Does the Central Bank's perception regarding the state of the economy affect industrial entrepreneurs' expectations? Are such expectations important for investment? Evidence from Brazil*

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Abstract

Studies on central bank communication in emerging countries are still scarce. There are no studies regarding the influence of central bank communication on entrepreneurs' expectations. This paper contributes to the literature in the following aspects: (a) based on the minutes of the Monetary Policy Committee (Copom) meetings, we develop an indicator that reveals the Central Bank's perception related to the state of the economy, and (b) we analyze the influence of the Central Bank's communication on the expectations and confidence of entrepreneurs, and the influence of such expectations on the aggregate investment. The findings reveal that the information provided by the Central Bank of Brazil regarding the economic environment affects entrepreneurs' expectations and that aggregate investment is influenced by these expectations.

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Keywords

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Resumo

Estudos sobre comunicação dos bancos centrais em países emergentes ainda são escassos. Não existem pesquisas sobre a influência da comunicação dos bancos centrais sobre as expectativas dos empresários. Este trabalho contribui para a literatura nos seguintes aspectos: (a) com base nas atas das reuniões do Comitê de Política Monetária (Copom), desenvolve um indicador que revela a percepção do Banco Central relacionada ao estado da economia, e (b) analisa a influência da comunicação do Banco Central sobre as expectativas e a confiança dos empresários e a influência de tais expectativas sobre o investimento agregado. Os resultados revelam que as informações fornecidas pelo Banco Central do Brasil em relação ao ambiente econômico afetam as expectativas dos empresários e que o investimento agregado é influenciado por essas expectativas.

Palavras-chave

Comunicação; expectativa; política monetária

JEL Classification: **E22, E52, E58**

1 Introduction

In the decision-making process, economic agents use all relevant available information to form their expectations. Investment decisions, for example, are strongly influenced by expectations and therefore require information about the economic environment. The management of expectations is an important task for the monetary authority, which involves the creation of a stable macroeconomic environment.

Since the management of expectations represents an important task for the monetary authority in economies with forward-looking agents, transparency and accountability through central bank communication have been gaining more importance. In fact, since the early 1990s, the conduct of

monetary policy has shifted from secrecy towards more transparency. The main explanation for this global trend is the increasing understanding that transparency can improve the effectiveness of monetary policy (WOODFORD, 2003). This approach has highlighted the role of communication in monetary policy.

Central bank communication emerges as an important tool in the task of managing expectations. According to Blinder *et al*. (2008), communication can be an important and powerful part of the central banks' toolkit since it has the ability to move financial markets, enhance the predictability of monetary policy decisions, and potentially help achieve central banks' macroeconomic objectives. As a consequence, to the extent that central bank communication becomes an instrument of big influence for central banks, studies about the influence of central bank communication on the expectations formation process are becoming more prominent (ERHMANN; FRATZCHER, 2007a).

In the last two decades, the literature on central banking has shown empirical evidence about the importance of central bank communication in the process by which agents form their expectations. The main findings suggest that financial markets, equity markets and inflation expectations react to monetary policy announcements and signaling (BLINDER *et al*., 2008; MONTES *et al*., 2015). However, most of the researches to date have focused on the effects of central bank communication on financial markets (BLINDER *et al*., 2008; MONTES *et al*., 2015; MONTES; NICOLAY, 2015). When reviewing the literature on central bank communication, it is observed that there are no studies regarding its influence on entrepreneurs' expectations.

This paper seeks to answer the following questions: does central bank's perception regarding the state of the economy affect industrial entrepreneurs' expectations? Are industrial entrepreneurs' expectations important for investment? The central hypothesis of the study is as follows: industrial entrepreneurs take into consideration the information contained in the minutes of the Monetary Policy Committee meetings when they form their expectations, which therefore affects investment.

This study analyzes whether the Central Bank's perception regarding the state of the economy — obtained through the minutes of the Brazilian Monetary Policy Committee (Copom) meetings — affects industrial entrepreneurs' expectations. Moreover, due to the fact that such expectations are important for investment decisions, this paper also analyzes the influence of industrial entrepreneurs' expectations on the aggregate investment. The study contributes to the literature in the following aspects: (a) based on the minutes of the Copom meetings, we develop,

using the theory of fuzzy sets, an indicator that reveals the Central Bank's perception related to the state of the economy, and (b) based on this indicator, we analyze the influence of the Central Bank's communication on the expectations and confidence of industrial entrepreneurs, and the influence of such expectations on the aggregate investment in Brazil. Therefore, in order to answer the questions raised above, this paper — following Montes and Scarpari (2015) and Montes and Nicolay (2015) — creates an indicator that reveals central bank's perception regarding the state of the economy, by using the theory of fuzzy sets. The analysis uses aggregate data for the period between 1999.Q2 and 2012.Q3 and different econometric methods: ordinary least squares (OLS), generalized method of moments (GMM) system, and impulse response through vector autoregression (VAR).

But why should the communication of the central bank be taken into consideration? More precisely, why should the information provided by the central bank be considered by entrepreneurs in the expectations formation process? According to Blinder *et al*. (2008), the central bank may have, or may be believed to have, superior information on the economic outlook. Central banks usually devote many more resources than private sector forecasters to forecasting and even to estimating the underlying unobservable state of the economy. Therefore, the creation of an indicator that captures the central bank's perception regarding the state of the economy is important, since entrepreneurs use all available information concerning this issue to make their decisions, including, particularly, the information provided by the central bank. Moreover, an analysis of the influence of this indicator on entrepreneurs' expectations is important in order to know if they consider the information provided by the central bank when they form their expectations.

The findings suggest that the expectations formed by entrepreneurs follow the information provided by the monetary authority in relation to the economic environment, i.e., the Central Bank's perception regarding the state of the economy, reported through the minutes of the Copom meetings, is taken into account by industrial entrepreneurs.

2 Central bank communication: importance and main empirical results

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 itself. This information is important since it affects, for example, the expectations formation process regarding future monetary policy and inflation in the subsequent periods. In this sense, central bank communication acts in a helpful way once 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 to influence the economy through agents' expectations, and to improve monetary policy (GÜRKAYNAK; SACK; SWANSON, 2005).

In recent years, several studies on central bank communication have been developed. Most research focuses on developed countries and on the influence central bank communication has on the expectations formed in financial markets about the behavior of interest rates and exchange rates, and about future monetary policy (e.g., ANDERSSON; DILLÉN; SELLIN, 2006; BEINE; JANSSEN; LECOURT, 2009; BERGER; De HAAN; STURM, 2011; BERGER; EHRMANN; FRATZSCHER, 2011; BRAND; BUNCIC; TURUNEN, 2010; CONNOLLY; KOHLER, 2004; CONRAD; LAMLA, 2007; EHRMANN; FRATZSCHER, 2007a, 2009; FRATZSCHER, 2008; HAYO; KUTAN; NEUENKIRCH, 2010; HAYO; NEUENKIRCH, 2012; JANSEN; De HAAN, 2005, 2007a; KOHN; SACK, 2004; MUSARD-GIES, 2006; RANALDO; ROSSI, 2010; REEVES; SAWICKI, 2007; ROSA, 2011; ROSA; VERGA, 2007; SIKLOS; BOHL, 2008; STURM; De HANN, 2011). In general, the findings of these studies suggest that central bank communication has impact on the expectations formed in financial markets.

There are also studies related to the influence of central bank communication on the macroeconomic performance, however, these studies exist to a lesser extent. There are, for example, studies related to the effect of central bank communication on inflation expectations. Jansen and De Haan (2007) examined the relationship between inflation expectations and risks to price stability. The results obtained showed a negative relationship between the effect of the European Central Bank's (ECB) communication and inflation expectations. Ullrich (2008) analyzed the impact of the ECB communication on expectations formation. The results indicated that a communication that shows monetary tightening increases inflation expectations for six months. This is due to the content related to the risk of inflation obtained through the statement.

The literature on central bank communication in Brazil is still incipient. The findings provided by the existing literature suggest the Central Bank's communication affects interest rates with different maturities and expectations regarding the future monetary policy (CARVALHO;

CORDEIRO; VARGAS, 2013; COSTA FILHO; ROCHA, 2009, 2010; MENDONÇA; FARIA, 2011, 2013; MONTES, 2012).

Costa Filho and Rocha (2009) discuss the role of communication in the conduct of monetary policy by the Brazilian Central Bank. They built a glossary that translates the qualitative information contained in the minutes of the Copom meetings into an ordered scale index, similar to the one built by Rosa and Verga (2007). They found evidence of a consistent behavior by the Copom, in the sense that its words are followed by actions in the same direction. Moreover, based on estimates of Taylor rules, they also found evidence that the index help to understand interest setting. Costa Filho and Rocha (2010) also verified if a better communication from the Brazilian Central Bank makes the monetary policy more predictable. They found that the interest rates increase during the releasing days, indicating that the Central Bank's communication has a conservative bias, while interest rates volatility decreases. They also found evidence that the market's reaction is independent from the content released, although signals of interest rates reduction imply a decrease in the volatility.

The work presented by Mendonça and Faria (2011) shows how an efficient communication process, which increases the Central Bank's transparency, affects the public expectations and its consequences for the conduction of monetary policy. The main conclusion is that an environment which permits the anticipation of future monetary policy actions by the public improves the efficiency of the policy. On the other hand, the article of Mendonça and Faria (2013) seeks to make an analysis of the Brazilian experience after the adoption of inflation targeting concerning the effects caused by the new practices of transparency and communication in the monetary policy. The study offers some interesting insights into how central bank communication improves the efficiency of the monetary policy for developing countries which have adopted inflation targeting. Regarding the empirical analysis, changes in the financial market's expectations due to monetary policy actions are analyzed based on methodologies proposed by Cook and Hahn (1989) and Kuttner (2001). The findings are in consonance with the idea that an increase in central bank transparency and communication improves the efficiency of expectations hypothesis of the term structure of interest rate and the anticipation of changes in the interest rate target.

The work of Montes (2012) studies the influence of monetary policy and the Central Bank's communication on the term structure of interest rates in Brazil. The study uses OLS, GMM and VAR to examine the direction taken by interest rates when affected by central bank communication and monetary policy. The study found evidence that due to the fact that

economic agents use their time analyzing the minutes of the monetary policy committee meetings, monetary policy and the Central Bank's communication significantly influence the process of expectation formation for interest rates with different maturities in Brazil.

Carvalho, Cordeiro and Vargas (2013) analyzed the effects of the Copom statements on the term-structure of interest rates in Brazil. They quantified the informational content of those statements by adapting the methodology developed by Lucca and Trebbi (2009) to the specificities of the "monetary policy jargon" in Portuguese. Using Google search queries, they measured the extent to which each Copom statement was perceived to be associated with more "hawkish" or "dovish" language. They also investigated whether changes in language preceded changes in the policy rate (the SELIC rate). The findings suggest that during Governor Tombini's administration, interest rate surprises started to be "passed through" one-to-one (or more) even at long maturities, as markets seemed to have bought the idea that the interest rate cuts that began in mid-2011 would lead to lower yields in Brazil into the foreseeable future. Most importantly, changes in the informational content of the Copom statements seemed to have meaningful effects on yields at short-to-medium maturities. However, this result only holds for the period prior to Tombini's administration.

Regarding the influence of the Central Bank's communication on other aspects of the Brazilian economy, such as inflation expectations and banks' behavior, we identify the works of Montes and Scarpari (2015), Montes and Nicolay (2015) and Montes *et al.* (2015).

Montes and Scarpari (2015) observe that there are no studies providing evidence for the relationship between central bank communication and bank risk-taking. They analyse whether the signal emitted by the Central Bank about a likely rise (or fall) of the basic interest rate for the next policy meeting and its pessimistic (or optimistic) perception regarding the macroeconomic environment are responsible for inducing banks to take less (or more) risks. They provide evidence for the link between monetary policies, the Central Bank's communication and bank risk-taking. The findings reveal the Central Bank's communication influences the behaviour of banks since their risk perceptions are affected.

The work of Montes and Nicolay (2015) proposes an indicator for the central bank's perception of inflation based in the minutes of the Copom meetings and analyzes the influence of central bank communication on inflation expectations through such indicator. 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.

The study of Montes *et al*. (2015) analyzes the effects of monetary policy signaling and clarity of central bank communication on disagreement about inflation expectations. The study also investigates whether greater transparency coincides with lower levels of disagreement about inflation expectations in Brazil. In order to analyze the effects of monetary policy signaling on disagreement about inflation expectations, they make use of the standard approach based on dummy variables as proposed by Rosa and Verga (2007). To analyze the influence of the clarity of the Central Bank's communication on disagreement about inflation expectations, they follow the literature about this issue (BULÍŘ; ČIHÁK; JANSEN, 2013; JANSEN, 2011, 2011a) and use the index of Flesch (1948). Furthermore, to investigate whether greater transparency coincides with lower levels of disagreement about inflation expectations, they use the two indexes of central bank transparency presented by Mendonça and Galveas (2012). The findings suggest that transparency is important to reduce disagreement about inflation expectations. Moreover, the estimates indicate that central bank communication and clarity affect disagreement about inflation expectations in Brazil.

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 three following approaches. The first one seeks to classify all manifestations of the central bank in accordance with the content and signals, and thus uses a numerical scale to encode these ratings. The second one seeks to analyze all forms of communication in the media — by the committee or its members — which are important for the monetary policy. In this case, specialized news agencies are used to extract the statements of the committee members on the days when they occur. These statements are extracted mechanically by 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 the monetary policy, as well as the words "economy" and "economics perspective" when the objective is to assess the future economic outlook. The third one considers some institutional characteristics related to the announcement of the monetary policy to measure the impact of communication.

Ehrmann and Fratzscher (2007) 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 minutes and classify the future monetary policy according to the information content of the minutes. Berger, De Haan and Sturm (2011) and Berger, Ehrmann and Fratzscher (2011) analyze 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 communication.

In terms of content, the main efforts in the literature regard the path of monetary policy (ANDERSSON; DILLÉN; SELLIN, 2006; BRAND; BUNCIC; TURUNEN, 2010; CONNOLLY; KOHLER, 2004; DEMIRALP; KARA; ÖZLÜ, 2012; EHRMANN; FRATZSCHER, 2009; HAYO; KUTAN; NEUENKIRCH, 2010; HAYO; NEUENKIRCH, 2012; MUSARD-GIES, 2006; RANALDO; ROSSI, 2010; ROSA, 2011; ROSA; VERGA, 2007; STURM; De HANN, 2011). Only a few works approach the other contents of central bank communication. The paper of Siklos and Bohl (2008) analyzes this issue in five aspects: exchange rate, output, asset price, fiscal policy and international regards. The study of Rozkrut *et al.* (2007) focuses on the path of future monetary policy, economic outlook and exchange rate. The work of Berger, Ehrmann and Fratzscher (2011) analyzes the press conference on three topics: (a) price stability; (b) developments in the real economy; and (c) monetary indicators. The works of Hayo and Neuenkirk (2012), Hayo, Kutan and Neuenkirch (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.

The index proposed in this paper is related to the economic outlook content. The indicator presented in this study provides information about the perception of the Central Bank regarding the stability of the economic environment.

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 regarding the economic outlook. This perception reflects an optimistic or a pessimistic view about the economic outlook. 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 focused on measures (indexes) for the signaling of monetary policy mostly based on binary scales. The purpose of this study is to measure the Central Bank's perception related to the economic outlook. In this sense, the use of a binary approach (i.e., a discrete approach based on dummy variables) to measure such perception may hide a great deal of important information and, as a consequence, classify different perceptions as equal.

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

Thus, our study differs from others in the literature about central bank communication as follows: (a) based on the ideas of Montes and Scarpari (2015) and Montes and Nicolay (2015), it proposes an indicator of central bank's perception regarding the state of the economy, and (b) it uses this indicator to answer whether such perception affects industrial entrepreneurs' expectations.

3 Empirical analysis

The minutes of the Copom meetings are an important communication tool of the monetary authority in Brazil. They explain the reasons for the decisions of the monetary policy and provide perspectives for future meetings considering the economic outlook.

The minutes of the meetings provide important information about the perception of the Central Bank of Brazil regarding the state of the economy. This perception is relevant to the expectations formation process. Therefore, based on the information regarding the economic outlook offered through the minutes of the meetings, the indicator for the perception of the Central Bank of Brazil is built. The idea is to classify the minutes of the Copom meetings

and thus capture the perception of the Central Bank of Brazil in relation to the economic environment, and whether this perception affects entrepreneurs' expectations.

In order to make decisions, such as investment decisions, entrepreneurs use the information they have about the current economic environment, long term interest rates and their expectations about the future (MONTES; BASTOS, 2013). In this sense, communication is an important tool for the central bank to influence agents' expectations (GÜRKAYNAK; SACK; SWANSON, 2005).

3.1 Data

The analysis uses quarterly series for the period from 1999.Q2 to 2012.Q3. In all series, the natural logarithm was applied. The monthly series (interest rate Selic, real exchange rate, inflation rate, real interest rate and credit) were transformed into quarterly series by calculating the average of the three months comprising the quarter. The series are:

a) Industrial entrepreneur confidence index (ICEI): this index is elaborated with the assistance of the Federations of Industries of 24 Brazilian states. The index is obtained on the basis of a survey that assesses the attitudes and stances of businessmen and their expectations in regard to the coming six months in terms of Brazilian economy and their own companies. The index is constructed based on two other indexes, one considering the current conditions and the other considering expectations for the next six months. The ICEI varies in the 0-100 interval.
b) Output gap (Gap): this series uses the Gross Domestic Product (GDP) at current prices in R$ million (series 4382 from the Central Bank of Brazil (CBB) website) seasonally adjusted by the method Census X12, deflated by the Extended Consumer Price Index (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 calculated.
c) Investment (GFCF): the proxy used for measuring private investment is the Gross Fixed Capital Formation (MENDONÇA; LIMA, 2011; MONTES, 2013; MONTES; BASTOS, 2013). This indicator is published by the Brazilian Institute of Geography and Statistics (IBGE).

d) Interest rate Selic (IR): it is a nominal interest rate (Selic — series 4189 from the CBB website). It is the main monetary policy instrument.
e) Real exchange rate (TC): it is a real effective exchange rate indexed by the IPCA (series 11752 from the CBB website).
f) Inflation rate (Infl.): it is the official inflation rate in Brazil measured by the IPCA accumulated in 12 months (series 13522 from the CBB website).
g) Real interest rate (IR_real): this indicator is the result of the difference between the basic interest rate (Selic — series 4189) accumulated in annual terms and the inflation rate (series 13522).
h) Credit as a proportion of the GDP (Credit): this series is obtained by dividing the series of credit operations in the financial system to the private sector (series 2046) by the GDP (series 4382).
i) Index of central bank communication (IC): the index of central bank communication measures the perception of the Central Bank of Brazil in relation to the economic environment. This index is built using economic outlook information provided in the minutes of the Copom meetings. It is important to stress that some sorts of central bank communication lack clarity and such problem complicates the task of the researcher to assess the content being informed and transform that information into an index (MONTES; NICOLAY, 2015). Siklos and Bohl (2008, p. 250) emphasize this issue:

> While many of the news sources are of the objective variety, that is, they are quantifiable, others are subject to the interpretation of the researcher who is attempting to determine from a particular statement, or speech, whether a central bank official is calling for higher or lower future interest rates, or some other financial asset price such as the exchange rate or stock prices. Consequently, as noted previously, there is clearly potential either for bias or for interpreting statements differently in hindsight. It is also conceivable, that statements are deliberately meant to obscure a central bank's likely course of action.

In fact, when we work with well-defined concepts, in which the regions of the elements are defined with a high degree of precision, the conventional set theory is a satisfactory approach to solve the problems posed. However, in the case of diffuse concepts or concepts with which it is difficult to define the belonging region, the theory of fuzzy sets is a recommended tool, since it mitigates the risk of classifying an element in the wrong set, as it may belong to some extent to a given set. Due to the fact that the minutes of the Copom meetings have great content related to various aspects of

the economy that connect with each other to some degree, the task of classifying these minutes incorporates interpretation, which increases the odds of misclassification. This problem is what we seek to reduce using the theory of fuzzy sets.[1]

Thus, the methodology used to construct the index makes use of the theory of fuzzy sets (ZADEH, 1965). This theory 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 its content analyzed as positive (optimistic) or negative (pessimistic) for the state of the economy. When it is considered optimistic, the paragraph assumes a value equal to 1, and when it is considered pessimistic, it assumes a value equal to 0. After analyzing the entire content of the minutes, a counting procedure is applied to measure the degree of economic stability perceived by the Central Bank. The count is the number of paragraphs with optimistic content regarding the economic environment divided by the total number of paragraphs. The index has values between 0 and 1 and increases when the central bank's perception regarding the economic environment gets more optimistic, i.e., the higher the index, the more optimistic about the state of the economy the central bank is.[2] Thus, the communication index is:

$$ic = \frac{number\ of\ optimistic\ paragraphs}{total\ number\ of\ paragraphs}$$

The methodology used to construct the index of communication (which uses the theory of fuzzy sets) can be generalized and used to evaluate different subjects covered by the releases. 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, it can be extended to other types of announcements of different central banks. Due to the fact that the minutes of the Copom meetings present a large content related

[1] For more details regarding this issue, see Montes and Scarpari (2015) and Montes and Nicolay (2015).

[2] Before the end of 2005, the minutes were published monthly; after the beginning of 2006, they started to be published every 45 days. In order to adjust their publication to the database from 2006 on, regarding the months when they are not published, 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 when no minutes are published.

to several aspects of the economy, the classification of the document is a task that incorporates interpretation. Hence, the theory of fuzzy sets is recommended for the construction of this type of index, since it mitigates the risk of classifying objects in the wrong set.[3]

j) Dummy variable for domestic shocks (Shoq): this dummy variable was created in order to consider domestic shocks that occurred in the period analyzed. This variable assumes values equal to 1 from the first quarter of 2001 to the fourth quarter of 2002, and 0 otherwise. This dummy variable seeks to capture the effects of the energy crisis and the impacts of the presidential election which chose Lula as president of Brazil (known as the "Lula effect" in the literature).

3.2 Analytical scheme and methodology

The scheme in Figure 1 illustrates the empirical analysis performed in this study. This scheme summarizes the core ideas investigated in the paper: the impact of the Central Bank's perception regarding the state of the economy on entrepreneurs' expectations and the influence of such expectations on the aggregate investment. Following Montes (2013) and Montes and Bastos (2013), the influence of the monetary policy, the economic activity and the exchange rate are considered in the analysis of the entrepreneurs' expectations. Following Ribeiro and Teixeira (2001), Mendonça and Lima (2011) and Montes (2013), the effects of the real interest rate, the credit and the inflation are taken into account in the analysis of the aggregate investment.

[3] The theory of fuzzy sets has been formalized to create an alternative to the conventional set theory. According to the theory of fuzzy sets, there are degrees of pertinence, so that an element is not classified as belonging or not to a set, exclusively; the element has a degree of pertinence according to a defined numerical function. Thus, the theory of fuzzy sets is useful for classifying diffuse concepts that lose information when classified in binary form (ZADEH, 1965).

Figure 1

Analytical scheme

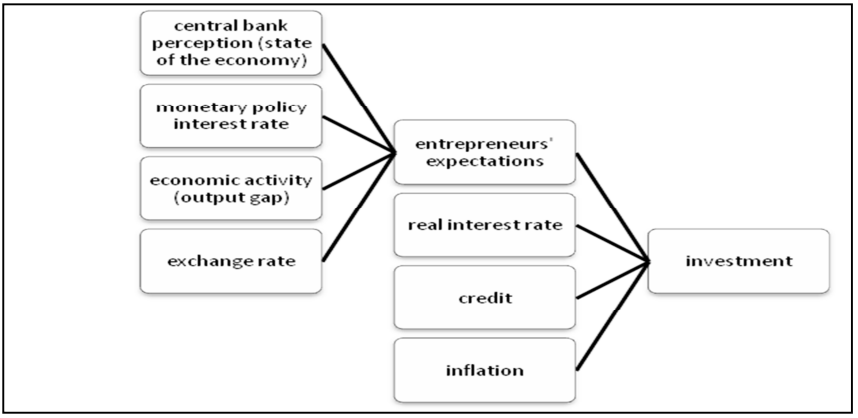


Table 1 shows the correlations and Figure 2 presents scatterplot graphs with regression lines. Table 1 and Figure 2 have the intention to indicate the relationship between the variables and thus serve as preliminary evidence of the signals of the coefficients in the estimates. The correlations are consistent with the arguments presented in the text and with economic theory. Positive correlations are found for the relation between the ICEI and the economic activity (Gap) and for the relation between the ICEI and the IC. On the other hand, a negative correlation is found for the relation between the ICEI and the basic IR. Moreover, positive correlations are found for the relation between the ICEI and the GFCF, and for the relation between the GFCF and the Credit. In turn, a negative correlation is found for the relation between the GFCF and the IR_real.

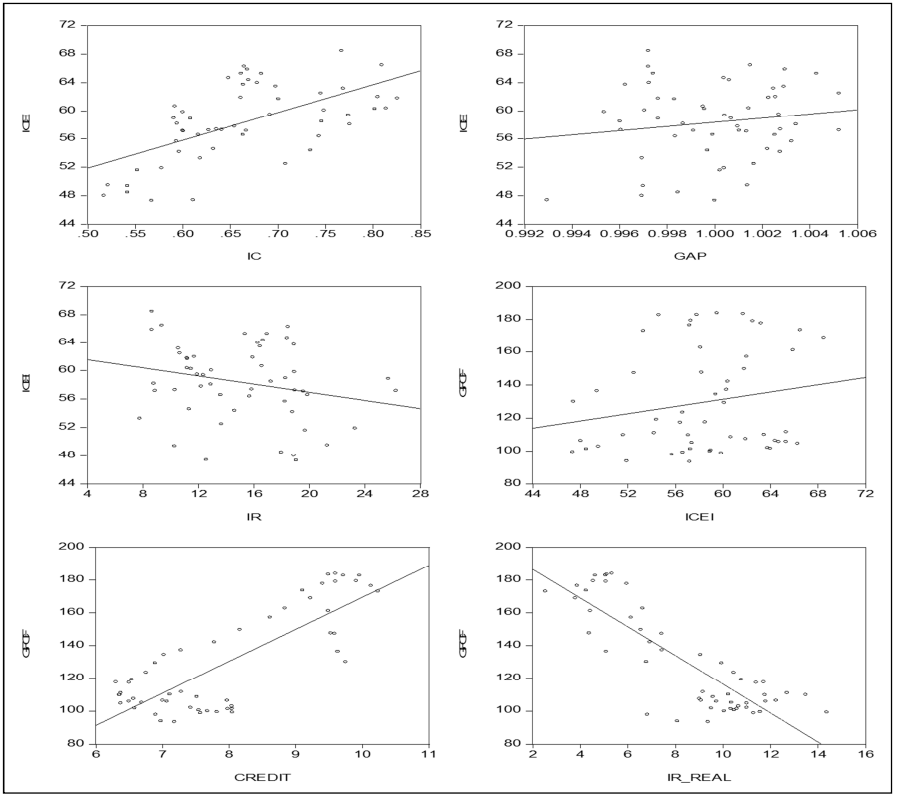
Table 1

Correlations between selected variables

VARIABLES	INDUSTRIAL ENTREPRENEUR CONFIDENCE INDEX (ICEI)	VARIABLES	INVESTMENT (GFCF)
ICEI	1.00	Investment (GFCF)	1.00
Output gap (Gap)	0.17	ICEI	0.19
Index of central bank communication (IC)	0.63	Credit as a proportion of the Gross Domestic Product (Credit)	0.77
Interest rate Selic (IR)	-0.23	Real interest rate (IR_real)	-0.84

Figure 2

Scatterplot graphs



A first condition to be analyzed before applying the econometric analysis is to check for the presence of unit roots in the series. Considering the low power problems and size distortions of the traditional tests — Augmented Dickey-Fuller (ADF), Phillips-Perron and Kwiatkowski, Phillips, Schmidt and Shin —, largely pointed in the literature[4], we applied more robust tests. Therefore, we used the Dickey-Fuller generalized least squares (DF-GLS) test (ELLIOTT; ROTHENBERG; STOCK, 1996) and the Ng--Perron (NG; PERRON, 2001) unit root tests (i.e., ADF^{GLS} and $\overline{MZ}_{\alpha}^{GLS}$) with modified AIC (MAIC), and Perron (1996) unit root test, considering structural breaks. According to Ng and Perron (2001, p. 1519):

[4] See Maddala and Kim (2003) for a survey of the literature.

> Many unit root tests have been developed for testing the null hypothesis of a unit root against the alternative of stationarity. While the presence or absence of a unit root has important implications, many remain skeptical about the conclusions drawn from such tests. This concern is justifiable, as these tests generally suffer from two problems. First, many tests have low power when the root of the autoregressive polynomial is close to but less than unity (e.g., DeJong et al. (1992)). Second, the majority of the tests suffer from severe size distortions when the moving-average polynomial of the first differenced series has a large negative root (e.g., Schwert (1989), Perron and Ng (1996)). Although less severe, the problem also arises when there is a large negative autoregressive root in the residuals. The consequence is over-rejections of the unit root hypothesis.

The analysis of Elliott, Rothenberg, and Stock (ERS) (1996) shows that detrending data by GLS yields power gains for unit root tests. Ng and Perron (2001) find that GLS detrending also allows for a more precise autoregressive spectral density estimate and ensures that it is invariant to the parameters of the trend function. They also show that the MAIC is more robust when there are negative moving average errors. Ng and Perron (2001) suggest that the use of the MAIC in conjunction with the GLS detrended data results in a class of tests that has good size and power. The findings of the tests suggest that all series are I(1) (Figure A.1 in the **Appendix**).

We conducted an empirical analysis using OLS, GMM and a GMM system. One reason for using the GMM is that it presents robust estimators even in the presence of serial autocorrelation and heteroskedasticity of unknown form, or nonlinearity, which is typical in macroeconomic time series models (HANSEN, 1982). Besides, one way to avoid the endogeneity and identification problems in the estimations is by using the GMM (HALL, 2005). As pointed out by 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.

As pointed out by Cragg (1983), the overidentification analysis has an important role in the selection of instrumental variables to improve the efficiency of the estimators. We performed a standard J-test with the objective of testing this property for the validity of the overidentifying restrictions (HANSEN, 1982). The chosen instruments were dated to the period t−1 or earlier to help predict the contemporaneous variables, which are unavailable at time t. This procedure for the choice of instrumental variables follows Johnston (1984). The estimations were performed using the software E-Views 8.0.

3.3 Estimates for the industrial entrepreneur confidence index

Taking the works of Montes (2013) and Montes and Bastos (2013) as a reference, the variables of equation (1) have been defined. The central idea is to analyze the influence of central bank's perception regarding the state of the economy (based on the minutes of the Copom meetings) on entrepreneurs' expectations. 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.

$$icei = \alpha_1 + \alpha_2 icei_{t-1} + \alpha_3 gap_{t-1} + \alpha_4 ic + \alpha_5 ir + \alpha_6 tc_{t-2} + \varepsilon_t,$$
$$\varepsilon \sim N(0, \sigma_\varepsilon^2) \quad (1)$$

The expected signs for the relations are expressed through the partial derivatives

$$\partial icei/\partial gap > 0; \partial icei/\partial ic > 0; \partial icei/\partial ir < 0; \partial icei/\partial tc > 0$$

Even if all series are I(1), it is possible to estimate, by using all series in level, if they are cointegrated. Hence, Johansen (1991) cointegration test was performed for the set of series — ICEI, Gap, IC, IR and TC. The choice of the VAR lag order was determined by using the Schwarz information criterion (SIC). The SIC indicates 2 lags (Figure A.2 in the **Appendix**). The cointegration test proposed by Johansen (1991, LR test statistic), based on the significance of the estimated eigenvalues, indicates that the trace statistic rejects the non-cointegration hypothesis (Figure A.3 in the **Appendix**).

Table 2 shows the results of the estimates. In OLS estimation, due to heteroskedasticity and autocorrelation, the Newey-West matrix was used. The Ramsey Regression Equation Specification Error Test (RESET) indicates that the model is not misspecified.[5] Furthermore, the F-test shows that the equation is significant. Regarding the GMM, the J-statistic indicates that we cannot reject the hypothesis that the model is correctly specified.[6]

[5] Diagnostic tests are shown in Figure A.4 (**Appendix**).

[6] Instrumental variables: C, ICEI(-2), ICEI(-3), IC(-1), IC(-2), IR(-1), IR(-2), TC(-3), TC(-4), Gap(-2), Gap(-3), Gap(-4).

Table 2

Estimates of the ordinary least squares (OLS) and the generalized method of moments (GMM) for equation (1)

EXPLANATORY VARIABLES	OLS	GMM
Constant	-5.5695** (2.3039) [-2.4174]	-7.8780*** (2.5594) [-3.0780]
ICEI(-1)	0.3917*** (0.1378) [2.8418]	0.2634* (0.13380) [1.9690]
Gap(-1)	5.8010** (2.5814) [2.2472]	9.0320*** (2.6914) [3.3558]
IC	0.3545*** (0.1186) [2.9890]	0.2829* (0.1483) [1.9071]
IR	-0.1131 (0.0796) [-1.4208]	-0.1529*** (0.0513) [-2.9766]
TC(-2)	0.2280** (0.0953) [2.3916]	0.2288*** (0.0759) [3.0109]
F-statistic	12.7665	
Probability (F-statistic)	0	
Adjusted R^2	0.5405	0.5482
J-test		7.7246
Probability (J-test)		0.2589
Instrument rank		12

NOTE: Marginal Significance Levels: *** denotes 0.01, ** denotes 0.05 and * denotes 0.1. Standard errors are in parentheses and t-statistics are in square brackets.

The estimates reveal that the coefficients present the expected signs and are statistically significant through the OLS and GMM, except the interest rate (IR), which was not statistically significant through the OLS. The results for the influence of both economic activity and monetary policy on entrepreneurs' expectations corroborate the findings present in Montes (2013) and Montes and Bastos (2013). Positive signs were found for the relation between the ICEI and the Gap, i.e., when economic activity increases, entrepreneurs become more optimistic and thus their expectations and confidence rise. The estimated coefficients for the interest rate presented negative signs. Thus the higher the interest rate, the lower the expectations and confidence of entrepreneurs.

Positive signs were found in the relation between the ICEI and the IC. The evidence suggests that the content in the minutes of the Copom meetings directly affect the expectations and confidence of entrepreneurs, i.e., when the Central Bank reveals a more optimistic view about the state of the economy, the expectations and confidence of entrepreneurs regarding the economic environment increase.

Regarding the exchange rate, the estimated coefficients showed positive signs. This result indicates that when the exchange rate depreciates, entrepreneurs tend to form optimistic expectations and therefore increase confidence, since it stimulates exports.

3.4 Estimates for the aggregate investment

Taking as a reference the works of Mendonça and Lima (2011) and Montes (2013) for the Brazilian economy, the variables of equation (2) have been defined. A dummy variable was added in order to capture the effects of domestic shocks on the aggregate investment. 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.

$$gfcf_t = \beta_1 + \beta_2 icei_{t-1} + \beta_3 credit_{t-1} + \beta_4 ir\_real_{t-3} + \beta_5 infl_{t-1} + \beta_6 SHOQ + \xi_t,\ \xi \sim N(0, \sigma_\xi^2) \quad (2)$$

The expected signs for the relations are expressed through the partial derivatives

$$\partial gfcfi/\partial icei > 0; \partial gfcf/\partial credit > 0; \partial gfcf/\partial ir\_real < 0; \partial gfcf/\partial \inf l < 0; \partial gfcf/\partial shoq < 0$$

Due to the fact that all series are I(1), Johansen (1991) cointegration test was performed for the set of series — GFCF, ICEI, Credit, IR_real and Infl. The choice of the VAR lag order was determined by using the SIC. The SIC indicates 2 lags (Figure A.5 in the **Appendix**). The cointegration test proposed by Johansen (1991, LR test statistic), based on the significance of the estimated eigenvalues, indicates that the trace statistic rejects the non-cointegration hypothesis (Figure A.6 in the **Appendix**).

Table 3 shows the results of the estimates. In the OLS estimation, due to the problem of autocorrelation, the Newey-West matrix was used. The Ramsey test indicates that the model is not misspecified.[7] Furthermore, the F-test shows that the equation is significant. In terms of the GMM estimation, the J-statistic indicates that we cannot reject the hypothesis that the model is

[7] Diagnostic tests are shown in Figure A.7 (**Appendix**).

correctly specified.[8] The estimated coefficients for the dummy variable (Shoq) showed negative signs, which justifies its inclusion in the equation.

Table 3

Estimates of the ordinary least squares (OLS) and the generalized method of moments (GMM) for equation (2)

EXPLANATORY VARIABLES	OLS	GMM
Constant	2.6091** (-1.1590) [2.5512]	2.3028** (-0.8902) [2.5867]
ICEI(-1)	0.3694** (-0.1774) [2.0830]	0.4302*** (-0.1294) [3.3253]
Credit(-1)	0.7362*** (-0.2226) [3.3081]	0.7343*** (-0.1563) [4.6966]
IR_real(-3)	-0.1489* (-0.0844) [-1.7639]	-0.1166* (-0.066) [-1.7671]
Infl(-1)	-0.2412*** (-0.0248) [-9.7165]	-0.2364*** (-0.0144) [-16.4320]
Shoq	-0.1262*** (-0.0288) [-4.3791]	-0.1819*** (-0.0186) [-9.7622]
F-statistic	74.5188	
Probability (F-statistic)	0	
Adjusted R^2	0.8823	0.8853
J-test		9.1252
Probability (J-test)		0.6922
Instrument rank		18

NOTE: Marginal Significance Levels: *** denotes 0.01, ** denotes 0.05 and * denotes 0.1.
Standard errors in parentheses ant t-statistics in square brackets.

The estimates show that when entrepreneurs are more optimistic about the economy (and therefore when the ICEI is high), the gross fixed capital formation increases. In this sense, the information provided by the central bank about its perceptions related to the state of the economy influences the

[8] The instrumental variables are: GFCF(-1), GFCF(-2), GFCF(-3), GFCF(-4), Credit(-2), Credit(-3), Credit(-4), IR_real(-4), IR_real(-5), IR_real(-6), IR_real(-7), Infl.(-2), Infl.(-3), ICEI(-2), ICEI(-3), ICEI(-4), ICEI(-5).

expectations and confidence of entrepreneurs, and these expectations and confidence are important for investment decisions.

The estimated coefficients for the relationship between the credit and the GFCF presented positive signs, indicating that when the availability of credit increases, entrepreneurs make more investments. This result corroborates the findings presented by Mendonça and Lima (2011) and Montes (2013) for the Brazilian economy under inflation targeting. The estimated coefficients for the real interest rate had negative signs, indicating that the higher the interest rate, the lower the investments made by entrepreneurs — this result was also found by Mendonça and Lima (2011) and Montes (2013) for the Brazilian economy under inflation targeting. Moreover, the estimated coefficients for the inflation rate had negative signs — result also found by Mendonça and Lima (2011) —, indicating that in higher inflation environments, entrepreneurs reduce investments.

So far, the individual estimates provide evidence that the CBB's perception regarding the state of the economy directly affects the expectations of entrepreneurs and that the aggregate investment is affected by the expectations and confidence of entrepreneurs.

3.5 Estimates through the system of simultaneous equations

A manner of validating the equations and coefficients previously achieved is the estimation through a system of equations. Hence, a system of simultaneous equations is estimated by the GMM. Based on this system, it is possible to observe the transmission mechanism related to the influence of central bank's perception regarding the state of the economy on investment through the expectations and confidence of entrepreneurs. The system is as follows:

$$\textit{System} \begin{cases} icei = \gamma_1 + \gamma_2 icei_{t-1} + \gamma_3 gap_{t-1} + \gamma_4 ic + \gamma_5 ir + \gamma_6 tc_{t-2} + \vartheta_t \\ gfcf_t = \theta_1 + \theta_2 icei_{t-1} + \theta_3 credit_{t-1} + \theta_4 ir\_real_{t-3} + \theta_5 infl_{t-1} + \theta_6 SHOQ + \tau_t \end{cases}$$

In which ϑ and τ are the error terms.

Table 4 shows the estimates of the system.[9] The signs of the estimated coefficients are the same found in the equations estimated individually. In addition, all variables are statistically significant, and the standard errors of all variables are lower than those found in the individual estimates.

The evidence suggests that the CBB's perception regarding the state of the economy based on the economic outlook information provided in the minutes of the Copom meetings affects the expectations and confidence of entrepreneurs, i.e., when the monetary authority signals that the economy presents good indicators, entrepreneurs form optimistic expectations about the state of the economy and their own businesses. Nevertheless, when the monetary authority signals that problems are occurring in the economy, the expectations and confidence deteriorate. Thus, the perspectives of the central bank about the state of the economy act as a useful guide for expectations in the economy, because investments are sensitive to changes in expectations and confidence. So far, the findings reveal that the monetary policy and central bank communication affect investments through the interest rate channel and the expectations channel. Moreover, estimates show that the credit is an important element for investments.

[9] The estimation of the system through the GMM applies the same instrumental variables of the individual estimates.

Table 4

Estimates of the generalized method of moments (GMM) for the system of simultaneous equations

EXPLANATORY VARIABLES	INDUSTRIAL ENTREPRENEUR CONFIDENCE INDEX (ICEI)		EXPLANATORY VARIABLES	INVESTMENT (GFCF)
Constant	-7.7108***		Constant	2.3330***
	(1.9492)			(0.6642)
	[-3.9558]			[3.5125]
ICEI(-1)	0.2013***		ICEI(-1)	0.4144***
	(0.0736)			(0.0993)
	[2.7346]			[4.1717]
Gap(-1)	8.7390***		Credit(-1)	0.7525***
	(1.9292)			(0.1078)
	[4.5298]			[6.9767]
IC	0.3468***		IR_real(-3)	-0.1201**
	(0.0829)			(0.0482)
	[4.1824]			[-2.4926]
IR	-0.1532***		Infl(-1)	-0.2353***
	(0.0351)			(0.0114)
	[-4.3613]			[-20.4997]
TC(-2)	0.2522***		Shoq	-0.1841***
	(0.0474)			(0.0164)
	[5.3211]			[-11.1765]
Adjusted R^2	0.5447			0.8854
J-test	0.2238			
Probability (J-test)	> 0.90			

NOTE: Marginal Significance Levels: *** denotes 0.01, ** denotes 0.05 and * denotes 0.1. Standard errors in parentheses ant t-statistics in square brackets.

3.6 Dynamic analysis through vector autoregression (VAR)

In order to provide robustness to the results already found, a dynamic analysis through VAR was done. In a general way, the dynamic analysis of vector autoregression is made through methods such as the impulse response function because it allows 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 the “orthogonality assumption” and thus the result may depend on the

ordering of variables in the VAR. The works of Koop, Pesaran and Potter (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 reordering of the variables in the VAR. Hence, the method of the generalized impulse response function is used.

Aiming at evaluating the transmission mechanism, the set of variables used in the VAR analysis is represented by GFCF, ICEI, IC, Gap and IR. Moreover, the dummy variable (Shoq) is used as an exogenous variable. The choice of the VAR lag order was determined by using the SIC. Table 5 indicates that the VAR lag order is 2.

Table 5

Vector Autoregression (VAR) lag order selection according to the Schwarz information criterion (SIC)

LAG	SIC
0	-14.06
1	-18.94
2	-19.05*
3	-18.74
4	-18.43

NOTE: The asterisk represents the lag chosen based on the SIC.

Figure 3 shows the results of the generalized impulse response functions. Figure 4 presents the stability of the VAR.

According to Figure 3, the ICEI is positively affected, with statistical significance, by an unexpected shock in the index of IC. This result is in accordance with those of the OLS and the GMM analyses. Moreover, when economic activity increases and therefore an unexpected shock in the Gap is observed, this causes a positive response, with statistical significance, in the ICEI. This result indicates that positive changes in economic activity positively affect the expectations and confidence of entrepreneurs. This result is in line with the evidence found by the estimations.

Corroborating the empirical literature and the evidence already found in this study, an unexpected shock in the interest rate adversely affects, with statistical significance, the expectations and confidence of entrepreneurs.

The results also suggest that when an unexpected shock in the ICEI occurs, the GFCF responds positively. Despite the fact that the result did not

show statistical significance, the great mass of the GFCF response was above the 0 axis (i.e., is in the area with positive values).

A positive shock in the index of central bank communication caused a positive change in investment. Moreover, a positive shock in the interest rate caused a decrease in investment.

Figure 3

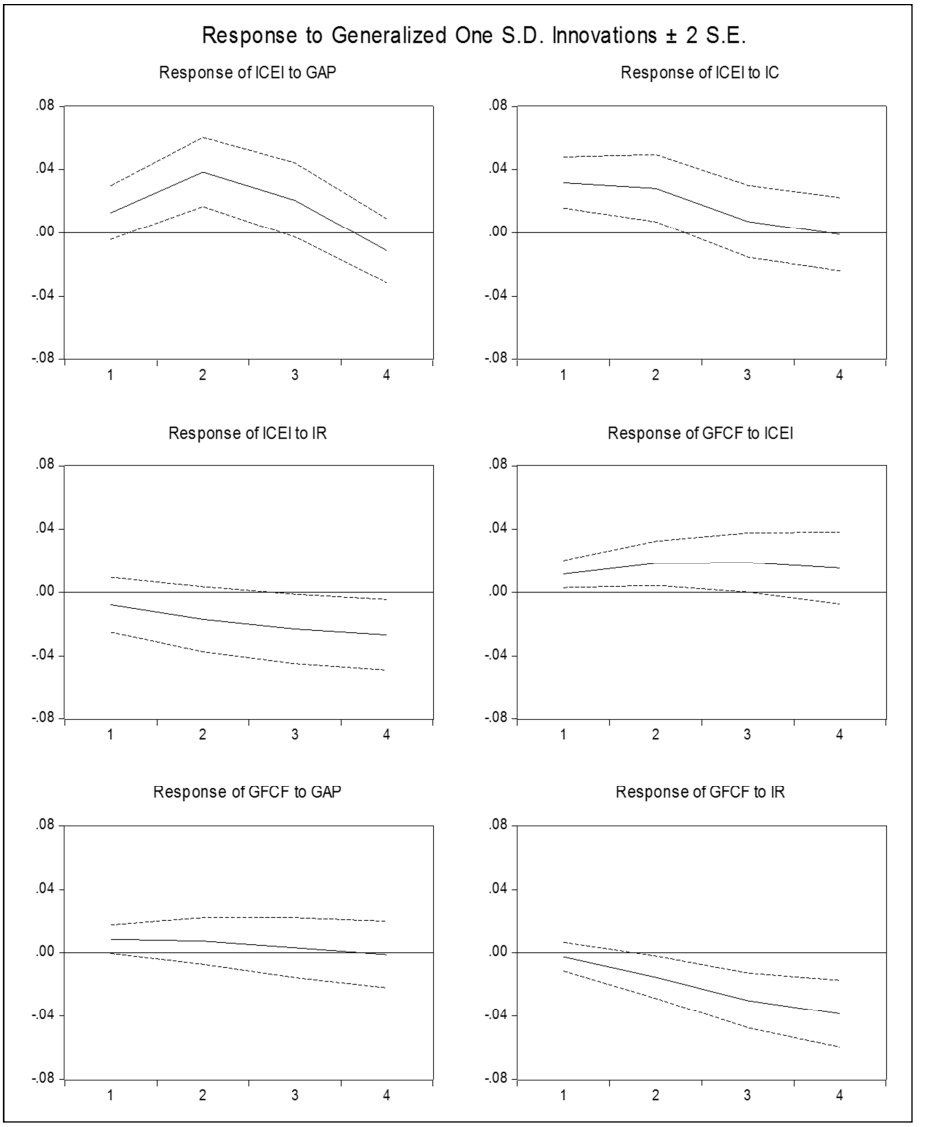
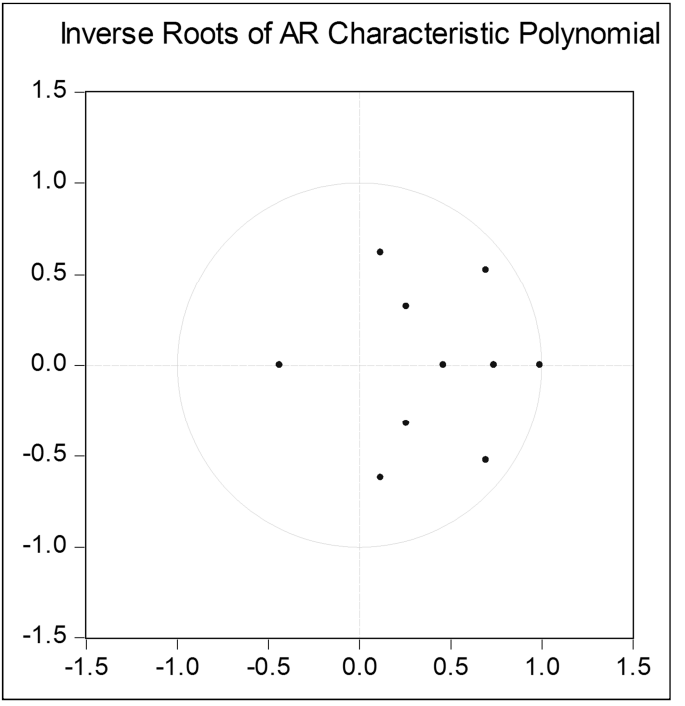


Figure 4

Vector Autoregression (VAR) stability



4 Conclusion

The literature on central bank communication is focused mostly on the effects of communication on financial market expectations. When reviewing the literature on central bank communication, a gap is observed with respect to empirical studies regarding the influence of this kind of communication on expectations in emerging countries. The present study sought to fill this gap by analyzing the influence of central bank communication on the expectations and confidence of entrepreneurs, and the influence of such expectations on the aggregate investment in Brazil. Besides, based on the minutes of the Brazilian Monetary Policy Committee meetings, we developed, using the theory of fuzzy sets, an indicator that reveals the Central Bank's perception related to the state of the economy.

The results show that the expectations formed by entrepreneurs follow the information provided by the central bank in relation to the economic environment, i.e., the state of the economy reported by the monetary

authority is taken into account by the industrial entrepreneurs and induces expectations to move in the same direction. Besides, the findings reveal that monetary policy and central bank communication affect investments through the interest rate channel and the expectations channel.

The study has important implications for the Central Bank's communication strategy. The expectations of entrepreneurs react in the direction of the communication of the monetary authority. Therefore, the monetary authority should be aware that what they reveal in their communications is embedded in the expectations of entrepreneurs. In this sense, the monetary authority should act in a committed way with credible objectives previously established.

Appendix

Figure A.1

Unit root test

Variables	DF-GLS				Ng-Perron				Perron-structural break				Perron-structural break				Perron-structural break			
	Lag	I/T	Test	5%	Lag	I/T	Test ($MZ\alpha^{GLS}$)	5%	Lag	I	Test	5%	Lag	I/T	Test	5%	Lag	T	Test	5%
icei	2	I/T	-2.731	-3.190	2	I/T	-11.649	-17.300	4	I	-4.934	-5.23	4	I/T	-5.322	-5.59	4	T	-4.319	-4.83
d(icei)	0	I	-6.081	-1.947	0	I	-24.968	-8.100	4	I	-5.248	-5.23	4	I/T	-5.328	-5.59	4	T	-5.298	-4.83
gap	3	I	-2.000	-1.947	3	I/T	-2.253	-8.100	4	I	-4.995	-5.23	4	I/T	-4.878	-5.59	4	T	-4.870	-4.83
d(gap)					3	I/T	0.110	-8.100	2	I	-12.855	-5.23	2	I/T	-14.385	-5.59	2	T	-12.767	-4.83
gfcf	2	I/T	-1.762	-3.190	2	I/t	-6.360	-17.300	1	I	-3.926	-5.23	1	I/T	-4.964	-5.59	1	T	-4.949	-4.83
d(gfcf)	0	I	-4.356	-1.947	0	I	-20.474	-8.100	1	I	-5.732	-5.23	1	I/T	-6.366	-5.59	1	T	-5.870	-4.83
ir	4	I/T	-2.160	-3.190	4	I/T	-8.793	-17.300	2	I	-4.239	-5.23	2	I/T	-4.489	-5.59	2	T	-3.884	-4.83
d(ir)	0	I	-3.192	-1.947	0	I	-14.686	-8.100	1	I	-5.438	-5.23	1	I/T	-5.785	-5.59	1	T	-5.438	-4.83
tc	2	I/T	-1.932	-3.190	2	I/T	-5.920	-17.300	1	I	-4.145	-5.23	1	I/T	-4.826	-5.59	1	T	-4.226	-4.83
d(tc)	0	I/T	-5.063	-3.186	0	I/T	-22.883	-17.300	0	I	-5.842	-5.23	0	I/T	-5.898	-5.59	0	T	-5.321	-4.83
infl	4	I/T	-1.536	-3.190	4	I/T	-5.582	-17.300	4	I	-3.305	-5.23	4	I/T	-3.027	-5.59	4	T	-2.536	-4.83
d(infl)	0	I/T	-4.008	-3.186	0	I/T	-17.833	-17.300	3	I	-6.496	-5.23	3	I/T	-6.632	-5.59	3	T	-5.236	-4.83
ir_real	0	I/T	-1.827	-3.183	0	I/T	-7.486	-17.300	0	I	-3.157	-5.23	0	I/T	-3.690	-5.59	0	T	-3.511	-4.83
d(ir_real)	0	I/T	-5.162	-3.186	0	I/T	-22.886	-17.300	0	I	-6.873	-5.23	0	I/T	-7.446	-5.59	0	T	-6.828	-4.83
credit	1	I/T	-1.556	-3.186	1	I/T	-4.908	-17.300	1	I	-4.138	-5.23	1	I/T	-3.940	-5.59	1	T	-2.762	-4.83
d(credit)	0	I/T	-4.410	-3.186	0	I/T	-20.551	-17.300	0	I	-5.235	-5.23	0	I/T	-5.514	-5.59	0	T	-4.754	-4.83
ic	0	I/T	-2.573	-3.183	0	I/T	-11.004	-17.300	1	I	-4.630	-5.23	1	I/T	-4.660	-5.59	1	T	-4.381	-4.83
d(ic)	0	I/T	-5.485	-3.186	0	I/T	-23.981	-17.300	1	I	-5.971	-5.23	1	I/T	-6.130	-5.59	1	T	-5.999	-4.83

Figure A.2

Vector autoregression (VAR) lag order selection for Brazil

Lag	SIC
0	-13.80
1	-17.47
2	-17.49*
3	-16.98
4	-17.00

NOTE: The asterisk represents the lag chosen based on the Schwarz information criterion (SIC).

Figure A.3

Johansen cointegration test

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept	Intercept	Intercept	Intercept	Intercept
	No Trend	No Trend	No Trend	Trend	Trend
Trace	1	1	1	1	2
Max-Eig	1	1	1	1	1

Information Criteria by Rank and Model

Schwarz Criteria by Rank (rows) and Model (columns)

0	-17.84	-17.84	-17.49	-17.49	-17.12
1	-17.83	**-18.06***	-17.80	-18.05	-17.75
2	-17.40	-17.67	-17.47	-17.66	-17.44
3	-16.81	-17.10	-16.98	-17.26	-17.11
4	-16.07	-16.43	-16.38	-16.58	-16.51
5	-15.30	-15.61	-15.61	-15.81	-15.81

*Critical values based on MacKinnon-Haug-Michelis (1999)

Unrestricted Cointegration Rank Test (Trace)

Hypot. No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Val.	Prob.**
None *	0.66	102.56	76.97	0.00
At most 1	**0.36**	**47.77**	**54.08**	**0.16**
At most 2	0.24	25.00	35.19	0.40
At most 3	0.16	10.73	20.26	0.57
At most 4	0.03	1.66	9.16	0.84

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Figure A.4

Diagnostic tests by the ordinary least squares (OLS) estimation for equation (1)

Ramsey RESET (numer of fifted terms= 1)	F-statistic 0.3097	p = 0.5806
Serial Correlation LM (1 lag)	F-statistic 15.1741	p = 0.0003
ARCH LM (1 lag)	F-statistic 0.9318	p = 0.3392
Jarque - Bera		1.0870 p = 0.5807

Figure A.5

Vector autoregression (VAR) lag order selection

Lag	SIC
0	-4.25
1	-12.07*
2	-11.76
3	-11.33
4	-10.57

Figure A.6

Johansen cointegration test

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept	Intercept	Intercept	Intercept	Intercept
	No Trend	No Trend	No Trend	Trend	Trend
Trace	2	3	3	3	4
Max-Eig	2	3	3	1	1

Information Criteria by Rank and Model

Schwarz Criteria by Rank (rows) and Model (columns)

0	-11.99	-11.99	-11.76	-11.76	-11.54
1	-11.94	**-12.01***	-11.79	-11.89	-11.68
2	-11.74	-11.73	-11.59	-11.63	-11.49
3	-11.25	-11.44	-11.36	-11.33	-11.24
4	-10.57	-10.84	-10.83	-10.83	-10.82
5	-9.81	-10.07	-10.07	-10.11	-10.11

*Critical values based on MacKinnon-Haug-Michelis (1999)

Unrestricted Cointegration Rank Test (Trace)

Hypot. No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Val.	Prob.**
None *	0.57	117.16	76.97	0.00
At most 1	0.43	72.85	54.08	0.00
At most 2	0.42	43.94	35.19	0.00
At most 3	**0.21**	**15.42**	**20.26**	**0.20**
At most 4	0.06	3.30	9.16	0.53

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Figure A.7

Diagnostic tests by the ordinary least squares (OLS) estimation for equation (2)

Ramsey RESET (numer of fifted terms= 1)	F-statistic 1.2508	p = 0.2696
Serial Correlation LM (1 lag)	F-statistic 28.9678	p = 0.0000
ARCH LM (1 lag)	F-statistic 2.5975	p = 0.1137
Jarque - Bera		0.8942 p = 0.6394

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