Survey-based inflation expectations in Brazil[1]

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1. Introduction

Inflation expectations play a fundamental role in the inflation formation process. However, since these variables are in fact latent (and thus, they cannot be directly observed) some proxies are usually adopted by central banks, such as: (i) expectations obtained from financial market data,[4] and (ii) survey-based expectations.

In 1999, the Central Bank of Brazil implemented a daily survey as part of the transition to the inflation targeting system. It was created in order to monitor market expectations of roughly 90 Brazilian banks and non-financial companies, and to improve the inputs for the monetary policy decision-making process.[5]

Because of the importance of the subject to monetary policy, this paper aims to identify the main features of Brazilian survey-based inflation expectations collected by the Central Bank of Brazil, as well as to map the main driving forces behind the expectation formation process.

2. Data

Figure 1 depicts the Brazilian CPI headline inflation rate (IPCA), which is the inflation rate adopted in the inflation targeting system, together with the respective survey-based inflation expectations, for several forecast horizons.

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1 The opinions in this paper are those of the authors and do not necessarily reflect the point of view of the Central Bank of Brazil. Any remaining errors are ours.

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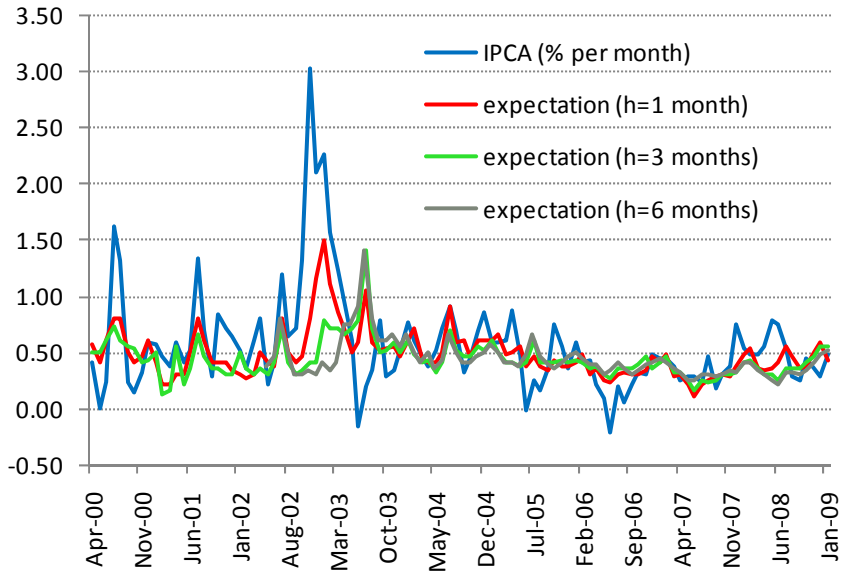
4 Inflation expectations extracted from Brazilian financial data might exhibit some problems due to the lack of market liquidity, and also with risk premium issues (eg how to separate expectations from risk premium, which depends on macroeconomic conditions).

5 Currently, it monitors market expectations for different inflation rates, GDP growth, industrial production growth, the exchange rate, the Selic interest rate, fiscal variables, and external sector variables.

Figure 1

CPI monthly inflation rate (IPCA)
and respective survey-based expectations



Note: The expectations represent the median values, across all consulted market institutions, according to the forecast horizon (h).

Table 1 gives some descriptive statistics of the short- and medium-run expectations, in comparison with the respective inflation rate. Similar statistics are presented in Table 2 for long-run expectations. First, note that the average and median values of expectations approach the inflation rate as long as the forecast horizon decreases, which is a natural result since the available information set becomes larger. In addition, the correlation between the inflation rate and the expectations increases, approaching the unit value.

Table 1

Descriptive statistics (time series in monthly values)

	IPCA (% p.m.)	Top 5 short h = 1 month	Median h = 1 month	Top 5 medium h = 3 months	Median h = 3 months	Top 5 medium h = 6 months	Median h = 6 months
Mean	0.559	0.509	0.483	0.449	0.439	0.434	0.438
Median	0.460	0.450	0.450	0.400	0.400	0.400	0.400
Maximum	3.020	1.880	1.490	1.720	1.400	1.300	1.400
Minimum	–0.210	0.100	0.100	0.150	0.160	0.200	0.210
Std. deviation	0.489	0.292	0.227	0.209	0.173	0.178	0.176
Correlation with IPCA	1.000	0.782	0.685	0.177	0.196	–0.083	–0.077

Note: The "Top 5" expectations represent the median values of the "Top 5" group (short or medium-run), whereas the so-called "median" expectations indicate the median of all consulted institutions for a given period. The sample period covers May 2002–December 2008 (80 observations).

Figure 2

CPI inflation rate – IPCA (% 12 months) and (median) inflation expectations

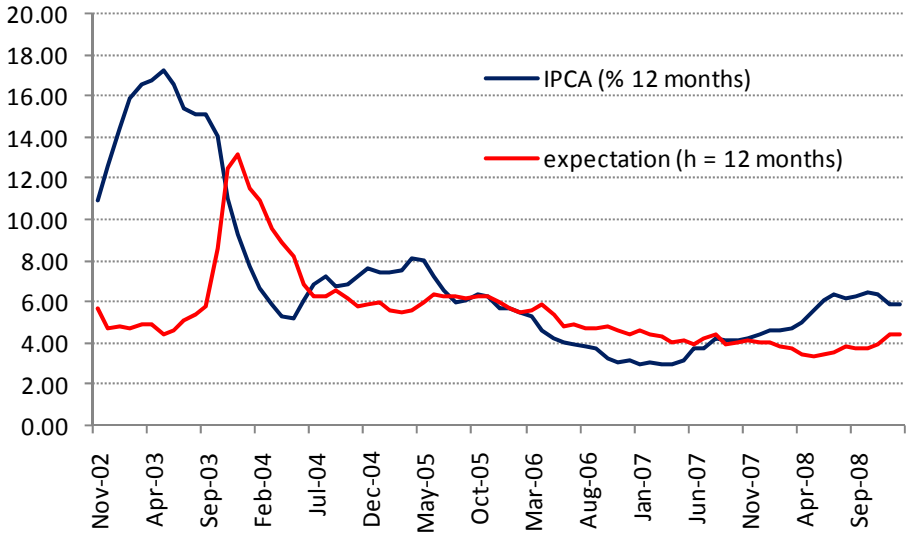


Table 2

Descriptive statistics

	IPCA (% 12 months)	Median (h = 12 months)
Mean	7.092	5.567
Median	6.060	4.920
Maximum	17.240	13.180
Minimum	2.960	3.370
Std. deviation	3.922	2.010
correlation with IPCA	1.000	0.172

Note: Sample period November 2002–December 2008.

3. Bias investigation

A relevant issue to be investigated regarding any inflation expectations series is the existence of bias. To do so, first consider the following regression:

$$\pi_t = c_1 + c_2 \pi^e_{t,t-h} + \varepsilon_t \,, \qquad (1)$$

where π_t represents the observed inflation rate, $\pi^e_{t,t-h}$ is the respective inflation expectations time series, formed with a forecast horizon of *h* periods (ie expectation of the inflation rate for period *t*, formed at period *t–h*), and ε_t is a random residual.

According to Grant and Thomas (1999), the existence of bias, or a "weak form of rationality",[6] can be verified through the following null hypothesis Ho: $(c_1;c_2)=(0;1)$[7] Tables 3 and 4 show the results of this "bias existence test" applied to the survey-based inflation expectations in Brazil.

Table 3

Bias existence test Ho: $(c_1;c_2)=(0;1)$

Sample period May 2002–December 2008	Top5short h = 1month	Median h = 1month	Top5medium h = 3months	Median h = 3months	Top5medium h = 6months	Median h = 6months	Median h = 12months
$\hat{c}_1$	–0.107	–0.153	0.373	0.316	0.658	0.652	5.224
Std. dev.	0.066	0.128	0.209	0.242	0.224	0.223	1.882
$\hat{c}_2$	1.309	1.474	0.413	0.553	–0.229	–0.213	0.335
Std. dev.	0.169	0.345	0.519	0.608	0.348	0.342	0.234
p-value	0.192	0.360	0.088	0.148	0.001	0.001	0.020

Note: The hypothesis test is based on Newey and West's (1987) HAC covariance matrix of residuals. For the median (h = 12 months) regression, the CPI inflation rate (% 12 months) is used as dependent variable, with a sample period November 2002–December 2008.

Table 4

Bias existence test Ho: $(c_1;c_2)=(0;1)$

Sample period January 2004–December 2008	Top5short h = 1month	Median h = 1month	Top5medium h = 3months	Median h = 3months	Top5medium h = 6months	Median h = 6months	Median h = 12months
$\hat{c}_1$	0.035	0.041	0.161	0.102	0.157	0.180	3.266
Std. dev.	0.086	0.088	0.117	0.150	0.173	0.195	0.914
$\hat{c}_2$	0.943	0.952	0.704	0.857	0.704	0.651	0.397
Std. dev.	0.156	0.167	0.249	0.349	0.392	0.476	0.146
p-value	0.915	0.770	0.361	0.484	0.548	0.470	0.000

Note: The hypothesis test is based on Newey and West's (1987) HAC covariance matrix of residuals. For the median (h = 12 months) regression, in which the CPI inflation rate (% 12 months) is again used as dependent variable, the bias test for a sample period January 2005–December 2008 generates a p-value = 0.563, in sharp contrast to the p-value = 0, obtained from the sample January 2004–December 2008.

Note from Table 3 that the null hypothesis is rejected at a 5% confidence level only for longer horizons (six and 12 months), whereas for one and three months the results suggest the non-existence of a forecast bias. In addition, results with recent samples (see Table 4) indicate that the survey-based expectations might be unbiased in all considered horizons.

[6] According to the authors, the "strong" form of rationality requires the forecast errors to be uncorrelated to any relevant available economic information.

[7] Obstfeld and Rogoff (1996, p 79) argue that rational expectation is a mathematical expectation conditional on the available information set. In other words, the rational expectations hypothesis does not require the forecasts to be strictly correct in all periods but, instead, requires the forecast errors to be unbiased and uncorrelated with any information in which the forecast is conditioned. See also Clements (2005, p 5) for further details.

Therefore, the previous results support a "weak form of rationality" for the Brazilian survey-based inflation expectations, partially reflecting the degree of sophistication of the models and frameworks used by the Brazilian market agents when forming their inflation expectations.[8]

Another feature of expectations usually discussed in the literature is whether forecast errors (e_t) are positively correlated to changes in the inflation rate. According to Henzel (2008), this feature would be compatible with the empirical evidence that agents often over-predict inflation during periods of a falling inflation rate, and vice versa. In order to verify this feature in the Brazilian data, consider the following regression:

$$e_t \cong \pi_t - \pi^e_{t,t-h} = \theta_1 + \theta_2 \Delta\pi_t + \in_t \qquad (2)$$

Table 5

Forecast error (e_t)

Sample period Jan 2004–Dec 2008	Top5short h = 1month	Median h = 1month	Top5medium h = 3months	Median h = 3months	Top5medium h = 6months	Median h = 6months	Median h = 12months
$\hat{\theta}_1$	0.013	0.023	0.048	0.048	0.042	0.045	0.143
Std. dev.	0.027	0.027	0.036	0.037	0.038	0.039	0.337
$\hat{\theta}_2$	**0.463**	**0.523**	**0.494**	**0.468**	**0.454**	**0.486**	**2.118**
Std. dev.	0.067	0.066	0.091	0.084	0.086	0.088	0.633

Note: The estimations are based on Newey and West's (1987) HAC covariance matrix. For the median (h = 12 months) regression, the CPI inflation rate (% 12 months) is used as regressor. In this case, the sample period January 2005–December 2008 produces $\hat{\theta}_2$ = 1.512.

Notice from Table 5 that $\hat{\theta}_2$ is statistically significant, positive, and (except for last column) also less than unit, reflecting a relatively low response of expectations to changes in the inflation rate, corroborating Henzel (2008). This empirical evidence might be linked to results from Tables 1 and 2, which indicate a lower sample standard deviation compared to the inflation rate series itself. Besides that, results from Table 5 are in line with some papers in the literature, such as Ball and Croushore (1995) and Mankiw et al (2003), in which agents seems to react slowly to new information during the formation of inflation expectations.

4. Some driving forces behind the expectation formation process

In this section, some driving factors behind the expectation formation process are presented, in order to reveal some additional features of the Brazilian inflation expectations. In Tables 6 and 7, some specifications of inflation expectations are shown, based on the following regressors: autoregressive term, inflation target (next 12 months), inflation rate (IPCA) and Selic short-term interest rate (both in percentage over 12 months), nominal exchange rate (Reais/USD), industrial production, Embi + Br and industrial capacity utilisation (UCI).[9]

[8] The formation of expectations of some US surveys is analysed by Mankiw et al (2003), in which the authors investigate the hypotheses of adaptive, rational or "sticky-information" expectations.

[9] All variables in log terms, excepting IPCA, Selic, target and expectation, which are used in log (1 + rate/100). None of the regressions has intercept, since inflation target is constant in the adopted sample period.

Table 6

Dependent variable: inflation expectations $\left(\pi^{e}_{t+12,t}\right)$

Regressors	I	II	III	IV
Expectation (t + 11,t–1)	**0.723**	**0.720**	**0.684**	**0.709**
	(0.000)	(0.000)	(0.000)	(0.000)
Inflation target (t + 12,t)	**0.207**	**0.210**	–0.005	–4.100
	(0.000)	(0.001)	(0.977)	(0.229)
IPCA (t)	**0.155**	**0.161**	**0.133**	**0.142**
	(0.000)	(0.000)	(0.004)	(0.002)
Selic (t)	**–0.071**	**–0.074**	**–0.068**	**–0.051**
	(0.000)	(0.000)	(0.000)	(0.045)
FX rate (t)	**0.007**	**0.007**	0.004	**0.008**
	(0.043)	(0.032)	(0.173)	(0.033)
Δ(ind. production (t))		0.014		
		(0.130)		
Embi + Br (t)			0.002	
			(0.211)	
Uci (t)				0.043
				(0.208)
R2	0.936	0.939	0.939	0.938
Adjusted R2	0.931	0.933	0.933	0.932
LM residuals autocorrelation Test (p-value,4 lags)	0.117	0.094	0.172	0.116

It can be seen from Table 6 that the autoregressive coefficient (around 0.70) indicates quite a significant persistence of inflation expectations. In addition, expectations are positively related to the inflation target, as well as to the current inflation and FX rates. On the other hand, results also suggest a negative coefficient for the Selic short-term interest rate, which reveals a significant reaction of long-term inflation expectations due to changes in monetary policy, also reflecting the credibility of monetary authority, according to market agents.[10]

Table 7 presents the behaviour of inflation expectations, in quarterly rates, with a three-month forecast horizon. First, a lower persistence is obtained in comparison to the previous results, probably due to the higher frequency of the inflation expectation rate. In addition, the coefficient for inflation is again positive, but the responses for the target and Selic seem to be not significant. Nonetheless, results of Table 7 also suggest that past FX rate volatility has a positive impact on short-/medium-term inflation expectations.

[10] Note that we have obtained a different response for the interest rate, in comparison with Minella et al (2003) or Cerisola and Gelos (2005), probably due to the sample period considered in this paper, which covers only the last five years of inflationary dynamics.

Table 7

Dependent variable: inflation expectations $\left(\pi^{e}_{t+3,t}\right)$

Regressors	I	II	III	IV
Expectation (t + 2,t–1)	**0.535**	**0.534**	**0.499**	**0.547**
	(0.000)	(0.000)	(0.000)	(0.000)
Inflation target (t + 12,t)	0.033	0.033	–0.059	–3.141
	(0.361)	(0.366)	(0.554)	(0.397)
IPCA (t)	**0.071**	**0.071**	0.058	0.053
	(0.015)	(0.016)	(0.093)	(0.133)
Selic (t)	0.001	0.001	–0.002	0.019
	(0.939)	(0.939)	(0.853)	(0.446)
FX rate volatility (t–2)	**0.166**	**0.165**	**0.132**	**0.223**
	(0.001)	(0.028)	(0.003)	(0.016)
Δ(ind. production (t))		0.000		
		(0.987)		
Embi + Br (t)			0.001	
			(0.317)	
Uci (t)				0.031
				(0.392)
R2	0.654	0.654	0.660	0.660
Adjusted R2	0.629	0.622	0.629	0.629
LM residuals autocorrelation Test (p-value,4 lags)	0.901	0.904	0.514	0.806

Note: All regressions are based on Newey and West's (1987) HAC covariance matrix. Sample period is January 2004–December 2008 (60 observations). P-values are shown in parentheses, and the 5% level significant coefficients are presented in bold. In Table 6, inflation expectations (median across all agents) are in percentage over 12 months, with a forecast horizon of h = 12 months. In Table 7, inflation expectations (median of *Top5* medium-term) are in quarterly percentage, with a forecast horizon of h=3 months. FX rate volatility refers to a 3-month moving average of the volatility of the monthly nominal exchange rate.

5. Conclusions

Nowadays, inflation expectations are frequently monitored by the vast majority of central banks, due to its importance on inflation forecasting setups. Departures from rational expectations represent a serious matter of concern to policymakers, since forecasting devices are usually based on a rational expectations hypothesis.

In this paper, we aim to provide a simple investigation of Brazilian survey-based inflation expectations, with respect to statistical properties and bias existence, as well as to identify some driving forces behind the expectation formation process. Empirical exercises indicate that expectations might be unbiased, and that different factors might help explaining short- and long-term inflation expectations in Brazil.

6. References

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