Box 1: Assessing the Forecasting Ability of Inflation Expectations in Colombia

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Introduction

Inflation expectations are a key factor in monetary policy decision-making. First, as crucial inputs for wage and price setting, they offer an estimation of the future direction of inflation. Second, they allow assessing the credibility of the inflation target set by the central bank (Sousa & Yetman, 2016)[2]. However, central banks do not have a single variable to measure such expectations; instead, they use a wide range of indicators whose selection depends on various characteristics, such as the source (e.g., surveys or market data), the type of agent (economic analysts, academics, market operators, etc.), the type of inflation considered (headline inflation or excluding food) and the time horizon (ranging from less than a month to more than ten years).

Banco de la República **has a wide range of measures of inflation expectations, and one of the main concerns associated with these measures lies in their forecasting ability.** In recent years, specifically in *2018*, *2019*, and *2021*, the Bank published studies addressing this question. However, almost four years have passed since the last documented analysis. This box aims to revisit this issue, using the most updated information available.

One of the main findings of this box is that expectations are not accurate predictors of future inflation, and their performance depends on the horizon and period assessed. Additionally, it is found that market-based expectations tend to perform better than survey-based expectations. However, these results should be carefully analyzed since large forecast errors do not imply that these expectations fail to reflect the agents' expectation formation process.

Methodology

The purpose of this box is to assess the forecasting ability of 12- and 24-month inflation expectations, both in terms of levels and direction. In other words, the analysis not only seeks to measure the accuracy of expectations in anticipating the exact future inflation but also to determine their ability to correctly forecast inflation trends (whether upward or downward). To this end, four different methodologies are used to compare expectation measures at levels (*Table B1. 1*) and two specific methodologies to assess their predictive ability regarding inflation direction (*Table B1. 2).*

[1] The opinions in this document do not reflect or represent the views of *Banco de la República* or its Board of Directors. Any errors or omissions are and will be the sole responsibility of the authors.

[2] Sousa, R. & Yetman, J, Inflation Expectations and Monetary Policy (2016). BIS Paper No. 89d, available at SSRN: *https://ssrn.com/abstract=2870936*

Table B1. 1. Tests to Measure Forecasting Ability in Levels

Test	Advantages	Disadvantages
Mean Difference	Simplicity	It does not adjust for serial correlation problems.
Diebold -Mariano	The literature considers it to be a simple test with wide applicability.	The test considers equal unconditional predictive ability and assumes that the error differential is stationary in covariance.
Giacomini-White	It focuses on the forecasting ability of the model used, considering the parameters and the underlying model's information set.	It depends on the model used to evaluate the model parameters and the information set. The variables used to calculate expectations are not known in advance.
Giacomini-Rossi	It evaluates forecasting ability with fixed rolling windows, capturing relative forecasting performance over time	A fixed data window is required.

Table B1. 2. Tests to Measure Forecasting Ability in Differences

Test	Advantages	Disadvantages
Pesaran-Timmerman	It is simple and widely used in finance and economics. Robust to errors in the forecast magnitude.	It is used to analyze dichotomous variables and does not consider the magnitude of changes
Fisher	It shows greater accuracy with small and easy-to-interpret samples.	Same disadvantages as the Pesaran-Timmerman test

The inflation expectations analyzed are obtained monthly, both from financial markets and surveys conducted by *Banco de la República*[3] (EME) and Fedesarrollo[4] (EOF). Specifically, from financial markets, we analyze the Breakeven-Inflation derived from the local government bonds

[3] The Monthly Expectations Survey (EME in Spanish) asks analysts belonging to banks, stock brokerage firms, corporations, pension funds, and universities, among others, about inflation expectations, MPR, and TRM., and occasionally about GDP.

[4] The Financial Opinion Survey (EOF in Spanish) is jointly conducted by Fedesarrollo and the BVC. In addition to analysts, the survey also asks portfolio managers more than 20 questions on a broader set of variables compared to the EME.

market, both in its original series[5] (BEI) and seasonally adjusted[6] (BEI SA), and by inflation risk and relative liquidity premiums[7] (adjusted BEI). The long-term trend extracted from the Hodrick-Prescott filter applied to the seasonality adjusted BEI series (HP BEI) is also analyzed. On the other hand, another measure of inflation expectations[8] is extracted from the swap market (SWAP BEI). These series are analyzed at 12 and 24 months (for this period, the previous measures are transformed into forward rates to make them comparable with the surveys). For further details on the estimation of these measures, see *Recuadro: Expectativas y señales de mercado provenientes de instrumentos financieros*, published in the *December 2020 version* of the document Determinantes de las Dinámicas de los Mercados de Capitales.

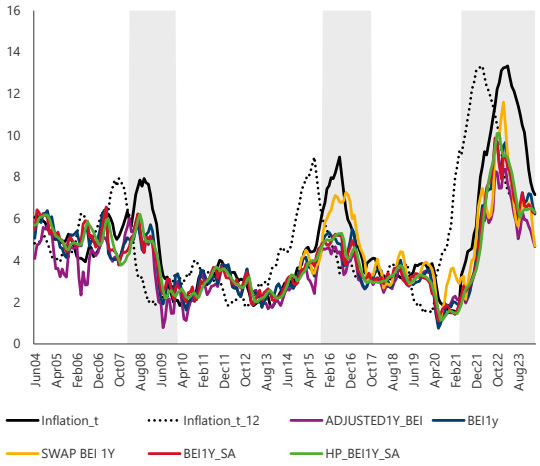
The analysis considered different time windows. The analysis takes a long sample (June 2004 to April 2023), for which only information from the BEI (both in its original and adjusted series) and the 12-month *Banrep* survey is available. For this reason, a comparable sample (October 2015 to April 2023) is also analyzed, which involves all the previously discussed measures. Additionally, a recent sample (April 2021 to April 2023) is analyzed to assess the recent evolution of these expectations over the last couple of years.

Additionally, a forecast combination exercise was conducted to assess whether this approach improves the predictive ability compared to individual series. Using data from October 2015 to April 2021 (training sample), 15 expectations series were generated using different forecast combination methods, including regression and eigenvector methodologies. During the test period (April 2021 to April 2023), the best performing combination[9] was selected according to the Mean-Absolute-Error (MAE). A simple average of expectations was also used as a reference.

The analysis periods were also divided according to periods of high inflation volatility. According to the Markov-Switching methodology, these periods correspond to: March 2008 to January 2010, November 2015 to October 2017, and May 2021 to April 2024. From these periods, the predictive ability of expectations formed during these periods was analyzed, as well as the predictive ability of expectations formed prior to the onset of these high-volatility periods. *Graph B1. 1. and Graph B1. 2* show the one-year inflation expectations analyzed, as well as the inflation observed twelve months later and the periods of high inflation volatility (shaded area).

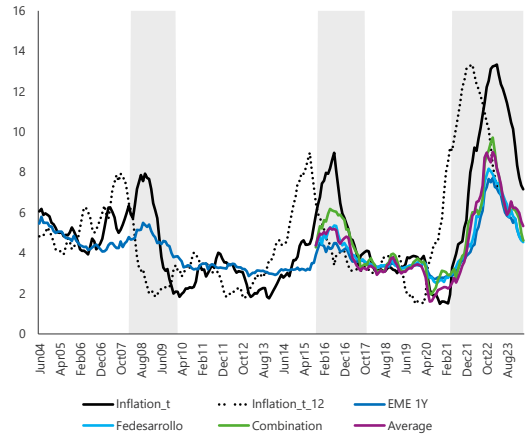
[5] It is calculated as the difference between the zero-coupon rates of the peso- and UVR-denominated TES.
[6] Given the seasonal performance typically observed in monthly inflation, UVR-denominated TES rates also tend to exhibit a seasonal performance, which directly impacts the BEI calculation. The seasonally adjusted BEI seeks to correct this pattern.
[7] Based on the methodology of Abrahams et al. (2015), "Decomposing real and nominal yield curves," and Espinosa et al. (2015), *"Expectativas de inflación, prima de riesgo inflacionario y prima de liquidez: una descomposición del break-even inflation para los bonos del gobierno colombiano,"* BEIs can be broken down into inflation expectations, inflation risk premium, and a relative liquidity component of peso-denominated TES versus UVR-denominated TES.
[8] From the rates of swaps linked to the IBR (OIS) and UVR/IBR variable rate swaps, it is possible to estimate a BEI (BEI swap) from the difference between both rates.
[9] After discarding some models that showed small forecast errors due to the use of negative weights, the combination resulting from a trimmed eigenvectors model was selected for the 12-month term. For the 24-month term, the bias-corrected eigenvector methodology was selected.

Graph B1. 1. 12-Month Inflation Expectations from the Market



Source: *Banrep*.

Graph B1. 2. 12-Month Inflation Expectations from Surveys



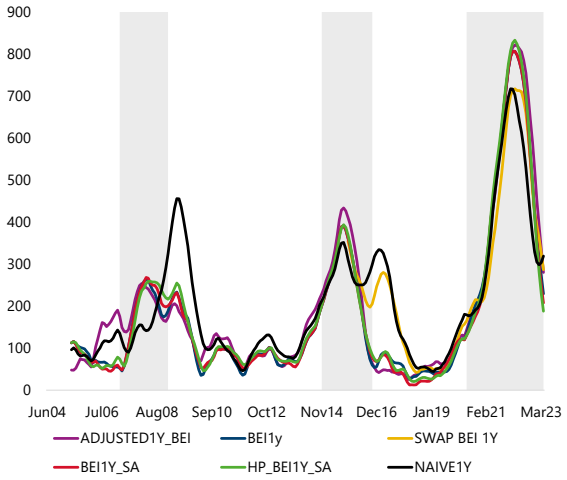
Source: *Banrep,* EOF.

Finally, periods with a high discrepancy between market and survey expectations were analyzed. First, those months during which the BEI (or the EME) varies by more than 10 bp, while the EME (or the BEI) varies in the opposite direction were analyzed. Another analysis involved those months during which half of the expectations indicated a change in a different direction than the other half (non-consensus period).

Assessment of Predictive Ability at Levels

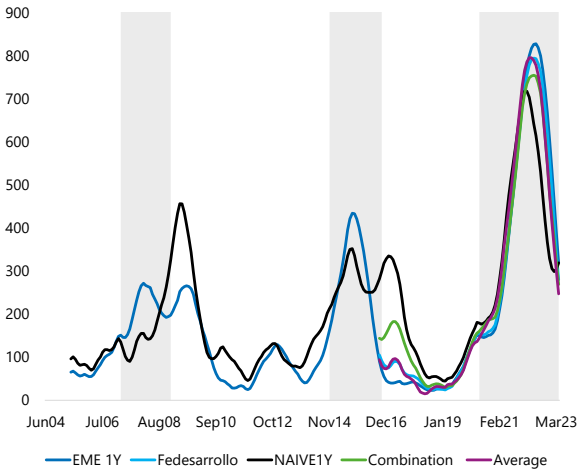
When analyzing forecast errors, no significant differences are observed between different measures of expectations, and given the large values of these errors, it could be said that these measures are not usually accurate predictors of future inflation. To answer how large the forecast errors are for each measure of inflation expectations, the mean absolute error is estimated using 12-month moving windows. It can be graphically observed that the size of the forecast errors of each measure depends on the prediction horizon and the period considered. Particularly, the largest forecast errors coincide with periods of high inflation volatility (*Graph B1. 3 and Graph B1. 4*). This pattern also holds for 24-month expectations. On the other hand, when assessing the magnitudes of these 12-month errors across the different windows (full sample, recent period, high volatility, etc.), it is also observed that the seasonally adjusted BEI tends to show the smallest forecast error in several scenarios and that in the recent period, the measures with the best forecasting ability are those of the market (*Table B1. 3*). At 24 months (*Table B1. 4*), it is observed that the seasonally adjusted measure also tends to show the smallest error in various scenarios, while the EME tends to show, on average, a larger error in the different scenarios.

Graph B1. 3. Mean Absolute Error of 12-Month Inflation Expectations from the Market



Source: *Banrep*.

Graph B1. 4. Mean Absolute Error of 12-month Inflation Expectations from Surveys



Source: *Banrep*, EOF.

Table B1. 3. Mean Absolute Error of 12-Month Inflation Expectations

12 months ahead

	Time Effect			High Discrepancy		Volatility Effect		No
	Long-Term	Comparable	Recent	Long-Term	Comparable	During	Before	Consensus
EME	181	230	571	251	243	276	343	239
Fedesarrollo		228	539		232			234
BEI	176	232	523	225	241	241	335	248
Adjusted BEI	189	240	557	249	242	248	347	254
SA BEI	175	226	512	211	212	239	335	241
HP SA BEI	178	230	517	208	203	246	339	238
Swap BEI		254	506		319			268
Naive	208	274	508	291	295	335	357	299
Combination			516					
Average			528					

Source: *Banrep*. **Note:** For the forecast combination exercise, a model is used that assigns a weight of 49.3% to the Swap BEI and 50.7% to the Fedesarrollo survey. The colors indicate relatively small (in blue) and relatively large (in red) forecast errors. SA means seasonally adjusted.

Table B1. 4. Mean Absolute Error of 24-Month Inflation Expectations

24 months ahead

	Time Effect			High Discrepancy		Volatility Effect		No
	Long-Term	Comparable	Recent	Long-Term	Comparable	During	Before	Consensus
EME		289	765		265			265
FBEI	224	283	728	271	270	208	385	270
Adjusted FBEI	222	290	760	268	262	192	413	262
SA FBEI	223	282	728	262	256	207	385	256
HP SA FBEI	225	286	737	263	258	212	389	258
Fswap BEI		290	723		265			265
Naive	270	339	743	368	378	343	406	378
Combination			695					
Average			695					

Source: *Banrep*. **Note:** For the forecast combination exercise, a model is used that assigns a weight of 16.3%, 16.9%, 16.7%, 16.9%, 17.0%, 16.07%, and 17.1% to the EME, FBEI, adjusted FBEI, seasonally adjusted FBEI, HP seasonally adjusted FBEI, and the Fswap BEI, respectively. The colors indicate relatively small (in blue) and relatively large (in red) forecast errors.

When performing the various statistical forecasting ability tests, it is confirmed that, despite the large forecast error during periods of high volatility, the seasonally adjusted BEI and FBEI often stand out as the measures with the best forecasting ability. To statistically compare the predictive ability of the different measures of inflation expectations, the various level tests described in Table B1.1 are conducted. From each of these tests, the measures are ranked according to their predictive ability, where the top position corresponds to the measure with the best forecasting ability (in case of a tie, both measures obtain the same ranking). Subsequently, the rankings obtained by each measure are averaged according to the

methodology used. For example, for the full sample (*Table B1. 5*), the seasonally adjusted BEI exhibits the best forecasting ability, followed by the BEI and the HP BEI (both tied). *Table B1. 6* summarizes the measure with the best forecasting ability for the 12- and 24-month terms, and for the different time windows, according to the previous methodology. Market-based measures are highlighted in blue, and survey-based measures in red.

Table B1. 5. Ranking of 12-Month Inflation Expectations (June 2004 to April 2023) According to their Forecasting Ability at Levels

	Means	D&M	G&W1	G&W2	G&R	TOTAL	RANKING
EME	5.00	3.00	5.00	5.00	2.00	4.00	5.00
Fedesarrollo							
BEI	2.00	5.50	**1.50**	3.00	4.50	3.30	2.00
Adjusted BEI	6.00	5.50	5.00	0.00	6.00	4.50	6.00
SA BEI	**1.00**	**1.00**	**1.50**	**1.00**	2.00	1.30	1.00
HP SA BEI	3.50	3.00	5.00	3.00	2.00	3.30	2.00
Swap BEI							
Naive	3.50	3.00	3.00	3.00	4.50	3.40	4.00

Source: *Banrep*.

Table B1. 6. Summary of the Expectation with the Best Forecasting Ability at Levels for Each Time Window

		12 months			24 months		
	Ranking->	1	2	3	1	2	3
Time Windows	Full	SA BEI	HP SA BEI	BEI	FSA BEI	FBEI	HP FSA BEI
	Comparable	Fedesarrollo	Swap BEI	SA BEI	FSA BEI	FBEI	HP FSA BEI
	Recent	Swap BEI	Combination	Average	Fswap BEI	Combination	FBEI
High Volatility	During	SA BEI	BEI	Naive	FSA BEI	HP FSA BEI	FBEI
	Before	SA BEI	Naive	BEI	FSA BEI	FBEI	HP FSA BEI
High Discrepancy	Full	SA BEI	EME	HP SA BEI	FSA BEI	FBEI	HP FSA BEI
	Comparable	Fedesarrollo	SA BEI	Swap BEI	Fswap BEI	EME	FSA BEI
No Consensus		Fedesarrollo	BEI	HP SA BEI	Fswap BEI	EME	FBEI

Source: *Banrep*.

Assessment of Predictive Ability in Differences

When assessing predictive ability in direction, surveys and the premium-adjusted FBEI perform better at 12 months, while the adjusted FBEI and the FSwap BEI perform better at 24 months. As in the previous section, this section summarizes the results of the directional forecasting ability tests (*Table B1. 7*). Three different scenarios are analyzed in these tests: *i*) the trend scenario, which assesses the direction of inflation over the forecast horizon; *ii*) the monthly scenario, which assesses the direction in which inflation varies between two consecutive months into the future; and *iii*) the deviation from the target, which assesses how far (in absolute value) inflation deviates from *Banrep*'s 3.0% target.

Table B1. 7. Summary of the Expectation with the Best Forecasting Ability in Direction for Each Time Window

		12 months			24 months		
	Ranking->	1	2	3	1	2	3
Comparable Sample	Trend	EME/Fedesarrollo	Average	SA BEI/comb.	Fswap BEI	EME	Average/comb
	Monthly Change	Adjusted BEI	SA BEI	Average	Adjusted FBEI	SA FBEI	FBEI
	Deviation from Target	EME	Fedesarrollo/comb.	Swap BEI	Average/comb	Adjusted FBEI	EME
High Volatility	Deviation from Target	HP SA BEI	Adj. BEI/SA	BEI	SA FBEI	FBEI/HP	Adjusted FBEI
	Monthly Change	Adjusted BEI	BEI	Swap BEI	Adjusted FBEI	HP SA FBEI	EME
	Deviation from Target	Adjusted BEI	BEI	EME	Adjusted FBEI	FBEI/SA	HP FSA BEI
High Discrepancy	Trend	Fedesarrollo	EME	BEI/SA BEI/HP	Fswap BEI	EME	Adjusted FBEI
	Monthly Change	Adjusted BEI	BEI/Swap BEI	ICEI	Adjusted FBEI	ICEI	FBEI/SA/HP
	Deviation from Target	EME	Fedesarrollo	BEI/adj/SA/swap	Adjusted FBEI	EME/FBEI	HP SA FBEI
No Consensus	Trend	Fedesarrollo	EME	BEI	Fswap BEI	Adjusted FBEI	EME
	Monthly Change	Fedesarrollo	Adjusted BEI	BEI	Adjusted FBEI	ICEI	FBEI
	Deviation from Target	Adjusted BEI	Fedesarrollo	BEI	Adjusted FBEI	EME	FBEI

Source: *Banrep*. Note: ICEI means Common Inflation Expectations Indicator in Spanish.

Conclusions

One of the main findings of this analysis, which is consistent with previous analyses, is that inflation expectations are not usually accurate predictors of future inflation, given the large values of forecast errors. No single measure consistently outperforms others in terms of predictive ability. However, this finding should be interpreted with caution since large forecast errors do not imply that these expectations fail to reflect the agents' view of future inflation performance. For example, in scenarios where inflation expectations are high, the Central Bank may intervene to mitigate significant inflation misalignments regarding the target, which in turn affects the forecasting ability of these expectations.

The analysis results exhibit that the predictive ability varies depending on the forecast horizon and changes over time. Additionally, forecast errors tend to increase during periods of high volatility, with no single measure consistently outperforming in these scenarios. Despite this, the seasonally adjusted BEI and FBEI stand out on several occasions as the measures with the best forecasting ability. Regarding forecast combination exercises, no significant improvement is observed in the MAE at the one-year horizon. However, at the two-year horizon, the improvement is comparable to that obtained by simply averaging the expectations.

Regarding forecasting ability in direction, premium-adjusted BEIs perform best when assessing monthly changes in inflation and inflation deviations from the target. Although all measures exhibit a good ability to forecast the direction of future inflation at 12- and 24-month horizons, this forecasting ability diminishes when analyzing expected monthly changes at these horizons or deviations from the inflation target.

In conclusion, the results highlight the importance of monitoring and analyzing all available measures of inflation expectations collectively. This approach allows for a better understanding of the expectation formation process by analysts and market participants.