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SPECIAL REPORT – INFLATION

The Anatomy of Inflation Expectations in Brazil

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- Inflation expectations are an essential part of an inflation-targeting regime, such as the one in Brazil, not only for the monetary authority, but also for other market participants such as traders and portfolio managers in their decision-making process.
- In this report we study the properties of inflation expectations, seeking patterns that could improve the decision-making process of the central bank (BCB), traders and portfolio managers, and even economic forecasters who want their projections to be more accurate than consensus estimates.
- We use data from Bloomberg consensus forecasts for monthly IPCA since the 2000s to: (i) perform statistical/data analyses and test for the rational expectations hypothesis (basically normality, unbiasedness); (ii) calculate probabilities of upside/downside surprises; (iii) analyze whether the behavior changes under different circumstances: when inflation is accelerating and when inflation is decelerating (in annual terms), also calculating upside/downside surprises; and (iv) analyze whether there are seasonal-related errors, also calculating the month-specific probability of upside/downside errors.
- Our conclusion is that survey-based expectations show patterns that, once known, can help both the BCB and investors improve their decision-making process. Looking at the current situation, for example: given that we are in a phase of accelerating inflation (at least until mid-year, by our estimation), the probability of upside surprises is higher now, so that, even though inflation expectations are being revised upward, the consensus will likely be surprised to the upside during that period.

Introduction

Inflation expectations are an essential part of an inflation-targeting regime, such as the one in Brazil, not only for the monetary authority, but also for other market participants such as traders and portfolio managers, in their decision-making process. For the central bank, inflation expectations are a major determinant of current inflation, so, in order to keep inflation at the target, the monetary authority has to thoroughly understand and manage inflation expectations. For traders and portfolio managers, inflation expectations affect many markets, so analyzing inflation expectations is essential when trading or investing, particularly nominal interest rates and also break-even inflation itself (the difference between nominal and real interest rates).

In this report we study the properties of inflation expectations, seeking patterns that could improve the decision-making process of market participants. More specifically, we aim to address whether there are statistical properties embedded in the forecasting errors of survey-based expectations that could improve the analysis of inflation expectations. For example, consensus surveys tend to under/overestimate realized inflation. If there is such a bias, does it change depending on the current state of inflation (accelerating/decelerating)? What is the probability of under/overestimating inflation for the next inflation release? Do errors in a specific month tend to be always to one side? We believe answers to these questions are relevant for both the monetary authority and traders and portfolio managers.

In order to answer these types of questions, we use data from Bloomberg economists' consensus forecasts for monthly IPCA since the 2000s and do the following exercises: (i) perform statistical/data analyses and test for the rational expectations hypothesis (basically normality, unbiasedness); (ii) calculate probabilities of surprises to the upside (consensus surveys underestimating realized inflation) or downside (surveys overestimating realized inflation); (iii) analyze whether the behavior changes under different circumstances: when inflation is accelerating and when inflation is decelerating (in annual terms), also calculating upside/downside surprises; and (iv) analyze whether there are seasonal-related errors, also calculating the month-specific probability of upside/downside errors.

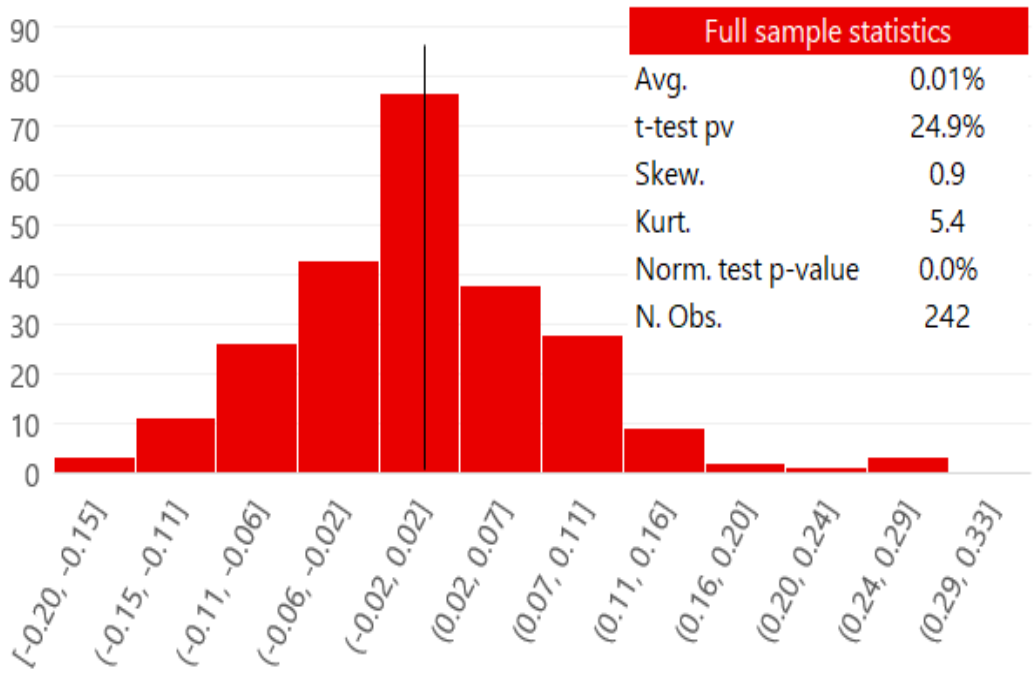
Full-Sample Data Analysis

The database used comes from Bloomberg economists' median expectations for monthly IPCA since the 2000s, totaling 242 observations. We then calculate the deviation from the consensus of the realized monthly IPCA to compute the survey-based consensus monthly forecasting error.

The rational expectations hypothesis (REH) in simple terms would predict that the market's forecasting errors would be normally distributed (no skew, no thick tails), with the average of errors being zero. We test those hypotheses to check the "statistical anatomy" of inflation expectations in Brazil.

Figure 1 shows the error distribution and some statistical properties. First, the average of the errors is +0.01%, which would be the first sign of non-rationality. However, the t-statistic test shows it is not significantly different from 0.00%. Second, the shape of the distribution is more skewed to the right (skew +0.9), and the kurtosis (a measure of thickness of the distribution's tails, that is, a measure of the quantity of extreme values in the distribution) is above 3.0 (indeed 5.4), meaning upside errors (economists underestimating inflation) are more usual than downside errors (economists overestimating inflation) and that extreme values in errors are more usual than in a normal distribution. Finally, normality tests confirm that we can reject the hypothesis of the series being normally distributed.

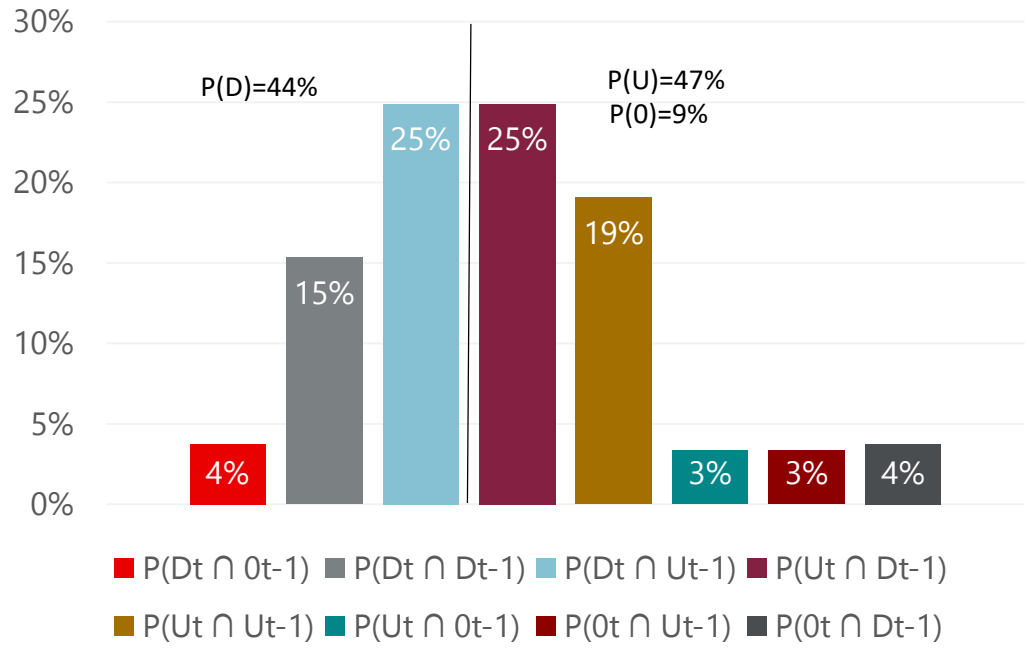
Figure 1. Distribution and Statistics of Survey-Based Forecasting Errors



Sources: Bloomberg, Santander.

Figure 2 shows the probabilities of surprises to the downside (economists overestimating inflation) and upside (economists underestimating inflation), considering the in-sample observations. The probability of downside surprises is 44%, the probability of upside surprises is 47%, and the probability of the economists being correct is 9%. We also calculate the probability of sequential same-sign surprises. For example, the probability of a downside surprise followed by another downside surprise (P(Dt∩Dt-1) is 15%, while the probability of two sequential upside surprises is 19%.

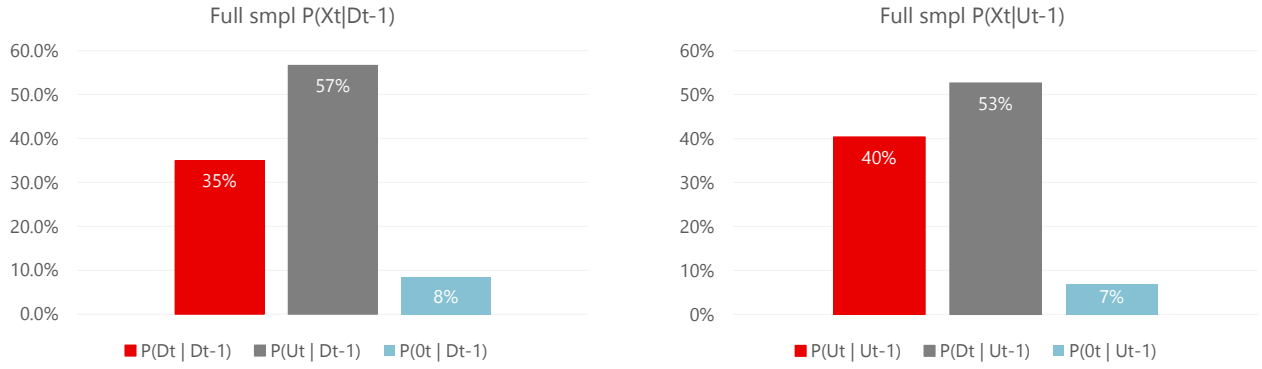
Figure 2. Probability of Surprises in Consensus Survey-Based Forecasts of Inflation



Sources: Bloomberg, Santander.

A better way to see this is to calculate the broad probability of a result given that the previous result was an upside or a downside surprise (Figure 3). In that case, the probability of a downside surprise, given a previous downside surprise (P(Dt|Dt-1), is 35%, while the probability of an upside surprise given a previous upside surprise (P(Ut|Ut-1) is 40%.

Figure 3. Probability of Surprises in Consensus Survey-Based Forecasts of Inflation Given a Previous Surprise



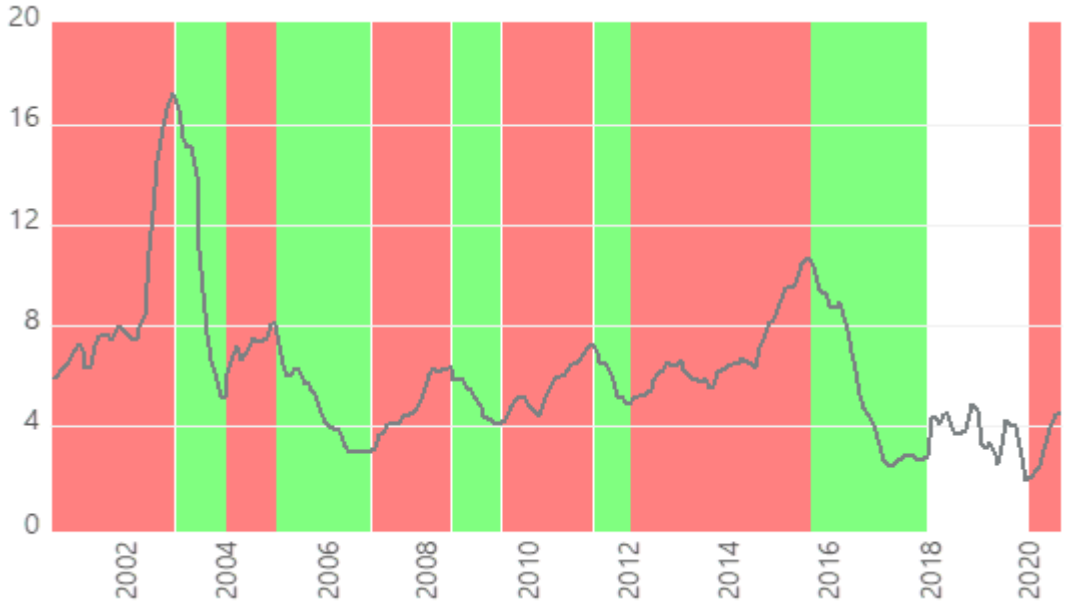
Sources: Bloomberg, Santander.

Therefore, from this first analysis we can conclude that it appears that forecasters do not follow the REH strictly and tend to be more surprised to the upside—that is, forecasters tend to underestimate inflation more than overestimate it (and with extreme values). However, we recognize that, although being interesting, the results are not notably helpful in practical terms for either the BCB or for investors' decision-making process. With that in mind, we go forward and test a different approach.

Data Analysis in Different Circumstances: Accelerating and Decelerating Inflation

Aiming to find more useful insights from the data, we question whether there could be different forecasting error patterns depending on the state of inflation. We separate subsamples of periods when inflation is accelerating (red shade) and decelerating (green shade) in year-over-year terms, as shown in Figure 4. The approach, then, is the same as in the full-sample section.

Figure 4. Periods of Accelerating and Decelerating Inflation in YoY Terms

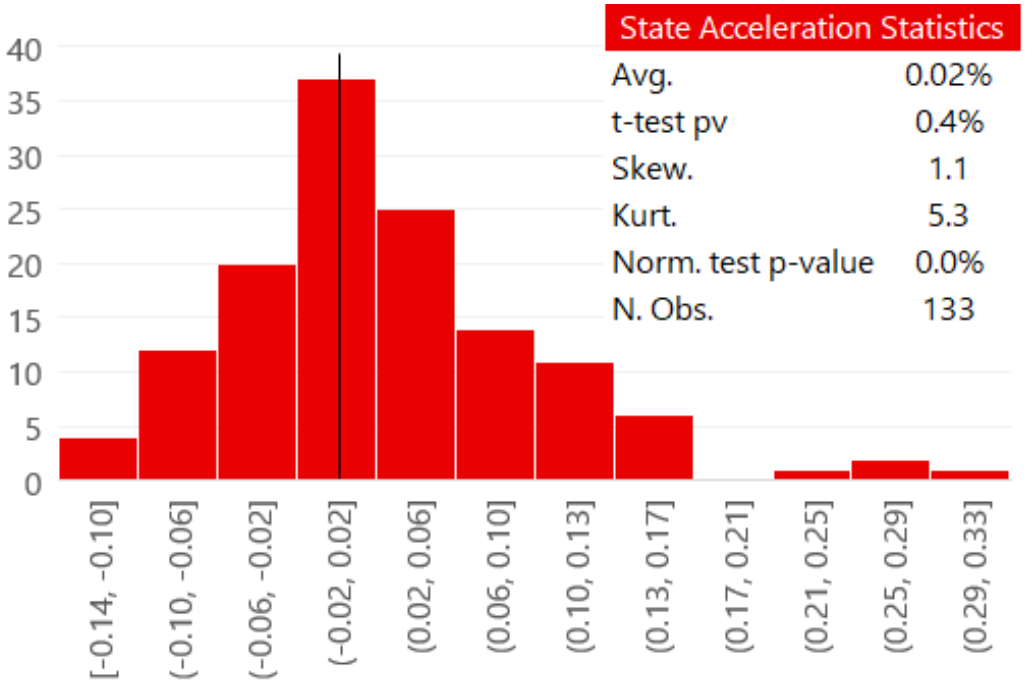


Sources: IBGE, Santander.

Figure 5 shows the distribution of consensus errors during periods of accelerating inflation. First, the average of errors is +0.02% (forecasters underestimating inflation), and, contrary to the full-sample analysis, this value is statistically significant. Second, the skew is positive, and kurtosis is above 3. As a result, forecasters tend to underestimate inflation more than overestimate it, and extreme values are more usual than in a normal distribution—indeed, analysis shows the normal distribution can be rejected for this series.

Therefore, we can conclude that there seems to be a state-related error bias, with economists tending to underestimate inflation in periods when it is accelerating, which suggests also that economic rationality is even weaker in that case.

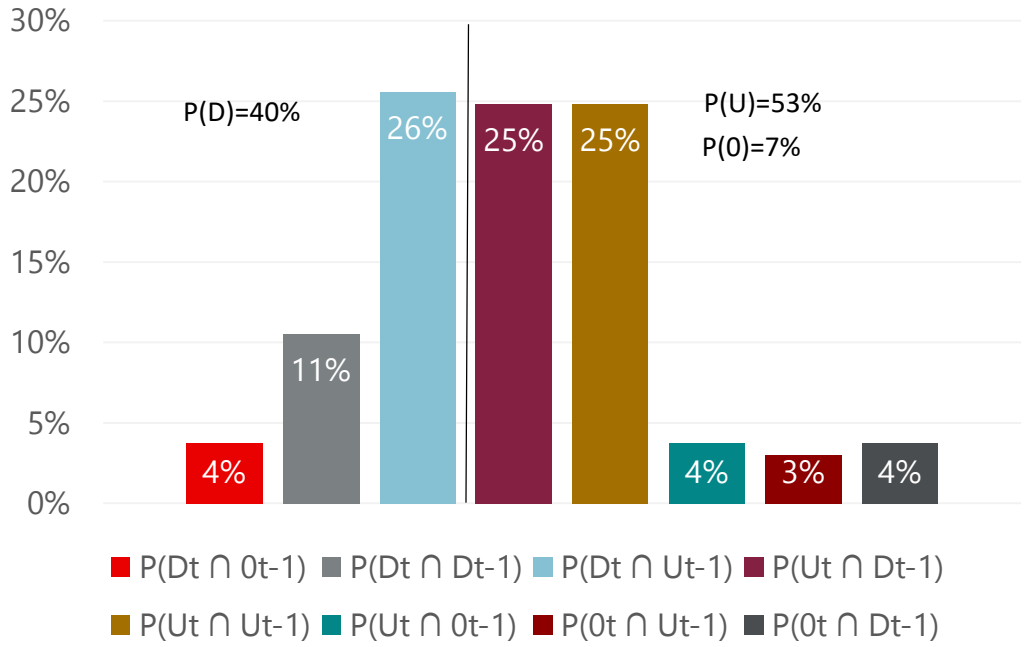
Figure 5. Distribution and Statistics of Economists' Forecasting Errors During Periods of Accelerating Inflation



Sources: Bloomberg, Santander

Moving to the calculation of the probability of errors (Figure 6), we find that upside surprises have a 53% probability of occurring during acceleration periods (vs. the 47% probability in the full sample) against only a 40% probability of downside surprises.

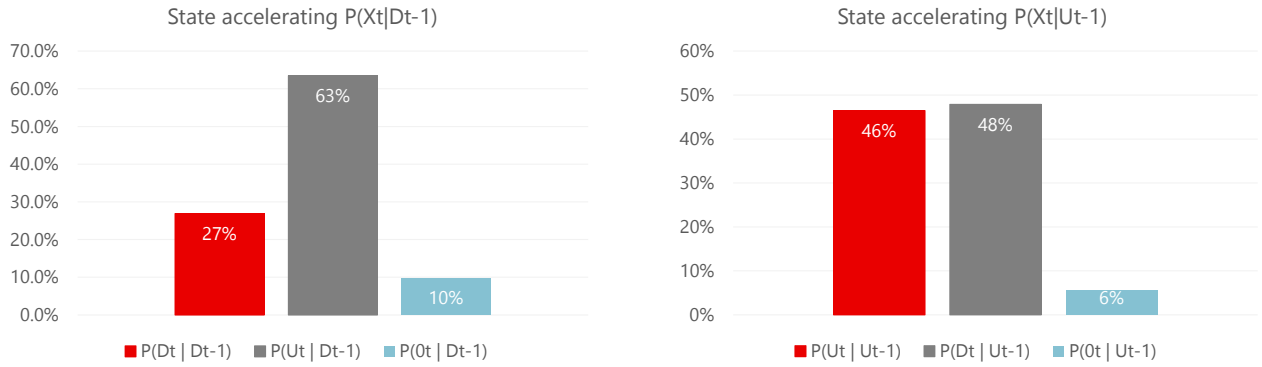
Figure 6. Probability of Surprises in Economists' Consensus Forecasts for Inflation During Periods of Accelerating Inflation



Sources: Bloomberg, Santander.

More interesting, in our view, the probability of a downside surprise given a previous downside surprise in periods of accelerating inflation (Figure 7) is just 27% (vs. 35% in the full sample), and the probability of upside surprises given a previous upside surprise is 46% (higher than the 40% in the full sample). Intuitively, rational behavior would require the probability of a downside surprise given an upside surprise to be higher than the probability of an upside surprise given an upside surprise, in order for the errors to be mean-reverting, but it seems there is a state-related error-memory or some autoregressivity in the error.

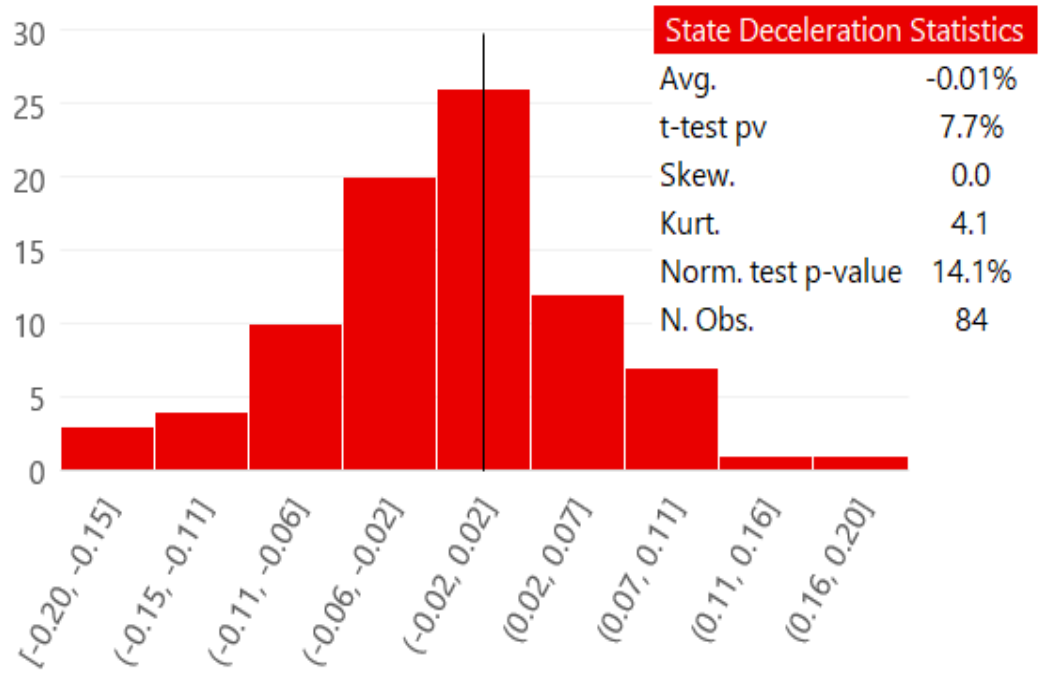
Figure 7. Probability of Surprises in Economists' Consensus Forecasts for Inflation Given a Previous Surprise in Periods of Accelerating Inflation



Sources: Bloomberg, Santander.

Moving on to periods of decelerating inflation, Figure 8 shows the distribution of errors and the statistics. The average error is -0.01%, with statistical significance at the 10% level. Although the kurtosis is above 3, suggesting more extreme values than in a normal distribution, the skew is zero, and we cannot reject that the distribution is normal. Therefore, market forecasters seem more rational (in economic terms) during periods of decelerating inflation.

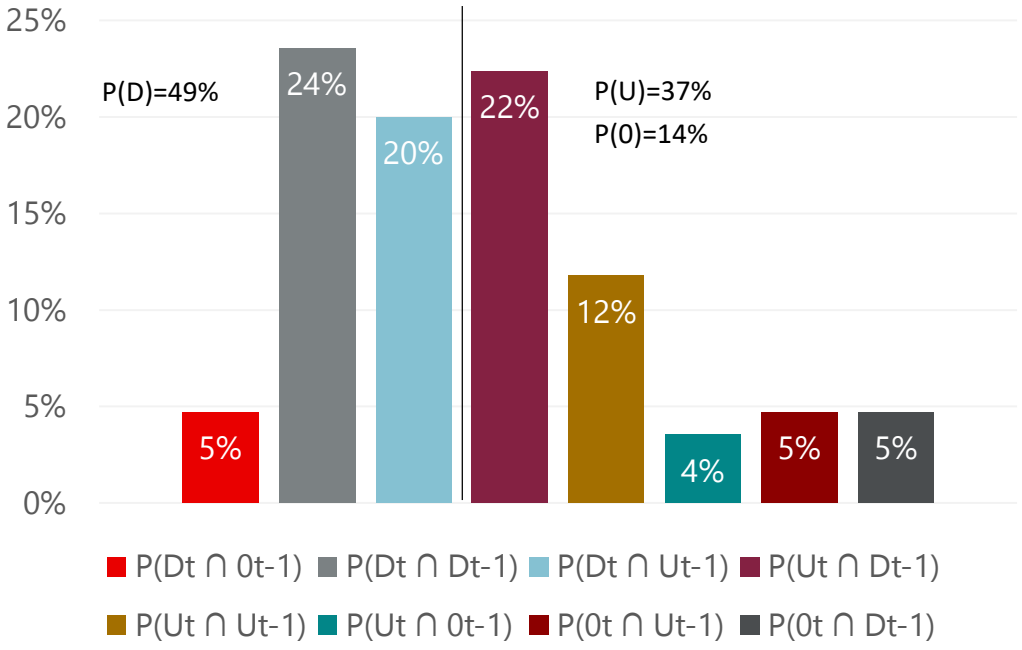
Figure 8. Distribution and Statistics of Economists' Forecasting Errors During Periods of Decelerating Inflation



Sources: Bloomberg, Santander.

Figure 9 shows the probabilities of surprises during periods of decelerating inflation. Downside errors have a 49% probability (vs. 40% during accelerating periods and 44% for the full sample), while upside errors have just a 37% probability (vs. 53% during accelerating periods and 47% for the full sample).

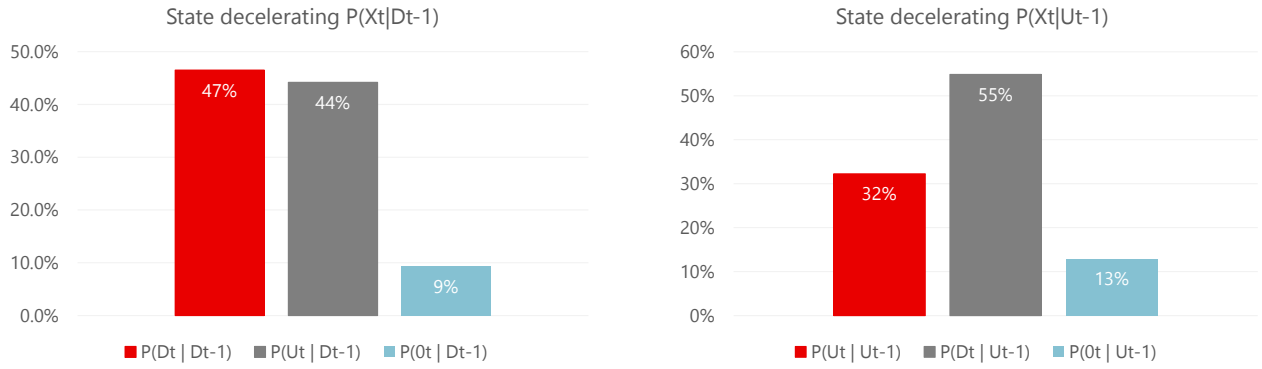
Figure 9. Probability of Surprises in Consensus Survey-Based Forecasts for Inflation During Periods of Decelerating Inflation



Sources: Bloomberg, Santander.

Again, there seems to be some state-related error bias, as the probability of downside surprises given a previous downside surprise is 47%, even higher than the probability of an upside surprise given a downside surprise. On the other hand, the probability of an upside surprise given an upside surprise is just 32%, against a 55% probability of a downside surprise given a previous upside surprise.

Figure 10. Probability of Surprises in Economists' Consensus Forecast for Inflation Given a Previous Surprise in Periods of Decelerating Inflation



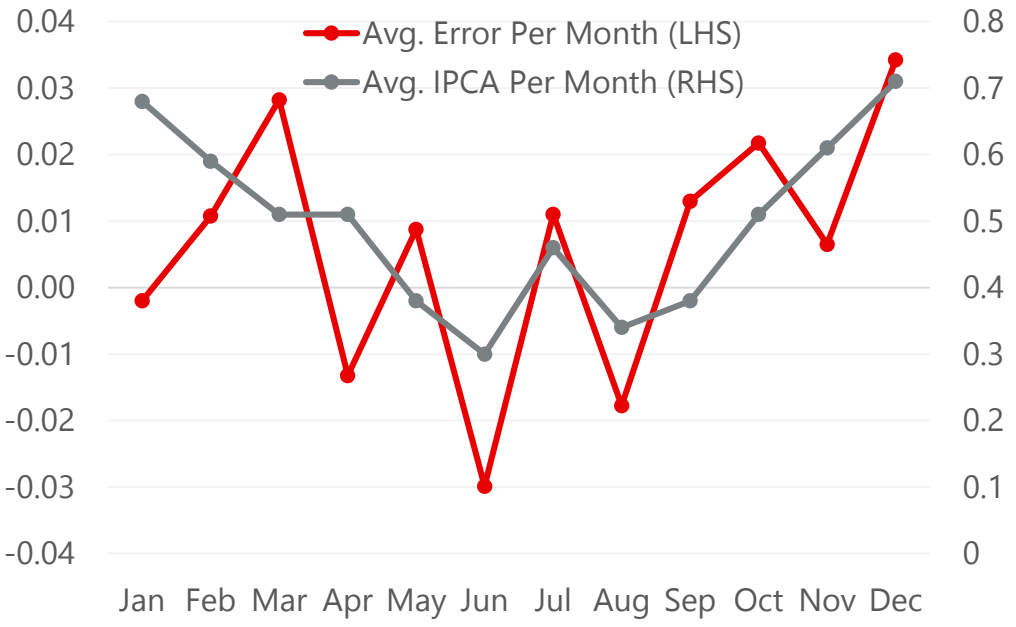
Sources: Bloomberg, Santander.

All in all, from the first and second sections of this report, we can conclude that: (i) the sign of the error seems to be associated with the state of inflation: upside (downside) errors are more common in accelerating (decelerating) periods of YoY inflation; and (ii) errors seem to have state-related memory: upside (downside) errors have a higher probability of occurring after upside (downside) errors, in accelerating (decelerating) states of inflation. An example of why this matters in practical terms is that, at the current juncture, during which inflation is accelerating (until at least mid-year, by our estimation), the probability of upside errors is 53%, vs. 37% in periods of decelerating inflation. Moreover, given that the central bank has to estimate a balance of risks for its monetary policy decisions, this finding should be included in its store of information, giving more weight to upside risks. In addition, investors should also take this into account when adjusting positions before an IPCA release.

Monthly Data Analysis: Seasonality of Errors

Moving forward, we next study whether we can also draw conclusions based on the seasonality of errors. In order to do that, we separate the errors by month, first plotting the errors with IPCA's seasonality itself (Figure 11) and then calculating the average error per month (Figure 12).

Figure 11. Market's Average Consensus Forecasting Errors by Month and IPCA Seasonality



Sources: IBGE, Bloomberg, and Santander

Figure 12. Economists' Average Consensus Forecasting Errors by Month and T-Statistic Tests

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avg. Error	0.00	0.01	0.03	-0.01	0.01	-0.03	0.01	-0.02	0.01	0.02	0.01	0.03
t-test p-value	0.90	0.51	0.23	0.26	0.64	0.02	0.36	0.12	0.38	0.36	0.76	0.08

Sources: IBGE, Bloomberg, and Santander

The similarity of errors per month and IPCA seasonality itself is considerable, although for most of the months the average error is not different from zero in statistical terms. The relevant months are June (-0.03% average error), August (-0.2% average error), and December (+0.03% average error).

Nonetheless, we find it useful to estimate the probability of upside/downside errors, and we encounter interesting results (Figure 13). For example, although the average error for April (-0.01%) is not significantly different from zero, there is a 60% probability of a downside surprise for that month (or 70% probability of no surprise + downside surprise). In general, the sign of the error yields a significant probability of surprise in that direction, especially if one sums up the probability of no surprise and the probability of surprise on the direction of the average error (which makes sense in terms of balance of risks).

Figure 13. Probability of Economists' Consensus Forecasts Being Surprised to the Upside, Downside or Not Being Surprised

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
P(U)	45%	50%	50%	30%	50%	30%	55%	30%	55%	60%	50%	65%
P(0)	10%	15%	10%	10%	10%	0%	5%	25%	10%	0%	5%	5%
P(D)	45%	35%	40%	60%	40%	70%	40%	45%	35%	40%	45%	30%

Sources: IBGE, Bloomberg, and Santander

An example of why this matters in practical terms: using these data, the BCB could assess whether the IPCA releases between the Copom's meetings have a higher/lower probability of surprising to the downside/upside, adding informational content to its estimate of balance of risks. For traders or portfolio managers, let's say they have a long position in the break-even in which they are confident for the medium/long term, but if they check the probability of surprise for the next IPCA release and see it has a high probability of being a downside surprise, then they might it find useful to downsize their position a bit or add some kind of hedge to protect against the possible short-term volatility.

Conclusion

In our view, the analysis of inflation expectations carried out in this report generates useful insights for the BCB on the conduct of monetary policy, for traders and portfolio managers in positioning themselves in the market, and even for economic forecasters when projecting inflation and aiming to achieve greater accuracy than the consensus forecast.

The first part of the analysis suggests that, in forecasting inflation, economists are not strictly rational (in economic terms), tending to underestimate inflation (though the average error is not significantly different from zero) and to commit more extreme errors than expected in a normal distribution. The second part of the analysis suggests that error signs seems to be associated with the state of inflation: upside (downside) errors are more common in accelerating (decelerating) periods of YoY inflation. During accelerating (decelerating) periods of inflation, the probability of upside (downside) surprises is higher. Moreover, errors seem to have state-related memory: upside (downside) errors have a higher probability of occurring after upside (downside) errors, in accelerating (decelerating) states of inflation. The last part of the analysis indicates there is a non-negligible relation between the seasonality of errors and the seasonality of IPCA itself and shows a clear pattern of errors in a few specific months.

Although not shown here (for reasons of space), the results are robust for different approaches. We tested Focus (BCB's survey) expectations as well as those of the Bloomberg survey, and we tested for a different segregation of accelerating/decelerating periods using the three-month moving average annualized and seasonally adjusted approach instead of the year-over-year approach, and the results were largely similar.

All in all, we believe the results are a useful tool for market participants to add to their store of information in order to assess the balance of risks for inflation in their decision-making process.

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