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## Article

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*Suggested Citation:* Oliveira, Luciano Vereda; Curi, Alexandre (2016) : Disagreement in expectations and the credibility of monetary authorities in the Brazilian inflation targeting regime, EconomiA, ISSN 1517-7580, Elsevier, Amsterdam, Vol. 17, Iss. 1, pp. 56-76, <https://doi.org/10.1016/j.econ.2016.03.002>

This Version is available at:

<https://hdl.handle.net/10419/179612>

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# Disagreement in expectations and the credibility of monetary authorities in the Brazilian inflation targeting regime

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Received 1 March 2016; accepted 17 March 2016

Available online 13 April 2016

## Abstract

Based on market expectations reported by the Central Bank of Brazil for the SELIC interest rate, the IPCA inflation, the exchange rate (BRL/USD) and the growth rate of industrial production for four different forecasting horizons, this work analyzes the term structures of disagreement in expectations regarding the future values of these variables. It also investigates the driving factors of disagreement, paying special attention to the influence of monetary authorities' credibility. An extensive regression analysis shows that the levels of the term structures of disagreement are negatively related to the output gap (although this result is not very robust); and that the levels of the term structures of disagreement in expectations about the IPCA inflation rate and the SELIC interest rate have a strong negative relationship with central bankers' credibility; this relationship is positive in the case of the growth rate of industrial production.

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*JEL classification:* C22; E31; E32; E52

*Keywords:* Disagreement in expectations; Monetary policy; Credibility; Term structures

## Resumo

Com base nas expectativas de mercado divulgadas pelo Banco Central do Brasil para a taxa de juros (SELIC), a inflação medida pelo IPCA, a taxa de câmbio (R\$/US\$) e a taxa de crescimento da produção industrial para quatro diferentes horizontes de previsão, este trabalho analisa as estruturas a termo das divergências de expectativas quanto aos valores futuros dessas variáveis. Ele também investiga os fatores determinantes das divergências, em especial, a influência da credibilidade da autoridade monetária. Uma extensa análise de regressão mostra que os níveis das estruturas a termo das divergências são negativamente relacionados com o hiato do produto (embora este resultado não é muito robusto); e que os níveis das estruturas a termo das divergências nas expectativas sobre a taxa de inflação (IPCA) e a taxa de juros (SELIC) têm uma forte relação negativa com a credibilidade do banco central; esta relação é positiva no caso de a taxa de crescimento da produção industrial.

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*Palavras-chave:* Divergência de expectativas; Política monetária; Credibilidade; Estrutura a termo

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Peer review under responsibility of National Association of Postgraduate Centers in Economics, ANPEC.

<http://dx.doi.org/10.1016/j.econ.2016.03.002>

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## 1. Introduction

Based on market expectations reported by the Central Bank of Brazil (CBB) for the future behavior of the SELIC interest rate, the inflation rate (as measured by the IPCA index), the exchange rate (BRL/USD) and the growth rate of industrial production for four different forecasting horizons, this work studies the dynamics of the term structures of disagreement in expectations regarding the future values of these variables. It also investigates the factors that explain their behavior, especially the role played by the credibility of monetary authorities and the business cycle. In an inflation targeting regime as the one prevailing in Brazil since June 1999, credibility can be measured according to the capacity of targets pursued by monetary authorities to attract inflation expectations.

The main results of the paper are: (i) the term structures of disagreement in expectations are, on average, positively sloped, with the exception of the term structure of disagreement in expectations regarding the future values of the growth rate of industrial production, which is negatively sloped; (ii) the standard deviations of the four time series representing disagreement about the future evolution of the growth rate of industrial production and the inflation rate decrease with the forecasting horizon; they increase with it in the case of the exchange rate (BRL/USD) and are insensitive to it in the case of the SELIC interest rate; (iii) regressions relating the levels of the term structures of disagreement in expectations to their potential macroeconomic determinants show that there is a negative relationship between the former and either to with the output gap or our measure of monetary authorities' credibility; (iv) the exception is the level of the term structure of disagreement in expectations about the growth rate of industrial production, which loads positively on our credibility index. These results support the idea that credible monetary authorities make inflation expectations converge to the targets they pursue, therefore reducing its dispersion.

Contributions (i), (ii), (iii) and (iv) are novel not only in the Brazilian literature dedicated to economic studies, but also in the international literature devoted to emerging economies. The Brazilian literature lacks studies analyzing the evolution of concrete measures of disagreement in expectations; furthermore, it lacks studies characterizing its hypothetical dependence to the forecasting horizon or the specific variable being forecasted. Likewise, there are no studies relating time series of disagreement measures to the observed paths of relevant macroeconomic variables. Finally, there is no research about the potential link between disagreement in expectations and Central Bank credibility.<sup>1</sup> Thus, results (i), (ii), (iii) and (iv) fill some important gaps in the literature applied to Brazil, in particular, and emerging economies, in general.

Evidences (iii) and (iv) are also novel at the international level, since there are no studies relating the credibility of monetary authorities in countries adopting the inflation targeting regime with disagreement in expectations concerning the future values of macroeconomic variables. The analysis of the term structures of disagreement in expectations is also an important contribution, for the most important paper dealing with this issue ([Andrade et al., 2014](#)) does not link the common trends followed by the time series that comprise these curves (namely, their level) with their driving factors.

The economic literature regarding disagreement in expectations (especially on the fields of macroeconomics and finance) has emphasized the fact that agents may disagree about the future behavior of the economy. Although articles discussing expectations' dispersion are numerous, we can classify them into four groups. The first group comprises papers trying to characterize disagreement by means of time series, aiming at explaining its course in light of the observed behavior of potentially relevant macroeconomic variables (for example, the output gap and the volatility of shocks affecting the economy), measures of the degree of independence of monetary authorities and their transparency standards.<sup>2</sup> The second group includes articles studying the sources of disagreement in agents' expectations, which can stem from a priori heterogeneous beliefs, differences in the models used by agents to assess the economic environment, differences in the information set that each agent uses to infer the current state of the economy, diversity of interpretations about new information revealed to the public, diversity of views about the nature of changes occurring in the economic

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<sup>1</sup> [García and Guillén \(2014\)](#) do not assess the hypothesis that credibility changes may affect disagreement in expectations about future values of inflation; also, the authors do not analyze the connection between credibility and disagreement in expectations concerning other macroeconomic variables (such as the growth rate of output).

<sup>2</sup> In this group we can include [Mankiw et al. \(2003\)](#), [Filardo and Guinigundo \(2008\)](#), [Ehrmann et al. \(2010\)](#), [Dovern et al. \(2012\)](#), [Siklos \(2013\)](#) and [Sill \(2014\)](#).

system (temporary vs. permanent changes) and so on.<sup>3</sup> The third group discusses the consequences of expectations' dispersion,<sup>4</sup> while the fourth comprises articles that try to verify if specific disagreement measures are good proxies for the inherent uncertainty of macroeconomic projections.<sup>5</sup>

Regarding the Brazilian economy, the fact that expectations are not the same for everyone has not received much attention. There are articles (such as [Bugarin and Carvalho, 2006](#); [Guillén, 2008](#); [Carvalho and Minella, 2009](#); [Carvalho, 2012](#); [de Paula and Nakane, 2013](#)) that study the rationality of the process by which inflation expectations are formed in Brazil and other Latin American economies (Chile and Mexico); the transmission mechanism determining the way expectations spread in the Brazilian financial market (i.e. checking if this mechanism complies to the framework proposed by [Carroll, 2003](#)<sup>6</sup>); that compare sticky information and imperfect information models aiming at verifying which one better describes the expectations formation process in Brazil; and that provide a comparison between central tendency measures of inflation expectations distributions (more specifically, means, medians, modes and core inflation measures) and the observed values of the inflation rate. The paper which comes closer to ours is [García and Guillén \(2014\)](#), who study inflation expectations distributions with the purpose of calculating a credibility index for the CBB and then comparing it with other indices proposed in the Brazilian literature ([Sicsú, 2002](#); [Nahon and Meurer, 2005](#); [de Mendonça, 2004](#); [de Mendonça and Souza, 2007, 2009](#)).<sup>7</sup>

Besides this introduction, this article has four sections. Section 2 discusses concepts that are important in the study of disagreement and presents the notation that we use throughout the paper. Section 3 presents some basic results related to the term structures of disagreement regarding inflation expectations as measured by the IPCA, the SELIC rate, the growth rate of industrial production and the exchange rate (BRL/USD). Section 4 studies the relationship between disagreement in expectations and its potential macroeconomic determinants, paying special attention to the measure of monetary authorities' credibility proposed by [de Mendonça and Souza \(2007, 2009\)](#). At last, Section 5 summarizes the main results of the paper and suggests some directions for future research.

## 2. Definitions, concepts and notation

The analysis of disagreement requires discussing a few concepts and presenting some notation:  $t$  represents the instant in which the forecast is made,<sup>8</sup>  $i$  identifies the agent responsible for the forecast ( $i \in I$ , here  $I$  is the group of agents surveyed; the number of agents in  $I$  is  $I$ ),  $X$  is the variable to be forecasted and  $E_{i,t}X^{a+j}$  represents the forecast calculated by the  $i$ th agent at time  $t$  about the value that variable  $X$  will take in the end of year  $a + j$ . If  $j = 0$ , then  $E_{i,t}X^a$  represents the forecast about the value of  $X$  in the end of the current year; if  $j = 1$ , then  $E_{i,t}X^{a+1}$  denotes the forecast about the value of  $X$  in the end of the next year and so on. The mean value of the distribution of expectations at  $t$  about the value that  $X$  will take in the end of year  $a + j$  is given by  $E_t X^{a+j} = 1/I \sum_I E_{i,t} X^{a+j}$ . The standard deviation of the same

<sup>3</sup> The most prominent representatives of this group are [Lahiri and Sheng \(2008\)](#), [Patton and Timmermann \(2010\)](#), [Wieland and Wolters \(2011\)](#) and [Andrade et al. \(2014\)](#).

<sup>4</sup> Among these consequences we highlight the possible effects of disagreement on risk premiums embedded in market prices of financial assets ([Soderlind, 2009](#); [Wright, 2011](#); [Carlin et al., 2012](#); [Buraschi and Whelan, 2012](#); [Ehling et al., 2012](#)), as well as its potential to prove more inertia to price inflation ([Mankiw and Reis, 2002](#); [Woodford, 2003](#); [Maćkowiak and Wiederholt, 2009](#)); affect the probability of regime changes in the economy ([Badarınza and Buchmann, 2011](#)); induce cyclical fluctuations without changes in fundamentals ([Lorenzoni, 2009](#); [Rondina and Walker, 2012](#); [Angeletos and La'O, 2013](#)); encourage the formation of speculative bubbles and abrupt movements in asset prices ([Scheinkman and Xiong, 2003](#); [Burnside et al., 2013](#)); justify the failure of the expectations hypothesis to explain the yield curve behavior ([Nimark, 2012](#)); and explain the failure of the hypothesis that one cannot predict the returns of a stock by means of indicators other than measures of its inherent risk, such as beta ([Hong and Stein, 2007](#)).

<sup>5</sup> In this group we can include [Giordani and Söderlind \(2003\)](#), [Lahiri and Sheng \(2010\)](#), [Grimme et al. \(2011\)](#), [Confitti \(2011\)](#) and [Rich et al. \(2012\)](#).

<sup>6</sup> More specifically, the hypothesis to be verified is whether forecasts made by agents who perform better in terms of forecasting errors are taken into account by other agents in the economy.

<sup>7</sup> The authors' hypothesis is that, if a central bank enjoys full credibility, then there is no reason for an agent to be persistently pessimistic or optimistic about central bank's attitudes toward inflationary pressures. Thus, under full credibility, the probability of an agent to be optimistic or pessimistic given that he (she) was pessimistic in the previous month is the same. However, if the central bank is not credible and agents are heterogeneous with respect to their beliefs about the credibility of the referred institution, then there will be a greater persistence in the state of being optimistic or pessimistic.

<sup>8</sup> This instant is characterized by a specific date, namely, a day  $d$ , a month  $m$  and a year  $a$ .

distribution at time  $t$  is given by  $sd_t X^{a+j} = 1/(I-1) \sum_1 (E_{i,t} X^{a+j} - E_t X^{a+j})^2$ .  $E_t^{\min} X^{a+j} = \min(E_{i,t} X^{a+j}, i \in I)$

denotes the minimum value of the distribution, while  $E_t^{\max} X^{a+j} = \max(E_{i,t} X^{a+j}, i \in I)$  represents its maximum value. The range of the distribution is defined below:

$$R_t X^{a+j} = E_t^{\max} X^{a+j} - E_t^{\min} X^{a+j} \quad (1)$$

The range  $R_t X^{a+j}$  is the measure of disagreement that we use throughout the paper, as other measures require the knowledge of the entire distribution of expectations.<sup>9</sup> As told in the introduction, we work with forecasts for the IPCA inflation rate ( $\pi$ ), the SELIC interest rate ( $s$ ), the exchange rate (BRL/USD) ( $e$ ) and the growth rate of industrial production ( $g$ ), therefore  $X = \pi, s, e, g$ .

Forecasts like  $E_{i,t} X^{a+j}$  are known as *fixed event forecasts* because the time horizon until the end of year  $a+j$  decreases as  $t$  advances through  $a$ , the year in which expectations are computed. This issue is better understood by an example. Suppose that an agent, in March 2000, computes his expectation about the value of the inflation rate in the end of 2000. In this case we can say that the time horizon of the forecast is 10 months because the first 2 months of 2000 have already passed and inflation figures for both months are known. By the same line of reasoning, when this agent computes his inflation expectation in September 2000 about the value of the inflation rate at the closing of 2000, the time horizon of his forecast decreases to only 4 months. This pattern of decreasing forecasting horizons as  $t$  advances through the year brings about a seasonal behavior in disagreement measures based on fixed event forecasts, since expectations dispersion tend to decrease as the forecasting horizon shrinks<sup>10</sup> (see Appendix 2).

It is to avoid the seasonal behavior inherent to disagreement measures based on *fixed event forecasts* that most articles in the literature recur to *fixed horizon forecasts*, in which the forecasting horizon does not vary with the passage of time.<sup>11</sup> As proposed in [Dovern et al. \(2012\)](#), the conversion of *fixed event forecasts* into *fixed horizon forecasts* is accomplished by applying the formula below:

$$E_t X^{12(j+1)} = \frac{12 - (m - 1)}{12} E_t X^{a+j} + \frac{m - 1}{12} E_t X^{a+j+1}, \quad j = 0, 1, 2, 3, \dots \quad (2)$$

In Eq. (2),  $m$  represents the month in which the forecast is made (or the month containing  $t$ ) and  $E_t X^{12(j+1)}$  denotes the average of agents' expectations about the value that variable  $X$  will take in the end of the next  $12(j+1)$  months. The same formula is used to interpolate minimum and maximum forecasts, which are put into (1) to compute the values of the disagreement measure  $R_t X^{12(j+1)}$ . In the end of the process we obtain something that resembles a term structure of disagreement in expectations, which is comprised by the "vertices"  $R_t X^{12}$ ,  $R_t X^{24}$ ,  $R_t X^{36}$ , etc. Given the fact that the CBB discloses forecasts for the current year, the next year and the following 3 years, formula (2) can be used with  $j=0, 1, 2, 3, 4$ ; therefore, we can always interpolate forecasts for the fixed time horizons of 12, 24, 36 and 48 months.

### 3. Characterizing the term structures of disagreement

Data on expectations were retrieved from the CBB's Market Expectations System ([www.bcb.gov.br/expectativa](http://www.bcb.gov.br/expectativa)), which is managed by the Department of Investor Relations and Special Studies (GERIN). Every weekday the GERIN collects forecasts from market participants (which can be financial institutions, real sector companies and consulting firms) and handles individual data aiming at building distributions of expectations and computing their basic statistics (mean, median, minimum and maximum values, standard deviations and coefficients of variation). Forecasts are fixed-event ones and refer to the closing of the current year, the next year and the three years that follow.

<sup>9</sup> Such information is not provided by the CBB. We are aware of the fact that papers on disagreement often use other measures, such as the inter-quartile range and Kulback-Liebler divergence measure. These two options, though, cannot be calculated without the entire distribution of individual forecasts. The standard deviation is also frequently used as a measure of disagreement, but we show in [Appendix 1](#) that our measure ( $R_t X^{a+j}$ ) and  $sd_t X^{a+j}$  provide similar results.

<sup>10</sup> Indeed, the disagreement measure observed in March 2000 for the value that the inflation rate will take in the end of 2000 tends to be greater than the disagreement measure observed in September 2000 for the value that the same variable will take at the closing of 2000. The divergence measure tends to increase again in March 2001, since the current year becomes 2001 and the time horizon of the forecast becomes 9 months once more.

<sup>11</sup> For example, [Mankiw et al. \(2003\)](#), [Patton and Timmermann \(2010\)](#) and [Dovern et al. \(2012\)](#).

Statistics of distributions are published daily, allowing to follow the evolution of the “market consensus” (i.e. the average and the median values of the distributions) and the dispersion around the central tendency. Dispersion is measured by the range (i.e. the distance between the maximum and the minimum values reported by agents) and the standard deviation of the distributions. However, there are some warnings that have to be made regarding the quality of the data informed by agents. Both reported individual expectations and statistics derived from their distributions are subject to abrupt changes in values, which tend to occur on some specific dates. The causes of these “jumps” and “breaks” are: (i) the routine of updating forecasts on Friday, which is the last day of the week available to insert a valid forecast to be published in the so-called Focus Report<sup>12</sup>; (ii) the routine of updating forecasts in some specific dates (the reference dates); if an institution does not insert any valid information (i.e. reported in the last 30 days) until the reference date, then its research department is excluded from the *Top 5*<sup>13</sup>; and (iii) the possibility of agents revising their expectations right after the release of some key economic and financial indicators.<sup>14</sup>

The measure of disagreement described in (1) is computed daily for each variable and interpolated to the forecasting horizons of interest by means of (2). Daily results are converted into monthly averages in order to mitigate the “jumps” and “breaks” described in the previous paragraph. This conversion is also justified because macroeconomic series that potentially influence the dynamics of disagreement are mostly observed on a monthly basis. Data were collected between November 2001 and August 2014. We consider disagreement regarding the SELIC interest rate, the IPCA inflation rate, the exchange rate (BRL/USD) and the growth rate of industrial production. The maximum and minimum values reported by agents are used to compute four  $R_t$  measures for each variable, which refer to the one-year ahead, two-years ahead, three-years ahead and four-years ahead forecasting horizons. Therefore, we are able to obtain 16 time series representing the evolution of disagreement; each time series has 154 observations. This procedure allows computing four term structures of disagreement in expectations deriving from Brazilian raw data, which are studied for the first time in the Brazilian economic literature. It is worth mentioning that the properties of these term structures are important in various fields, such as the study of the reasons why agents have different expectations (see, for instance, Patton and Timmermann, 2010).

### 3.1. Analysis of the term structure of disagreement in expectations about inflation ( $R_t\pi$ )

Fig. 1 shows the trajectories followed by  $R_t\pi^{12}$ ,  $R_t\pi^{24}$ ,  $R_t\pi^{36}$  and  $R_t\pi^{48}$  between November 2001 and August 2014. Disagreement in inflation expectations rises strongly in late 2002, falling abruptly during 2003. This period coincides with the uncertainties brought about by the possibility that the candidate Luiz Inácio Lula da Silva would win the presidential elections of 2002. Values taken by disagreement measures since 2004 vary between 1 and 4, that is, the distance between the maximum and the minimum values recorded for the four time series neither exceed 4 percentage points or are less than 1 percentage point. We can observe that the four time series follow similar paths and that there are periods in which the time series corresponding to  $R_t\pi^{48}$  rovers above (below)  $R_t\pi^{12}$ ; in other words, the spread between long term and short term disagreement becomes positive (negative). Positive spreads can be seen between 2005 and 2008, while negative values prevail in 2010.

Table 1 shows some basic statistics of  $R_t\pi^{12}$ ,  $R_t\pi^{24}$ ,  $R_t\pi^{36}$  and  $R_t\pi^{48}$ , which are calculated for the same time period. The information shown in Table 1 helps to characterize the main properties of the term structure of disagreement in expectations about future inflation, which is one of the goals of our paper. The average values of the four time series increase with their forecasting horizon (meaning that the average term structure is positively sloped), while standard

<sup>12</sup> The “Focus - Market Report” is published every Monday morning.

<sup>13</sup> Trying to improve the predictive power of research participants, to acknowledge their analytical effort and to induce them to reveal their true expectations, the CBB elaborates the so-called Top 5 ranking. The Top 5 is a rating system based on the accuracy rate for three different forecasting horizons (short, medium and long term). The variables for which the CBB prepares and publishes Top 5 rankings are the inflation rate (as measured by the IPCA, the IGP-DI and the IGP-M indices), the SELIC rate and the exchange rate (BRL/USD). The existence of three valid forecasts (i.e. reported in the last 30 days) for a given month or year in the last reference date (or couple of dates, in the case of the SELIC rate and the exchange rate) constitutes a condition that must be fulfilled in order to take part of the monthly ranking. Even the GERIN recognizes that “... there is a higher frequency of updating information ... in these reference dates” (taken from the article “Market Expectations System”, which is part of the Frequently Asked Questions series).

<sup>14</sup> For example, the release of the IPCA-15 for a given month (say, January 2014) and the observation that this number has exceeded the level expected by the market can affect the expectations for the IPCA inflation rate not only for January, but also for the following months and the IPCA inflation rate at the closing of 2014.

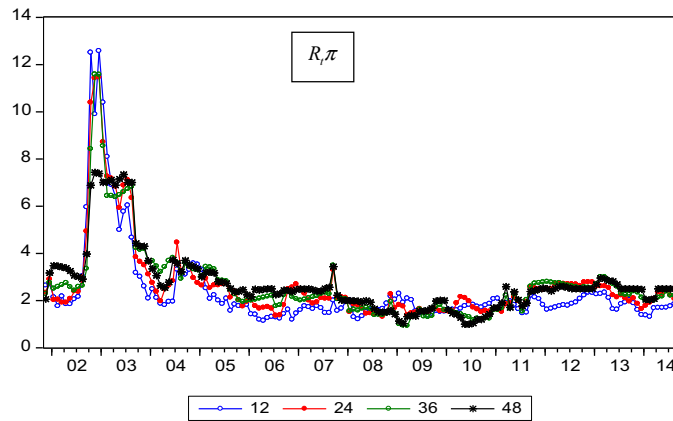


Fig. 1. Trajectories of the measures of disagreement in expectations regarding the IPCA inflation rate between November 2001 and August 2014. The time series representative of disagreement for 12-month ahead, 24-month ahead, 36-month ahead and 48-month ahead forecasting horizons are depicted by blue, red, green and black lines, respectively.

Table 1

Basic statistics calculated for the four groups of four time series representing disagreement in expectations. Besides the heading, the first four lines correspond to statistics calculated from divergence measures of exchange rate expectations, the next four lines correspond to disagreement measures derived from inflation expectations and so on. Each line pertains to a given forecasting horizon, which can be 12, 24, 36 and 48 months ahead. Columns 2 to 10 inform averages, medians, standard deviations, maximum and minimum values, skewness and kurtosis measures, the first order autocorrelation and the twelfth order autocorrelation. Each time series contains 154 monthly observations taken from the period between November 2001 and August 2014.

Series	Average	Median	Max	Min	Std. dev	Skewness	Kurtosis	AC (1)	AC (12)
<i>R(e)</i>									
12	0.57	0.50	2.35	0.28	0.28	3.29	17.96	0.89	0.07
24	0.78	0.72	2.12	0.39	0.30	1.82	7.81	0.93	0.25
36	0.89	0.81	2.15	0.42	0.34	1.48	5.11	0.93	0.26
48	1.02	0.92	2.52	0.45	0.43	1.48	4.86	0.95	0.32
<i>R(<math>\pi</math>)</i>									
12	2.36	1.83	12.58	1.15	1.83	3.78	18.32	0.91	0.08
24	2.63	2.13	11.46	1.32	1.72	3.26	14.46	0.92	0.12
36	2.69	2.27	11.58	0.93	1.67	3.00	13.93	0.92	0.26
48	2.74	2.50	7.43	1.00	1.40	2.08	7.29	0.95	0.35
<i>R(s)</i>									
12	3.85	3.49	12.33	2.16	1.63	2.52	10.34	0.87	0.23
24	5.90	5.56	15.50	3.71	1.75	3.06	14.70	0.90	0.00
36	6.41	6.25	12.13	4.02	1.61	1.69	6.52	0.90	0.15
48	6.56	6.35	13.39	4.14	1.73	2.09	8.22	0.90	0.04
<i>R(g)</i>									
12	4.49	3.87	13.08	1.68	2.15	1.73	6.19	0.88	0.18
24	4.14	3.67	10.45	2.00	1.58	1.41	4.85	0.86	0.23
36	4.06	3.77	8.30	2.07	1.30	0.95	3.23	0.87	0.31
48	3.97	3.64	7.49	2.11	1.20	0.85	3.11	0.89	0.32

deviations decrease with the forecasting horizon. Skewness measures are all positive, meaning that the distributions of the values observed throughout the period exhibit long right tails. Kurtosis measures are all above 3, being higher for series pertaining to short forecasting horizons. All series are very persistent, as pointed out by their first order autocorrelation ( $AC(1)$ ).

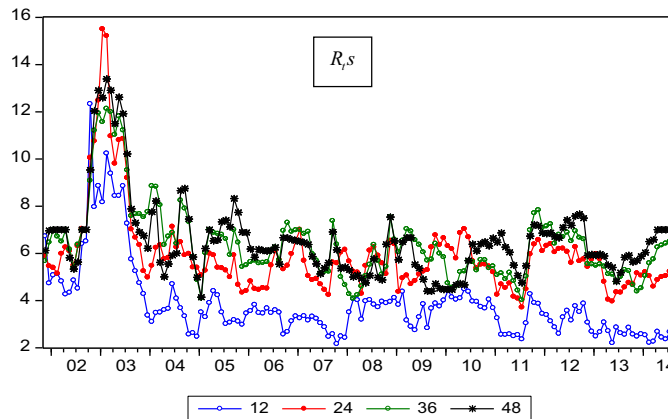


Fig. 2. Trajectories of the measures of disagreement in expectations regarding the SELIC interest rate between November 2001 and August 2014. The time series representative of disagreement for 12-month ahead, 24-month ahead, 36-month ahead and 48-month ahead forecasting horizons are depicted by blue, red, green and black lines, respectively.

### 3.2. Analysis of the term structure of disagreement in expectations about the SELIC interest rate ( $R_{t,s}$ )

Fig. 2 shows the paths of  $R_{t,s}^{12}$ ,  $R_{t,s}^{24}$ ,  $R_{t,s}^{36}$  and  $R_{t,s}^{48}$  for the period starting in November 2001 and ending in August 2014. Disagreement in expectations about the future of the SELIC interest rate rises strongly in late 2002, falling sharply throughout 2003. The reasons have already been discussed in the case of the disagreement in expectations about future inflation. From 2004 onward the four time series oscillate inside the interval  $[2, 8]$ , meaning that the distance between their maximum and minimum values are never below 2 percentage points or above 8 percentage points. All series share a common path, but there are periods in which  $R_{t,s}^{48}$  comes closer to  $R_{t,s}^{12}$  (for example, between the end of 2009 and the beginning of 2010).

Table 1 shows some basic statistics of  $R_{t,s}^{12}$ ,  $R_{t,s}^{24}$ ,  $R_{t,s}^{36}$  and  $R_{t,s}^{48}$ . Average values increase with the forecasting horizon, while standard deviations remain approximately constant. Skewness measures are all positive, meaning that the distributions of values observed throughout the period have a long right tail. Kurtosis measures are always above 3 and tend to be higher at short forecasting horizons. All four time series are quite persistent, as pointed out by their first order autocorrelations (which are around 0.9).

### 3.3. Analysis of the term structure of disagreement in expectations about the growth rate of industrial production ( $R_{t,g}$ )

Fig. 3 shows the paths of  $R_{t,g}^{12}$ ,  $R_{t,g}^{24}$ ,  $R_{t,g}^{36}$  and  $R_{t,g}^{48}$ , which are the time series corresponding to disagreement in expectations regarding the future values of the growth rate of industrial production for four different forecasting horizons (1, 2, 3, and 4 years ahead). Disagreement measures rise sharply between late 2008 and early 2009, fall right after then and settle down at a slightly lower level than the one occupied before the jump. The increase in disagreement measures reflects the international economic and financial crisis triggered by the bankruptcy of Lehman Brothers in the US in September 2008. From 2011 onward, disagreement measures vary between 2 and 6; this means that the distance between the highest and the lowest expected values of the growth rate of industrial production never exceeds 6 percentage points or are short of 2 percentage points. As before, the four time series follow a common trend. There are times in which  $R_{t,g}^{48}$  comes closer to  $R_{t,g}^{12}$  (for example, in the beginning of 2014) and there are times when the opposite occurs (for example, between 2008 and 2010).

Table 1 shows some basic statistics of the four time series  $R_{t,g}^{12}$ ,  $R_{t,g}^{24}$ ,  $R_{t,g}^{36}$  and  $R_{t,g}^{48}$ . Unconditional means and standard deviations decrease with the forecasting horizon, skewness measures are always positive and kurtosis measures always exceed 3, being higher at short forecasting horizons. The four time series are quite persistent, as indicated by their first order autocorrelations.



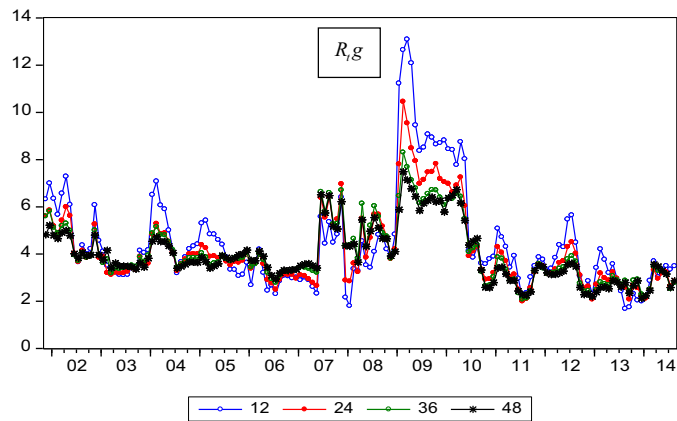


Fig. 3. Trajectories of the measures of disagreement in expectations regarding the growth rate of industrial production between November 2001 and August 2014. The time series representative of disagreement for 12-month ahead, 24-month ahead, 36-month ahead and 48-month ahead forecasting horizons are depicted by blue, red, green and black lines, respectively.

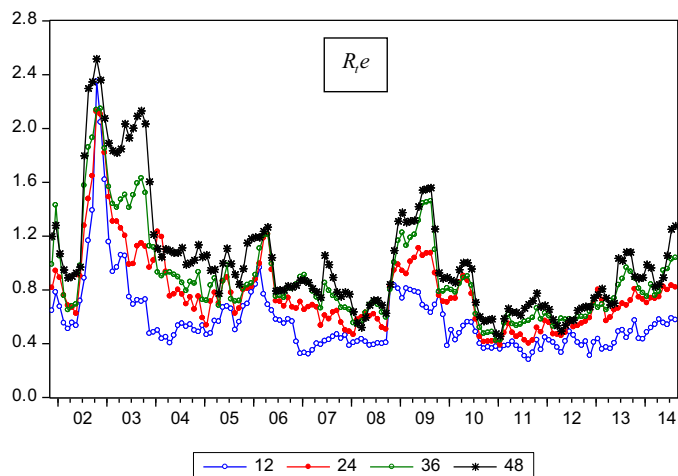


Fig. 4. Trajectories of the measures of disagreement in expectations regarding the BRL/USD exchange rate between November 2001 and August 2014. The time series representative of disagreement for 12-month ahead, 24-month ahead, 36-month ahead and 48-month ahead forecasting horizons are depicted by blue, red, green and black lines, respectively.

### 3.4. Analysis of the term structure of disagreement in expectations about the exchange rate ( $R_t e$ )

Finally, Fig. 4 shows the trajectories followed by the series  $R_t e^{12}$ ,  $R_t e^{24}$ ,  $R_t e^{36}$  and  $R_t e^{48}$ , which measure the disagreement in expectations about the future values of the exchange rate for four different forecasting horizons. Disagreement rises strongly in late 2002, remains high in early 2003 and reduces from there. There is also a significant increase in late 2008, but the stress weakens after 2009. The reasons for these outbreaks have already been discussed: first, the credibility crisis triggered by the possibility that Lula could win the presidential election of 2002; second, the disturbances caused by the international economic and financial crisis. Disagreement measures vary between 0.4 and 1.2 from 2011 onward, meaning that the distances between the higher and the lower forecasts of the BRL/USD exchange rate in the end of the four forecasting horizons are always below 1.20 R\$/US\$ and above 0.40 R\$/US\$. The four time series share a common trend. Once more, there are periods in which  $R_t e^{48}$  rovers next to  $R_t e^{12}$  (for example, in late 2010) and periods in which both series depart from each other (for example, throughout 2009).

Table 1 shows some basic statistics of  $R_t e^{12}$ ,  $R_t e^{24}$ ,  $R_t e^{36}$  and  $R_t e^{48}$ , in an attempt of characterizing the main properties of this term structure. The unconditional means and standard deviations increase with the forecasting horizon. Asymmetry measures are all positive and tend to be higher for shorter forecasting horizons. Kurtosis measures all exceed

3 and also tend to be higher at short forecasting horizons. The four time series are very persistent, as suggested by their first order autocorrelation.

### 3.5. Summary of results

In summary, the average term structures of disagreement are all positively sloped, the exception being the term structure of disagreement in expectations about the future values of the growth rate of industrial production, which is negatively sloped on average. This fact could suggest that nominal variables are not firmly anchored in Brazil, leading disagreement measures regarding inflation, the SELIC rate and the exchange rate to be higher at longer forecasting horizons. On the other hand, one possible explanation for the fact that disagreement measures regarding the growth rate of industrial production do not increase with the forecasting horizon is the action of some sort of reverting property, i.e. the tendency of expectations to converge to a level determined by the natural growth rate of the economy – perhaps this figure is less uncertain than, for instance, the long term inflation rate.

Mean values are always greater than medians, suggesting that all time series are subject to the occurrence of exceptionally high values. This fact can be explained by periods of crisis or increased uncertainty in the economy, as suggested by the graphical analysis. Asymmetry measures are higher for nominal variables ( $R_t\pi$ ,  $R_t s$ ,  $R_t e$ ) than for real variables ( $R_t g$ ); the same is true for kurtosis measures. Regarding standard deviations, they decrease with the forecasting horizon in the cases of  $R_t g$  and  $R_t \pi$ , increasing with it the case of  $R_t e$  and being relatively insensitive to the forecasting horizon in the case of  $R_t s$ .

These results can be compared with those achieved by [Patton and Timmermann \(2010\)](#) and [Andrade et al. \(2014\)](#), which are the only papers studying term structures of disagreement in expectations that we have found in our research. The first paper deals with distributions of expectations for the GDP growth rate and the inflation rate (as measured by the CPI) at four different forecasting horizons (1 month, 6 months, 12 months and 24 months ahead). The authors conclude that disagreement tends to be higher at longer forecasting horizons; that is, both term structures are positively sloped. The second article analyzes the disagreement in expectations about the future values of the US federal funds rate, the growth rate of output and the inflation rate (as measured by the CPI). Forecasting horizons start at one-year-ahead forecasts and end in the range between 6 and 10 years ahead. The authors conclude that the average term structure of disagreement about the growth rate of output is downward sloping; that the term structure of disagreement about future inflation is flat; and that the term structure of disagreement in expectations about the future values of the US federal funds rate is upward sloping.<sup>15</sup>

## 4. Macroeconomic determinants of disagreement in expectations

The main purpose of this section is to investigate the determinants of disagreement in expectations regarding the future values of the IPCA inflation rate, the exchange rate (BRL/USD), the SELIC interest rate and the growth rate of industrial production. This task is accomplished by estimating various regressions relating a measure of the general level of disagreement in expectations to a bunch of potentially relevant macroeconomic variables, paying special attention to the output gap and an index of monetary authorities' credibility. Instead of working directly with the disagreement measures analyzed in Section 3 (each one pertaining to a specific forecasting horizon ranging from one to four years ahead), in this section we use a measure of the general level of the term structure of disagreement in expectations. More specifically, the explained variable in all regressions is the first principal component extracted from the original set of four time series comprising each term structure, which is a good proxy for the common trend followed by them. We have seen in Section 3 that this common trend is very important because it tends to attract the dynamics of the underlying time series.

The application of this technique has a long tradition in the study of conventional yield curves (see [Litterman and Scheinkmann, 1991](#)), which justifies its application to the term structures that we study here; it also serves as another

<sup>15</sup> It should be emphasized that comparing these results with ours is not straightforward. Patton and Timmermann do not use the same disagreement measure, as they have access to the entire distribution of individual data. In the case of [Andrade et al. \(2014\)](#), the authors use fixed event forecasts for forecasting horizons up to two years. Thus, a two-years ahead forecast can be actually a six-quarters ahead forecast if it was taken from a survey released in the mid-year. In addition, the disagreement measure adopted by the authors is the distance between the mean values of the ten highest and lowest forecasts.

attempt to smooth the jumps and breaks that potentially contaminate our measure of disagreement, which is subject to outliers (see (1)). Indeed, a sudden move of the time series representing, say, the disagreement in expectations prevailing at the one-year ahead forecasting horizon should not be considered an outlier if the same kind of abrupt move is also observed at the same time in the dynamics of the other time series representing disagreement. One can expect that this sort of systematic movement, which is important from the economic point of view, is captured by the first principal component, while erratic movements are filtered out. Thus, the dependent variables in the regressions we estimate are the levels (or the first principal components) of the term structures formed by  $R_t X^{12}$ ,  $R_t X^{24}$ ,  $R_t X^{36}$  and  $R_t X^{48}$ , which are denoted by  $l(R_t X^{12}, R_t X^{24}, R_t X^{36}, R_t X^{48}) = l_t(X)$ , being  $X = \pi, s, e, g$ . Taking this notation into account, the regressions that we estimate are the following:

$$l_t(X) = \beta_0 + \beta_1 gap_t + \beta_2 cred_t + \varepsilon_t^l \quad (3)$$

$$l_t(X) = \beta_0 + \beta_1 gap_t + \beta_2 cred_t + \beta_5 d_t^a + \beta_6 d_t^e + \beta_7 d_t^s + \varepsilon_t^l \quad (4)$$

$$l_t(X) = \beta_0 + \beta_1 gap_t + \beta_2 cred_t + \beta_3 X_t + \beta_4 vol(X_t) + \varepsilon_t^l \quad (5)$$

$$l_t(X) = \beta_0 + \beta_1 gap_t + \beta_2 cred_t + \beta_3 X_t + \beta_4 vol(X_t) + \beta_5 d_t^a + \beta_6 d_t^e + \beta_7 d_t^s + \varepsilon_t^l \quad (6)$$

According to (6), which is the equation that incorporates the largest number of driving factors, the general level of the term structure of disagreement in expectations about the future values of the variable  $X$  at time  $t$  ( $l_t(X)$ ) depends on a measure of the output gap ( $gap_t$ )<sup>16</sup>; a *proxy* for the credibility of monetary authorities ( $cred_t$ ); the level of the variable being forecasted at time  $t$  ( $X_t$ ); a *proxy* for the volatility of variable  $X$  ( $vol(X_t)$ ), which captures the magnitude of the changes that affected  $X$  between  $t - 1$  and  $t$ ; and three *dummy* variables ( $d_t^a$ ,  $d_t^e$  and  $d_t^s$ ). The dummy  $d_t^a$  equals 1 in November and December 2001, taking value 0 otherwise; its purpose is controlling the effects exerted by the Argentine crisis. The dummy  $d_t^e$  takes value 1 between June 2002 and March 2003, being equal to 0 otherwise; its purpose is controlling the effects of the confidence crisis triggered by the possibility that the candidate Luiz Inácio Lula da Silva could win the 2002 presidential elections in Brazil. Finally, the variable  $d_t^s$  equals 1 between September 2008 and June 2009, taking value 0 in the rest of the sample; this dummy variable captures the immediate consequences of the crisis prompted by the breakdown of the U.S. investment bank Lehman Brothers.

The main result we seek is that the enhancement of monetary authorities' credibility brings about a decrease in the dispersion of market expectations regarding the future values of variables such as inflation and the overnight interest rate. In an inflation targeting regime, a possible *proxy* for the credibility of monetary authorities is the difference between the "market consensus" for future inflation and the target pursued by the central bank. If central bankers are credible, then (i) the market consensus for future inflation converges to the target, and (ii) the target acts as a focal point attracting inflation expectations, narrowing the distribution of individual expectations. The second result we wish to show is that disagreement is countercyclical in nature, confirming the conclusions of [Dovern et al. \(2012\)](#) regarding disagreement in expectations about the future values of inflation and the 3-month interest rate in G7 countries.

We adopt the strategy of estimating regressions with an increasing number of explanatory variables, that is, firstly we estimate regression (3), then regressions (4) and (5), and finally we estimate regression (6). We follow this procedure to check the robustness of our results; indeed, if the sign, the magnitude and the statistical significance of the coefficient assigned to a certain explanatory variable do not change much as we move from (3) to (6), then we should conclude that the estimated effect of this variable on  $l_t(X)$  is robust. We pay special attention to the coefficients  $\beta_1$  and  $\beta_2$ , which measure the effects that the output gap and the credibility index exert on the general level of disagreement. Regression (3) was estimated taking  $cred_t$  and  $gap_t$  as explanatory variables. Regression (5) adds two controls, which are the level occupied by the variable being forecasted ( $X_t$ ) and a measure of its recent volatility ( $vol(X_t)$ ). Both controls were used by [Mankiw et al. \(2003\)](#) in their analysis of the driving factors of disagreement in inflation expectations.<sup>17</sup> Regression (4) was estimated after inserting the dummy variables  $d_t^a$ ,  $d_t^e$  and  $d_t^s$  in the original set of explanatory variables. The

<sup>16</sup> The output gap is calculated by means of the first principal component of a set of three specific gap measures. The gap of GDP derives from the series of GDP at current prices, which is seasonally adjusted by the X12 method, deflated by the IPCA inflation index and then divided by potential GDP. Potential GDP comes from the original GDP series after being processed by the Hodrick–Prescott filter. Analogous procedures are applied to the industrial production index and the IBC-Br, generating the other two measures of output gap.

<sup>17</sup> Expectations were taken from three different sources, namely, Michigan, Livingston and SPF. The last two focus on expert forecasts, while the first one addresses forecasts made by the general public.

role of these dummies is taking into account the possibility that the occurrence of strong shocks could force the central bank to tolerate some deviation between inflation expectations and the target pursued by monetary authorities without necessarily deteriorating their credibility.<sup>18,19</sup> Regression (6) has already been discussed.

The credibility index is computed according to *de Mendonça and Souza (2007, 2009)*. The index equals 1 if the median of the distribution of inflation expectations for the next 12 months ( $E_t \pi^{12}$ )<sup>20</sup> coincides with the target pursued by monetary authorities for the same period ( $\pi_t^{trgt}$ ). The value of the credibility index decreases as the distance between  $E_t(\pi^{12})$  and  $\pi_t^{trgt}$  increases; it becomes zero when  $E_t(\pi^{12}) < \pi_t^{inf}$  or when  $E_t(\pi^{12}) > \pi_t^{sup}$ . The upper and lower bounds  $\pi_t^{sup}$  and  $\pi_t^{inf}$  derive from the limits of the band assigned by the National Monetary Council for the inflation rate to be observed at the closing of the current and the next year. Formalizing this measure in mathematical terms:

$$cred_t = \begin{cases} 1 & \text{if } E_t(\pi^{12}) = \pi_t^{trgt} \\ 1 - \frac{1}{\pi_t^{sup} - \pi_t^{trgt}} \times (E_t(\pi^{12}) - \pi_t^{trgt}) & \text{if } \pi_t^{trgt} < E_t(\pi^{12}) < \pi_t^{sup} \\ 1 - \frac{1}{\pi_t^{trgt} - \pi_t^{inf}} \times (\pi_t^{trgt} - E_t(\pi^{12})) & \text{if } \pi_t^{inf} < E_t(\pi^{12}) < \pi_t^{trgt} \\ 0 & \text{if } E_t(\pi^{12}) \geq \pi_t^{sup} \text{ or } E_t(\pi^{12}) \leq \pi_t^{inf} \end{cases} \quad (7)$$

The inflation target specified for the next 12 months is computed by means of a formula similar to (2), that is:

$$\pi_t^{trgt} = \frac{12 - (m - 1)}{12} \pi_t^{trgt,a} + \frac{m - 1}{12} \pi_t^{trgt,a+1} \quad (8)$$

In (8),  $m$  represents the month in which the target for the next 12 months is calculated (or the month containing time  $t$ ),  $\pi_t^{trgt,a}$  denotes the inflation target pursued by monetary authorities for the current year (or the year containing time  $t$ ) and  $\pi_t^{trgt,a+1}$  is the target specified for the year that follows. Formula (8) was also used to interpolate the upper and lower limits of the bands that are fixed around the targets set by the National Monetary Council.

Regressions (3)–(6) are estimated by ordinary least squares (OLS), two-stage least squares (2SLS) and the generalized methods of moments (GMM). In all three cases we use the Newey-West estimator to provide an estimate of the covariance matrix of the parameters even in the presence of heteroscedasticity and serial correlation in the error terms. In the cases of 2SLS and GMM, the variable  $cred_t$  is replaced by two instruments,  $cred_{t-1}^{end}$  and  $cred_{t-2}^{end}$ . The variable  $cred_t^{end}$  is the time series formed by the credibility measures calculated by applying formulas (7) and (8) to the last working day of each month. The usage of instruments in this case is mandatory because  $cred_t$  is based on the first moment of the distribution of inflation expectations, which is probably contemporaneously affected by the same shocks hitting disagreement measures, that essentially reflect second order moments of the same distribution (in other words, shocks affecting the entire distribution of expectations also impact instantaneously its moments of first and second order).

The variables  $gap_t$ ,  $X_t$  and  $vol X_t$  do not necessarily require instruments because a shock in the general level of disagreement in expectations (which essentially reflects the opinions of experts regarding the future values of  $X$ ) do not affect them at the same time. This identification hypothesis stems, for example, in the model proposed by *Carroll (2003)*, which holds that the projections made by experts spread slowly in the population in a way that resembles a disease. According to this model, a shock that hits the distribution of experts' expectations does not affect contemporaneously

<sup>18</sup> One can only speculate that a credible central bank can smooth the negative effects of shocks, allowing more pronounced and/or more persistent deviations between inflation expectations and the target pursued by the institution. On the other hand, central bankers who lack credibility are forced to halt significant deviations between expectations and targets.

<sup>19</sup> The dummy variable  $d_t^a$  aims at controlling for the possibility that the credibility loss observed in November and December 2001 is even greater than the one indicated by the credibility measure  $cred_t$ .

<sup>20</sup>  $E_t(\pi^{12})$  is available at <https://www3.bcb.gov.br/expectativas/publico/consulta/serieestatisticas>.

Table 2

Estimation results of regressions (3)–(6) by OLS, 2SLS and GMM. The explained variable is the level of the term structure of disagreement in expectations about future inflation ( $l_t(\pi)$ ). The statistical significance is indicated as following: \* (\*\*, \*\*\*) means a significance level of 0.10 (0.05, 0.01). Standard deviations of the coefficients are written in quotes. “C” denotes the constant of the regression; “Adj  $R^2$ ” denotes the Adjusted  $R^2$  measure of goodness-of-fit. The sample contains 150 observations taken from the period between January 2002 and June 2014. Estimations were made by means of the Newey-West estimator to preserve inference against the negative effects of heteroscedasticity and serial correlation in the error terms. The variable “ $cred_t$ ” is our proxy for monetary authorities’ credibility; it is calculated as the mean values, in each month, of daily observations of the credibility measure described in (7). We replace “ $cred_t$ ” by its instruments “ $cred_{t-1}^{end}$ ” and “ $cred_{t-2}^{end}$ ” when estimating the regressions by 2SLS and GMM. The instruments are the first and second lags of the series formed by the values of the credibility measure observed in the last day of each month. The “ $gap_t$ ” variable denotes the output gap, while the dummy variables are  $d_t^a$ ,  $d_t^c$  and  $d_t^s$ , respectively.

$l_t(\pi)$	C	Gap <sub>t</sub>	Cred <sub>t</sub>	d <sup>a</sup>	d <sup>c</sup>	d <sup>s</sup>	$\pi_t$	(Vol) $\pi$	Adj $R^2$
OLS	2.82**	−0.13	−4.81***						0.42
	{1.15}	{0.10}	{1.62}						
	1.72**	−0.23**	−3.20***	−0.39	3.71**	−1.16***			0.61
	{0.81}	{0.11}	{1.11}	{0.36}	{1.46}	{0.38}			
	−1.60**	−0.04	−1.65*				0.36***	2.52***	0.74
	{0.78}	{0.06}	{0.85}				{0.05}	{0.23}	
2SLS	−1.61**	−0.13***	−1.18*	−0.44**	2.11*	−1.04***	0.32***	1.76***	0.80
	{0.62}	{0.05}	{0.63}	{0.17}	{1.07}	{0.19}	{0.04}	{0.19}	
	2.80**	−0.13	−4.77***						0.42
	{1.14}	{0.10}	{1.59}						
	1.74**	−0.23**	−3.24***	−0.40	3.69**	−1.15***			0.61
	{0.81}	{0.11}	{1.11}	{0.37}	{1.46}	{0.37}			
GMM	−1.86***	−0.03	−1.38*				0.38***	2.55***	0.74
	{0.70}	{0.06}	{0.74}				{0.06}	{0.23}	
	−1.79***	−0.13***	−0.99*	−0.41**	2.14*	−1.06***	0.33***	1.77***	0.80
	{0.57}	{0.05}	{0.58}	{0.16}	{1.08}	{0.19}	{0.04}	{0.20}	
	2.67**	−0.05	−4.63***						0.41
	{1.16}	{0.07}	{1.62}						
GMM	1.08	−0.14*	−2.43**	−0.11	4.14***	−0.89***			0.59
	{0.70}	{0.08}	{1.01}	{0.30}	{1.56}	{0.27}			
	−1.84***	−0.03	−1.39*				0.37***	2.55***	0.74
	{0.68}	{0.06}	{0.73}				{0.05}	{0.22}	
	−1.84***	−0.12***	−0.93*	−0.42**	2.07*	−1.06***	0.34***	1.79***	0.80
	{0.54}	{0.05}	{0.55}	{0.16}	{1.06}	{0.18}	{0.04}	{0.19}	

(i.e. at the same month that the shock occurs) the expectations of other agents, therefore this shock does not affect instantaneously their pricing and production decisions, as well as other economic choices.<sup>21</sup>

In the next subsections we investigate the driving factors of disagreement in expectations regarding the future values of the IPCA inflation rate (Section 4.1), the SELIC interest rate (Section 4.2), the exchange rate (Section 4.3) and the growth rate of industrial production (Section 4.4). As mentioned before, we are especially interested in studying the relationship between the general level of disagreement in expectations regarding the future values of each variable and two potentially relevant explanatory variables, the output gap and our measure of monetary authorities’ credibility.

#### 4.1. Macroeconomic determinants of disagreement in inflation expectations

Table 2 shows the results achieved after estimating regressions (3)–(6) using the general level of the term structure of disagreement in inflation expectations as the explained variable ( $l_t(\pi)$ ). The sample starts in January 2002 and ends in June 2014; this holds for all regressions presented in Tables 2–5. The annual inflation rate observed in the last 12

<sup>21</sup> In any case, the estimated values for the coefficients  $\beta_1$  and  $\beta_2$  (as well as their statistical significance) are relatively insensitive to the use of conventional instruments replacing  $X_t$  and  $vol(X_t)$  (i.e. the first and second lags of both variables). Results achieved after estimating these regressions will not be discussed here due to space limitations, but they are available upon request.

Table 3

Estimation results of regressions (3)–(6) by OLS, 2SLS and GMM. The explained variable is the level of the term structure of disagreement in expectations about the future SELIC rate ( $l_t(s)$ ). The statistical significance is indicated as following: \* (\*\*, \*\*\*) means a significance level of 0.10 (0.05, 0.01). Standard deviations of the coefficients are written in quotes. “C” denotes the constant of the regression; “Adj  $R^2$ ” denotes the Adjusted  $R^2$  measure of goodness-of-fit. The sample contains 150 observations taken from the period between January 2002 and June 2014. Estimations were made by means of the Newey-West estimator to preserve inference against the negative effects of heteroscedasticity and serial correlation in the error terms. The variable “ $cred_t$ ” is our proxy for monetary authorities’ credibility; it is calculated as the mean values, in each month, of daily observations of the credibility measure described in (7). We replace “ $cred_t$ ” by its instruments “ $cred_{t-1}^{end}$ ” and “ $cred_{t-2}^{end}$ ” when estimating the regressions by 2SLS and GMM. The instruments are the first and second lags of the series formed by the values of the credibility measure observed in the last day of each month. The “ $gap_t$ ” variable denotes the output gap, while the dummy variables are  $d_t^a$ ,  $d_t^e$  and  $d_t^s$ , respectively.

$l_t(s)$	C	Gap <sub>t</sub>	Cred <sub>t</sub>	d <sup>a</sup>	d <sup>e</sup>	d <sup>s</sup>	$s_t$	Vol( $s_t$ )	Adj $R^2$
OLS	2.26*	−0.23**	−3.87**						0.32
	{1.22}	{0.09}	{1.70}						
	1.15	−0.29***	−2.34*	0.37	3.71**	−0.45			0.52
	{0.96}	{0.11}	{1.31}	{0.43}	{1.44}	{0.43}			
	−0.16	−0.11*	−2.57**				0.02	−0.01	0.63
	{1.47}	{0.05}	{1.03}				{0.23}	{0.01}	
	0.78	−0.09	−1.74**	−0.45	2.66**	0.25	−0.16	−0.01**	0.72
{1.13}	{0.06}	{0.77}	{0.33}	{1.27}	{0.24}	{0.17}	{0.01}		
2SLS	2.24*	−0.23**	−3.84**						0.32
	{1.21}	{0.09}	{1.69}						
	1.18	−0.29***	−2.40*	0.35	3.68**	−0.44			0.52
	{0.96}	{0.11}	{1.32}	{0.43}	{1.43}	{0.42}			
	−0.21	−0.10*	−2.44**				0.02	−0.01	0.63
	{1.48}	{0.05}	{1.01}				{0.24}	{0.01}	
	0.77	−0.09	−1.68**	−0.44	2.68**	0.25	−0.17	−0.01**	0.72
{1.13}	{0.06}	{0.76}	{0.33}	{1.27}	{0.24}	{0.17}	{0.01}		
GMM	2.24*	−0.23**	−3.84**						0.32
	{1.21}	{0.09}	{1.69}						
	0.88	−0.26***	−2.00*	0.47	3.65**	−0.37			0.52
	{0.78}	{0.10}	{1.10}	{0.37}	{1.45}	{0.38}			
	0.15	−0.10*	−2.87***				0.02	−0.01	0.63
	{1.48}	{0.06}	{0.96}				{0.23}	{0.01}	
	0.77	−0.08	−1.78**	−0.45	3.32**	0.23	−0.15	−0.01**	0.71
{1.08}	{0.06}	{0.79}	{0.34}	{1.47}	{0.23}	{0.16}	{0.01}		

months ( $\pi_{t-1,t}$ ) serves as a *proxy* for the level of the inflation rate. The square of the difference between the inflation rates observed in the current and the previous month ( $vol(\pi_t)$ ) serves as a *proxy* for the magnitude of the shocks that have affected the inflation rate between  $t - 1$  and  $t$ .

We can observe that the Adjusted  $R^2$  measure achieved after estimating regression (6) is greater than 0.80 and that all explanatory variables are statistically significant at conventional levels. The coefficient assigned to the level of the IPCA inflation rate at time  $t$  ( $\beta_3$ ) is positive, as well as the coefficient attached to the variability measure  $vol(\pi_t)$  ( $\beta_4$ ); both results indicate that the general level of disagreement in expectations about future inflation rises when inflation rises and/or becomes more volatile. The uncertainties brought about by the 2002 elections induced a significant increase in  $l_t(\pi)$ , while the crisis triggered by the bankruptcy of Lehman Brothers and the Argentine crisis put a downward pressure on  $l_t(\pi)$ . There is negative relationship between the output gap and the general level of disagreement in expectations about future inflation; in other words,  $l_t(\pi)$  is counter-cyclical. The coefficient attached to the measure of credibility proposed by de Mendonça and Souza (2007) ( $\beta_2$ ) is negative, suggesting that an improvement of the credibility of monetary authorities seems to reduce the general level of disagreement in expectations about future inflation. These results are in line with those found in Dovern et al. (2012), who show that either a more robust economic activity or a greater degree of independence enjoyed by the Central Bank exert a negative effect on the dispersion of expectations regarding future inflation in G7 countries. This piece of evidence can be added to the arguments in favor of adopting an inflation targeting regime, since it corroborates the idea that inflation expectations become better anchored.

Table 4

Estimation results of regressions (3)–(6) by OLS, 2SLS and GMM. The explained variable is the level of the term structure of disagreement in expectations about the future exchange rate ( $l_t(e)$ ). The statistical significance is indicated as following: \* (\*\*, \*\*\*) means a significance level of 0.10 (0.05, 0.01). Standard deviations of the coefficients are written in quotes. “C” denotes the constant of the regression; “Adj  $R^2$ ” denotes the Adjusted  $R^2$  measure of goodness-of-fit. The sample contains 150 observations taken from the period between January 2002 and June 2014. Estimations were made by means of the Newey-West estimator to preserve inference against the negative effects of heteroscedasticity and serial correlation in the error terms. The variable “ $cred_t$ ” is our proxy for monetary authorities’ credibility. We replace “ $cred_t$ ” by its instruments “ $cred_{t-1}^{end}$ ” and “ $cred_{t-2}^{end}$ ” when estimating the regressions by 2SLS and GMM. The “ $gap_t$ ” variable denotes the output gap, while the dummy variables are  $d_t^a$ ,  $d_t^e$  and  $d_t^s$ , respectively.

$l_t(e)$	C	Gap <sub>t</sub>	Cred <sub>t</sub>	d <sup>a</sup>	d <sup>e</sup>	d <sup>s</sup>	$e_t$	Vol( $e_t$ )	Adj $R^2$
OLS	1.44	−0.39***	−2.51						0.20
	{1.10}	{0.10}	{1.51}						
	−0.08	−0.39***	−0.58	0.25	5.25***	0.61			0.59
	{0.58}	{0.10}	{0.79}	{0.48}	{1.03}	{0.38}			
	−5.58***	−0.29***	0.30				2.30***	25.52***	0.68
	{1.18}	{0.09}	{0.61}				{0.52}	{6.55}	
2SLS	−4.51***	−0.33***	0.58	0.12	2.84***	0.21	1.69***	17.36***	0.75
	{0.93}	{0.10}	{0.53}	{0.42}	{0.88}	{0.39}	{0.41}	{4.59}	
	1.39	−0.39***	−2.41*						0.20
	{1.05}	{0.10}	{1.44}						
	−0.06	−0.39***	−0.62	0.24	5.23***	0.62*			0.59
	{0.58}	{0.09}	{0.78}	{0.48}	{1.04}	{0.37}			
GMM	−5.48***	−0.29***	0.20				2.28***	25.41***	0.68
	{1.21}	{0.09}	{0.64}				{0.53}	{6.50}	
	−4.40***	−0.33***	0.46	0.10	2.82***	0.24	1.67***	17.15***	0.76
	{0.93}	{0.10}	{0.54}	{0.42}	{0.87}	{0.40}	{0.41}	{4.59}	
	1.15	−0.40***	−2.12						0.20
	{0.93}	{0.09}	{1.32}						
GMM	0.02	−0.40***	−0.71	0.25	5.12***	0.58			0.59
	{0.54}	{0.09}	{0.74}	{0.48}	{1.00}	{0.36}			
	−4.78***	−0.32***	0.08				1.95***	25.50***	0.67
	{0.95}	{0.09}	{0.62}				{0.44}	{6.82}	
	−4.36***	−0.32***	0.35	0.22	2.80***	0.30	1.67***	16.93***	0.76
	{0.91}	{0.10}	{0.53}	{0.42}	{0.86}	{0.41}	{0.41}	{4.63}	

An evaluation of the economic significance of the coefficients can be performed by taking into account that the standard deviation of the time series  $l_t(\pi)$  equals 1.94. This means that the transition between a state in which there is no credibility (therefore  $cred_t = 0$ ) to a state in which central bankers enjoy full credibility (thus  $cred_t = 1$ ) would make the general level of disagreement in expectations regarding future inflation to fall by something around 0.5 standard deviations – indeed, regressions of type (6) indicate that the modulus of the estimated value of  $\beta_2$  oscillate around 1. Regarding the effects of the output gap, estimated regressions of type (6) indicates that the coefficient  $\beta_1$  is statistically significant at the 10% confidence level (this result does not depend on the estimation method) and takes values around 0.12 in absolute terms. This result suggests that an one percentage point increase in the output gap would make the general level of disagreement in expectations about future inflation to fall by approximately 0.05 standard deviations.

#### 4.2. Macroeconomic determinants of disagreement in interest rate expectations

Table 3 shows the results achieved after estimating regression (3)–(6) by OLS, 2SLS and GMM. The explained variable is the general level of the term structure of disagreement in expectations regarding the future values of the SELIC interest rate ( $l_t(s)$ ). The SELIC rate observed in the current month and expressed in annual terms ( $s_t$ ) serves as a proxy for the level occupied by this variable, while the square of the difference between the SELIC rates observed in the current and the previous month ( $Vol(s_t)$ ) serves as a measure of the magnitude of the shocks that affected the path of the interest rate between  $t - 1$  and  $t$ .

Table 5

Estimation results of regressions (3)–(6) by OLS, 2SLS and GMM. The explained variable is the level of the term structure of disagreement in expectations about the future growth rate of industrial production ( $l_t(g)$ ). The statistical significance is indicated as following: \* (\*\*, \*\*\*) means a significance level of 0.10 (0.05, 0.01). Standard deviations of the coefficients are written in quotes. “C” denotes the constant of the regression; “Adj  $R^2$ ” denotes the Adjusted  $R^2$  measure of goodness-of-fit. The sample contains 150 observations taken from the period between January 2002 and June 2014. Estimations were made by means of the Newey-West estimator to preserve inference against the negative effects of heteroscedasticity and serial correlation in the error terms. The variable “ $cred_t$ ” is our proxy for monetary authorities’ credibility; this variable is replaced by its instruments “ $cred_{t-1}^{end}$ ” and “ $cred_{t-2}^{end}$ ” when estimating the regressions by 2SLS and GMM. The “ $gap_t$ ” variable denotes the output gap, while the dummy variables are  $d_t^a$ ,  $d_t^e$  and  $d_t^s$ , respectively.

$l_t(g)$	C	Gap <sub>t</sub>	Cred <sub>t</sub>	d <sup>a</sup>	d <sup>e</sup>	d <sup>s</sup>	$g_t$	Vol( $g_t$ )	Adj $R^2$
OLS	−1.75***	−0.25	2.99***						0.20
	{0.55}	{0.20}	{1.07}						
	−2.19***	−0.07	3.17***	2.33***	1.42**	2.81**			0.34
	{0.51}	{0.13}	{1.04}	{0.22}	{0.59}	{1.13}			
	−1.79***	−0.31*	2.83**				0.03	0.00	0.19
{0.58}	{0.18}	{1.09}				{0.07}	{0.00}		
2SLS	−2.21***	−0.26*	2.65***	2.53***	1.24**	3.71**	0.11*	0.00	0.37
	{0.49}	{0.13}	{1.00}	{0.31}	{0.52}	{1.42}	{0.06}	{0.00}	
	−1.71***	−0.25	2.91***						0.20
	{0.55}	{0.21}	{1.09}						
	−2.08***	−0.07	2.99***	2.30***	1.35**	2.85**			0.34
{0.52}	{0.13}	{1.04}	{0.23}	{0.59}	{1.14}				
GMM	−1.73***	−0.32*	2.72**				0.03	0.00	0.19
	{0.59}	{0.18}	{1.12}				{0.07}	{0.00}	
	−2.06***	−0.26**	2.39**	2.49***	1.13**	3.78***	0.11*	0.00	0.37
	{0.51}	{0.13}	{1.04}	{0.32}	{0.52}	{1.44}	{0.06}	{0.00}	
	−1.68***	−0.24	2.85***						0.20
{0.54}	{0.20}	{1.05}							
GMM	−2.04***	−0.06	2.86***	2.32***	1.33**	2.89**			0.34
	{0.51}	{0.14}	{1.02}	{0.23}	{0.58}	{1.14}			
	−1.72***	−0.31*	2.70**				0.03	0.00	0.19
	{0.57}	{0.18}	{1.07}				{0.07}	{0.00}	
	−2.05***	−0.26*	2.28**	2.51***	1.11**	3.90***	0.12**	0.00	0.37
{0.50}	{0.13}	{0.97}	{0.31}	{0.51}	{1.41}	{0.05}	{0.00}		

The adjusted  $R^2$  measure of goodness-of-fit is larger than 0.70 in all regressions of type (6), meaning that regressors explain well the observed behavior of  $l_t(s)$ . According to the regression analysis, the variable  $cred_t$  is always statistically significant at conventional confidence levels. The estimated sign of  $\beta_2$  is negative no matter the regression type or the estimation method, implying that an improvement in the credibility of monetary authorities puts a downward pressure on the general level of disagreement in expectations regarding the future values of the SELIC rate. We can see that a larger output gap tends to reduce  $l_t(s)$ , but this result is not as robust as the one pertaining to  $cred_t$  because the coefficient attached to  $gap_t$  is not statistically significant in regressions of type (6). Regarding the dummy variables  $d_t^a$ ,  $d_t^e$  and  $d_t^s$ , only the second one exerts a statistically significant effect on  $l_t(s)$ . These results are in line with those reported by [Dovern et al. \(2012\)](#), who show that either a more robust economic activity or a greater degree of independence enjoyed by the Central Bank exert a negative effect on the dispersion of expectations regarding future values of the 3-month interest rates in G7 countries.

The economic importance of the estimated values of the coefficients  $\beta_1$  and  $\beta_2$  can be evaluated by considering that the standard deviation of the time series  $l_t(s)$  equals 1.85. This means that the transition between a state in which the central bank has no credibility at all to another state in which monetary authorities enjoy full credibility would make the general level of disagreement in expectations regarding the future values of the SELIC rate to fall by at least 1 standard deviation. This conclusion comes from the fact that regressions of type (6) indicate that the modulus of  $\hat{\beta}_2$  are often greater than 1.7. Regarding the effects of the output gap, estimated regressions of all types indicate that the coefficient  $\beta_1$  is statistically significant in most of the cases. Estimated values are between  $-0.3$  and  $-0.1$ , meaning



that an one percentage point increase in the output gap would make the general level of disagreement in expectations about future SELIC rates to fall by something between 0.05 and 0.16 standard deviations.

#### 4.3. Macroeconomic determinants of disagreement in exchange rate expectations

Table 4 shows estimation results achieved when one tries to relate the level of the term structure of disagreement regarding the future values of the exchange rate (BRL/USD) with the credibility index of monetary authorities, the output gap and other explanatory variables. Regressions (3)–(6) are estimated by three different methods: OLS, 2SLS and GMM. The mean value of the exchange rate in each month is taken as a *proxy* for the level occupied by the exchange rate at time  $t$ , while the square of the difference between the mean values observed in the current and the previous month ( $\text{Vol}(e_t)$ ) serves as a measure of the magnitude of the shocks affecting the exchange rate between  $t - 1$  and  $t$ .

The adjusted  $R^2$  measure of goodness-of-fit is never less than 0.70 in regressions of type (6), meaning that the complete set of regressors do well in explaining the observed behavior of the general level of disagreement in exchange rate expectations. Results achieved after estimating regressions (3)–(6) show that the explanatory variables that exert a statistically significant effect on  $l_t(e)$  at conventional confidence levels are the current level of the exchange rate itself (whose coefficient is positive), the magnitude of exchange rate changes (whose coefficient is also positive), the output gap (which has a negative coefficient) and the dummy variable marking the elections held in 2002 (whose coefficient is positive). The credibility measure has no statistically significant relationship with the general level of disagreement in expectations regarding the future values of the exchange rate; this result holds for almost all estimated regressions.

We are not able to compare our results with other findings in the literature because the only paper focusing on the interaction between the exchange rate and disagreement (Menkhoff et al., 2009) resorts to different explanatory variables. The economic importance of the coefficient attached to the output gap can be evaluated by considering that the standard deviation of the time series  $l_t(e)$  equals 1.92. Having this in mind, one can show that an increase of 1 percentage point in the output gap forces the general level of the disagreement in expectations about the future values of the exchange rate to fall by something around 0.2 standard deviations – this result comes from the fact that  $\hat{\beta}_1$  varies between  $-0.3$  and  $-0.4$ .

#### 4.4. Macroeconomic determinants of disagreement in expectations about the growth rate of industrial production

Finally, Table 5 shows the results achieved after estimating regressions (3)–(6) and taking  $l_t(g)$  as the explained variable. The growth rate of industrial production observed between the current month and the same month of the previous year serves as a proxy for the level occupied by the growth rate of industrial production at time  $t$ , while the square of the difference between the growth rates observed in the current month and the previous month, that is, ( $\text{Vol}(g_t)$ ), serves as a *proxy* for the magnitude of the shocks affecting the growth rate of industrial production between  $t - 1$  and  $t$ .

The adjusted  $R^2$  measure of goodness-of-fit is never greater than 0.40, meaning that even the set of regressors used in regressions of type (6) have a hard time in explaining the observed behavior of the general level of disagreement in expectations regarding the growth rate of industrial production. The coefficients attached to the dummy variables  $d_t^a$ ,  $d_t^e$  and  $d_t^s$  are all positive and statistically significant at conventional confidence levels. The coefficient assigned to our measure of the credibility of monetary authorities is also positive, being statistically significant at conventional confidence levels in all regressions. The fact that  $\hat{\beta}_2$  has a positive sign will be interpreted in the next subsection. At last, the coefficient attached to the output gap has a negative sign but is not statistically significant in all regressions.

When compared to other results found in the literature on disagreement, ours do not differ much. For example, [Dovern et al. \(2012\)](#) find a negative coefficient attached to their measure of economic activity, but the relationship is not statistically significant at conventional confidence levels. They also find that granting independence to central bankers exert a negative influence on disagreement in expectations regarding the future values of the GDP growth rate; in this case estimated coefficients are statistically significant at the 10% confidence level. An economic assessment of the estimated value of coefficient  $\beta_2$  can be performed if one considers that the standard deviation of the time series corresponding to  $l_t(g)$  equals 1.95. As regressions (3)–(6) indicate a coefficient whose magnitude is never below 2.5, the transition between a state in which the central bank has no credibility to a situation in which monetary authorities

enjoy full credibility would make the general level of disagreement in expectations regarding the future values of the growth rate of industrial production to increase by at least 1.2 standard deviations, which constitutes a sizable effect.

#### 4.5. Summary of results

In this subsection we make a general assessment of the results compiled in Sections 4.1–4.4, paying special attention to their interpretation. We start the analysis discussing the role played by the dummy variables  $d_t^a$ ,  $d_t^e$  and  $d_t^s$ . Regarding the dummy variable marking the elections held in 2002, the coefficient attached to it ( $\beta_6$ ) (which was estimated in regressions (4) and (6)) is statistically significant at conventional confidence levels no matter the disagreement measure being explained ( $l_t(\pi)$ ,  $l_t(s)$ ,  $l_t(e)$  or  $l_t(g)$ ) and the estimation method. All estimated values of  $\beta_6$  are positive and large, ranging between 1 and 5; this suggests that political disturbances affecting the proper operation of economic policies and decision making have a major impact on individual expectations and their dispersion. The coefficient attached to the dummy variable  $d_t^s$  ( $\beta_7$ ), which marks the effects of the subprime crisis, has a positive sign in regressions taking  $l_t(\pi)$  as the explained variable; this sign is negative in regressions explaining  $l_t(g)$ . These are the cases in which  $\beta_7$  is statistically significant at conventional confidence levels.

At last, the coefficient attached to the dummy variable  $d_t^a$  ( $\beta_5$ , which marks the contagion of the Argentine crisis) is positive and statistically significant at conventional confidence levels in the case of the growth rate of industrial production. This result can be explained both by the connection between the two economies and the fact that  $d_t^a$  takes value 1 in a period also marked by the so-called blackout crisis. Thus, the problems in the production of electricity observed between July 2001 and February 2002 would have affected not only the growth rate of the Brazilian economy, but also agents' expectations (and their disagreement) regarding the future level of economic activity and their assessment about the costs in terms of declining production.

The coefficients assigned to the level of the variable being forecasted and its recent volatility ( $\beta_3$  and  $\beta_4$ , respectively; both coefficients are estimated in regressions (5) and (6)) are positive and statistically significant at conventional confidence levels in the cases of the general level of the term structure of disagreement in expectations regarding inflation and the exchange rate (BRL/USD). These results for inflation are in line with those found in Mankiw et al. (2003) and Dovern et al. (2012).

The coefficient assigned to the output gap ( $\beta_1$ ) is always negative, meaning that the levels of the term structures of disagreement in expectations regarding the future values of all variables hold a negative relationship with it. This effect is statistically significant in most of the cases, being quite strong in the case of the exchange rate (in which the effect is detected no matter the estimation method and the particular regression being estimated). Its economic importance, though, does not seem to be as relevant as the one enjoyed by the measure of monetary authorities' credibility.

The effects of increased credibility of monetary authorities are in line with what was anticipated in the cases of the general level of disagreement in expectations regarding the future values of IPCA inflation and the SELIC rate; indeed, the estimated values of the coefficient  $\beta_2$  are negative in all regressions, regardless the estimation method. In addition,  $\beta_2$  is statistically significant at conventional confidence levels. The reasons are very clear: if agents believe that central bankers are committed to the inflation target they pursue, then expectations regarding future inflation tend to converge to this target, reducing the dispersion of the distribution of individual point of views about the future inflation path. Regarding the interest rate, the validity of the Fisher equation suggests that a higher concentration of inflation expectations around the target helps reducing the disagreement in expectations regarding the future values of the overnight interest rate.

Regarding the effects of increased credibility on disagreement in expectations about the future values of the growth rate of industrial production, results are not in accordance with what was expected a priori. Indeed, results suggest that enhancing the credibility of monetary authorities tends to increase disagreement in expectations regarding the future values of the growth rate of industrial production. The fact that  $\hat{\beta}_2$  has a positive sign can be interpreted if one pays attention to the following arguments: first, under an inflation targeting regime, the loss function of central bankers puts a much higher weight on deviations of expected inflation from its target than on deviations of the growth rate of output from its natural growth path; second, our measure of monetary policy credibility increases when expected inflation comes closer to the target; and third, agents do not know for sure the sacrifice ratio of the Brazilian economy, meaning that they do not know the costs of reducing the misalignment between expected inflation and its target. The three arguments suggest that central bankers who are successful in maintaining expected inflation near its target (therefore minimizing their loss function) have to bear the side effect of increasing disagreement in expectations regarding the

growth rate of industrial production; indeed, since the costs of this policy in terms of growth are not well known, agents' divergence about future growth actually increases.

## 5. Conclusion

This article raises some stylized facts of the behavior of the term structures of disagreement in expectations regarding the future values of the inflation rate, the SELIC interest rate, the exchange rate (BRL/USD) and the growth rate of an index of industrial production. Raw data come from the CBB's Market Expectations System, referring to the Brazilian economy throughout the period between November 2001 and August 2014. This period covers most of the Brazilian inflation targeting regime, which started officially in June 1999. The term structures that we study comprise four "vertices", each one pertaining to a given forecasting horizon (which can be of 12, 24, 36 or 48 months ahead). The main findings of this stage are the following: (i) the term structures of disagreement in expectations are, on average, positively sloped, with the exception of the term structure of disagreement in expectations regarding the future values of the growth rate of industrial production, which is negatively sloped; and (ii) the standard deviations of the four time series representing disagreement regarding the future evolution of the growth rate of industrial production and the inflation rate decrease with the forecasting horizon; they increase with it in the case of the exchange rate (BRL/USD) and are insensitive to it in the case of the SELIC interest rate.

The results of Sections 4.1–4.4 suggest that the levels of the four term structures of disagreement in expectations have a negative relationship with the output gap. This effect is statistically significant in most of the cases, being very strong (i.e. not depending on the specific regression being estimated or the estimation method) in the case of disagreement in expectations regarding the exchange rate. This evidence highlights the importance of providing a solid ground for economic growth, since agents see less uncertainty and disagree less about future of the economy during periods of prosperity.

We also verify that the levels of the term structures of disagreement in expectations regarding the future values of inflation and the SELIC rate are negatively related to the index of monetary authorities' credibility; this relationship is positive in the case of the level of the term structure of disagreement in expectations regarding the future values of the growth rate of industrial production. Results are not only statistically significant regardless the specific regression being estimated and the estimation method, but are also economically relevant. They reinforce the idea that credible monetary authorities are able to anchor inflation expectations more firmly, allowing monetary policy to operate in a better background and providing better results in terms of macroeconomic stabilization. The positive sign of the coefficient attached to the credibility measure in the case of the general level of disagreement in expectations regarding the future values of the growth rate of industrial production can be understood as a result of two interacting aspects of the Brazilian economy, which are the inflation targeting regime adopted by the country since 1999 and the probable uncertainty about the costs, in terms of economic activity, of reducing the misalignment between inflation and its target. Regarding future research, our discussion in Section 1 makes it clear that there is still much to do in the literature applied to emerging countries, particularly Brazil.

## Appendix 1. Correlation between two alternative measures of disagreement in expectations

This appendix compares the measure of disagreement in expectations used throughout this work, which is the range of the distribution of individual expectations (notation:  $R_t(X^{a+j})$ ), with the standard deviation of the same distribution (notation:  $sd_t(X^{a+j})$ ). The monthly series pertaining to the range is calculated as the average of the ranges observed in a given month for the distributions of the values that agents expect that a given variable will take in the end of a given year. The same is done for the standard deviation.

Table 6 shows the results, where each row pertains to a specific variable and each column refers to a given year. Cells inform the correlation between the two measures of disagreement in expectations, which are formed for the closure of the year informed in the heading of the table. For example, the column referring to 2005 shows that the correlations between the series formed by the standard deviations and the ranges of the distributions of expectations for the closing of 2005 are 0.9873 in the case of the exchange rate, 0.9818 in the case of the inflation rate and so on. The table shows only correlations calculated from a sample of at least 24 observations. The correlation coefficients are greater than 0.9 in most of the cases, which allows one to conclude that both measures provide similar results.

Table 6

The table shows the correlation between measures  $R_t(X^{a+j})$  and  $sd_t(X^{a+j})$ , which were calculated based on expectations for the end of each year between 2003 and 2016. Variables are the exchange rate ( $e$ ), the inflation rate as measured by the IPCA ( $\pi$ ), the SELIC interest rate ( $s$ ) and the growth rate of industrial production ( $g$ ).

Correl ( $R(X_t), sd(X_t)$ )	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
$e$	0.9873	0.9817	0.9658	0.9679	0.9575	0.9459	0.8748	0.9383	0.9079	0.9326	0.9463	0.8534	0.3136	0.5114
$\pi$	0.9818	0.9618	0.9663	0.9541	0.9803	0.9350	0.9069	0.9034	0.9476	0.9004	0.8895	0.9380	0.8826	0.9160
$s$	0.9377	0.9755	0.9824	0.9682	0.9579	0.9051	0.8806	0.9304	0.9104	0.9437	0.9310	0.8686	0.6043	0.7443
$g$	0.9405	0.8203	0.7254	0.8041	0.5135	0.6937	0.9026	0.9309	0.8609	0.9518	0.9614	0.9689	0.8327	0.9204

## Appendix 2. Seasonality of disagreement in fixed event expectations

The regular variation of the forecasting horizon as time passes during the year, which is typical of fixed event expectations, can create a seasonal pattern in time series of disagreement measures. This occurs because disagreement tends to decrease with the forecasting horizon, a possibility implied by the arrival of information about the developments of the economic variable being forecasted.

Table 7 serves to evaluate the hypothesis that the ranges of the distributions of individual expectations vary as a function of  $a$  and  $t$ . Some explanations are required to help reading the table. The columns of the table (except the one identified by the title “Average”) indicate the year for which projections are being made. The column referring to 2005 shows the average values of the ranges of the distributions of expectations for the value that each variable takes at the

Table 7

Study the possibility of a seasonal pattern in the series of disagreement in expectation in fixed event. This regular variation occurs because the disagreement in expectation tends to decrease as the prospective period decreases. Instructions to read the table are detailed in Appendix 2.

	Average	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
$R(e)$																	
1	0.329	0.700	0.227	0.246	0.221	0.193	0.218	0.541	0.698	0.134	0.291	0.210	0.267				
6	0.460	0.657	0.679	0.388	0.541	0.493	0.329	0.274	0.600	0.400	0.290	0.460	0.405				
12	0.621	0.809	1.702	0.508	0.559	0.832	0.337	0.400	0.832	0.355	0.400	0.459	0.428	0.448			
24	0.825		0.953	1.829	1.064	0.593	0.820	0.743	0.498	1.001	0.740	0.420	0.577	0.730	0.754		
36	0.933			1.471	1.853	1.120	0.737	0.850	0.908	0.665	1.180	0.818	0.422	0.630	0.698	0.778	
48	1.041				1.262	2.095	1.219	1.071	1.210	0.868	0.778	1.321	0.900	0.478	0.689	0.744	0.900
$R(\pi)$																	
1	0.909	5.122	0.839	0.600	0.398	0.486	0.584	0.608	0.344	0.577	0.334	0.484	0.534				
6	1.720	1.606	4.692	1.947	1.398	1.233	1.324	1.697	1.439	1.485	1.295	1.138	1.392				
12	3.046	2.824	13.257	2.211	3.795	1.955	1.538	2.089	2.173	1.641	2.203	1.955	2.493	1.470			
24	2.974		2.910	11.293	3.185	2.650	1.945	2.800	2.126	1.644	1.565	1.591	2.500	2.800	1.657		
36	3.041			2.743	11.600	3.685	3.350	2.000	2.000	2.050	1.420	1.615	1.600	2.800	2.500	2.171	
48	2.820				3.207	7.000	3.685	3.350	2.264	2.500	2.000	1.420	2.040	1.700	2.500	2.500	2.500
$R(s)$																	
1	1.171	4.162	1.900	0.583	0.761	1.750	0.500	0.898	1.750	0.500	0.500	0.500	0.250				
6	2.975	4.283	7.500	3.143	2.989	2.405	2.125	2.429	2.964	2.250	1.440	2.150	2.025				
12	4.013	5.000	9.286	3.500	2.643	3.693	3.478	2.600	4.409	4.205	3.978	3.705	2.888	2.786			
24	6.394		5.500	12.762	5.120	5.650	4.477	6.825	6.475	6.568	6.864	5.304	6.318	6.000	5.262		
36	6.400			6.545	11.857	7.994	4.810	5.591	7.000	4.500	6.591	5.745	5.467	7.148	5.500	4.452	
48	6.654				7.000	13.000	6.050	5.000	7.000	6.500	5.500	6.523	4.352	6.750	6.830	6.000	6.000
$R(g)$																	
1	2.719	3.809	2.670	2.493	2.134	3.289	3.753	2.065	5.615	2.617	1.867	1.103	1.212				
6	4.468	3.760	3.075	4.727	5.409	2.654	4.450	2.205	9.416	4.618	3.448	6.938	2.916				
12	4.305	7.121	4.628	4.300	4.581	3.764	2.980	2.010	5.077	9.099	4.000	3.932	2.409	2.067			
24	3.326		4.480	3.000	2.910	3.500	4.500	2.920	3.745	3.445	4.955	2.368	3.163	1.800	2.455		
36	4.057			5.834	4.230	4.800	3.500	4.000	4.170	7.595	3.832	4.000	2.742	3.200	2.380	2.453	
48	3.402				3.231	4.000	3.300	3.000	4.600	3.300	4.095	4.232	4.991	2.000	3.700	2.280	1.500

closing of the same year. The average disagreement in expectations observed in December 2001 (which is depicted in the line marked by the number 48, since there is a 48-month distance between December 2001 and December 2005) equals 1.26, 3.21, 7.00 and 3.23 in the cases of disagreement regarding the future values of the exchange rate, inflation, interest rate and the growth rate of industrial production, respectively. Disagreement measures become smaller in December 2004 (which is depicted in the line marked by the number 12, since there is a 12-month distance between December 2004 and December 2005), as roughly indicated by the figures of 0.56, 3.80, 2.64 and 4.58 that prevail in the same cases; they shrink more in November 2005 (which is depicted in the line marked by the number 1, since there is a 1-month distance between November 2005 and December 2005), as indicated by the figures of 0.22, 0.40, 0.76 and 2.13 that prevail in the same cases. Following the same logic, the mean values observed in December 2002, December 2003 and June 2004 are marked by the numbers 36, 24 and 6, respectively. We expect that, for each variable, the values informed in each column decrease as the number attached to the row decreases; more specifically, it is anticipated that values in rows marked by the number 48 are larger than those referring to the number 1.

The row identified by the title “Average” shows the mean values of each line, i.e., this column reports the average of the numbers observed between 2002 and 2017 for each distance between the moment in which the projection is made and the year for which the projection is made. As previously described, these distances vary from 48 months before closing the year  $a$  up to 1 month before the close of the year  $a$ . It is expected that, for each variable, the observed values decrease in this column with the line number; More specifically, it is expected that the values contained in the row designated by the numeral 48 are larger than the values in the row identified by the number 1.

Results shown in [Table 7](#) confirm the hypotheses formulated above. Indeed, for each variable, the values depicted in each column decrease as the number assigned to the line decreases. This pattern is clear in forecasts made for the closing of 2006 onwards. It is less clear in forecasts made for the closing of years before 2006, probably as a result of the disruptive effects of the confidence crisis triggered by the possibility that the candidate Lula would win the 2002 election. It is also true that, for each variable, the values informed in the column marked by “Average” decrease as the number attached to the line decreases. This is especially true for exchange rate and interest rate forecasts, since the referred values decrease monotonically as we move from line 48 to line 1. This is less true for inflation and the growth rate of industrial production forecasts, since informed values only take a clear downward trend from the line designated by the number 12 onwards. Anyway, the big picture confirms the idea that disagreement in expectations tends to decrease as the forecasting horizon decreases.

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