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Central bank's perception on inflation and inflation expectations of experts: Empirical evidence from Brazil

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Abstract

Purpose – Due to the fact that studies on central bank communication in emerging countries are still scarce and there are few studies related to the influence that central bank's perspectives about the state of the economy have on inflation expectations in emerging economies, the purpose of this paper is to contribute to the literature in the following aspects: it proposes an indicator of the central bank's perception of inflation based on the minutes of the COPOM meetings, and, it analyzes the influence of central bank communication on expert inflation expectations through such indicator.

Design/methodology/approach – Due to the fact that the perception of the Central Bank of Brazil is not directly observable, it is measured through the fuzzy set theory by an indicator that captures the informational content of the minutes of the COPOM meetings. The empirical analysis uses ordinary least squares, the generalized method of moments and vector-autoregressive through impulse-response analysis.

Findings – The findings suggest that the expectations of financial market experts react according to the content of the information provided by the central bank, i.e., announcements cause deterioration of expectations in times of instability, and reduce inflation expectations when inflation is controlled. The results also support the idea that the credibility of inflation targeting plays a key role in determining inflation expectations.

Practical implications – This paper suggests a new approach on studies about central bank communication. The focus here is not on the effect of the announcements in terms of future monetary policy, but on the perception of the central bank in terms of inflation. This central bank's perception reflects the optimistic or pessimistic view about the economic outlook and risk of inflation and this perception is considered by experts of financial markets.

Originality/value – For Brazil, there are no studies about the influence of communication through the minutes of the Brazilian Monetary Policy Committee meetings on inflation expectations. The authors develop an indicator in order to measure central bank's perception of inflation based on the minutes of COPOM meetings.

Keywords Communication, Perception, Central bank, Inflation expectation

Paper type Research paper

1. Introduction

The management of expectations is an important task of the monetary authority. In this sense, central bank communication has grown in importance and has become an instrument of great influence (Blinder *et al.*, 2008). Regarding the influence of

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communication on the economy, there are two main approaches. One discusses the impact of central bank communication on financial markets (e.g. Kohn and Sack, 2004; Rosa and Verga, 2007; Ehrmann and Fratzscher, 2007a, b). The other deals with the influence of communication on economic performance (e.g. Fujiwara, 2005; Rozkrut *et al.*, 2007; Ullrich, 2008).

Most studies on central bank communication are concerned about developed countries. Besides, most of these studies regard the influence that communication has on expectations – from financial markets' participants – about interest rates, exchange rates, and the future behavior of the monetary authority. Regarding emerging economies, the analysis for the effects of central bank communication on expectations is crucial, because uncertainties in these economies are higher and, thus, it is more difficult to guide expectations. However, there are few studies addressing emerging countries. Hence, based on existing literature, three gaps are identified: studies on central bank communication in emerging countries are still scarce; there are few studies related to the influence that central bank's perspectives about the state of the economy have on inflation expectations in emerging economies; and there are few studies using the economic outlook content of central bank communications. For Brazil (an inflation targeting emerging country), so far there are no studies about the influence of communication through the minutes of the Brazilian Monetary Policy Committee (COPOM) meetings on inflation expectations.

This study contributes to the literature in the following aspects: it proposes an indicator of the central bank's perception of inflation based on the minutes of the COPOM meetings; and it analyzes the influence of central bank communication on expert inflation expectations[1] through such indicator. Due to the fact that the perception of the Central Bank of Brazil (CBB) is not directly observable, it is measured through the fuzzy set theory by an indicator that captures the informational content of the minutes of the COPOM meetings. The analyzed time period is May 2003-April 2013.

Thus, the paper is divided as follows. The second section addresses the importance of central bank communication for the expectation formation process and presents a brief review of the empirical literature. The third section presents the index of communication based on the fuzzy set theory and an empirical analysis of the influence of central bank communication on inflation expectations. The fourth section presents the conclusion.

2. Importance of communication as a guide to expectations

According to Blinder *et al.* (2008), central bank communication can be defined as the provision of information by the central bank to the public regarding present and future monetary policy, the economic outlook and the goals of the central bank. This information is important since it affects, for example, the expectation formation process regarding future monetary policy and inflation in the following periods. In this sense, central bank communication acts in a helpful way since it guides agents' expectations and, thus, plays an important role in decision making (Jansen, 2011). Due to the fact that central bank communication affects expectations, communication represents an important tool for central banks affect the economy through agents' expectations, and to improve monetary policy (Gürkaynak *et al.*, 2005).

The existing empirical literature on central bank communication focusses efforts on showing the influence of communication on interest rates (e.g. Guthrie and Wright, 2000; Kohn and Sack, 2004; Andersson *et al.*, 2006; Ehrmann and Fratzcher, 2007a, b; Rosa and Verga, 2007; Heinemann and Ullrich, 2007; Sturm and De Haan, 2011) and on the exchange rate (Jansen and De Haan, 2005, 2007a; Conrad and Lamla, 2007; Fratzscher, 2008).

The studies regarding the effect of communication on inflation expectations are scarcer in the literature. The study of Jansen and De Haan (2007b) found evidence of a negative relationship between the European Central Bank (ECB) communication regarding risks to price stability (measured on the basis of the frequency and strength of the keyword "vigilance") and changes in euro area break-even inflation. Ullrich (2008) analyzed the informational content of the monthly introductory statements of the ECB president explaining interest rate decisions with regard to inflation expectations of financial market experts for the euro area. Estimations are conducted for the influence of ECB communication on expectations formation as well as the influence of other macroeconomic variables. The results suggest that the indicator developed to measure the informational content of ECB rhetoric contributes to the explanation of the inflation expectations formation. Besides, the results indicate that a communication that shows a monetary tightening increases inflation expectations for six months. This is due to the content on inflation risk obtained in a statement.

Kuttner and Posen (1999) analyzed the link between inflation expectations and inflation targeting coupled with more communication in the UK, New Zealand and Canada. Nevertheless, the analysis does not rely on direct measures of inflation expectations, but rather employs indirect approaches such as the Taylor rule and the time series properties of inflation rates. The study of Kliesen and Schmid (2004) investigates the influence of surprises in macroeconomic data releases, monetary policy surprises and central bank communication of the Federal Reserve on inflation expectations. The inflation expectations are gathered from concepts of inflation compensation included in nominal Treasury securities and inflation indexed Treasury securities. The findings suggest that Federal Reserve communication reduces uncertainty about the future rate of inflation, while surprises in monetary policy actions increase uncertainty about the path the rate of inflation is going to take.

Regarding the literature on central bank communication in Brazil, this is still incipient. The findings provided by the existing literature suggest that central bank communication affects interest rates with different maturities and expectations regarding future monetary policy (Costa-Filho and Rocha, 2009, 2010; de Mendonça and Faria, 2011, 2013; Montes, 2012). In turn, there are no studies about the influence of central bank communication on inflation expectations in Brazil.

Since the main goal of the central bank is to control inflation and anchor expectations, and its communication represents an important instrument to guide expectations, a special attention should be given to this. Moreover, the language used in communications is not clear and it may contain a high degree of ambiguity, which difficults the task of classifying central bank communication in a binary way. Furthermore, the content commonly used in the literature on monetary policy is not the most suitable to explain the formation of agents' expectations; because they use all available information, it is necessary the creation of a new indicator that measures the perception of the central bank about the economic outlook.

2.1 Measures of central bank communication

There are different ways of measuring the communication of the central bank through indexes. It is possible to distinguish the following approaches. The first seeks to classify all manifestations of the central bank in accordance with the content and signals, and thus use a numerical scale to encode these ratings. The second seeks to analyze all forms of communication in the media – by the committee or its members – which are important for monetary policy. In this case, specialized news agencies are

used to extract the statements of committee members in the days when they occurred. The extractions are done mechanically using a set of search words that includes the name of the member of the monetary policy committee and the words "interest rate," "monetary" and "inflation" when the objective is to evaluate the conduct of monetary policy, as well as the words "economy" and "economics perspective" when the objective is to assess the future economic outlook. The third considers some institutional characteristics related to the announcement of monetary policy to measure the impact of communication.

Ehrmann and Fratzscher (2007b) use research tools to collect the communications of all members of the monetary policy committee. Rosa and Verga (2007) present a discrete index. The index uses a glossary of sentences in order to obtain the information contained in the minute, and thus to classify the future monetary policy according to the information content of the minutes. Berger *et al.* (2011) analyzes the communications in terms of future monetary policy, price stability, real sector and monetary indicators. Heinemann and Ullrich (2007) show the Wording Indicator. This index is based on code words according to the full cycle of high and fall of interest rates from the ECB.

In terms of content, the main efforts on the literature regard the path of monetary policy (Connolly and Kohler, 2004; Musard-Gies, 2006; Andersson *et al.*, 2006; Rosa and Verga, 2007; Ehrmann and Fratzscher, 2009; Hayo and Neuenkirch, 2012; Brand *et al.*, 2010; Hayo *et al.*, 2010; Ranaldo and Rossi, 2010; Sturm and De Hann, 2011; Rosa, 2011; Demiralp *et al.,* 2012). Only a few works make an effort on the other contents of the central bank communication. The paper of Siklos and Bohl (2008) analyzes the content of central bank communication in five aspects: exchange rate, output, asset price, fiscal policy and international regards. The study of Rozkrut *et al.* (2007) focusses on the path of future monetary policy, economic outlook and exchange rate. The work of Berger *et al.* (2011) analyzes the press conference on three topics: price stability; developments in the real economy; and monetary indicators. The papers of Hayo and Neuenkirch (2012), Hayo *et al.* (2010), Kohn and Sack (2004) and Ehrmann and Fratzscher (2007a) study the influence of communication on the path of monetary policy and economic outlook content.

Regarding information related to inflation, Conrad and Lamla (2007) present an indicator that withdraws the forward-looking content from the speeches of the ECB president about risk to price stability, and turns it in an index about the path of monetary policy. The main differences between the indicator proposed by Conrad and Lamla (2007) and the index proposed in this paper are related to the content used in the index and the construction methodology. The indicator presented in Conrad and Lamla (2007) seeks to indicate future monetary policy, while the index proposed in this study provides information about the instability of the economic environment, more precisely in relation to inflation control. Furthermore, it represents central bank's perception, that is a more complete reference to agent's expectations than communication about the path of monetary policy.

This paper suggests a new approach on studies about central bank communication. The focus here is not on the effect of the announcements in terms of future monetary policy, but on the perception of the central bank in terms of inflation. This central bank's perception reflects the optimistic or pessimistic view about the economic outlook and risk of inflation. Although we measure the index based on the information extracted from the official releases, it is not about the communication itself, but its content, or the central bank's perception, more precisely.

The idea of central bank's perception cannot be well exploited by a binary approach based on dummy variables. The literature so far has focussed on measures (indexes) for the signaling of monetary policy mostly based on binary scales. The purpose of this study is to measure central bank's perception related to inflation risks and not to measure the signaling of monetary policy. In this sense, the use of a binary approach (i.e. a discrete approach based on dummy variables) to measure central bank's perception related to inflation risks may hide many important information and, as a consequence, it may classify as equal different perceptions. Moreover, the content about the path of monetary policy is not the most adequate to study inflation expectations; the risk of inflation has a stronger influence over inflation expectations than the signaling of future monetary policy, as pointed by Ullrich (2008).

The methodology to construct the index consist into analyze relevant information released at the announcement. This index is calculated using the minutes from the COPOM meetings, released eight days after the interest rate (Selic) decision. Each information is classified as negative or positive to control inflation. The COPOM minutes are organized by numbered paragraph. Each paragraph is considered a relevant information to analyze and classify as optimistic or pessimistic. After the classification a counting procedure is applied to quantify how pessimistic is the announcement. The counting consists in number of paragraphs classified as pessimistic divided by the number of paragraphs, which is equal to the percentage of pessimistic paragraphs on the announcement. The methodology, here presented, when applied to different announcements, can utilize other detailing level, or even the so called statement-level.

3. Empirical analysis

The period of analysis is from May 2003 to April 2013 (monthly)[2]. The variables used are:

- Inflation expectations (*ie*): the series uses the monthly average of the daily expectations for the inflation rate obtained from the CBB. These expectations are based on expert surveys.
- Inflation rate (inf): this series uses the inflation rate (Consumer Price Index (IPCA) – series number 13522 obtained from the CBB).
- Output gap (gap): this series is constructed using the GDP at current prices – R$ millions – (series number 4382 obtained from the CBB) seasonally adjusted by the method Census X12, deflated by the IPCA. The natural logarithm was applied to the series and its long-term trend was obtained through the Hodrick-Prescott filter. Subsequently, the difference between the output and its long-term trend was obtained. The idea is to capture the pressures on inflation from economic activity (e.g. Bevilaqua *et al.*, 2007; Ullrich, 2008).
- Credibility index (*ci*): the credibility index is based on the idea of Agénor and Taylor (1992) that series of expected inflation could be applied to derive a credibility index. As Svensson (2000) proposed, the credibility can be measured by the difference between expected inflation (series obtained from the CBB) and the target. In this sense, the credibility index is the index proposed by de Mendonça (2007). The credibility index has a value equal to 1 when the annual expected inflation ($E[\pi]$) is equal to the target (π^T) and decreases in a linear way while inflationary expectation deviates from the announced target.

Therefore, the credibility index shows a value between 0 and 1 strictly if the expected inflation is situated between the maximum and minimum limits (π^*) established for each year and assumes a value equal to 0 when the expected inflation exceeds one of these limits[3]. The index uses the series of inflation expectations obtained from the CBB, the inflation target defined by the monetary authority and the tolerance bands[4]. Hence:

$$ci = \begin{cases} 1 & \text{if } E[\pi] = \pi_t^T \\ 1 - \frac{1}{\pi_t^* - \pi_t^T}\left[E[\pi] - \pi_t^T\right] & \text{if } \pi_{tMIN}^* < E[\pi] < \pi_{tMAX}^* \\ 0 & \text{if } E(\pi) \geqslant \pi_{tMAX}^* or E[\pi] \leqslant \pi_{tMIN}^* \end{cases}$$

- Real interest rate (*real_ir*): the real interest rate is obtained through the difference between the nominal interest rate – Selic – (series number 4189 from the CBB) and the inflation rate – IPCA – (series number 13522).
- Real exchange rate (*real_er*): real effective exchange rate index. This series was obtained from the CBB – number 11752).
- Energy price (*energy*): this series captures the pressure from energy costs. The series "Commodity Index – Brazil Energy" is a weighted average (monthly) of prices from Brent, natural gas and coal (series number 20052).
- Index of central bank perception (*CB_perception*): based on economic outlook information provided in the minutes of the COPOM meetings, the index of central bank perception measures the perception of the CBB in relation to price stability. Due to the fact that the content of the minutes of the COPOM meetings does not possess a high degree of clarity, the methodology used to construct the index makes use of the theory of fuzzy sets (Zadeh, 1965). The theory of fuzzy sets is useful for classifying diffuse concepts that lose information when classified in binary form. The minutes are divided into sections and each section has numbered paragraphs. Each paragraph has had its content analyzed as positive (optimistic) or negative (pessimistic) for the control of inflation. When it is considered optimistic thus the paragraph assumes a value equal to 0, and when pessimistic, it assumes a value equal to 1. After analyzing the entire content of the minutes, a counting procedure is applied to measure the degree of instability for controlling inflation which was communicated by the central bank. The count is the number of paragraphs with content deemed negative (pessimistic) to control inflation divided by the total number of paragraphs. The index has values between 0 and 1, and is increasing in relation to the increased risks to inflation control, i.e., the higher (lower) is the index, it means that the central bank is more pessimistic (optimistic) about the behavior of inflation[5]. Thus, the index is:

$$CB\_perception = \frac{Number\ of\ pessimistic\ paragraphs}{Total\ number\ of\ paragraphs}$$

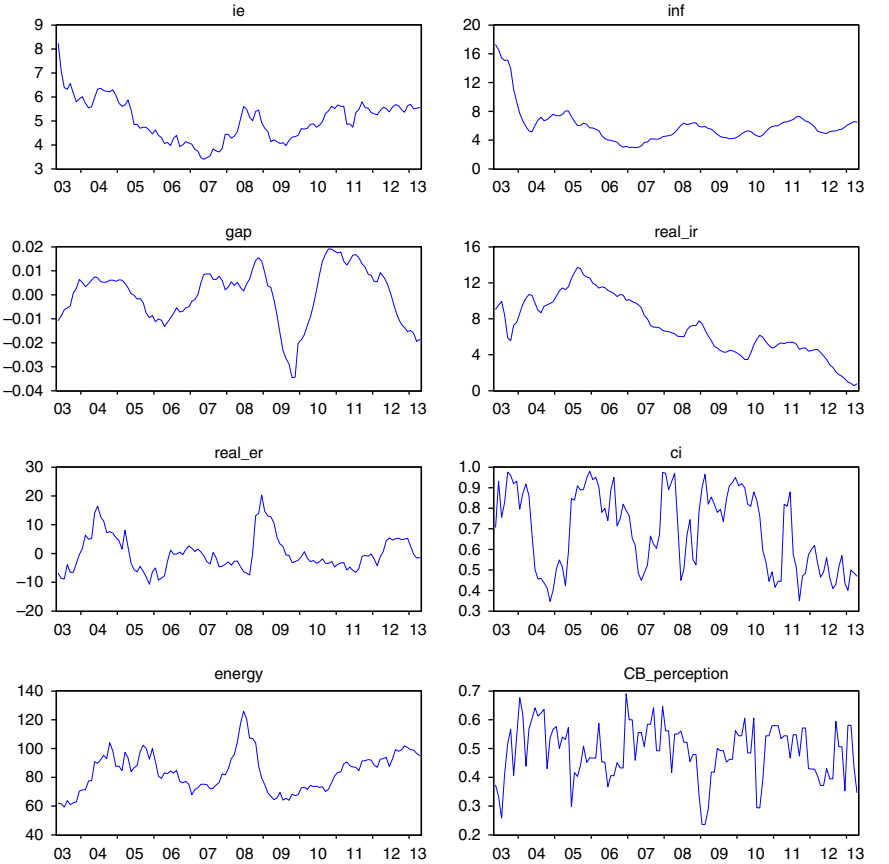
The methodology used to construct the index (which uses the theory of fuzzy sets) can be generalized and used to evaluate different subjects covered by the releases. The index is formed based on the information about the economic outlook, with a focus on inflation risks. However, the same methodology can be applied to evaluate

the communications related to economic growth forecast or expectations for the path of the exchange rate. Moreover, although the methodology uses the minutes of the COPOM meetings, this methodology can be extended to other types of announcements of different central banks.

Figure 1 shows the graphs with the time evolution of the main variables.

3.1 Estimations and results

The empirical analysis uses ordinary least squares (OLS), the generalized method of moments (GMM) and vector-autoregressive (VAR) through impulse-response analysis. The GMM is used to deal with the problems of heteroscedasticity, autocorrelation and endogeneity (Hansen, 1982). According to Wooldridge (2001, p. 95), "to obtain a more efficient estimator than two-stage least squares (or ordinary least squares), one must have overriding restrictions." The weighting matrix in the equation was chosen to enable the GMM estimates to be robust, considering the possible presence of heteroskedasticity and autocorrelation of unknown form. It is important to note that the coefficients estimated by GMM are consistent only if the instrumental variables used in the analysis are exogenous. Therefore, the hypothesis of exogeneity of the instruments



Source: Figure prepared by the authors

Figure 1.
Time evolution of the main variables

requires that these variables do not directly affect the dependent variable. In this sense, a standard procedure that guarantees such hypothesis is based on Johnston (1984), i.e., the chosen instruments were dated to the period $t-1$ or earlier. Cragg (1983) pointed out that overidentification analysis has an important role in the selection of instrumental variables to improve the efficiency of the estimators. Hence, a standard *J*-test was performed with the objective of testing this property for the validity of the overidentifying restrictions.

A first condition to be analyzed before applying the econometric analysis is to check if a series is stationary. Therefore, the Kwiatkowski-Phillips-Schmidt-Shin test (KPSS) was applied. The advantage of this test results from the powerless of conventional tests, as these tend not to reject the null hypothesis too often (Franses and Haldrup, 1994; Cati *et al.*, 1999). Moreover, Kwiatkowski *et al.* (1992) argue that the KPSS test can distinguish series that appear to be stationary, series that appear to have a unit root, and series for which the data are not sufficiently informative to be sure whether they are stationary or integrated – as is the case of series with short periodicity. The results show that all series are *I*(0) (Table AI).

The equation estimated through OLS and GMM is based on Ullrich (2008) and considers the characteristics of an emerging economy (such as Brazil) based on Cerisola and Gelos (2005), de Mendonça (2009) and de Mendonça and Valério (2010). The equation is:

$$ie_t = \alpha_0 + \alpha_1 inf_{t-1} + \alpha_2 gap_{t-1} + \alpha_3 real\_ir_{t-3} + \alpha_4 real\_er_{t-1} + \alpha_5 ci_t + \alpha_6 energy_t + \alpha_7 CB\_perception_t + v_t \quad (1)$$

where, $a_1 > 0, a_2 > 0, a_3 < 0, a_4 > 0, a_5 < 0, a_6 > 0\ a_7 > 0$ and v is a random error term. These expected relation are b*a*sed on the correlations found between inflation expectations and the variables in Equation (1) (Table AII, presents the correlations).

The lags of the variables were determined empirically, following the general-to-specific method, observing the statistical significance of the coefficients and the principle of parsimony (Hendry, 2001).

Table I below shows the results of the estimates[6]. Regarding the OLS estimates, the *F*-statistics show that the estimated equation is significant and the Ramsey (RESET) tests indicate that the model does not present a problem of specification. Regarding GMM, the *J*-statistics indicate that we cannot reject the hypothesis that the model is correct specified[7].

Regarding the influence of past inflation, the evidence points a positive relation, with statistical significance. Thus, when inflation in the past period increases, inflation expectations also increase. This result corroborates Carlson and Parkin (1975) which argue that past inflation affects inflation expectations.

The output gap is used to capture the influence of the economic cycle on inflation expectations. The results suggest that when the economy is heated (sluggish), higher (lower) inflation expectations are formed. However, statistical significance was found only in the estimates through GMM.

In turn, the evidence for the influence of the real interest rate indicate an inverse relationship (negative sign of the estimated coefficient) and with statistical significance. Therefore, an increase (reduction) in the real interest rate causes a decrease (increase) in inflation expectations.

The findings for the influence of the real exchange rate on inflation expectations indicate that, if the real exchange rate increases (decreases), inflation expectations will

Table I.
OLS and GMM estimates (dependent variable: inflation expectations – *ie*)

	Equation for inflation expectation							
	OLS				GMM			
	Spec. 1	Spec. 2	Spec. 3	Spec. 4	Spec. 1	Spec. 2	Spec. 3	Spec. 4
Constant	2.12091***	3.029059***	1.461419*	2.352763**	3.870768***	4.626957***	3.346917***	3.33485***
	(*0.63892*)	(*0.840933*)	(*0.81735*)	(*1.036626*)	(*0.260718*)	(*0.381147*)	(*0.37333*)	(*0.574885*)
	[3.319525]	[3.602021]	[1.787995]	[2.269635]	[14.84655]	[12.13954]	[8.965042]	[5.800897]
inf(−1)	0.247479***	0.253459***	0.249846***	0.254258***	0.176526***	0.173733***	0.170184***	0.198821***
	(*0.022186*)	(*0.023821*)	(*0.024439*)	(*0.025067*)	(*0.015222*)	(*0.015331*)	(*0.017212*)	(*0.018665*)
	[11.15447]	[10.64018]	[10.22309]	[10.14316]	[11.59678]	[11.33186]	[9.887427]	[10.65201]
gap(−1)	7.865531	2.985471	7.009302	3.175189	20.67621***	17.71646***	19.21555***	7.432297**
	(*6.49854*)	(*5.797457*)	(*6.42106*)	(*5.565856*)	(*2.813324*)	(*3.348812*)	(*2.801486*)	(*3.73972*)
	[1.210354]	[0.514962]	[1.091611]	[0.570476]	[7.349388]	[5.290372]	[6.859058]	[1.987394]
real_ir(−3)	−0.063091***	−0.049093**	−0.065842***	−0.053714***	−0.060152***	−0.044961***	−0.056285***	−0.032071***
	(*0.016608*)	(*0.01973*)	(*0.015476*)	(*0.018115*)	(*0.009407*)	(*0.01299*)	(*0.008632*)	(*0.010564*)
	[−3.798868]	[−2.488199]	[−4.254482]	[−2.965119]	[−6.394356]	[−3.461216]	[−6.520108]	[−3.035818]
real_er(−1)	0.033597*	0.026601	0.035492**	0.029317**	0.061591***	0.053871***	0.058524***	0.043458***
	(*0.018002*)	(*0.016337*)	(*0.014234*)	(*0.014342*)	(*0.006683*)	(*0.007986*)	(*0.006387*)	(*0.007047*)
	[1.866253]	[1.628207]	[2.493559]	[2.044206]	[9.216277]	[6.745328]	[9.162852]	[6.167201]
ci		−0.925168**		−0.762131*		−0.513302*		−0.828367***
		(*0.46541*)		(*0.438249*)		(0.295951)		(0.271091)
		[−1.987856]		[−1.739034]		[−1.734415]		[−3.055678]
energy	0.02219***	0.017398***	0.02193***	0.018039***	0.009002***	0.003023	0.009284***	0.007903**
	(*0.005651*)	(*0.006066*)	(*0.005571*)	(*0.006485*)	(*0.002173*)	(*0.00289*)	(*0.002287*)	(*0.003369*)
	[3.926736]	[2.868126]	[3.936515]	[2.781452]	[4.141908]	[1.045968]	[4.059414]	[2.345336]
CB_perception			1.389581**	1.087783*			1.011398*	1.502752***
			(*0.699311*)	(*0.631518*)			(*0.56701*)	(*0.499535*)
			[1.987072]	[1.722488]			[1.783738]	[3.008298]

(*continued*)

Table I.

	Equation for inflation expectation							
	OLS				GMM			
	Spec. 1	Spec. 2	Spec. 3	Spec. 4	Spec. 1	Spec. 2	Spec. 3	Spec. 4
Adjusted R^2	0.72	0.75	0.75	0.77	0.40	0.42	0.45	0.64
F-statistic (*p*-value)	0.00	0.00	0.00	0.00				
Ramsey – RESET (1) (*p*-value)	0.43	0.41	0.67	0.46				
Jarque-Bera (*p*-value)	0.82	0.78	0.54	0.93				
ARCH (1) (*p*-value)	0.00	0.00	0.00	0.00				
ARCH (2) (*p*-value)	0.00	0.00	0.00	0.00				
ARCH (4) (*p*-value)	0.00	0.00	0.00	0.00				
ARCH (8) (*p*-value)	0.00	0.00	0.00	0.00				
LM(1) (*p*-value)	0.00	0.00	0.00	0.00				
LM(2) (*p*-value)	0.00	0.00	0.00	0.00				
Rank					25	25	25	25
J-statistic (*p*-value)					0.87	0.88	0.82	0.83

Notes: Standard errors in parentheses ant *t*-statistics in square brackets: *,**,***Marginal Significance at 0.1, 0.05, 0.01 levels, respectively
Source: Table prepared by the authors

raise (reduce). The estimated coefficients showed positive sign and statistical significance. This result corroborates the analysis of Cerisola and Gelos (2005) which also found that a more depreciated real exchange rate implies an increase in the real costs of imported inputs and a pass-through link between depreciation and inflation expectations.

The findings for the influence of credibility on inflation expectations suggest, with statistical significance, that the higher the credibility, inflation expectations will be lower, which represents an important result, especially in emerging countries with inflation targeting.

The findings for the influence of energy prices on inflation expectations suggest that such prices exert a positive influence on inflation expectations. This result was also found by Ueda (2010) when he analyzed the determinants of inflation expectations in Japan and the USA.

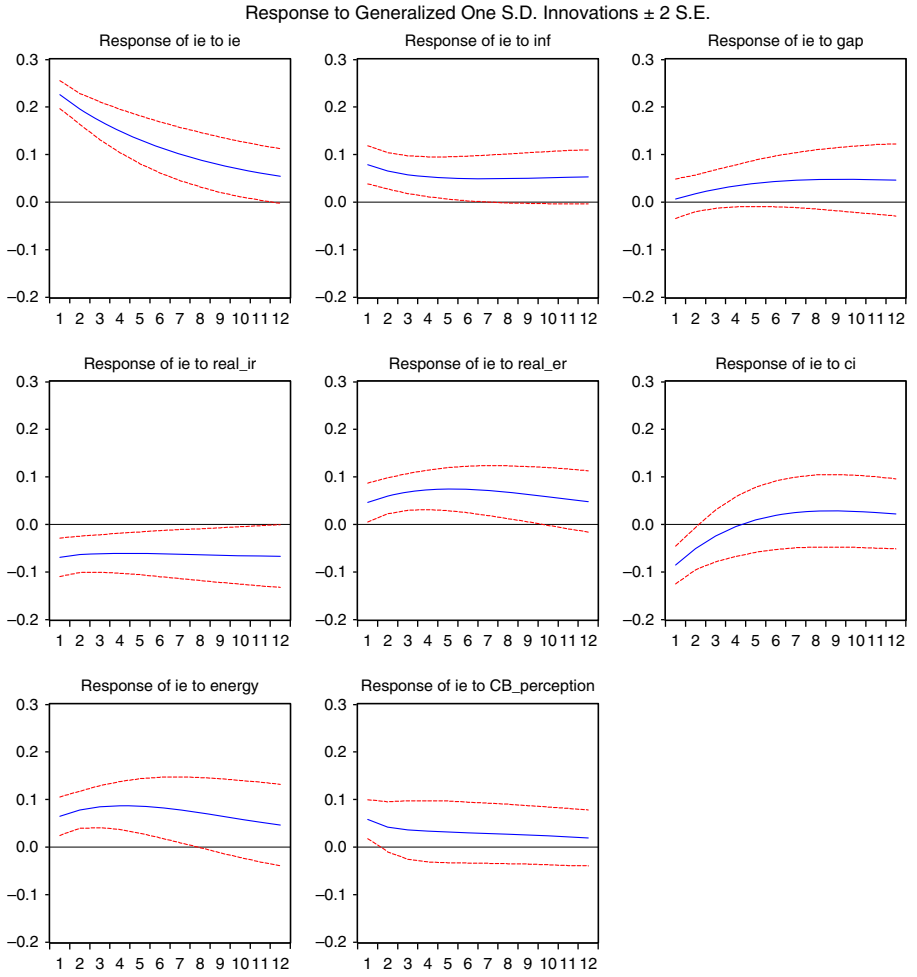
Regarding the effect of central bank's perception on inflation expectations, the estimated coefficients showed positive signs and statistical significance. The evidences suggest that in periods of inflationary pressures, when the central bank communicates that there are difficulties in relation to the control of inflation, such announcements may act raising inflation expectations.

In a general way the dynamic analysis of a VAR is made through methods such as impulse-response functions because it permits evaluation of the impulse on key variables caused by shocks (or innovations) provoked by residual variables over time (Sims, 1980). As pointed out by Lutkenpohl (1991), the conventional method applies "orthogonality assumption" and thus the result may depend on the ordering of variables in the VAR. Koop *et al.* (1996) and Pesaran and Shin (1998) developed the idea of the generalized impulse-response function as a manner of eliminating the problem of the ordering of variables in the VAR. The main argument is that the generalized impulse responses are invariant to any re-ordering of the variables in the VAR.

Thus, aiming at eliminating the known problem in the results caused by the order of variables in the VAR, the generalized impulse-response function is adopted. The variables used in the analysis are: *ie*, *inf*, *gap*, *ci*, *real_ir*, *real_er*, *energy*, *CB_perception*[8]. The choice of the VAR lag order was determined using the Schwarz information criterion (SIC). Based on SIC the VAR lag order is one. The stability test for the VAR is shown through Figure A1. Figure 2 below shows the results.

Based on the different methods of analysis (OLS, GMM and VAR), the following findings are important to highlight: inflation expectations are positively affected by past inflation and energy prices; demand pressures (output gap) positively affect inflation expectations (statistical significance was not found in the VAR); inflation expectations are negatively affected by the real interest rate; credibility is an important element to reduce inflation expectations, and; in periods of inflationary pressures, when the central bank communicates that there are difficulties in relation to the control of inflation, such announcements may act raising inflation expectations.

The impulse-response graphs regarding the influence of credibility on inflation expectations and the influence of *CB_perception* on inflation expectations deserve attention. It is observed that an unexpected positive shock on *ci* causes a decrease in *ie*. Hence, the gain of credibility is an important aspect for reducing inflation expectations. Concerning the relationship between central bank's perception about inflation control and inflation expectations, it is observed that an unexpected positive shock on *CB_perception* causes an increase in *ie*. Thus, when the central bank has the perception that inflation is increasing, inflation expectations deteriorate. These results are in agreement with the previous estimations in Table I.



Source: Figure prepared by the authors

Figure 2.
Impulse Response

4. Conclusion

The present study sought to fill a gap regarding empirical studies for the influence of central bank communication on inflation expectations, especially for developing countries, by analyzing the effects of the economic outlook content of the minutes of the COPOM meetings on inflation expectations.

The paper contributes with a new index of central bank's perception. Besides, the findings suggest that the expectations of financial market experts react according to the content of the information provided by the central: when the central bank has the perception that inflation is increasing, the experts take into account this information and inflation expectations deteriorate; in turn, when the central bank has the perception that inflation is under control and provide this information, inflation expectations are reduced. The results also support the idea that the credibility of inflation targeting plays a key role in determining inflation expectations.

Notes

1. Inflation expectations of experts are obtained from the CBB and regard the development of inflation in the following 12 months.
2. The choice of the period is because, since May 2003, the minutes are published eight days after the end of the meeting.
3. π^* represents the tolerance limits for the inflation target, i.e., the maximum and minimum limits established for each year. For more details regarding the inflation target (π^T) and the tolerance limits (π^*_{tMAX} and π^*_{tMIN}) established for each year, see: www.bcb.gov.br/pec/metas/tabelametaseresultados.pdf
4. Although different indexes of credibility have been proposed – as summarized in the works of de Mendonça and de Guimarães e Souza (2009) and Nahon and Meurer (2009) – and therefore there is a variety of indexes of credibility capable of being used in empirical analyses, the present work does not seek to analyze the influence and power of each index on monetary policy in Brazil – although such research is important. Thus, the option for using the index proposed by de Mendonça (2007) is due to the following arguments: the index is recognized by international literature, being this index used in several applied studies; simplicity of understanding and preparation; the index captures the changes and fluctuations in credibility in a way compatible with the regime of inflation targeting adopted in Brazil, i.e., the index uses predetermined tolerance bands, and not ad-hoc tolerance bands as proposed by other indices; and the index is rigorous enough and punishes appropriately deviations of inflation expectations in relation to the inflation target.
5. By the end of 2005 the minutes were published monthly, after the beginning of 2006 the minutes are now published every 45 days. In order to adjust the publication of the minutes to the database, from 2006 ahead, regarding the months that there is no publication of the minutes, it is considered that the agents use the latest information available, i.e., the minutes of the previous month. Thus, the value found in the index is repeated for the month that there is no minute.
6. The reported *t*-statistics in the OLS estimates are based on the estimator of Newey and West (1987), due to heteroskedasticity and autocorrelation.
7. Instrumental variables: *ie*(−1); *ie*(−2); *ie*(−3) *ie*(−4); *inf*(−2); *inf*(−3); *gap*(−2); *gap*(−3); *gap*(−4); *real_ir*(−4); *real_ir*(−5); *real_er*(−2); *real_er*(−3); *real_er*(−4); *real_er*(−5); *ci*(−1); *ci*(−2); *ci*(−3); *energy*(−1); *energy*(−2); *energy*(−3); *CB_perception*(−1); *CB_perception*(−2); *CB_perception*(−3).
8. The VAR includes an exogenous variable: a dummy variable for the subprime crisis, which assumes value 1 from 2008.11 to 2009.8, and 0 otherwise.

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Appendix

Variables	Exogenous	Bandwidth	KPSS test statistic	1%	5%	10%
ie	C	9	0.282	0.739	0.463	0.347
inf	C	8	0.429	0.739	0.463	0.347
gap	C	9	0.047	0.739	0.463	0.347
real_ir	CT	9	0.129	0.216	0.146	0.119
real_er	C	8	0.045	0.739	0.463	0.347
ci	CT	8	0.113	0.216	0.146	0.119
energy	CT	8	0.084	0.216	0.146	0.119
CB_perception	C	7	0.098	0.739	0.463	0.347

Notes: KPSS test – spectral estimation method is Bartlett Kernel and the Newey West Bandwidth is used. "C", intercept and "CT", intercept and trend
Source: Table prepared by the authors

Table AI.
Stationarity test

	ie
ie	1.000
inf	0.753
gap	0.209
real_ir	−0.121
real_er	0.128
energy	0.202
ci	−0.340
CB_perception	0.011

Table AII.
Correlations

Source: Table prepared by the authors

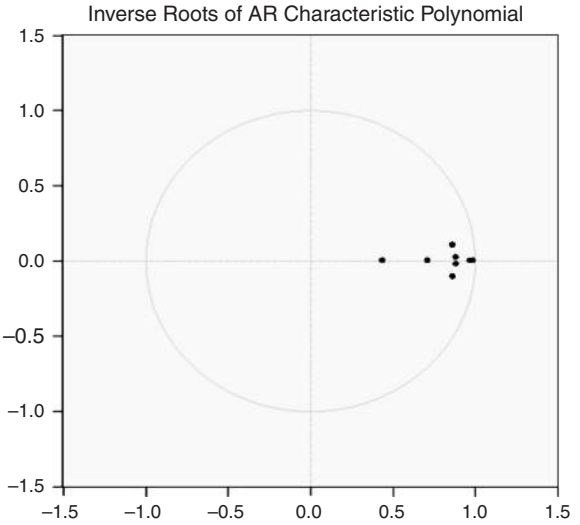

Figure A1.
VAR stability test

Source: Figure prepared by the authors

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