.52	0.40	Maximum 7	6.22	12.52	0.45

Those results confirm our expectations and indicate that the cointegration methodology can be used to analyze the impacts of surprises from macroeconomic announcements on interest and inflation curves.

4.2 - Impacts of macroeconomic surprises on the curves for nominal yield, expected inflation and real yield

Three vector error corrections (VEC) were estimated, one for each group of analyzed term structure (nominal yields, real yields and expected inflations) to verify how the surprises impact each of those components when inserted into the system as exogenous variables. Therefore, it is possible to understand the market dynamics, i.e., whether the shocks generate variations in inflation expectations, nominal yield or real yield.

To make the coefficients comparable, the surprises were normalized as defined in equation (2). The coefficients may be interpreted as the effect of a surprise with a magnitude of one standard deviation of the indicator on the vertices of the yield curve.

Table 5 shows the VEC results for 3, 12 and 36 month vertices[7]. We consider those vertices representing respectively short, medium and long-term effects[8]. Analyzing the domestic macroeconomic surprises reveals that the unexpected component of COPOM decisions regarding the monetary policy Selic interest rate has a statistically significant impact on short-term nominal interest rates. This effect is larger for the shorter vertices and decreases as the term increases until the coefficient is negative and not significant in the long-term. One possible explanation for this result is that the market understands that an unexpected increase in the short-term monetary policy rate changes expectations towards tougher monetary policy in the future, leading to an increase in short- (3-month) and mid-term (12-month) nominal yields. However, it is interesting to see neither inflation expectations nor real yields are affected.

In the medium-term, the Brazilian GDP had significant coefficients, positive for expected inflation and negative for real yield, while generating practically no effect on nominal yield. Apparently, the market considers that the Central Bank will not increase nominal yield in response to an upsurge in the economy above expectations in the previous quarter; consequently, an increase in inflation is expected but compensated for by a lower real interest rate.

Surprises in inflation had a positive and significant effect on the nominal interest curve, with IPCA exerting an effect on all of the curves, whereas the IGPM affects expected inflation and long-term real yield but not nominal interest. Because the IPCA is the official indicator for the inflation target system adopted by the Brazilian Central Bank, this indicator is expected to affect monetary policy decisions, and consequently the yield curve would be expected to react more intensely to surprises in the IPCA than in the IGPM. One interpretation of the positive IPCA coefficient is that the market believes that an inflation surprise would lead to a cycle of increased of the short-term monetary policy rate by the Central Bank, which would reflect the increase in nominal interest rates in all vertices. The fact the inflation expectations response to a positive IPCA shock is significantly positive only for the next three months interpreted as a sign of credibility for the Central Bank. The response of the monetary

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[7] Tables A.1, A.2 and A.3 in the appendix present the results for all of the tested vertices. The results show that our resultas do not change by summarizing results only 3, 12 and 26-month verticces. Figures A.1, A.2 and A.3 in the appendix show the residues of the three estimated VECs.

[8] For a developed economy, medium-term refers to 2-10 years and long-term is considered to be more than 10 years, however, for a emerging economy like Brazil, the liquidity of fixed income instruments with more than 3-years is very limited, that is way we adopted these more appropriate concepts of medium- and long-term horizons.

policymaker would be enough to offset increases in inflation expectations on the 12- and 36-month vertices.

Surprises in Brazilian industrial production also showed significant and positive coefficients, whereas the employment and retail sales data did not appear to be significant. This observation indicates that the industrial production indicator is the factor most closely monitored by investors and that surprises in this indicator may change projections for the Brazilian economy and lead to a shift in interest rates to correct for excess demand or supply. Looking at real yields and inflation expectations indicate that an positive surprise in the industrial production index increases real yields in the medium-term (12-month) and increases inflation expectations in the long-term (36-months).

Table 5 – Estimated coefficients for normalized surprises

		3 months			12 months			36 months		
		Nominal Yield	Inflation Expect.	Real Yield	Nominal Yield	Inflation Expect.	Real Yield	Nominal Yield	Inflation Expect.	Real Yield
BRAZIL	**Selic rate**	8.95	-4.44	9.28	6.85	1.57	4.38	-0.81	-1.77	0.27
		(7.49)***	(-0.46)	(0.89)	(4.14)***	(0.52)	(1.30)	(-0.38)	(-0.86)	(0.13)
	GDP	-0.48	10.24	-9.53	0.37	11.28	-11.04	-0.15	2.28	-0.78
		(-0.31)	(0.81)	(-0.71)	(0.17)	(2.85)**	(-2.55)**	(-0.05)	(0.85)	(-0.29)
	IPCA	2.32	16.94	-8.92	3.72	2.49	2.41	3.45	1.09	2.89
		(2.45)**	(2.21)**	(-1.08)	(2.83)***	(1.03)	(0.90)	(2.03)**	(0.67)	(1.74)*
	IGPM	0.62	2.08	-0.67	0.95	1.17	-0.27	0.87	5.05	-3.51
		(0.71)	(0.29)	(-0.09)	(0.78)	(0.53)	(-0.11)	(0.55)	(3.38)**	(-2.31)**
	Trade Balance	-3.54	-3.46	10.38	-1.31	-0.90	0.45	-1.59	0.79	-1.50
		(-4.1)***	(-0.50)	(1.39)	(-1.10)	(-0.41)	(0.19)	(-1.03)	(0.54)	(-1.00)
	Unemployment	-0.30	-5.49	3.74	-1.62	-0.72	-1.26	-0.51	-2.54	0.85
		(-0.32)	(-0.72)	(0.46)	(-1.25)	(-0.30)	(-0.48)	(-0.30)	(-1.58)	(0.52)
	Job Creation	0.44	-10.84	7.17	0.48	0.43	-0.61	-1.08	3.78	-5.00
		(0.25)	(-0.76)	(0.47)	(0.20)	(0.10)	(-0.12)	(-0.34)	(1.26)	(-1.63)
	Retail Sales	0.08	3.23	-3.11	1.89	2.91	-1.63	2.15	2.91	-0.87
		(0.10)	(0.50)	(-0.45)	(1.71)*	(1.43)	(-0.73)	(1.50)	(2.13)**	(-0.63)
	Industrial Production	5.22	0.06	2.58	4.94	-0.81	4.61	5.22	4.63	0.46
		(5.79)***	(0.01)	(0.33)	(3.95)***	(-0.35)	(1.83)*	(3.22)***	(3.00)**	(0.29)
USA	**CPI**	-0.02	-0.79	2.28	-0.84	-2.86	2.70	-3.32	-1.42	-1.09
		(-0.02)	(-0.10)	(0.26)	(-0.60)	(-1.12)	(0.96)	(-1.83)*	(-0.83)	(-0.62)
	ISM	5.87	2.30	36.27	5.27	0.63	14.25	0.73	-2.16	7.04
		(6.36)***	(0.31)	(4.52)***	(4.13)***	(0.27)	(5.52)***	(0.44)	(-1.37)	(4.39)***
	New Home Sales	-0.48	0.30	0.59	-0.43	-2.37	1.75	-0.30	-0.27	-0.66
		(-0.57)	(0.04)	(0.08)	(-0.37)	(-1.10)	(0.74)	(-0.20)	(-0.19)	(-0.45)
	Retail Sales	0.89	-5.90	3.40	1.47	2.13	-0.39	0.98	-0.47	0.99
		(0.96)	(-0.79)	(0.42)	(1.14)	(0.90)	(-0.15)	(0.59)	(-0.30)	(0.62)
	Durable Goods Orders	-0.55	-0.61	-0.65	-1.66	-0.23	-1.13	-1.20	2.49	-3.85
		(-0.61)	(-0.08)	(-0.08)	(-1.33)	(-0.10)	(-0.45)	(-0.74)	(1.61)	(-2.45)**
	Job creation	0.89	0.64	1.00	2.59	1.02	1.10	3.41	-1.10	3.82
		(1.02)	(0.09)	(0.13)	(2.15)**	(0.46)	(0.45)	(2.18)**	(-0.74)	(2.52)**
	Fed Funds rate	1.26	3.45	-0.67	2.60	-5.38	7.05	7.24	6.41	0.18
		(0.75)	(0.25)	(-0.05)	(1.11)	(-1.25)	(1.49)	(2.39)**	(2.22)**	(0.06)

Note: This table shows the estimated VEC coefficients for the variation of short, average and long-term vertices of nominal yield, expected inflation and real yield curves in response to surprises of one standard deviation for each of the macroeconomic announcements. The t statistic of each coefficient is in brackets. *, ** and *** indicate statistical significance of 10%, 5% and 1%, respectively. All of the coefficients were multiplied by 100 for better visualization.

Another interesting result is that the IPCA and Brazilian industrial production show significant coefficients on the same order of magnitude in the three periods: short-term, medium-term and long-term. Therefore, surprises in the IPCA or in industrial production lead to almost parallel shifts in all nominal yield curves.

Unanticipated positive U.S. activity level shocks (ISM and Job Creation) cause an increase in Brazilian nominal and real yields and no noticeable effect in future inflation. This result may indicate

that an upsurge in the U.S. economy, above market estimates, increases Brazilian economy expected activity and, consequently, increases nominal and real Brazilian rates. The U.S. activity data contain a greater number of significant coefficients for the long-term than for the short-term. This pattern may occur because the yield and short-term inflation curves are very closely related to domestic monetary policy and to specific factors of internal demand and production. In contrast, the medium-term and long-term economic reality is influenced by the global economic cycle, in which the U.S. plays a very important role.

The unexpected component of the FOMC decisions regarding the monetary policy Fed Funds rate showed positive and significant coefficients for the long-term nominal interest rates and non-significant coefficients over the short-term, in agreement with the study by Hausman and Wongswan (2011), who found that the explanatory power of surprises in U.S. monetary policy on the interest rate were greater for the long-term than for the short-term in 20 other foreign countries.

Table 5 also shows which announcements have the higher impact on the yield and inflation expectation curves. Over the short- and medium-term, a one standard deviation surprise in the Selic rate has the higher impact on the nominal yield curve compared with other variables. Surprises in the U.S. manufacturing production index (ISM) exhibit the second highest coefficient, followed by Brazilian industrial production and the inflation level measured by the IPCA.

Over the long-term, the effect of the FOMC becomes significant and shows the largest coefficient. The influence of Brazilian industrial production and the IPCA remains high, and the number of U.S. jobs created and CPI are also relevant.

The largest variation in short- and medium-term inflation occurs for surprises in the IPCA of one standard deviation. The most intense response in the long-term is for shocks in the FOMC followed by surprises in IGPM and Brazilian industrial production.

Real yield data in the short-, medium- and long-term show the highest coefficients for the U.S. industrial activity index. Surprises in the GDP are also relevant in the medium-term, and the coefficient for job creation announcements is the second highest in the long-term, although it is not significant. Announcements surprises for job creation and durable goods orders in the U.S. and the IGPM in Brazil are significant and almost indistinguishable among terms.

In short, out of the nine tested Brazilian data indicators, four had an impact on the nominal yield curve. Of those, one is related to monetary policy, another to inflation and the other two to activity. Surprises in the GDP, IPCA, IGPM, retail sales and industrial production affect the expected inflation, and the COPOM's Selic rate decisions, GDP, IPCA, IGPM and industrial production affect the real interest rates.

Of the U.S. economic shocks, only surprises in the Fed Funds rate showed a significant effect on expected inflation and only in the 36-month horizon. Surprises in U.S. indicators of industrial activity (ISM) and job creation significantly affect positively both nominal and real yields. The unexpected components of Fed Fund Rates and CPI also generate a statistically significant response in long-term nominal interest rates, positive for the former and negative for the later. Finally, unexpected surprises of durable goods orders impact long-term real interest rates in a puzzling negative way.

4.3 - Impacts of lagged surprises

The last step of our empirical analysis was to estimate the impact of surprises on the yield curve one day after the surprise to determine whether the initial market response to surprises are exaggerated and whether the market corrects for the exaggeration on the next day.

For this purpose, we added the term $\sum_{k=1}^{m} \gamma_{n,k} A_{k,t-1}$ to equation 4. Where A is the same vector of surprises for each indicator k but lagged by one day, and γ is the coefficient that measures the lagged impact of surprises of each announcement on the vertice n of the yield and inflation curves.

The coefficients of the three VECs were re-estimated with the additional term for lagged surprises. The values of the coefficients without lag changed slightly without affecting the previously obtained results. Table 6 shows the estimated coefficients for the variation of vertices in response to surprises of one standard deviation for each of the macroeconomic announcements on the day after the announcement.

For a few data sources, lagged surprises show a statistically significant effect in the nominal yield curve.

Table 6 – Estimated coefficients for surprises lagged by one day

		3 months			12 months			36 months		
		Nominal Yield	Inflation Expect.	Real Yield	Nominal Yield	Inflation Expect.	Real Yield	Nominal Yield	Inflation Expect.	Real Yield
BRAZIL	**Selic rate**	0.30	-5.24	1.36	- 1.30	- 0.15	- 1.16	0.28	1.12	- 0.72
		(0.25)	(- 0.54)	(0.13)	(- 0.77)	(- 0.05)	(- 0.34)	(0.13)	(0.55)	(- 0.34)
	GDP	2.96	22.05	-5.99	3.28	4.58	- 1.93	2.74	4.52	- 1.54
		(1.91)*	(1.75)*	(- 0.44)	(1.53)	(1.15)	(- 0.44)	(0.99)	(1.70)*	(- 0.57)
	IPCA	0.77	-17.80	17.86	1.43	- 0.93	2.58	2.54	1.26	1.14
		(0.81)	(-2.31)**	(2.15)**	(1.08)	(- 0.38)	(0.96)	(1.49)	(0.77)	(0.69)
	IGPM	-0.84	4.36	-4.35	- 0.25	- 1.41	1.62	- 0.71	- 0.26	- 0.09
		(-0.96)	(0.61)	(- 0.57)	(- 0.20)	(- 0.63)	(0.66)	(- 0.45)	(- 0.17)	(- 0.06)
	Trade Balance	-0.94	- 1.49	2.99	- 1.37	-2.32	1.20	- 1.11	- 0.13	- 0.83
		(-1.08)	(- 0.21)	(0.40)	(- 1.14)	(- 1.05)	(0.49)	(- 0.71)	(- 0.09)	(- 0.55)
	Unemployment	-0.11	5.26	-3.57	0.04	- 0.11	0.29	- 0.39	-2.68	2.42
		(- 0.12)	(0.69)	(- 0.44)	(0.03)	(- 0.04)	(0.11)	(- 0.23)	(- 1.67)*	(1.48)
	Job Creation	- 0.47	-12.53	12.41	-2.71	1.49	- 1.86	- 0.55	0.83	- 0.14
		(- 0.26)	(- 0.87)	(0.80)	(- 1.10)	(0.33)	(- 0.37)	(- 0.17)	(0.27)	(- 0.05)
	Retail Sales	- 0.37	- 0.15	- 1.43	- 0.92	-2.84	2.55	- 1.40	-2.31	1.27
		(- 0.47)	(- 0.02)	(- 0.20)	(- 0.83)	(- 1.39)	(1.13)	(- 0.98)	(- 1.68)*	(0.91)
	Industrial Production	0.88	-7.09	14.47	1.42	2.08	- 1.00	0.45	- 0.45	1.88
		(0.96)	(- 0.96)	(1.83)*	(1.12)	(0.90)	(- 0.39)	(0.28)	(- 0.29)	(1.19)
	CPI	0.24	-4.09	6.00	- 0.86	0.53	- 0.23	-2.28	-2.13	0.23
		(0.24)	(- 0.50)	(0.68)	(- 0.61)	(0.21)	(- 0.08)	(- 1.26)	(- 1.24)	(0.13)
	ISM	1.20	- 0.20	1 0.04	1.75	1.12	2.36	3.24	2.37	1.33
		(1.29)	(- 0.03)	(1.23)	(1.36)	(0.48)	(0.90)	(1.94)*	(1.50)	(0.82)
	New Home Sales	0.33	- 0.26	- 0.29	- 0.63	0.36	- 0.03	- 1.39	- 0.17	- 0.65
		(0.39)	(- 0.04)	(- 0.04)	(- 0.54)	(0.17)	(- 0.01)	(- 0.91)	(- 0.12)	(- 0.44)
USA	**Retail Sales**	0.81	4.04	-4.91	1.06	- 0.52	1.37	0.59	- 1.24	1.36
		(0.87)	(0.53)	(- 0.60)	(0.82)	(- 0.22)	(0.52)	(0.35)	(- 0.77)	(0.83)
	Durable Goods Orders	2.18	- 0.71	1.41	2.81	2.70	- 1.32	4.44	1.08	2.01
		(2.41)**	(- 0.10)	(0.18)	(2.24)**	(1.17)	(- 0.52)	(2.74)***	(0.70)	(1.27)
	Job Creation	0.75	9.31	-8.45	- 0.50	0.51	- 1.06	-4.42	- 1.39	-2.40
		(0.86)	(1.32)	(- 1.11)	(- 0.42)	(0.23)	(- 0.43)	(-2.84)***	(- 0.93)	(- 1.58)
	Fed Funds rate	- 0.24	2.90	1.19	4.15	2.02	1.93	6.06	2.41	4.88
		(- 0.14)	(0.21)	(0.08)	(1.77)*	(0.47)	(0.41)	(2.00)**	(0.83)	(1.65)*

Note: This table shows the estimated coefficients of VECs for the variation of short-, medium- and long-term vertices of nominal yield, expected inflation and real yield curves in response to surprises of one standard deviation of each of the macroeconomic announcements on the day after the announcement. The t statistic of each coefficient is in brackets. *, ** and *** indicate a statistical significance of 10%, 5% and 1%, respectively. All of the coefficients were multiplied by 100 for better visualization.

THE IMPACT OF SURPRISES ON THE DAY AFTER ANNOUNCEMENT

The Brazilian retail sales coefficient for long-term expected inflation is significant and opposite from the previous day. In both cases, the market "exaggerated" its response to the surprise from indicators on the day of the announcement and corrected that response the following day, indicating an "overshooting" of the market response to the surprise.

Surprises in IPCA are significant and show a high and negative coefficient for the effect on short-term expected inflation, indicating that expected inflation returns to practically the same level as before the surprise. Surprinsigly, all of this movement on the day after the announcement is absorbed by an similar in size increase in the real yield, and no significant change occurs in the nominal yield. One possible explanation for this movement is that the more liquid Pre x DI swap market (nominal yields) returns all of the "overshooting" on the same day, whereas the IPCA x DI swap (real yields) is only corrected by the market on the following day because it is less liquid.

Surprises in the indicator of U.S. durable goods orders had (the expected) significant positive effects on all horizons; however, these effects were not significant on the day of the announcement. The same pattern occurs for short-term Brazilian GDP. Surprises from the Fed Funds and in U.S. industrial activity (ISM) are significant and remain positive, indicating that the market continues the process that started on the previous day. On the other hand, Job Creation surprises seems to overshoot, they have a negative significant coefficient for the 36-month nominal yields on the following day, opposed to a positive and significant coefficient on the day of the announcement.

Finally, we found that there was a higher number of significant coefficients for the contemporary surprises than for the lagged surprises, leading us to believe that the most important and significant part of the variations caused by surprises occurs on the day of the announcement. However, market responses to surprises are not all absorbed on the same day, leaving some room for adjustments in the following trading day.

5 - Conclusions

This study presents empirical evidence of the influence that surprises in macroeconomic data announcements exerted on the Brazilian nominal and real yield curve and market inflation expectations in the years from 2005 to 2011. We used a VEC to estimate the results while preserving the strong substitution effect and the long-term cointegration relationships among the several vertices.

Besides considering nominal yields, we also estimated the effect of surprises in announcements on expected inflation and on the real yield curve and, to the best of knowledge, added to the literature a more complete quantification of the effects on short-, medium- and long-term inflation expectations.

Surprises in activity generate immediate market responses. Positive surprises in the IPCA and industrial production cause an increase in all nominal yield curves. Positive surprises from the IPCA affect the short-term expected inflation, whereas surprises from industrial production affect the long-term expected inflation. We complement Tabak's (2004) study by finding evidence that the nominal yield curve reacts to the unexpected component of COPOM decisions monetary-policy interest rates. Positive surprises cause an increase in the short- and medium-term nominal yields.

Our results also indicate that the U.S. economy affects Brazilian yields, mainly through the U.S. indicators of industrial activity levels and job numbers. We confirmed the results of Hausman and Wongswan (2011) for Brazil. The long-term interest rates vary in response to surprises from the FOMC, whereas the short-term rates show practically no reaction to the same surprises.

Finally, we studied whether the market reaction to surprises on the day of the announcement are overshooted by estimating the response to surprises lagged by one day. We found evidence of "overshooting" in the long-term nominal yield for the announcement of job positions for the U.S. and

"overshooting" in the responses of the short- and long-term expected inflation to surprises in IPCA and retail sales, respectively.

Possible extensions of the study are as follows: (1) verifying the effect of surprises on the volatility of interest rates; (2) study the response of the stock market and the Brazilian exchange rate to macroeconomic surprises; (3) using high frequency data to measure the latency of the market response to surprises in announcements and possible "overshooting" throughout the announcement day.

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Table A.1 – Estimated coefficients for the nominal yield curve

	Indicator	Pre 1 month	Pre 3 months	Pre 6 months	Pre 12 months	Pre 18 months	Pre 24 months	Pre 30 months	Pre 36 months
BRAZIL	**COPOM**	8,70	8,95	8.30	6.85	4.05	2.50	0.16	- 0.81
		(7.43)***	(7.49)***	(6.52)***	(4.14)***	(2.14)**	(1.25)	(0.07)	(- 0.38)
	GDP	1.11	- 0.48	0.61	0.37	0.55	0.44	0.59	- 0.15
		(0.73)	(- 0.31)	(0.37)	(0.17)	(0.22)	(0.17)	(0.22)	(- 0.05)
	IPCA	0.79	2.32	2.51	3.72	3.40	3.13	3.54	3.45
		(0.85)	(2.45)**	(2.49)**	(2.83)***	(2.27)**	(1.96)**	(2.12)**	(2.03)**
	IGPM	0.17	0.62	0.88	0.95	0.88	1.21	1.24	0.87
		(0.20)	(0.71)	(0.95)	(0.78)	(0.63)	(0.83)	(0.81)	(0.55)
	Trade Balance	-4.58	-3.54	- 1.78	- 1.31	- 1.38	- 1.39	- 1.85	- 1.59
		(-5.43)***	(-4.11)***	(- 1.94)*	(- 1.10)	(- 1.01)	(- 0.96)	(- 1.22)	(- 1.03)
	Unemployment	- 0.29	- 0.30	- 0.59	- 1.62	- 1.48	- 1.20	- 1.55	- 0.51
		(- 0.32)	(- 0.32)	(- 0.59)	(- 1.25)	(- 0.99)	(- 0.76)	(- 0.94)	(- 0.30)
	Job Creation	- 0.39	0.44	0.70	0.48	- 1.04	- 0.85	- 1.51	- 1.08
		(- 0.23)	(0.25)	(0.38)	(0.20)	(- 0.37)	(- 0.29)	(- 0.49)	(- 0.34)
	Retail Sales	0.05	0.08	1.10	1.89	1.92	1.78	2.06	2.15
		(0.06)	(0.10)	(1.30)	(1.71)*	(1.52)	(1.33)	(1.47)	(1.50)
	Industrial Production	5.67	5.22	5.16	4.94	5.26	5.58	5.58	5.22
		(6.42)***	(5.79)***	(5.37)***	(3.95)***	(3.68)***	(3.68)***	(3.51)***	(3.22)***
USA	**CPI**	- 0.45	- 0.02	- 0.93	- 0.84	- 1.64	-2.73	-3.19	-3.32
		(- 0.45)	(- 0.02)	(- 0.87)	(- 0.60)	(- 1.02)	(- 1.61)	(- 1.79)*	(- 1.83)*
	ISM	4.26	5.87	6.30	5.27	4.41	3.18	1.76	0.73
		(4.71)***	(6.36)***	(6.41)***	(4.13)***	(3.02)***	(2.05)**	(1.08)	(0.44)
	New Home Sales	- 0.35	- 0.48	- 0.60	- 0.43	- 0.52	- 0.39	0.45	- 0.30
		(- 0.43)	(- 0.57)	(- 0.66)	(- 0.37)	(- 0.39)	(- 0.27)	(0.30)	(- 0.20)
	Retail Sales	0.33	0.89	0.94	1.47	1.48	1.35	0.46	0.98
		(0.37)	(0.96)	(0.95)	(1.14)	(1.00)	(0.87)	(0.28)	(0.59)
	Durable Goods Orders	- 0.28	- 0.55	- 0.70	- 1.66	- 1.71	- 1.44	- 1.66	- 1.20
		(- 0.32)	(- 0.61)	(- 0.73)	(- 1.33)	(- 1.20)	(- 0.95)	(- 1.05)	(- 0.74)
	Job Creation	0.18	0.89	1.53	2.59	3.52	3.89	4.09	3.41
		(0.21)	(1.02)	(1.66)*	(2.15)**	(2.55)**	(2.66)***	(2.67)***	(2.18)**
	FOMC	0.59	1.26	1.84	2.60	5.22	7.17	7.81	7.24
		(0.36)	(0.75)	(1.03)	(1.11)	(1.96)*	(2.53)**	(2.64)***	(2.39)**

Note: This table shows the estimated VEC coefficients for the variation of each one of the vertices of the nominal yield curves in response to normalized surprises for each of the macroeconomic announcements. The t statistic of each coefficient is between brackets. *, ** and *** indicate statistical significance of 10%, 5% and 1%, respectively. All of the coefficients were multiplied by 100 for better visualization.

Table A.2 – Estimated coefficients for expected inflation

|	Indicator	IPCA 1 month	IPCA 3 months	IPCA 6 months	IPCA 12 months	IPCA 18 months	IPCA 24 months	IPCA 30 months	IPCA 36 months
BRAZIL	**COPOM**	0.08	-4.44	-3.88	1.57	-2.19	-3.56	-2.35	- 1.77
		(0.00)	(- 0.46)	(- 0.74)	(0.52)	(- 0.92)	(- 1.56)	(- 1.14)	(- 0.86)
	GDP	7 0.87	1 0.24	1 0.00	1 1.28	7.48	5.21	3.23	2.28
		(2.07)**	(0.81)	(1.46)	(2.85)***	(2.42)**	(1.75)*	(1.20)	(0.85)
	IPCA	5 1.19	16.94	- 1.75	2.49	1.40	0.36	0.78	1.09
		(2.45)**	(2.21)**	(- 0.42)	(1.03)	(0.74)	(0.20)	(0.48)	(0.67)
	IGPM	-4.54	2.08	0.93	1.17	3.41	4.06	4.45	5.05
		(- 0.24)	(0.29)	(0.24)	(0.53)	(1.97)**	(2.44)**	(2.96)***	(3.38)***
	Trade Balance	-46.75	-3.46	0.35	- 0.90	- 0.26	0.16	- 0.17	0.79
		(-2.46)**	(- 0.50)	(0.09)	(- 0.41)	(- 0.15)	(0.10)	(- 0.12)	(0.54)
	Unemployment	-2 0.04	-5.49	-5.54	- 0.72	- 1.71	-2.11	-3.07	-2.54
		(- 0.97)	(- 0.72)	(- 1.34)	(- 0.30)	(- 0.92)	(- 1.18)	(- 1.90)*	(- 1.58)
	Job Creation	-2 1.60	-1 0.84	- 1.36	0.43	3.51	4.86	3.44	3.78
		(- 0.56)	(- 0.76)	(- 0.18)	(0.10)	(1.01)	(1.45)	(1.14)	(1.26)
	Retail Sales	-8,72	3.23	- 1.86	2.91	1.90	1.81	2.89	2.91
		(- 0.50)	(0.50)	(- 0.53)	(1.43)	(1.20)	(1.19)	(2.11)**	(2.13)**
	Industrial Production	-8.10	0.06	2.06	- 0.81	1.17	2.08	3.92	4.63
		(- 0.41)	(0.01)	(0.52)	(- 0.35)	(0.66)	(1.21)	(2.52)**	(3.00)***
USA	**CPI**	-17.98	- 0.79	- 1.73	-2.86	- 1.12	- 0.85	- 1.13	- 1.42
		(- 0.81)	(- 0.10)	(- 0.39)	(- 1.12)	(- 0.56)	(- 0.44)	(- 0.65)	(- 0.83)
	ISM	-13.94	2.30	0.34	0.63	0.69	0.32	- 1.31	-2.16
		(- 0.68)	(0.31)	(0.08)	(0.27)	(0.38)	(0.18)	(- 0.82)	(- 1.37)
	New Home Sales	1.57	0.30	- 1.18	-2.37	- 1.54	- 1.14	- 0.66	- 0.27
		(0.08)	(0.04)	(- 0.32)	(- 1.10)	(- 0.92)	(- 0.71)	(- 0.45)	(- 0.19)
	Retail Sales	-17.30	-5.90	9.18	2.13	0.55	- 0.14	- 1.04	- 0.47
		(- 0.85)	(- 0.79)	(2.26)**	(0.90)	(0.30)	(- 0.08)	(- 0.65)	(- 0.30)
	Durable Goods Orders	-2.75	- 0.61	- 0.59	- 0.23	0.12	1.13	2.42	2.49
		(- 0.14)	(- 0.08)	(- 0.15)	(- 0.10)	(0.07)	(0.66)	(1.56)	(1.61)
	Job Creation	-4.80	0.64	-4.11	1.02	- 0.41	- 0.52	- 0.32	- 1.10
		(- 0.25)	(0.09)	(- 1.07)	(0.46)	(- 0.24)	(- 0.32)	(- 0.21)	(- 0.74)
	FOMC	1.47	3.45	0.67	-5.38	0.14	2.45	5.53	6.41
		(0.04)	(0.25)	(0.09)	(- 1.25)	(0.04)	(0.76)	(1.90)*	(2.22)**

Note: This table shows the estimated VEC coefficients for the variation of each of the vertices of the expected inflation curve in response to normalized surprises in each of the macroeconomic announcements. The t statistic of each coefficient is in brackets. *, ** and *** indicate statistical significance of 10%, 5% and 1%, respectively. All of the coefficients were multiplied by 100 for better visualization.

Table A.3 – Estimated coefficients for the real yield curve

|	Indicator	Real yield 1 month	Real yield 3 months	Real yield 6 months	Real yield 12 months	Real yield 18 months	Real yield 24 months	Real yield 30 months	Real yield 36 months
BRAZIL	**COPOM**	3.56	9.28	1 1.53	4.38	5.71	4.97	1.75	0.27
		(0.14)	(0.89)	(1.99)**	(1.30)	(2.23)**	(2.09)**	(0.82)	(0.13)
	GDP	-63.11	-9.53	-9.79	-11.04	-6.76	-4.11	- 1.69	- 0.78
		(- 1.88)*	(- 0.71)	(- 1.31)	(-2.55)**	(-2.05)**	(- 1.34)	(- 0.61)	(- 0.29)
	IPCA	-32.77	-8.92	5.66	2.41	2.85	3.30	3.17	2.89
		(- 1.59)	(- 1.08)	(1.23)	(0.90)	(1.41)	(1.75)*	(1.88)*	(1.74)*
	IGPM	2.57	- 0.67	- 0.30	- 0.27	-2.79	-3.07	-3.02	-3.51
		(0.14)	(- 0.09)	(- 0.07)	(- 0.11)	(- 1.50)	(- 1.77)*	(- 1.96)*	(-2.31)**
	Trade Balance	5 1.93	1 0.38	1.54	0.45	- 0.32	- 1.46	- 1.76	- 1.50
		(2.79)***	(1.39)	(0.37)	(0.19)	(- 0.17)	(- 0.85)	(- 1.15)	(- 1.00)
	Unemployment	15.20	3.74	4.25	- 1.26	0.01	0.40	1.25	0.85
		(0.74)	(0.46)	(0.93)	(- 0.48)	(0.01)	(0.21)	(0.74)	(0.52)
	Job Creation	-5.59	7.17	-2.42	- 0.61	-4.50	-5.98	-5.36	-5.00
		(- 0.15)	(0.47)	(- 0.28)	(- 0.12)	(- 1.20)	(- 1.71)*	(- 1.72)*	(- 1.63)
	Retail Sales	- 1.33	-3.11	1.28	- 1.63	0.23	0.38	- 0.71	- 0.87
		(- 0.08)	(- 0.45)	(0.33)	(- 0.73)	(0.14)	(0.24)	(- 0.50)	(- 0.63)
	Industrial Production	9.25	2.58	3.59	4.61	4.01	3.24	1.15	0.46
		(0.47)	(0.33)	(0.82)	(1.83)*	(2.09)**	(1.81)*	(0.72)	(0.29)
USA	**CPI**	2 0.30	2.28	1.46	2.70	0.51	- 0.54	- 1.24	- 1.09
		(0.93)	(0.26)	(0.30)	(0.96)	(0.24)	(- 0.27)	(- 0.70)	(- 0.62)
	ISM	66.59	36.27	23.84	14.25	1 0.07	8,48	8,07	7.04
		(3.34)***	(4.52)***	(5.34)***	(5.52)***	(5.13)***	(4.63)***	(4.94)***	(4.39)***
	New Home Sales	- 1.16	0.59	1.00	1.75	0.96	0.61	0.04	- 0.66
		(- 0.06)	(0.08)	(0.24)	(0.74)	(0.54)	(0.36)	(0.02)	(- 0.45)
	Retail Sales	17.32	3.40	-9.36	- 0.39	1.15	1.66	1.22	0.99
		(0.87)	(0.42)	(-2.10)**	(- 0.15)	(0.58)	(0.91)	(0.74)	(0.62)
	Durable Goods Orders	- 1.79	- 0.65	- 0.29	- 1.13	- 1.70	-2.45	-3.85	-3.85
		(- 0.09)	(- 0.08)	(- 0.07)	(- 0.45)	(- 0.88)	(- 1.37)	(-2.41)**	(-2.45)**
	Job Creation	3.55	1.00	6.51	1.10	3.19	3.89	3.99	3.82
		(0.19)	(0.13)	(1.55)	(0.45)	(1.72)*	(2.25)**	(2.59)***	(2.52)**
	FOMC	19.85	- 0.67	5.32	7.05	3.68	2.78	1.12	0.18
		(0.54)	(- 0.05)	(0.65)	(1.49)	(1.02)	(0.83)	(0.37)	(0.06)

Note: This table shows the estimated VEC coefficients for the variation of each of the vertices of the real yield curve in response to normalized surprises of each of the macroeconomic announcements. The t statistic of each coefficient is in brackets. *, ** and *** indicate statistical significance of 10%, 5% and 1%, respectively. All of the coefficients were multiplied by 100 for better visualization.

## Figure A.1 – Residuals of the expected inflation VECs
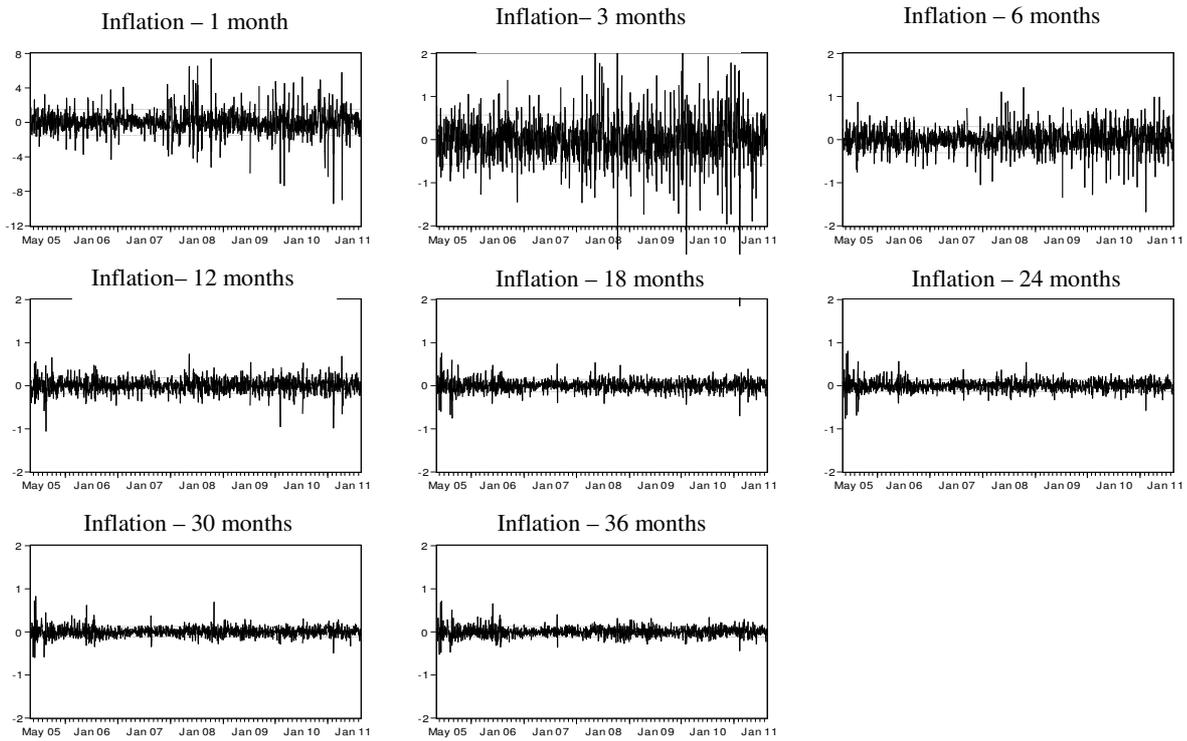
Note: This figure shows a series of residuals for each series of expected inflation data for the VEC of the expected inflation curve.

Figure A.2 – Residuals of the nominal interest rate VECs.
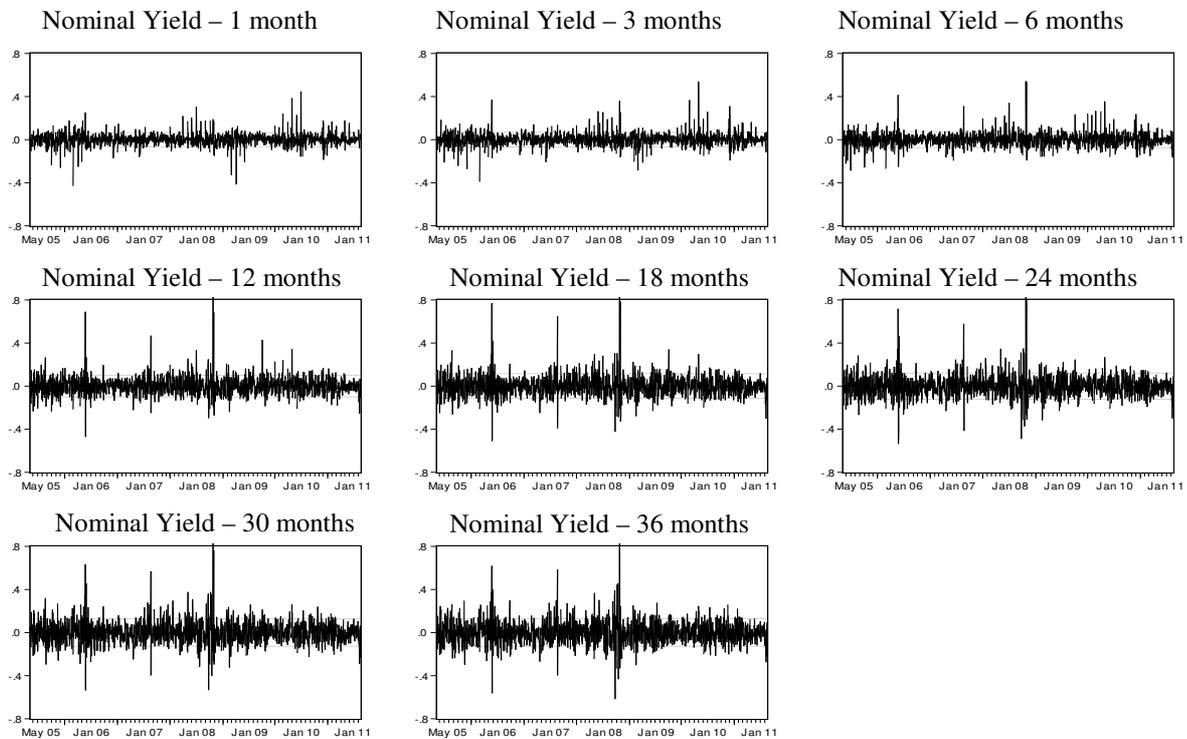
Note: This figure shows the series of residuals for each series of nominal yield data for the VEC of the nominal yield curve.

Figure A.3 – Residuals of the real interest rate VECs
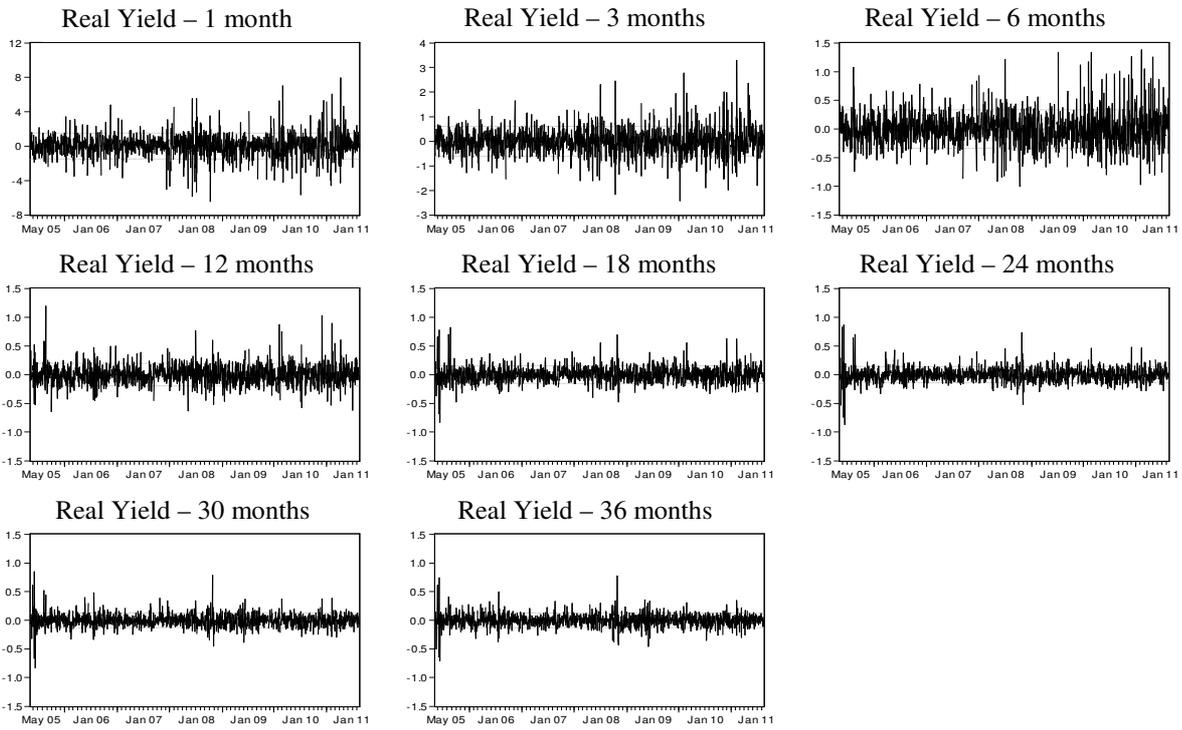
Note: This figure shows the series of residuals for each series of real yield data for the VEC of the real yield curve.