Box 2

Analysis of Macroeconomic Expectations implicit in Financial Market Instruments

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This box analyzes the macroeconomic expectations underlying financial market information. This note complements the study presented in the *January 2021 Monetary Policy Report*[1], which was based on the responses of the *Monthly Survey of Economic Analysts' Expectations.*

As stated in the previous report, expectations of variables such as inflation and the policy interest rate are not observable and therefore their monitoring and analysis must be based on inferences made from observed variables. The exercises that permit such inferences are crucial to Central Banks because the aforementioned expectations provide signals about the present and future behavior of the agents, thus allowing to judge the current state of the economy as well as its prospects. They also provide a benchmark to contrast the Central Bank's forecasts, guide its communication strategy, and focus on its actions.

The expectations implied in the valuation of financial instruments have several desirable characteristics. For example, they are available daily for multiple horizons, including the long term (e.*g.*, five and ten years). However, these measures are an indirect estimate of expectations and therefore an approximation, whose actual signal could be affected by factors such as market liquidity.

Given the importance of expectations for economic analysis, *Banco de la República* monitors the expected policy interest rate and the inflation expectations underlying the prices of TES[2]. This Box analyzes these expectations and investigates whether there is a long-term empirical relationship between them.

The following is a characterization of these variables with historical information available from January 2006 to March 2021.

1. Inflation Expectations

Break-even inflation (BEI) rates are used as a proxy for inflation expectations implied in the valuation of financial instruments. These rates reflect the average inflation expected by market agents investing their resources in these securities.

Intuitively, the break-even inflation rate is defined as the difference between the yield of bonds at a nominal rate and bonds at a real rate (i.e., inflation-linked bonds), with the same maturity and credit quality. BEI rates are therefore actually an inflation compensation measure, which, in addition to expectations, includes an inflation risk premium and a liquidity risk premium associated with market conditions. However, Espinosa *et al.* (2015) note that, in the Colombian case, the latter is relatively small *vis-à-vis* expected inflation. (The calculation of the BEI rate is detailed in Annex B2.1A).

Banco de la República, in its macroeconomic assessment and forecasting exercise, also monitors forward BEI rates (FBEI). These enable the analysis of inflation expectations of the financial market once the short-term effects of transitory shocks have faded. For example, the 2-3-year BEI rate reflects the expected average inflation over a three-year period beginning after two years, removing inflation expectations for the first two years from the medium-term analysis. (The calculation of these rates is detailed in Annex B2.1B).

Panel A in Graph B2.1 illustrates BEI rates for one-, two-, five-, and ten-year horizons. These rates are constructed with information from the term structure of the rates of return of TES in Pesos and TES in UVR, which are bonds issued by the Colombian government.

Inflation expectations follow the level and dynamics of observed inflation, especially one and two years ahead. Their term structure increases with the time horizon, while their volatility decreases. However, this structure inverted between 2006 and 2008 and between 2016 and 2017. The first period was characterized by strong demand pressures, and the second one by supply shocks associated with *El Niño*.

In 2009, the inflation figure expected by the financial market fell structurally, in line with the reduction of observed inflation in Colombia since that year. Between 2006 and 2009, inflation expectations for the set of terms analyzed were around 4.8%, while for 2010-2019 this average fell to 3.5%. However, the differences between expected short- and long-term rates increased, being relatively wide in the periods following the global financial crisis periods between 2010 and 2011 and in the tapering period in 2013.

In the COVID period, inflation expectations fell to historical lows, and the terms spreads widened. Data as of

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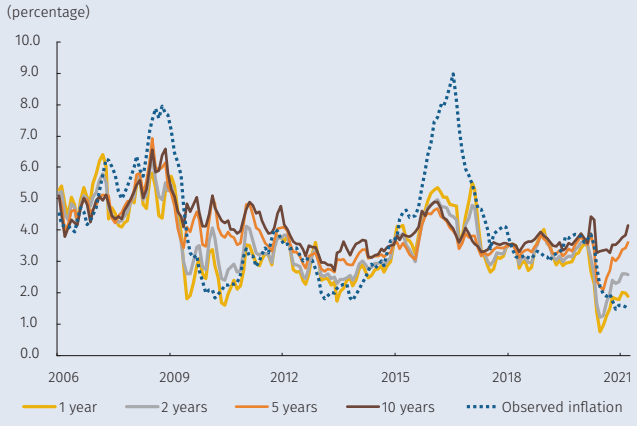
1 https://www.banrep.gov.co/es/informe-politica-monetaria-enero-2021-0

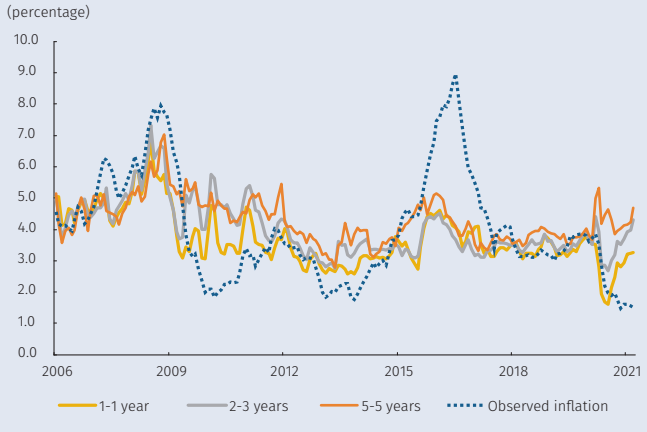
2 TES are debt instruments (e.g., bonds) issued by the Colombian government.

Graph B2.1
Annual Inflation Expectations
(January 2006 – March 2021)

A. BEI Rates



B. FBEI Rates



Source: *Banco de la República.*

March 2021 illustrate a rebound in expected inflation, and for the five- and ten-year horizons it is above its pre-pandemic level.

Panel B in Graph B2.1 shows the evolution of the 1-1, 2-3, and 5-5 years FBEI rates. The level of medium- and long-term expectations is higher after cleaning up the effects of temporary shocks in nearby horizons. During the pandemic, inflation expectations by the financial market in the short and medium term fell, but recent data suggest rapid increases of inflation in the longer horizons.

2. Expected Monetary Policy Rate

Banco de la República also extracts information from the policy response expected by the financial market implicit in the price of TES.

Following the theory of interest rate expectations, the expectation for the policy interest rate (EPR) at a given term is roughly the sum of the expected future path of policy rates one period ahead on the same time horizon. The EPR could also be estimated as the difference between the TES rate of return and the term premium. The latter is the compensation required by investors for assuming the risk of placing their resources on bonds at a specific maturity. The TES rate is observed on the market, while the premium is estimated following Espinosa *et al.* (2014). The derivation of the EPR is presented in Annex B2.2A.

As in the case of FBEI rates in the context of inflation expectations, it is possible to monitor the expected forward policy interest rate (FEPR) in order to study the policy response expected by the financial market in the medium and long terms, once the impact of temporary shocks to the economy has faded. For example, the FBEI 5–5-year rate is a proxy of the expected average policy rate over a five-year period beginning after five years. (The derivation of the FBEI is presented in Annex B2.2B).

Panel A of Graph B2.2 shows the term structure of the EPR rates for the same horizons and periods defined for BEI rates. The structure does not have a clearly defined slope. Its direction depended on the shocks that the economy faced in each period. For example, between 2006 and 2008, and between late 2015 and early 2017, the slope was negative, reflecting that the financial market expected a higher policy interest rate in the short-term than in the long-term. During the first period, there were strong demand pressures, and in the second period there were supply shocks on the various CPI groups, particularly food. Both periods were characterized by increasing inflation expectations as well as increases in the monetary policy rate.

As in the case of inflation expectations, the term structure of EPR registered a change in level in 2009, in line with the reduction in observed inflation. In the 2006-2009 period, the average EPR for the analyzed horizons was around 7.3%, while between 2010 and 2019 it oscillated around 4.4% and volatility was much lower.

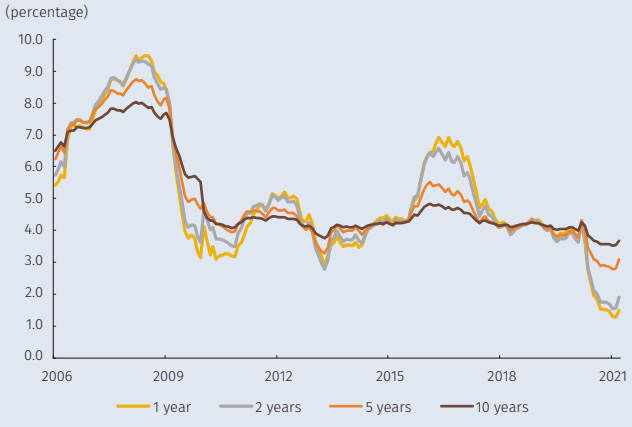
In the COVID period, the financial market's expectations of the policy interest rate for the various maturities fell rapidly due to the expected effects of the pandemic on economic activity and prices. Data as of March 2021 exhibit a change in the trend of expectations of this rate for the different horizons considered.

Panel B in Graph B2.2 shows the evolution of the 1-1, 2-3, and 5-5 years FEPR rates. These rates are used as a proxy for medium- and long-term expectations of the monetary policy reaction, once expected movements are withdrawn from the nearest horizon. The term structure of FEPR rates also illustrates the structural decline in policy interest rate expectations in 2009, and its slope depended on shocks to the economy over the period considered.

The 5-5-year FEPR rate reflects the long-term expectation of the financial market over the monetary policy rate. On average, this rate was around 4.4% between 2010 and 2019, and since the beginning of the pandemic it reduced to 4.2%.

Graph B2.2
Expected Monetary Policy Rate
(January 2006 a March 2021)

A. EPR Rate



B. FEPR Rate

Source: *Banco de la República.*

3. Relationship Between Expected Policy Interest Rates and Inflation Expectations

This section examines the long-term empirical relationship between the macroeconomic expectations underlying the valuation of TES by the financial market. To develop this analysis, a cointegration regression defined as follows is proposed:

$$i_t^{Pe,m} = \mu + \gamma \pi_t^{e,m} + \varepsilon_t, \qquad (1)$$

where $i_t^{Pe,m}$ and $\pi_t^{e,m}$ represent the expected policy interest rate and the annual inflation expectations for a horizon m[3]; ε_t corresponds to the error term; μ is a constant of the regression, and γ indicates the long-run balance relationship.

Table B2.1 presents the results of the cointegration analysis between the policy interest rate and inflation expectations defined in equation (1). Each panel presents the results of the Johansen test, which statistically evaluates whether there is a long-run relationship between two variables, and the estimated value of γ, which provides a quantification of that relationship. Table B2.1, panel A, estimates the relationship between the EPR and the BEI rate for two-, five- and ten-year maturities, while Panel B considers the FEPR and FBEI rates for 1-1, 2-3, and 5-5-year horizons. Both exercises use monthly data between January 2006 and March 2021.

The results of the Johansen test in panels A and B do not allow to reject the null hypothesis, pointing statistically at the existence of a systematic relationship between movements of the expected policy interest rate and inflation expectations for the different horizons and information sets considered.

In each of the exercises carried out, the estimated coefficient for γ is positive, greater than one, and statistically significant. These results suggest that when the financial market has higher inflation expectations, it also expects *Banco de la República* to raise the policy interest rate, and that this increase be higher than that of expected inflation. However, financial market agents also expect this policy reaction to be stronger in the short term than in the long term.

In conclusion, and similar to the information from the *Monthly Expectations Survey*[4] in the January 2021 *Monetary Policy Report*, the expected policy interest rates derived from financial market instruments show a positive and significant relationship to inflation expectations over different terms.

References:

Espinosa, J. A.; Melo, L. F.; Moreno, J. F. (2015). "Expectativas de inflación, prima de riesgo inflacionario y prima de liquidez: una descomposición del break-even inflation para los bonos del gobierno colombiano," *Borradores de Economía*, No. 903, *Banco de la República*.

Espinosa, J. A.; Melo, L. F.; Moreno, J. F. (2014). "Estimación de la prima por vencimiento de los TES en pesos del gobierno colombiano," *Borradores de Economía*, No. 854, *Banco de la República.*

3 For BEI and EPR rates, this is the *n* year term as per the definitions presented in Annexes B2.1A and B2.2A. In the case of the FBEI and FEPR rates, it corresponds to the a-b year term of the formulas in Annexes B2.1B and B2.2B.

4 www.banrep.gov.co/es/resultados-mensuales-expectativas-analistas-economicos

Table B2.1
Estimation of the long-run Relationship between Policy Interest Rate and Inflation Expectations

A. Cointegration analysis between EPR and BEI rates

Term	2 years	5 years	10 years
Johansen Test †			
No. of long-term relation			
0	0.00	0.00	0.01
1	0.36	0.29	0.13
Cointegration regression			
γ	1.896***	1.83***	1.645***
	(0.11)	(0.14)	(0.18)
μ	-0.018***	-0.02***	-0.017**
	(0.004)	(0.005)	(0.007)

B. Cointegration analysis between FEPR and FBEI rates

Term	1-1 year	2-3 years	5-5 years
Johansen Test †			
No. of long-term relation			
0	0.00	0.00	0.03
1	0.48	0.16	0.25
Cointegration regression			
γ	2.091***	1.467***	1.175***
	(0.13)	(0.17)	(0.22)
μ	-0.027***	-0.008	-0.001
	(0.005)	(0.007)	(0.009)

Note: *, **, *** Significant at 10%, 5.0% and 1.0%, respectively.
Values in parentheses correspond to standard deviations.
† The p-values of the Johansen Test are shown, whose null hypothesis contrasts the existence *of N* cointegration equations.
Source: *Banco de la República.*

Annex B2.1

This Annex provides the technical details of the calculation of the BEI and FBEI:

A. Break-Even Inflation Rate (BEI)

The BEI rate in time *t* to term *n* years is defined as:

$$\pi_t^{e,n} = \frac{(1+i_t^n)}{(1+r_t^n)} - 1$$

where i_t^n and r_t^n correspond to the yields of a bond with nominal fee (*e.g.*: TES in pesos) and a bonus with real rate (*e.g.*: TES in UVR), respectively. The bonds have the same term to n years, and the same credit quality. The BEI rate $\pi_t^{e,n}$ reflects the expected average inflation over the next n years.

B. Forward Break-Even Inflation (FBEI)

The FBEI rate $\pi_t^{e,a-b}$ in time t to term $a-b$ years represents the average inflation expectation over a period of b years starting after a years. The FEIB rate $\pi_t^{e,a-b}$ is given by:

$$\pi_t^{e,a-b} = \left[\frac{(1+\pi_t^{e,n})^n}{(1+\pi_t^{e,a})^a}\right]^{\frac{1}{b}} - 1$$

where $\pi_t^{e,a}$ and $\pi_t^{e,n}$ correspond to the BEI rates for periods a and n years, where $n = a + b$.

Annex B2.2

This Annex provides the technical details of the calculation of the EPR and FEPR:

A. Expected Monetary Policy Rate (EPR)

Under the theory of interest rate expectations, the market interest rate of a bond i_t^n to term n in time t is estimated as:

$$i_t^n = \mathbb{E}_t \sum_{i=0}^{n-1} i_{t+i}^{P^e} + \tau_t^n \quad (1)$$

where $\mathbb{E}_t \sum_{i=0}^{n-1} i_{t+i}$ is the sum of the expected future path of policy rates one period ahead i_t^P on the same time horizon, and τ_t^n is the term premium.[e]

The EPR $i_{t\ e,n}^{P}$ in time t to term n years is defined as:

$$i_t^{P^{e,n}} = \mathbb{E}_t \sum_{i=0}^{n-1} i_{t+i}^{P^e} \quad (2)$$

When substituting equation (2) in (1), the EPR $i_t^{pe,n}$ can also be written as:

$$i_t^{P^{e,n}} = i_t^{n} - \tau_t^n$$

The EPR rate $i_t^{P^{e,n}}$ reflects the expected policy interest rate over the next *n* years.

B. Forward Monetary Policy Rate (FEPR)

The FEPR $i_t^{Pe,a-b}$ in time t to term $a-b$ years represents the expected MPR over a period of b years starting after *a* years. The FEPR is given by:

$$i_t^{P^{e,a-b}} = \left[\frac{(1 + i_t^{P^{e,n}})^n}{(1 + i_t^{P^{e,a}})^a}\right]^{\frac{1}{b}} - 1$$

where $i_t^{P^{e,a}}$ y $i_t^{P^{e,n}}$ are the EPR rates to terms a and n years, where $n = a + b$.