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Empirical Findings on Inflation Expectations in Brazil: a survey

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Non-technical Summary

Inflation expectations of economic agents have a crucial role in both theory and practice of monetary policy. Nonetheless, yet remains an open and relevant question in the literature: How expectations are formed and how best to model this process?

Empirical evidence on survey-based expectations consistently suggests that such expectations are biased and forecast errors are predictable. Both outcomes are in sharp contrast to traditional macro models based on the full-information rational expectations assumption, which comprise unbiased expectations and forecast error unpredictability.

This paper provides a novel collection of empirical findings and stylized facts about inflation expectations in Brazil, based on a set of 23 papers selected *ad hoc* from the literature. The goal is to provide a concise view of the many empirical aspects of these expectations, in order to help bridging the gap between theory and practice.

For instance, the empirical evidence indicates that the inflation-targeting regime has played a critical role in macroeconomic stabilization in Brazil, and the inflation target has worked as important coordinator of expectations. Besides, fiscal policy has also been key in shaping expectations, together with the exchange rate and commodity price dynamics, economic activity and monetary policy.

In turn, survey data from professional forecasters suggests that expectations are, in general, persistent, and Top5 forecasters, according to epidemiological investigations, update their forecasts more often and are influential to other forecasters. On the other hand, consumers seem to adjust their expectations essentially to current inflation.

Altogether, these findings form a practical guide about the observed features of inflation expectations in Brazil, which might be useful for developing macroeconomic models for the Brazilian economy.

Sumário Não Técnico

As expectativas de inflação de agentes econômicos têm um papel crucial tanto na teoria como na prática da política monetária. No entanto, há uma questão relevante em aberto na literatura: Como as expectativas são formadas e qual a melhor forma de se modelar o processo de formação de expectativas?

Evidências empíricas sobre expectativas baseadas em pesquisa (*survey*) sugerem consistentemente que tais expectativas são viesadas e os erros de previsão baseados nessas expectativas são previsíveis. Ambos os resultados contradizem os tradicionais modelos macroeconômicos baseados em expectativas racionais e informação completa, que envolvem expectativas não viesadas e imprevisibilidade do erro de previsão.

Este artigo apresenta uma nova coleção de evidências empíricas e fatos estilizados sobre expectativas de inflação no Brasil, com base em um conjunto de 23 artigos selecionados *ad hoc* da literatura. O objetivo é fornecer uma visão concisa dos diversos aspectos empíricos envolvendo tais expectativas, a fim de ajudar a preencher a lacuna entre teoria e prática.

Por exemplo, a evidência empírica indica que o regime de metas de inflação tem desempenhado um papel crítico na estabilização macroeconômica no Brasil, e a meta de inflação tem sido bastante importante na coordenação das expectativas. Além disso, a política fiscal também tem sido chave na definição das expectativas, juntamente com a taxa de câmbio, os preços de *commodities*, a atividade econômica e a política monetária.

Por sua vez, os dados de pesquisa (*survey*) com analistas profissionais sugerem que as expectativas são, em geral, persistentes e os analistas *Top5*, conforme estudos epidemiológicos, atualizam suas previsões com maior frequência e são influentes para outros analistas. Por outro lado, os consumidores parecem ajustar suas expectativas apenas devido à taxa corrente de inflação.

Tal coleção de evidências empíricas constitui um guia prático sobre as características observadas das expectativas de inflação no Brasil, que pode ser útil no desenvolvimento de modelos macroeconômicos para a economia brasileira.

Empirical Findings on Inflation Expectations in Brazil: a survey

Wagner Piazza Gaglianone [*]

Abstract

This paper provides a collection of empirical findings and stylized facts about inflation expectations in Brazil. A set of 23 papers selected *ad hoc* from the literature is employed in order to provide a concise overview of several aspects of these expectations, such as disagreement, forecast bias, role of information, epidemiology, driving-forces of the inflation expectations' formation process, and credibility of the monetary policy, among others. These findings form a practical guide about inflation expectations in Brazil, which might be useful for policymakers and academics interested in designing forward-looking policy rules as well as developing macroeconomic models for the Brazilian economy.

Keywords: Inflation, Expectations, Survey, Monetary Policy.

JEL Classification: E31, E37, E52.

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1. Introduction

Inflation expectations of economic agents have a crucial role both in theory and in practice of monetary policy, especially within an inflation-targeting regime. Nonetheless, remains an open (and relevant) question in the literature: How expectations are formed and how best to model this process? (Coibion and Gorodnichenko, 2015)

According to classic economic theory, there is no disagreement among agents, since it is often assumed, among others, that all agents form their inflation expectations conditional on the same information set. However, in the case of different information sets and/or significant information frictions, for instance, the degree of sticky-information can generate important implications for the macro dynamics and for the respective monetary policy responses as well.

More recent rational expectations models with information rigidities, such as those proposed by Mankiw and Reis (2002), Woodford (2002), Sims (2003), Reis (2006a,b) and Maćkowiak and Wiederholt (2009), have been associated with agent's inattention regarding new information, due to costs of collecting and processing information. Such models have the advantage of explaining in a parsimonious way some features of individual expectations observed in data (e.g. disagreement and predictable forecast errors), which are not compatible with the usual assumption of perfect information.

In particular, the *sticky-information* models proposed by Mankiw and Reis (2002) and Reis (2006a, 2006b) are grounded on the hypothesis that agents do not have access to instant information. For instance, Mankiw and Reis (2002) assume that information acquisition follows a Poisson process, such that every period agents have a constant probability (λ) of receiving new information. Whenever a given agent updates her/his information set, she/he obtains perfect information and forms expectations rationally.[1] [2]

On the other hand, *noisy-information* models proposed by Woodford (2002), Sims (2003) and Maćkowiak and Wiederholt (2009) assume that, although agents continuously keep track of the macroeconomic variables and update their respective information sets every period, only a noisy signal about the true state of the economy can be observed.

[1] The parameter λ is known in the literature as the degree of attention in the sticky-information setup, whereas $(1-\lambda)$ denotes the degree of information rigidity.

[2] The infrequent updating of expectations implies that, in each period, only a fraction of agents have access to new macro data; and actions/expectations of agents that have not updated their beliefs are still based on old information sets. Consequently, updating agents, in a given period, must have all the same expectations, whereas the other agents do not revise their expectations.

Since there is a continuous access to information (but to imperfect information), expectations can be described in this setup as a weighted average between new and previous information, such that the weight on past beliefs is interpreted as the degree of information rigidity.

Based on these two main strands of the literature, a wide variety of frameworks developed to model the expectations formation process has been proposed in the literature, leading to different results in terms of macro dynamics and policy implications. Which theoretical approach provides the best description about the macro reality is still a matter of intense debate in the literature. For instance, see the recent discussion in Coibion, Gorodnichenko and Kamdar (2017).

This paper provides empirical facts about inflation expectations in Brazil in order to help bridging the gap between theory and practice. Section 2 presents a short discussion about the available data on inflation expectations in Brazil. Section 3 provides a list of empirical findings and stylized facts about such expectations *vis-à-vis* the mentioned literature on the expectations formation process; and Section 4 concludes.

2. Data on inflation expectations in Brazil

Nowadays, there are two main sources of inflation expectations in Brazil: (i) extracted from financial market data (breakeven inflation), and (ii) survey-based inflation expectations. Regarding the former, there are many advantages, such as availability on a daily frequency, focus on financial market participants' beliefs; and data based on agents' decisions involving financial losses and gains. Nonetheless, there are also disadvantages, usually related to the potential lack of market liquidity and risk premium issues. In respect to the latter, survey-based expectations are increasingly being used in the literature, among others, because they can outperform traditional forecasting methods (Ang, Bekaert and Wei, 2007)[3] and due to the fact that forecasters have access to econometric models and may add expert judgment to these models (Faust and Wright, 2013).

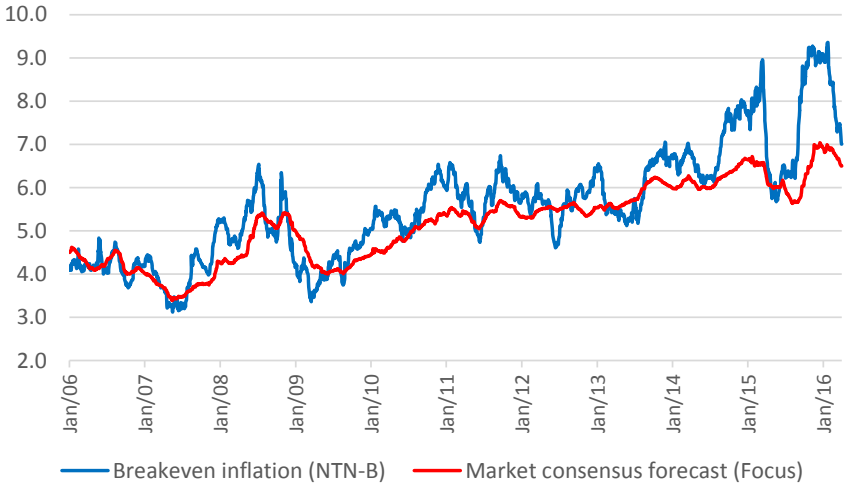
Figure 1 shows the difference between these two sources of twelve-month-ahead inflation expectations in Brazil. Note the red line representing the average market forecast surveyed by the Banco Central do Brasil (BCB) that, overall, follows the low frequency dynamics of the inflation expectations extracted from financial data (blue line). The

[3] Such as ARIMA models; regressions using real activity measures motivated from the Phillips curve; term structure models that include linear, non-linear, and arbitrage-free specifications.

expectations from the Focus survey are smoother compared to the one from financial data (using NTN-B bond market data and the parametric model of Svensson, 1994), essentially due to the risk premium embodied in that time series.

Figure 1 – Breakeven inflation and survey-based professional forecasts (*Focus*)

(12 months ahead, % 12 months)



In respect to the survey-based inflation expectations, there are two main sources of such data in Brazil: (a) market professional forecasts (Focus survey); and (b) consumer expectations (FGV survey), as next discussed.

2.1 The Focus survey of market professional forecasters (BCB)

The Focus survey is organized by the Banco Central do Brasil and started in 1999 with the implementation of the inflation-targeting regime. It contains daily forecasts from more than 100 institutions (financial or non-financial), for different horizons and a large number of economic variables. It also has a Top5 ranking contest built to improve forecasting expertise. Its innovative design received the *Certificate of Innovation Statistics* from the World Bank in 2010. See Marques (2013) for further details.

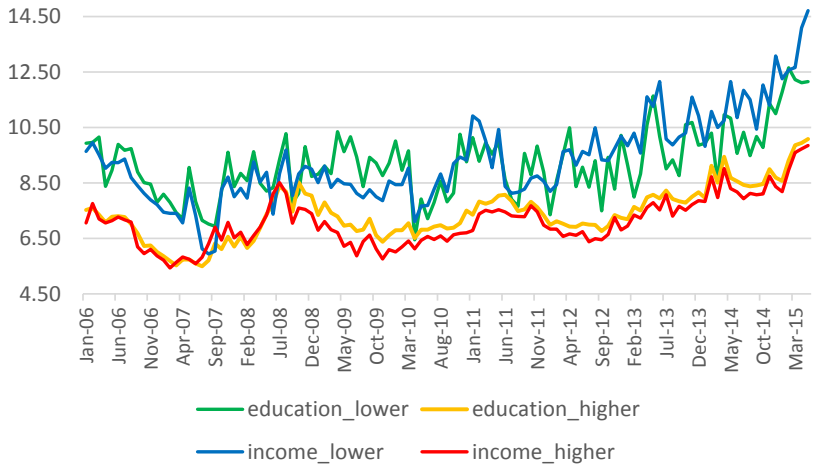
2.2 The Economic Tendency Survey (FGV)

The survey conducted by FGV-IBRE has monthly data since September/2005 from more than 2,000 consumers, with countrywide coverage (seven major state capitals). Respondents are classified into four groups of household income level; and survey

information can also be grouped by different education levels. Besides inflation expectations, the survey has qualitative information on household consumption, savings and employment, among others. See Campelo Jr et al. (2014) for further details.

Figure 2 shows the evolution of 12-month-ahead inflation expectations of consumers, for different groups of income and education.

Figure 2 – Consumer inflation forecasts for the next twelve months (% 12 months)



Note two interesting data features from Figure 2:

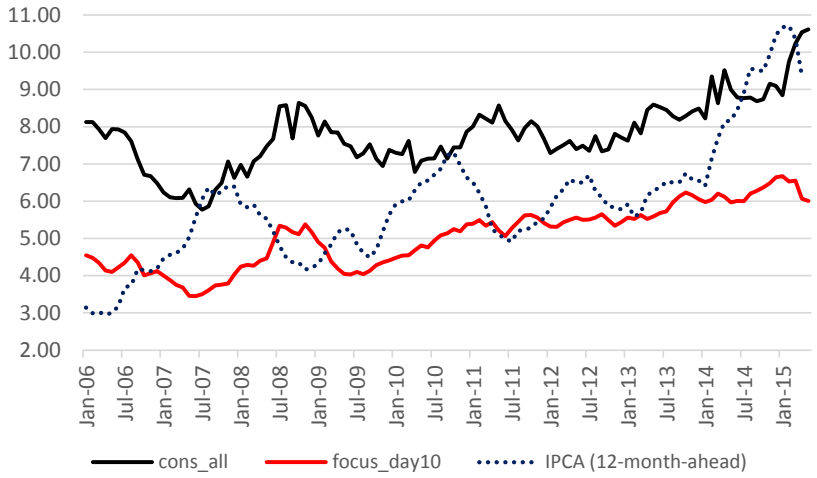
(i) Considerable degree of heterogeneity of consumer expectations, in which consumers with lower income or lower education (blue and green lines, respectively) exhibit relatively higher inflation expectations;[4] and

(ii) Volatility of expectations: consumers with higher income or higher education (red and orange lines, respectively) report more stable inflation expectations along time (i.e., lower variance in the time-dimension).

Figure 3 shows a comparison of the aggregate survey-based inflation forecasts from both market professional forecasters and consumers.

[4] However, recall that different consumers also have distinct consumption baskets, which, in turn, leads to expectations reported to the survey for different price indices (and not to a unique CPI).

Figure 3 - Consumer and market professional forecasts of inflation compared to observed IPCA (% 12 months)



Source: Gaglianone, Issler and Matos (2016)

The black line represents the consumer consensus (average) forecast of twelve-months-ahead inflation as measured by IPCA, whereas the red line shows the market consensus forecast with the same forecast horizon.[5] The black dotted line denotes the IPCA 12-months-ahead (used, for instance, to compute forecast errors and forecast bias).

Note that both survey expectations roughly form together upper and lower bounds, containing the actual inflation rate inside along the investigated sample. Also, note the different dynamics of expectations from consumers and market forecasters, especially at the end of the considered sample.

Finally, it is interesting to note that consumer inflation forecasts are (overall) higher compared to market forecasts; and that market agents (in general) underestimate inflation, whereas consumers, on the contrary, tend to overestimate it (which is a feature often reported in the literature on consumers' surveys).

3. Empirical findings

Nowadays, there is a significant amount of papers investigating the inflation expectations in Brazil along the many empirical aspects. The most recent papers already employ inflation forecasts at a micro data level (i.e., using a panel of individual forecasts). The empirical investigation at such individual level allows testing modern theoretical models to Brazilian data, besides providing a better understanding of the expectation

[5] Surveyed at the 10th calendar day of each month.

formation process as a whole; which is crucial for the macro dynamics modeling and policy analysis.

This section presents, in a concise form of bullet points, a novel collection of empirical findings and stylized facts about inflation expectations in Brazil, extracted from a list of 23 papers selected *ad hoc* from the literature. Of course, this is not intended to be an exhaustive list about the subject, but rather a representative set of papers providing distinct and practical aspects of the formation process of inflation expectations in Brazil.

The empirical findings are organized according to the following topics: (1) Driving-forces of inflation expectations; (2) Breakeven inflation; (3) Disagreement; (4) Role of information in the expectations' formation process; (5) Epidemiology and/or Top5 forecasters (Focus); (6) Forecast updating; (7) Forecast errors and/or forecast accuracy; (8) Forecast bias and/or rationality; and (9) Credibility of the monetary policy.

3.1 Driving-forces of inflation expectations

- Inflation target has helped anchor expectations (Cerisola and Gelos, 2005);
- The stance of fiscal policy has been instrumental in shaping expectations. Past inflation appears not to be so important in determining expectations (Cerisola and Gelos, 2005);
- Inflation expectations have been influenced by past inflation, the inflation targets, exchange rate and commodity prices, economic activity and the stance of monetary policy (Bevilaqua, Mesquita and Minella, 2008);
- Recursive estimates suggest that the backward-looking component of market expectations has been ceding ground to the inflation target: IT is gaining credibility (Bevilaqua, Mesquita and Minella, 2008);
- From a set of expectations' theories (rational, adaptive and sticky-information), the sticky-information approach better explains the behavior of median inflation expectations in Brazil (Guillén, 2008);
- Expectations of inflation 12 months ahead are persistent, positively related to the inflation target, current inflation and exchange rates, and negative related to the Selic interest rate. In turn, 3-month-ahead inflation expectations depend on current inflation and past FX rate volatility (Araujo and Gaglianone, 2010);
- Inflation targets play an important role in inflation expectations (Carvalho and Minella, 2012);

- Brazilian consumers adjust their expectations (in the short and long run) to current inflation (Campelo Jr et al., 2014).

3.2 Breakeven inflation

- The breakeven inflation rate (the difference between nominal and real interest rates) is decomposed as: *breakeven inflation = inflation expectation + inflation risk premium – liquidity premium + convexity* (Vicente and Graminho, 2015);
- Average inflation risk premium is estimated as 0.20%, with a standard deviation of 0.46%. The liquidity premium and convexity have very small values, less than 1 basis point for a 12-month horizon (less than the bid-ask spread of Brazilian fixed income bonds), and therefore can be ignored (Vicente and Graminho, 2015).
- Financial market-based inflation expectations, besides providing a closer monitoring of inflation expectations (since they can be updated on a continuously intra-day basis), are also competitive, in the short run, in terms of predictive ability when compared to survey-based expectations (Araujo and Vicente, 2017).

3.3 Disagreement

- Dispersion of expectations declined considerably, particularly during periods of high uncertainty (Cerisola and Gelos, 2005);
- Country risk premium and change in inflation explain disagreement in Brazil (Carvalho and Minella, 2012);
- Disagreement in Brazil is persistent and negative related to output growth, and positive related to inflation for consumers and to change in inflation for market professional forecasters (Gaglianone, 2016).

3.4 Role of information in the expectations' formation process

- Market forecasters attach more weight to public information than private information; because public information is more precise than private information (Areosa, 2016);
- Market forecasters overweight private information in order to differentiate themselves from each other, that is, strategic substitutability (Areosa, 2016);

- New information leads individual forecasters to update their expectations immediately. However, the parameter is not very high, which is consistent with sticky information and staggered updating of expectations (Correa and Picchetti, 2016);
- When precision of new information increases, agents put more weight on the piece of information received, which is consistent with Morris and Shin's (2002) model (Correa and Picchetti, 2016);
- Information is important but incentives also play a key role regarding agent's attention to update forecasts. A structural model allows quantifying the average effects of information and the Top5 contest on attention, and to perform counterfactual exercises to discuss optimal survey design in order to improve the accuracy of survey forecasts (Gaglianone et al., 2016).

3.5 Epidemiology and/or Top5 forecasters

- Based on an epidemiologic approach, Top5 forecasts (of the Focus survey) seem to influence the expectations of other forecasts (Guillén, 2008);
- Top5 forecasters are influential to other forecasters (Carvalho and Minella, 2012);
- A significant number of institutions has already been ranked as a Top5 forecaster: 50% as short-term and 64% as medium-term (Marques, 2013);
- The frequency of forecasts updating is higher among the Top5 group, during the 6 months before the ranking release: Top5 institutions update their forecasts every 7 days, on average, while others do it every 12 days (Marques, 2013).

3.6 Forecast updating

- Agents do not update their forecasts every period and even agents who update disagree in their predictions (Cordeiro et al., 2015);
- The probability of forecast updating (monthly IPCA) between two consecutive months is 50% on average (standard deviation of 7%) whereas the simulated value is 23% (Cordeiro et al., 2015);
- The probability of inflation forecast updating is 12% on a daily basis; whereas the monthly frequency suggests an updating probability of 48%, when based on the critical dates used to compute the Top5 ranking (Gaglianone et al., 2016).

3.7 Forecast errors and/or forecast accuracy

- Using financial data to extract inflation expectations (and estimate the inflation risk premium) performs better (i.e., lower forecast errors) about 12-month-ahead inflation compared to the expectations from the Focus survey (Val, Barbedo and Maia, 2010);
- Survey forecasts perform better than VAR forecasts (Carvalho and Minella, 2012);
- Common forecast errors prevail over idiosyncratic components across respondents (Carvalho and Minella, 2012);
- As in other countries, a clear pattern of auto-correlation of forecast errors is found for Brazil. A bias-adjusted forecast model (based on current and past median Focus survey forecasts) shows lower RMSE and MAE compared to the median Focus survey forecast or an AR(1) benchmark (Kohlscheen, 2012);
- Forecast errors are highly correlated between and within the groups of forecasters: commercial banks, investment banks, asset management firms and consultancies (Da Silva Filho, 2013);
- Asset management firms produce better 6-month ahead forecasts than all other groups, and 9-12-month ahead forecasts compared to investment banks; and there was no evidence that commercial and investment banks differ in their forecasting abilities from consultancies firms (Da Silva Filho, 2013);
- By comparing the IPCA forecasting performance, there is not a historical stability in the prevalence of the Top5 over all surveyed institutions: some periods the highest error comes from the aggregate group, while in other occasions, the whole group has better forecasts (Marques, 2013);
- Bias-corrected forecasts and forecast combination of consumers and market agents perform better than the consensus forecast (Gaglianone, Issler and Matos, 2016).

3.8 Forecast bias and/or rationality

- Negative and statistically significant forecast bias, indicating that inflation is, on average, above market expectations. As expected, its magnitude decreases as the forecast horizon diminishes (Guillén, 2008);
- The bias investigation supports a weak-form of rationality for the Brazilian survey-based inflation expectations (Araujo and Gaglianone, 2010);

- The null hypothesis of unbiased expectations is rejected at a 5% confidence level only for longer horizons (6 and 12 months), whereas for 1 and 3 months the results suggest no forecast bias (Araujo and Gaglianone, 2010);
- Unbiased expectations, in all forecast horizons, based on the sample 2004-2008 (Araujo and Gaglianone, 2010);
- Studies for Brazil point to the absence of systematic forecast biases, although the evidence suggests that available information could have been used more efficiently (Carvalho and Minella, 2012);
- Unbiasedness and the weak rationality hypotheses are not rejected for the inflation forecasts surveyed by the BCB when the forecast horizon is one month (Kohlscheen, 2012);
- Increases (decreases) in inflation are systematically associated with underestimations (overestimations) of inflation in the following month (full sample and Top5), suggesting that models in which past realizations of inflation have greater weight in the formation of average expectations are more accurate than rational expectations assumption (Kohlscheen, 2012);
- Negative bias of inflation forecasts, suggesting that inflation has been underpredicted in four groups of forecasters: commercial banks, investment banks, asset management firms and consultancies (Da Silva Filho, 2013);
- Brazilian consumers overestimate the 12-month-ahead inflation by 2.7 p.p. on average, whereas the Focus survey market agents underpredict it by -0.35 p.p. The overestimation of inflation by consumers is a data feature also observed abroad. For instance, 0.4 p.p. in the U.S.; 0.7 p.p. in Sweden; and 4.4 p.p. in the Euro area (Campelo Jr et al., 2014);
- Negative bias of the Focus consensus (average) forecast of monthly IPCA: forecasters on average underpredict inflation by -0.019 p.p., -0.032 p.p. and -0.071 p.p. for horizons of 1, 6 and 12 months, respectively (Gaglianone and Issler, 2014);
- Consumers systematically overestimate the 12-month-ahead inflation by 2.01 p.p. and market agents underestimate it, on average, by -0.68 p.p., on average. Forecast bias is higher for consumers with lower education level or lower income (Gaglianone, Issler and Matos, 2016);

- Rejection of rationality using the consensus forecasts for consumers, although between 22% and 40% of consumers pass rationality tests at the individual level (Gaglianone, Issler and Matos, 2016).

3.9 Credibility of the monetary policy

- The success of the BCB on achieving the target on a given year influences the inflation expectations at the beginning of the subsequent year (Sicsú, 2002);
- Lower credibility is related to increased disagreement among forecasters (Sicsú, 2002);
- The inflation-targeting framework has played a critical role in macroeconomic stabilization; and the inflation targets have worked as important coordinators of expectations (Minella et al., 2003);
- The BCB has reacted strongly to inflation expectations (Minella et al., 2003);
- Recursive estimates suggest that the backward-looking component of market expectations has been ceding ground to the inflation target: IT is gaining credibility. Nevertheless, credibility has not been perfect; oftentimes inflation expectations seem to have over-reacted to current developments, for instance, upward inflation surprises (Bevilaqua, Mesquita and Minella, 2008);
- Credibility indices based on reputation represent an alternative in the cases where the series of inflation expectation are not available. Credibility is a result of the state of expectation, while reputation is given by actual departures of inflation from the target (Mendonça and Souza, 2009);
- Empirical evidence confirms the hypothesis that higher credibility implies lower variations in the interest rate for controlling inflation (Mendonça and Souza, 2009);
- Agents perceive the BCB as following a Taylor rule consistent with inflation targeting, suggesting high credibility of the monetary authority (Carvalho and Minella, 2012);
- A new measure of central bank credibility using Markov Chains and the Focus survey-based inflation expectations data at a micro level provides an improvement *vis-à-vis* the existing ones (Guillén and Garcia, 2014);
- A credibility measure using a Kalman filter and breakeven inflation indicates that credibility declined in mid-2008 (during the U.S. subprime mortgage crisis), had

remained relatively stable from early 2009 to mid-2015, strong declined by the end of 2015 and had recovered from mid-2016 until mid-2017 (Val et al., 2017);

- The credibility measure based on the Focus survey of professional forecasters showed a more regular behavior, reflecting the degree of anchoring of the survey-based inflation expectations for the considered medium/long-term horizon (Val et al., 2017).

4. Conclusions

This paper presents a set of stylized facts about inflation expectations in Brazil, organized in distinct empirical aspects. Regarding the formation process of inflation expectations in Brazil, the empirical evidence based on survey data from professional forecasters suggests that expectations are persistent and the target indeed helped anchoring expectations. Besides, fiscal policy has also been key in shaping expectations, together with the exchange rate and commodity prices dynamics, economic activity and the evolution of monetary policy interest rate. In turn, consumers adjust their expectations essentially due to current inflation.

In respect to inattention, evidence suggests that survey participants do not update their forecasts every period and even agents who update disagree[6] in their predictions. The probability of forecast updating is 12% on a daily basis and 48% on a monthly frequency, which is consistent with sticky information and staggered updating of expectations (see Ball and Croushore, 1995; and Mankiw et al., 2003). Besides, Top5 forecasters update their forecasts more often and are influential to other forecasters, according to epidemiological investigations.

Concerning information, professional forecasters seem to attach more weight to public information than private information (because public information seems to be more precise than private information) and overweight private information in order to differentiate themselves from each other. Moreover, when the precision of new information augments, agents put more weight on the piece of information received, in

[6] According to Giordani and Soderlind (2003), disagreement is a key indicator of inflation uncertainty. Patton and Timmermann (2010) note that disagreement is persistent and moves counter-cyclically in the U.S., and dispersion among forecasters is highest at long horizons where private information is of limited value and lower at short forecast horizons. In Brazil, disagreement is persistent and depends on the country risk premium and on the inflation rate, in the case of consumers (or on the change in inflation, in the case of professional forecasters).

line with Morris and Shin's (2002) approach, which introduces strategic interaction in noisy information models.

Empirical evidence on rationality and unbiasedness forecasts are mixed and the results quite often depend on issues such as the forecast horizon or the sample investigated. On the one hand, some studies suggest that unbiasedness and the weak rationality hypotheses are not rejected for the inflation forecasts surveyed by the BCB. On the other hand, many papers report a negative and statistically significant forecast bias,[7] indicating that market professional forecasters, on average, underestimate inflation. In contrast, consumers usually overestimate inflation, and forecast bias is higher for consumers with lower education level or lower income. Regarding forecast accuracy, bias-corrected forecasts and forecast combination of consumers and professional forecasters, in general, perform better than the survey consensus forecasts, which, in turn, often dominate inflation forecasts from VAR or AR(1) benchmarks.

Finally, empirical evidence indicates that the inflation-targeting regime has played a critical role in macroeconomic stabilization in Brazil, and the inflation target has worked as important coordinator of expectations. Nevertheless, credibility has not been perfect; oftentimes inflation expectations seem to have over-reacted to current developments, for instance, upward inflation surprises. A measure based on financial data suggests that credibility declined in mid-2008, remained stable until mid-2015, deteriorated by the end of 2015 and recovered from mid-2016 until mid-2017. In turn, credibility based on the Focus survey of professional forecasters showed a more regular behavior, reflecting the degree of anchoring of the survey-based inflation expectations in Brazil for the medium/long-term forecast horizon. Moreover, lower credibility seems to be associated with increased disagreement among forecasters, whereas higher credibility seems to be associated with lower variations in the monetary policy interest rate.

Altogether, these empirical findings help characterizing the inflation expectations formation process in Brazil. They represent a valuable input to policymakers and academics interested in designing forward-looking policy rules and improving the ability of macroeconomic models to fit the Brazilian data.

[7] Recall that even full-information agents can make biased forecasts if these agents, for instance, have asymmetric loss functions over forecast errors (see Elliott, Komunjer, and Timmermann, 2008; and Capistrán and Timmermann, 2009). Other sources of forecast bias often presented in the literature are model misspecification, strategic incentives (Ottaviani and Sørensen, 2006), or information rigidities (Mankiw and Reis, 2002). In this sense, disagreement across agents, with different asymmetries in the loss function, can arise without resorting to information rigidities.

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Appendix

Table A1 – Selected papers and respective data/topics investigated

List of papers *(in chronological order)*	Survey-based inflation expectations *(Focus)*	Financial market-based inflation expectations *(breakeven)*	Consumer survey-based inflation expectations	Credibility of monetary policy (quantitative)	Modeling of inflation expectations	Forecast bias and/or rationality investigation	Disagreement among forecasters (quantitative)	Reaction function of Central Bank of Brazil	Estimation of aggregate supply curve	Degree of attention of individual forecasters	Role of information in expectation formation process	Epidemiology of the survey forecasts
Sicsú (2002)	x			x			x					
Minella, de Freitas, Goldfajn and Muinhos (2003)	x			x	x			x	x			
Cerisola and Gelos (2005)	x				x		x					
Bevilaqua, Mesquita and Minella (2008)	x				x							
Guillén (2008)	x			x	x	x	x				x	x
Mendonça and Souza (2009)	x			x								
Araujo and Gaglianone (2010)	x				x	x						
Val, Barbedo and Maia (2010)	x	x				x						
Carvalho and Minella (2012)	x			x	x		x	x				x
Kohlscheen (2012)	x					x						
Da Silva Filho (2013)	x					x						
Marques (2013)	x					x						
Campelo Jr, Bittencourt, Velho and Malgarini (2014)	x		x		x	x						x
Gaglianone and Issler (2014)	x					x						
Guillén and Garcia (2014)	x			x			x					
Cordeiro, Gaglianone and Issler (2015)	x				x		x			x		
Vicente and Graminho (2015)	x	x										
Areosa (2016)	x				x	x					x	
Correa and Picchetti (2016)	x				x						x	
Gaglianone, Giacomini, Issler and Skreta (2016)	x					x	x			x	x	
Gaglianone, Issler and Matos (2016)	x		x			x						
Araujo and Vicente (2017)	x	x										
Val, Gaglianone, Klotzle and Figueiredo (2017)	x	x		x								

Table A2 – Selected papers and main findings

List of papers ***(in chronological order)***	**Main Findings**
Sicsú (2002)	Sample: Jan/2000-Apr/2002. The author constructs two indexes: (1) monetary policy credibility (using deviation of inflation expectations from target); and (2) Pearson coefficient to measure disagreement among professional forecasters. Conclusions: (i) the success of Central Bank of Brazil on achieving the target on a given year influences the inflation expectations on the beginning of the subsequent year; and (ii) lower credibility is related to increased disagreement among forecasters.
Minella, de Freitas, Goldfajn and Muinhos (2003)	Sample: Apr/1994-Feb/2003. The inflation-targeting framework has played a critical role in macroeconomic stabilization. The estimations indicate: (i) the inflation targets have worked as an important coordinator of expectations; (ii) the Central Bank has reacted strongly to inflation expectations; (iii) there has been a reduction in the degree of inflation persistence; and (iv) the exchange rate pass-through for administered or monitored prices is two times higher than for market prices.
Cerisola and Gelos (2005)	Sample: Apr/2000-Sep/2004. Macro determinants of survey inflation expectations in Brazil. Results: inflation target has helped anchor expectations (with the dispersion of expectations declining considerably, particularly during periods of high uncertainty); the stance of fiscal policy has also been instrumental in shaping expectations. Past inflation appears not to be so important in determining expectations; and empirical evidence does not suggest the presence of substantial inertia in the inflation process.
Bevilaqua, Mesquita and Minella (2008)	Sample: Jan/2000-Aug/2006. Inflation expectations have been influenced by past inflation, the inflation targets, exchange rate and commodity prices, economic activity and the stance of monetary policy. Recursive estimates suggest that the backward-looking component of market expectations has been ceding ground to the inflation target (IT is gaining credibility). Nevertheless, credibility has not been perfect; oftentimes inflation expectations seem to have over-reacted to current developments (e.g., upward inflation surprises).
Guillén (2008)	Sample: Jan/2000-Dec/2007. Investigates a set of expectations theories (rational, adaptive and sticky-information) and finds evidences that the latter better explains the behavior of median inflation expectations in Brazil. A negative (and statistically significant) forecast bias is also reported, indicating that inflation is, on average, above market expectations. As expected, its magnitude decreases as long as the forecast horizon diminishes. Based on an epidemiologic approach, Top5 forecasts seems to influence the expectations of other forecasts.
Mendonça and Souza (2009)	Sample: Sep/1999-Oct/2007. Proposes three indices of credibility and investigates which measures are most useful in predicting variations of interest rates. The empirical findings suggest that the credibility indices based on reputation represent an alternative in the cases where the series of inflation expectation are not available (credibility is a result of the state of expectation, while reputation is given by actual departures of inflation from the target). Furthermore, the empirical evidence confirms the hypothesis that higher credibility implies lower variations in the interest rate for controlling inflation.
Araujo and Gaglianone (2010)	Sample: May/2002-Dec/2008. The bias investigation supports a weak form of rationality for the Brazilian survey-based inflation expectations. The null hypothesis (unbiased expectations) is rejected at a 5% confidence level only for longer horizons (6 and 12 months), whereas for 1 and 3 months the results suggest no forecast bias. Recent sample (2004-2008) indicates unbiased expectations in all horizons. Expectations of inflation 12-months-ahead are persistent, positively related to the inflation target, current inflation and exchange rates, and negative related to the Selic interest rate. The 3-months-ahead inflation expectations depend on current inflation and past FX rate volatility.

Table A2 (cont.) – Selected papers and main findings

List of papers ***(in chronological order)***	**Main Findings**
Val, Barbedo and Maia (2010)	Sample: Jan/2004-Jul/2008. The paper uses financial data to extract inflation expectations and estimate the inflation risk premium. The results from the Brazilian debt market for inflation-indexed bonds issued from 2006 to 2008 show that the proposed methods perform better (lower forecast errors) about inflation expectations 12-months-ahead compared to the expectations from the Focus survey. This result can be explained by the high liquidity of the inflation-indexed bonds and the fact that surveys of market professional forecasters contain risk premia greater than those from the respective inflation-indexed traded bonds.
Carvalho and Minella (2012)	Sample: Jan/2000-Jul/2008. Assesses the behavior of survey forecasts in Brazil, during the inflation-targeting regime, by investigating the epidemiology, determinants, and performance of forecasts using the Focus survey. Main results: (i) Top5 forecasters are influential to other forecasters; (ii) survey forecasts perform better than VAR forecasts; (iii) common forecast errors prevail over idiosyncratic components across respondents; (iv) inflation targets play an important role in inflation expectations; and (v) agents perceive the BCB as following a Taylor rule consistent with inflation targeting. The last two suggest high credibility of the monetary authority.
Kohlscheen (2012)	Sample: Jan/2002-Apr/2010. Unbiasedness and the weak rationality hypotheses are not rejected for the inflation forecasts surveyed by the BCB when the forecast horizon is one month. However, as in other countries, a clear pattern of auto-correlation of forecast errors is found. Furthermore, increases (decreases) in inflation are systematically associated with underestimations (overestimations) of inflation in the following month. This is true for both, the full sample and the Top5 forecasters, suggesting that models in which past realizations of inflation have greater weight in the formation of average expectations are more accurate than the assumption of rational expectations.
Da Silva Filho (2013)	Sample: Jan/2002-Jun/2012. The Focus survey is divided in 4 groups: Commercial Banks, Investment Banks, Asset Management Firms and Consultancies. Results indicate a negative bias of inflation forecast errors, suggesting that inflation has been under predicted in all groups. Forecast errors are also highly correlated between and within groups. The null hypothesis of equal forecasting accuracy is rejected: (i) Asset management firms produce better 6-month ahead forecasts than all other groups, and 9-12-month ahead forecasts compared to investment banks; and (ii) there was no evidence that commercial and investment banks differ in their forecasting abilities from consultancies firms.
Marques (2013)	Sample: Jan/2006-Jun/2012. A significant number of institutions has already been ranked as a Top5 best forecaster in Focus survey: 50% as short-term and 64% as medium-term. By comparing the IPCA forecasting performance, there is not a historical stability in the prevalence of the Top5 over all institutions: some periods the highest error comes from the aggregate group, while in other occasions, the whole group has better forecasts. The frequency of forecasts updating is higher among the Top5, during the 6 months before the ranking release: Top5 update their forecasts every 7 days, on average, while others do it every 12 days.
Campelo Jr, Bittencourt, Velho and Malgarini (2014)	Sample: Sep/2005-Dec/2013. Investigates how Brazilian consumers form their inflation expectations on the basis of the information stemming from the FGV/IBRE survey, allowing for individual heterogeneity in the light of the recent inattentiveness literature. Brazilian consumers adjust their expectations (in short and long run) only to current inflation, and overestimate the 12-month-ahead inflation by 2.7 p.p. on average (whereas the Focus survey market agents under predict it by 0.35 p.p.) The overestimation of inflation by consumers is a data feature also observed abroad (e.g., 0.4 p.p. in the U.S.; 0.7 p.p. in Sweden; and 4.4 p.p. in the Euro area).
Gaglianone and Issler (2014)	Sample: Jan/2006-Feb/2014. An econometric setup is proposed to investigate a panel of inflation forecasts (micro data from the Focus survey) and the possibility to improve their out-of-sample forecast performance by employing a bias-correction device. Data reveals a negative bias of the consensus (average) forecast of monthly IPCA: forecasters on average under predict inflation by -0.019 p.p., -0.032 p.p. and -0.071 p.p. for horizons of 1, 6 and 12 months, respectively. Based on the optimization problem of individual forecasters, a feasible GMM estimator is suggested to aggregate the information content of each individual forecast and optimally recover the conditional expectation of inflation.
Guillén and Garcia (2014)	Sample: Apr/2002-Apr/2007. Develops an index of the BCB's credibility using Markov Chains and the Focus survey-based inflation expectations data at a micro level (individual survey participants). The novelty is to consider the dispersion of inflation expectations, by assuming the hypothesis that long-term expectations' heterogeneity comes from different beliefs about central bank's aversion to inflation (such that the existence of persistently optimistic or pessimistic agents would reflect a credibility loss). By comparing the results with the literature, the authors show that the new measure of central bank credibility provides an improvement *vis-à-vis* the existing ones.

Table A2 (cont.) – Selected papers and main findings

List of papers ***(in chronological order)***	**Main Findings**
Cordeiro, Gaglianone and Issler (2015)	Sample: Jan/2002-Nov/2014. Investigates the expectations formation process using the Focus survey (individual data of inflation expectations) and a hybrid model featuring both sticky-information and noisy-information models. Data indicates that agents do not update their forecasts every period and that even agents who update disagree in their predictions. Using a Minimum Distance Estimation - MDE procedure, the model formally fits the data, but with a higher degree of information rigidity than observed. The probability of forecast updating (monthly IPCA) between two consecutive months is 50% on average (standard deviation of 0.07) whereas the simulated value is 23%.
Vicente and Graminho (2015)	Sample: Jan/2006-Sep/2013. The breakeven inflation rate (the difference between nominal and real rates) is decomposed in the following fundamental factors: inflation expectation, convexity term, and liquidity and inflation risk premia, such that breakeven inflation = inflation expectation + inflation risk premium – liquidity premium + convexity. Estimates show that the liquidity premium and convexity have very small values, less than 1 basis point for a 12-month horizon (less than the bid-ask spread of Brazilian fixed income bonds), and therefore can be ignored. These same estimates show a mean inflation risk premium of 0.20% with a standard deviation of 0.46%.
Areosa (2016)	Sample: Jan/2004-Dec/2014. Applies a noisy information model with strategic interactions à la Morris and Shin (2002) to a panel of forecasts from the Focus survey (micro data) to provide evidence of how professional forecasters weight private and public information when building inflation expectations in Brazil. Main results: (i) forecasters attach more weight to public information than private information because (ii) public information is more precise than private information. Nevertheless, (iii) forecasters overweight private information in order to (iv) differentiate themselves from each other (strategic substitutability).
Correa and Picchetti (2016)	Sample: Jan/2006-Sep/2013. Investigates how the disclosure of new information regarding the recent behavior of inflation affects inflation expectations, based on a panel of individual inflation forecasts (Focus survey) and the release of a daily signal about the inflation rate. New information leads individual forecasters to update their expectations immediately. However, the parameter is not very high, which is consistent with sticky information and staggered updating of expectations. When precision of new information increases, agents put more weight on the piece of information received, which is consistent with Morris and Shin's (2002) model.
Gaglianone, Giacomini, Issler and Skreta (2016)	Sample: Jan/2004-Jan/2015. Novel approach to inattention using the Focus survey-based inflation expectations data at a micro level. To understand the relative importance of information and other reasons to be attentive (such as the BCB Top5 contest) a theoretical model is constructed where agents optimally decide how to allocate attention (i.e., effort to revise forecasts in response to time-varying incentives). Structural estimation of the model allows to quantify the average effects of information and the contest on attention, and to perform counterfactual exercises to discuss optimal survey-design in order to improve the accuracy of forecasts.
Gaglianone, Issler and Matos (2016)	Sample: Jan/2006-May/2015. Compares inflation expectations of consumers (FGV Economic Tendency Survey) with market professional forecasters (Focus Survey). Consumers systematically overestimate the twelve-month-ahead inflation (by 2.01 p.p., on average), whereas market agents underestimate it (by 0.68 p.p.). These biases lead to rejection in rationality tests using the consensus forecasts for consumers, although from 22% to 40% of consumers pass rationality tests at the individual level. Bias-corrected forecasts and forecast combination of consumers and market agents perform better than the consensus forecast.
Araujo and Vicente (2017)	Sample: Nov/2014-Mar/2017. The objective of the paper is to propose a methodology to estimate (short run) financial market-based inflation expectations, which embodies inflation seasonality and tackles the issue of lagged inflation for market inflation-indexed bonds. An advantage of such approach using breakeven inflation is to provide a closer monitoring of inflation expectations, since it can be updated on a continuously intra-day basis. The results of an out-of-sample empirical exercise reveal that the proposed framework is able to generate inflation expectations with good predictive ability compared to the (Focus) survey-based inflation expectations.
Val, Gaglianone, Klotzle and Figueiredo (2017)	Sample: Jan/2006-Jul/2017. Estimates the credibility of the BCB's monetary policy using the Kalman filter in two measures of inflation expectations: survey of professional forecasters (Focus) and breakeven inflation derived from the yield curves of government bonds. The results indicate four shifts in credibility based on breakeven inflation: (i) decline in mid-2008 (U.S. subprime mortgage crisis); (ii) relative stability from early 2009 to mid-2015; (iii) strong decline by the end of 2015; and (iv) recovery from mid-2016 until mid-2017 (end of the sample). The credibility based on the Focus survey showed a more regular behavior, reflecting the degree of anchoring of the survey-based inflation expectations for the medium/long horizon.