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Monetary Policy Surprises and the Brazilian Term Structure of Interest Rates*

Benjamin Miranda Tabak**

Abstract

This paper examines the information content of COPOM decisions to change or to leave unchanged monetary policy by estimating the responses of the term structure to changes in the target for interest rates on COPOM meeting days. Within an event-study approach the evidence suggests that market participants anticipate, at least partially, monetary policy actions. Furthermore, it is found that the introduction of the floating exchange and inflation targeting regime has had a dampening effect on interest rate surprises along the term structure.

Keywords: information content, announcements, interest rates, monetary policy.
JEL Classification: E4, G1

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1. Introduction

In this paper the influence of monetary policy on the term structure of interest rates is examined by estimating the effect of changes in the Brazilian Monetary Policy Committee's (COPOM) short-term interest target rate.

There is a voluminous empirical literature examining this issue for the Fed funds rate such as Balduzzi et alli (1997, 1998), Bernanke and Blinder (1992), Cook and Hahn (1989), Reinhart and Simmin (1997) and Rolley and Sellon (1995, 1998a, 1998b). Furthermore, Buttiglione et alli (1996), Dale (1993), Haldane and Read (2000) and Hardy (1996) analyze the market reaction to changes in official interest rates for different countries such as the UK and Germany.

We are not aware of previous studies that have focused on the effects of changes in COPOM's target rate on the term structure of interest rates for the Brazilian market. Yet, the study of the response of market interest rates to changes in target official rates may give additional insights in the transmission channels of monetary policy, as it should be able to change the entire spectrum of short and long-term interest rates.

Cook and Hahn (1989) were pioneers in this literature. They found evidence of strong response of short-term market interest rates and small response of long-term to changes in the Fed funds rate in the 1970s.

Rolley and Sellon (1995) using a different sampling approach found evidence suggesting that long-term rates anticipate policy changes, well in advance of monetary policy actions, which could explain the results found in Cook and Hahn (1989).

Rolley and Sellon (1998a) estimate statistically significant responses of long-term interest rates. Besides, Roley and Sellon (1998b) examine how Treasury security yields, stock prices, and federal funds futures rates respond on Federal Open Market Committee (FOMC) meeting dates when expected policy actions do not occur. They found evidence supporting the existence of no announcement effects.

Others studies have focused on the impact of monetary policy surprises on other markets. An interesting example is Thorbecke and Alami (1994) that found evidence of significant effects on stock prices for changes in the federal funds target changes.

An interesting research paper is that of Haldane and Read (2000), which studies the response of the yield curve to monetary policy surprises for the United Kingdom, United States, Germany and Italy. They found evidence that the introduction of the inflation targeting regime has had a significantly dampening effect on yield curve surprises at the short end.

This paper seeks to determine whether there are significant surprises in monetary policy by studying the relationship between changes in the official target rate and in market interest rates. Moreover, it tests whether the introduction of the floating exchange and inflation targeting regime has had any impact on these interest rate surprises along the term structure of Brazilian interest rates.

The Brazilian economy has undergone significant changes in the 1990s. The first important structural break has been the Real stabilization plan that had success in defeating a two digit monthly inflation in Brazil in the mid 1990s. In early 1999 monetary authorities has adopted an inflation targeting (IT) framework for monetary policy and has abandoned the fixed exchange rate policy. The main goal of this paper is to address the implications of this change in monetary policy on domestic interest rates surprises.

Empirical evidence suggests that the adoption of the inflation targeting (IT) framework with a floating exchange rate has had a dampening effect on interest rate surprises along the term structure, which could be explained by a greater transparency of the conduct of monetary policy after the adoption of the IT.

The paper is structured as follows. In Section 2 we present the methodology that will be used in this paper. Section 3 shows the empirical responses of the Brazilian term structure of interest rates to changes in the COPOM's target rate while in Section 4 evidence on response of the spreads of the term structure is presented. Section 5 concludes the paper.

2. Data and Methodology

In this section we explore the methodology and the data employed in this study as well. We show explicitly how the term structure of interest rates was built from different

financial instruments. Furthermore, we delineate the methodology that will be followed in the remainder of the paper.

2.1. The Data

The main data of the paper consist of spot interest rates for maturities 1, 2 3, 6 and 12 months.

The Term structure is obtained through the interest rates embedded in the CDI over, the DI futures contracts (from the first to the third month contracts) and DI x Pre swap rates for 6, 12 and 24 months maturities. The spot rates are built by accumulating the implicit term rates between maturities of the instruments cited above, assuming that the term rate between maturities is constant[1].

The DI x Pre swaps maturing on 6, 12 and 24 months' time are contracts in which a part pays a fixed rate over an agreed principal, and receives a floating rate over the same principal, while the reverse occurs with his or her counterpart. There are no intermediate cash flows; the contracts are only settled on maturity.

The floating rate in swap contracts is the overnight CDI rate, which tracks very closely the average rate in the market for overnight reserves at the central bank[2]. The parties trade a fixed interest rate that is used in our calculations.

The implicit interest rate for maturity within T days is given by

$$R_{t,T} = \left\{ \left[\left(1+\frac{R_0}{100} \right)^{T_0} \times \prod_{j=0}^{4} \left(1+\frac{R_{j,j+1}}{100} \right)^{\max\left[0;\min\left(T-T_j;T_{j+1}-T_j\right)\right]} \times \left(1+\frac{R_{5,6}}{100} \right)^{\max[0;T-T_6]} \right]^{1/T} -1 \right\} \times 100$$

[1] The main idea is that fixed income instruments have their nature changed on a day-by-day basis as each day they become securities with smaller term to maturity. However, with the definition of a limited number of terms, we have the so-called vertexes, which can be seen as virtual securities with the same maturity term.

[2] These contracts have been traded over-the-counter in Brazil since the early 90's, and must be registered either on BM&F (a futures exchange) or on CETIP (a custodian).

where

R_0 is the CDI over (one day overnight interest rate)

$R_{0,1}$ is the implicit term rate by the CDI over and the one-month DI future

$R_{1,2}$ is the implicit term rate by the one and two-months DI future

$R_{2,3}$ is the implicit term rate by the two and three-months DI future

$R_{3,4}$ is the implicit term rate by the three-months DI future and the 6-months SWAP DI x Pre

$R_{4,5}$ is the implicit term rate by the 6 and 12-months SWAP DI x Pre

$R_{5,6}$ is the implicit term rate by the 12 and 24-months SWAP DI x Pre

T_0 to T_6 represent, in working days, the maturity of each financial instrument (T_0 stands for the one-day CDI interest rate).

2.2. The Expectation Hypothesis

The Expectation Hypothesis can explain the influence of changes in official interest rate target on market interest rates. According to the Expectation Hypothesis of the term structure the long rate on a bond is related to the short-term rate and expected future short rates. The relation between one and two-period rates is given by:

$$R_t = \frac{1}{2}\left(r_t + E_t r_{t+1}\right) + \varepsilon_t \qquad (1)$$

where R_t is the two-period rate and r_t is the one-period rate, E_t is the expectation operator conditional on available information at instant t., and ε_t is a term premium. In general if we have a one-period rate and a long n-period rate then:

$$R_t = \frac{1}{n}\left(\sum_{i=0}^{n} E_t r_{t+i}\right) + \varepsilon_t \qquad (2)$$

Thus the Expectation Hypothesis states that long-term rates are an average of current short-term rates and expected future short-term rates plus a risk premium term.

Monetary policy affects long-term rates as it influences current and expected short-term rates. Additionally, the response of long-term rates in changes in COPOM's target rate should depend on the expected persistence of changes in the target.

The Expectation theory of the term structure in general is tested assuming additionally rational expectations. In that case

$$E_t r_{t+1} = r_{t+1} + \eta_{t+1} \qquad (3)$$

where η_{t+1} is a mean zero, iid white noise error.

We can rearrange equation (2) as[3]

$$\frac{1}{n}\left(\sum_{i=0}^{n} E_t r_{t+i}\right) = \frac{1}{n}\left(\sum_{i=0}^{n} \left(r_{t+i} + \eta_{t+i}\right)\right) = \frac{1}{n}\left(\sum_{i=0}^{n} r_{t+i}\right) = R_t - \varepsilon_t - \varpi_t \qquad (4)$$

and subtracting r_t from both sides gives

$$\frac{1}{n}\left(\sum_{i=0}^{n} E_t r_{t+i}\right) - r_t = \alpha + \beta\left(R_t - r_t\right) - \varpi_t \qquad (5)$$

where we have used $\alpha = -\varepsilon_t$ a constant term premium.

Equation (6) can be estimated and we should expect, if the Expectation Hypothesis holds, that the slope should be one. Furthermore, if there is a risk premium for being in longer term bonds then the intercept can be statistically significant, however it must be time-invariant.

[3] Where $\varpi_t = \frac{1}{n}\left(\sum_{i=0}^{n} \eta_{t+i}\right)$.

The purpose of this paper is not to perform direct test of the Expectation Hypothesis but to test whether market interest rates for different maturities have significant responses to changes in the target rate[4]. Even if the Expectation Hypothesis holds it may be that long-term rates do not respond as agents recognize that monetary policy action is not likely to persist for prolonged periods of time in the same direction.

2.3. Testing for Interest Rates Surprises

From the Expectation Hypothesis we have that long term interest rates can be seen as compounded short term expected interest rates. In general long term interest rates affect aggregate demand decisions. However, monetary authorities decide the target for short term interest rates and these decisions should affect long term interest rates by changing expectations for the path of future short term interest rates.

The main goal of this paper is to test what are the effects of changes in the short term interest rates, specifically, study the effects of changing the target for the short term interest rate, which is used as an instrument to achieve price stability and lower inflation expectations.

In this paper we follow along the line of Cook and Hahn (1989), which examined the one day response of bond rates to changes in the target fed funds rates using the following regression

$$\Delta R_t = \alpha + \beta \Delta T \arg et_t + \varepsilon_t \qquad (6)$$

where ΔR_t stands for changes in market interest rates and $\Delta Target_t$ for changes in the Fed funds target rate. The parameter β measures the mean interest rate surprise for any given maturity. If official target rate changes were fully anticipated then this coefficient should be equal to zero.

[4] Tabak and Andrade (2001) have shown that the standard approach tend to lead to the acceptance of the EH plus Rational Expectation for the 2, 3 and 6 months interest rates but not for the 12 month interest rates while using an "error-orthogonality" approach provided a decisive rejection of the EH plus Rational Expectations for all maturities.

In this paper we test whether the term structure of interest rates respond to changes in target rates, and to what extent. Furthermore, we test if the introduction of the inflation targeting regime has had any impact on the way interest rate surprises affect the term structure.

Additionally, an interesting issue that is explored in this paper is whether changes in target rates have significant responses in the term structure spreads. We test

$$\Delta(R_t - r_t) = \alpha + \beta\Delta\text{Target}_t \qquad (7)$$

In the next sections we perform these tests and give some interpretations of the results that are found.

3. Measuring the response of the term structure to Monetary Policy

We estimate the response of interest rates to changes in the official target rate with the regression

$$\Delta r_{i,t} = \alpha + \beta\Delta\text{Target}_t + \varepsilon_t \qquad (8)$$

where $r_{i,t}$ stands for the interest rate on maturity i at instant t.

3.1 Active Monetary Policy

The one-day response of interest rates to changes in the target is shown in table 1. The sample contains 31 changes in the target from June 26 1996 through February 14 2001. The meetings where the COPOM decided not to change the target were excluded from the analysis. Standard errors are robust to heteroscedasticity and autocorrelation as they were corrected using the Newey and West (1987) procedure[5].

The α and β coefficients for all maturities up to 12 months are presented in the second and third columns of table1. The response of interest rates are not significant in all

[5] This correction is necessary as the Durbin-Watson (DW) statistics indicate that there may be autocorrelation in the residuals of these regressions.

cases, which can be easily seen by comparing estimated coefficients with their standard errors.

Table 1: One-day response of interest rates to changes in the Target

Maturity	Intercept	Response	R^2	SE	DW
1 month	0.2870 (0.2213)	0.2213 (0.1216)	23.20%	1.6518	2.2986
2 months	0.1084 (0.1630)	0.0712 (0.0813)	11.87%	1.2368	2.2571
3 months	0.0542 (0.1541)	0.0445 (0.0764)	5.55%	1.1724	2.3389
6 months	0.0253 (0.1656)	0.0058 (0.0739)	0.09%	1.2392	2.3701
12 months	0.0050 (0.1610)	-0.0203 (0.0639)	1.22%	1.1670	2.3238

Newey-West (1987) standard errors are given in parentheses

The sample contains 31 changes in the target from June 26 1996 through February 14 2001.

This result is in line with the findings of Cook and Hahn (1989) for the US bond market, which found evidence that for the 1980s market participants were able to anticipate monetary policy actions (contrasting with the 1970s where interest rate surprises where more pronounced).

3.2. Inaction and Action in Monetary Policy

In this sub-section we test whether the results obtained previously remain unaltered by using a larger sample with 54 observations containing 31 changes and 23 no changes in the target from June 26 1996 through February 14 2001.

Results are shown in table 2 and are similar as those found in table 1. The predictive power of the regressions increased slightly for the one-month response but decreased for

other maturities. Standard errors are huge if compared with estimated coefficients, which leads to the conclusion that both the intercept and slope are not statistically different from zero.

Table 2: One-day response of interest rates to changes in the Target

Maturity	Intercept	Response	R^2	SE	DW
1 month	0.1842 (0.1459)	0.1524 (0.1204)	25.25%	1.2488	2.1975
2 months	0.0275 (0.1017)	0.0710 (0.0806)	9.51%	1.0437	2.6019
3 months	-0.0164 (0.1074)	0.0444 (0.0757)	3.56%	1.1011	2.6036
6 months	-0.0168 (0.0997)	0.0058 (0.0730)	0.06%	1.0693	2.6842
12 months	-0.0251 (0.0930)	-0.0204 (0.0629)	0.85%	1.0456	2.6842

* Significant at the 99% confidence level
** Significant at the 95% confidence level
Newey-West (1987) standard errors are given in parentheses

The sample contains 54 months with changes and no changes in the target from June 26 1996 through February 14 2001.

The results so far appear to indicate that monetary policy does not affect the term structure of interest rates in Brazil. This leads to the conclusion that COPOM actions have been fully anticipated which is a rather strong assertion.

This could be further examined by an analysis of the relationship between changes in the term structure and futures changes in the target. The results found previously could be due to the fact that interest rates should respond to surprises in monetary policy but not to anticipated actions.

Table 3 presents results for regressing the changes in the term structure to future changes in the target rate. As it can be seen, regressions for changes in market interest rates two days before COPOM's meeting are not significant but if we test for an

anticipation of five days then for all maturities we have significant responses, which leads to the conclusion that COPOM's decisions are indeed anticipated by market participants.

However, the slope is significantly different from one that could mean that although changes in the target rate are being anticipated they may not being fully anticipated. Wald tests performed on these coefficients reject the null of a response equal to one for all maturities.

Table 3: Movements in interest rates for different maturities before COPOM meetings

	Two days before		**Five days before**	
Maturity	Intercept	Response	Intercept	Response
1 month	0.0495	0.1159	0.0394	0.2217***
	(0.1709)	(0.1061)	(0.2352)	(0.1314)
2 months	0.0795	0.0853	0.0619	0.2269***
	(0.2009)	(0.1125)	(0.2033)	(0.1267)
3 months	0.0488	0.0671	0.1047	0.2310***
	(0.1938)	(0.1069)	(0.2129)	(0.1257)
6 months	0.0782	0.0934	0.1245	0.2612**
	(0.1228)	(0.0745)	(0.2219)	(0.1142)
12 months	0.0705	0.0878	0.0629	0.2502*
	(0.1099)	(0.0566)	(0.1882)	(0.0914)

* Significant at the 99% confidence level
** Significant at the 95% confidence level
Newey-West (1987) standard errors are given in parentheses
The sample contains 54 months with changes and no changes in the target from June 26 1996 through February 14 2001.

3.3. The introduction of the Inflation Targeting Regime and Floating Exchange Regime

A problem with the tests performed so far is that monetary policy has had a significant change in 1999, with the introduction of both a floating exchange (after many years with a crawling-peg exchange rate regime) and an inflation targeting regime.

We add a dummy variable for the change in the exchange rate regime that gives a zero value for the period before January 1999 and one thereafter. The regression that we estimate is given by

$$\Delta R_t = \alpha + \beta_1 \Delta T \arg et_t + \beta_2 Dummy \quad \Delta r_t + \varepsilon_t \qquad (9)$$

In this case β_2 measures the effect of the introduction of the floating exchange regime and the inflation targeting regime. In table 4a we show the results.

Table 4a: One-day response of interest rates to changes in the Target

Maturity	Intercept	Response	IT Response	R^2	SE	DW
1 month	0.1033 (0.1166)	0.3462* (0.1193)	-0.3467* (0.1196)	55.44 %	0.9550	1.7668
2 months	-0.0350 (0.1035)	0.2210* (0.0441)	-0.2684* (0.0458)	40.37 %	0.8391	2.4030
3 months	-0.0776 (0.1150)	0.1909* (0.0309)	-0.2621* (0.0334)	31.20 %	0.9211	2.4075
6 months	-0.0766 (0.1162)	0.1490* (0.0236)	-0.2562* (0.0287)	29.13 %	0.8919	2.3794
12 months	-0.0763 (0.1091)	0.1020* (0.0236)	-0.2192* (0.0307)	22.03 %	0.9185	2.4470

* Significant at the 99% confidence level
** Significant at the 95% confidence level
Newey-West (1987) standard errors are given in parentheses
The sample contains 54 months with changes and no changes in the target from June 26 1996 through February 14 2001.

The results shown in table 4a are in line with the findings of Haldane and Read (2000). The introduction of the floating exchange rate and inflation target regime has had a dampening effect on interest rate surprises in Brazil, as the coefficient for the dummy variable is negative for all maturities. Yet, the explanatory power had a huge increase.

Table 4b. Wald Tests (H_0: $\beta_1 + \beta_2 = 0$)		
Maturity	χ^2-Statistic	p-value
1 month	0.0039	0.9499
2 months	24.18	0.0000
3 months	47.07	0.0000
6 months	54.09	0.0000
12 months	41.57	0.0000

We also performed Wald tests for the joint restriction on both coefficients β_1 and β_2=0, if there is a significant effect from the IT framework then the sum of these coefficients should be statistically distinguishable from zero. As we can see from table 4b this seems to be the case for all maturities except for the one-month interest rate[6].

We can conclude that the regressions made before were misspecified. In average the interest rate surprise is significant for the whole sample. Additionally, the response of interest rates decreases as maturity lengthens, as one should expect.

This dampening effect that was found in this paper could be due to two main reasons. The first one relates to the greater transparency that is associated to the IT framework. Another reason is that under a fixed exchange rate regime all decisions from COPOM's meeting should be reflected in interest rates as the impact on the exchange rate was blocked, while with a floating exchange rate regime the exchange rate can absorb part of surprises and thus the impact on interest rates could be reduced.

4. Measuring the response of the term structure spreads to Monetary Policy

We also checked how the slope of the term structure responded to changes in the target. We estimated the following regression

$$\Delta\left(R_{i,t} - r_t\right) = \alpha + \beta\Delta\text{Target}_t \qquad (10)$$

where R stands for long-run rates and r for short-term rates.

[6] We have also used a dummy to capture the effects of meetings that have decided to change interest rates from meetings in which the target was not changed. These dummies were insignificant for all maturities and results remained qualitatively the same.

Table 5 shows the one-day responses of the slope of the yield curve responded to changes in the target, where 2m-1m is the spread between two and one-month rates, using only effective changes in the target.

Table 5: One-day response of the term structure Spread to changes in the Target

$$\Delta(R_t - r_t) = \alpha + \beta\Delta\text{Target}_t$$

Spread	Intercept	Response	R^2	SE	DW
2m – 1m	-0.1786 (0.1177)	-0.0814*** (0.0460)	32.63%	0.7460	2.0169
3m –1m	-0.2328*** (0.1354)	-0.1080*** (0.0539)	35.93%	0.9200	2.0634
6m –1m	-0.2617 (0.1668)	-0.1467** (0.0594)	41.75%	1.1050	1.9680
12m – 1m	-0.2820 (0.2123)	-0.1730** (0.0707)	43.43%	1.2590	1.8114

* Significant at the 99% confidence level
** Significant at the 95% confidence level
Newey-West (1987) standard errors are given in parentheses
The sample contains 31 changes in the target from June 26 1996 through February 14 2001.

Both the response of the spread and the explanatory power increase as maturity lengthens. The expected signs of coefficients are correct and interpretation could be that changes in the target rate may not imply in further changes in the future, in which case long-term rates would rise as well.

In table 6 we show evidence using the entire sample, including no changes in the target. A fact that's worth mentioning is that although explanatory power has decreased a little, response to target rate changes are almost the same for all cases[7].

[7] We have also used a dummy for the IT period and it was not significant for all maturities. In this case the target has affect only the spread between the 12 and 6 months and the one month interest rate. However, Wald tests for the restriction that the sum of the coefficients on the target and the dummy is equal to zero have been rejected for all cases.

Table 6. One-day response of the term structure spread to changes in the target.

$$\Delta(R_t - r_t) = \alpha + \beta \Delta \text{Target}_t$$

Spread	Intercept	Response	R2	SE	DW
2m – 1m	**-0.1566****	**-0.0814*****	**23.50%**	**0.6991**	**2.1055**
	(0.0792)	**(0.0455)**			
3m –1m	**-0.2007*****	**-0.1080****	**23.73%**	**0.9217**	**1.9150**
	(0.1161)	**(0.0532)**			
6m –1m	**-0.2011**	**-0.1466***	**34.89%**	**0.9536**	**1.9211**
	(0.1229)	**(0.0589)**			
12m – 1m	**-0.2093**	**-0.1729****	**36.61%**	**1.0832**	**1.8977**
	(0.1336)	**(0.0704)**			

* Significant at the 99% confidence level
** Significant at the 95% confidence level
*** Significant at the 90% confidence level
Newey-West (1987) standard errors are given in parentheses
The sample contains 54 months with changes and no changes in the target from June 26 1996 through February 14 2001.

A final test is made using five-day response to changes in the target. Results show that the response is higher which is consistent with results found in the previous section. There is some degree of anticipation of monetary policy actions by market participants.

Table 7 Five-days response of the term structure Spread to changes in the Target.
$\Delta(R_t - r_t) = \alpha + \beta\Delta\text{Target}_t$

Spread	Intercept	Response	R2	SE	DW
2m – 1m	**-0.1785**** **(0.0857)**	**-0.1045*** **(0.0263)**	**35.13%**	**0.6763**	**1.7929**
3m –1m	**-0.3845***** **(0.1969)**	**-0.1626*** **(0.0439)**	**25.66%**	**1.3178**	**1.5017**
6m –1m	**-0.6217**** **(0.2998)**	**-0.2588*** **(0.0645)**	**27.02%**	**2.0248**	**1.6079**
12m – 1m	**-0.6187***** **(0.3085)**	**-0.2904*** **(0.0723)**	**28.91%**	**2.1678**	**1.6482**

* Significant at the 99% confidence level
** Significant at the 95% confidence level
*** Significant at the 90% confidence level
Newey-West (1987) standard errors are given in parentheses
The sample contains 54 months with changes and no changes in the target from June 26 1996 through February 14 2001.

Evidence so far shows that changes in the target rate may be predicted and are incorporated in market interest rates before COPOM's meetings.

5. Conclusions

The results found in this paper appear to indicate that the term structure do not respond to monetary policy actions, measured by changes in official target rate changes. These results are robust using two distinct samples, one which includes only effective changes and another which includes also no changes in the target rate.

However, assuming that the target rate should indeed influence interest rate for different maturities we performed tests checking if expected target changes would influence interest rates. Results were conclusive for different sampling approaches. There is some degree of anticipation in monetary policy action by market participants.

Two types of additional tests were done. In the first place, we tested if spreads of the interest rates responded to changes in the target rate and found that they do, although not on a one-to-one basis.

Some extensions are suggested for further research. The first would be to perform these tests with a higher frequency and check whether the term structure respond differently in different positions in the Business Cycle. Another extension would be to use interest rates futures contracts to extract market expectations on target rate changes and perform the regressions using anticipated and no anticipated monetary policy actions.

Finally, an alternative methodology could be to decompose official rates changes into their anticipated and no anticipated components, and then estimating the response of the term structure to unanticipated policy changes.

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