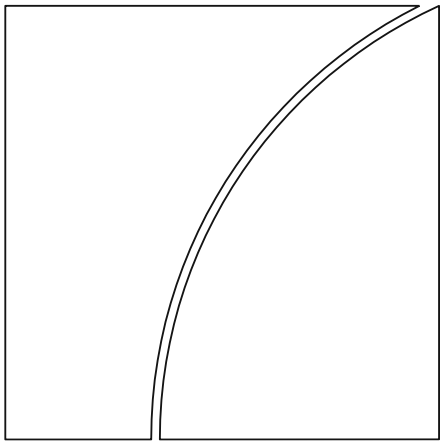

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The Measure Matters: Differences in the Passthrough of Inflation Expectations in Colombia

by Andres Sanchez-Jabba and Erick Villabon-Hinestroza

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JEL classification: C26, D84, E12, E31

Keywords: Inflation expectations, inflation dynamics, New-Keynesian Phillips Curve, Generalized Method of Moments

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The Measure Matters: Differences in the Passthrough of Inflation Expectations in Colombia[♠]

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Abstract

This study examines the effect of different measures of inflation expectations on inflation dynamics in Colombia from 2009 to 2024. We estimate New Keynesian Phillips Curves (NKPC) and Structural VAR (SVAR) models using data from economic surveys and sovereign bond yields. Our results show that survey-based expectations have a greater passthrough to inflation, with a one percentage-point increase leading to a 0.8 percentage-point rise in inflation, compared to a 0.67 percentage-point rise from market-based expectations. These differences are attributed to how economic agents form expectations, influenced by asymmetric losses, forecasting costs, and information rigidities. Our findings provide crucial insights for monetary authorities, who increasingly rely on various measures of inflation expectations for policy analysis. Understanding the distinct effects of these measures helps central banks implement policies that avoid unintended consequences, such as unnecessary contractions in economic activity.

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Keywords: Inflation expectations, inflation dynamics, New-Keynesian Phillips Curve, Generalized Method of Moments.

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1. Introduction

Measuring the passthrough of inflation expectations is fundamental for monetary policy, as changes in this variable constitute an essential driver of inflation dynamics (Mankiw, Reis & Wolfers, 2003; Coibion & Gorodnichenko, 2015). A review of 19 empirical studies reporting a total of 121 estimates for inflation expectations from the period 1946-2016, found a statistically significant effect for this variable in 119 cases. Clearly, expectations matter for inflation and should be closely monitored by central banks (Bernanke, 2007).

Recently, a growing number of measures of expectations using data from economic surveys and financial assets support policy analysis among monetary authorities (Sousa & Yetman, 2016). Survey-based expectations are typically obtained from polls applied to consumers and professional forecasters. Market-based expectations are calculated as the difference between the yields of nominal and inflation-indexed bonds with equivalent maturities terms. The increasing availability of measures is reflected in the variation of estimates related to the passthrough of this variable, with studies reporting effects that range from 0.1 to 1.3.

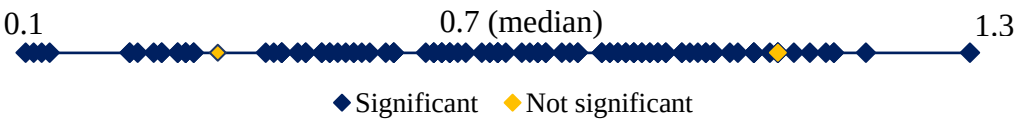


Figure 1. Estimates for the Passthrough of Inflation Expectations (1946-2016)

We reviewed 19 empirical studies containing a total of 121 estimates for inflation expectations, which vary according to the estimation method, country sample, and empirical specification. The statistical significance of estimates is determined by setting a 95% confidence level for each study.

This variation poses significant challenges for central banks. When considering the various measures for policy analysis, practitioners should ponder the potentially heterogeneous passthrough of expectations to avoid unintended policy effects. Excessive policy shocks based on measures with a greater passthrough might create unnecessary contractions in economic activity or generate financial risks. Conversely, modest policy responses when using measures that exhibit a smaller passthrough might prove insufficient in containing episodes of elevated inflation.

In this study, we show that survey-based expectations exhibit a greater passthrough compared to financial market expectations. Specifically, when using survey data, we find that a one percentage-point (pp) increment in expectations leads to an expected increase in inflation of 0.8 pp. This effect diminishes to 0.67 pp when we employ financial market data. We estimate New Keynesian Phillips Curves (NKPC) and Structural VAR (SVAR) models measuring inflation expectations with information obtained from economic surveys and sovereign bonds yields.

The latter plausibly reflects underlying differences in the formation of expectations among economic agents, which we relate to asymmetric losses, forecasting costs, and information rigidities. We argue that financial analysts overshoot their expectations to hedge against losses from underpredicting inflation, and that survey respondents use less sophisticated forecasting methods, thus explaining variations in the passthrough of inflation expectations.

Our study focuses on Colombia, where monetary policy has operated under an inflation-targeting regime with a flexible exchange rate since 1999 (Gómez et al., 2023). During our study period, expectations remained anchored around the Central Bank of Colombia's (CBoC) long-term target, facilitating the study of inflation dynamics. By focusing on an emerging market economy with a long history of inflation targeting, this study adds a unique perspective to the empirical evidence predominantly centered on advanced economies.

Besides contributing to the empirical literature on inflation dynamics, our paper offers valuable insights for practitioners. By recognizing the distinctive passthrough of various measures of inflation expectations, central banks can implement policy responses that avoid unintended effects, thereby enhancing the effectiveness of monetary policy.

2. Data

The measures of inflation expectations used in our study consist of one-year-ahead forecasts, thus reflecting short-run inflation expectations. The first measure is the Breakeven Inflation (BEI) rate, calculated as the difference between the yields of nominal and inflation-indexed securities with equivalent maturity terms. The BEI indicates the expected inflation rate at which an investor is indifferent between purchasing nominal and inflation-protected securities. One of the main advantages of using the BEI consists

of the incentive among financial analysts to provide an accurate forecast for inflation to avoid negative real returns on the purchase of financial securities. However, the BEI plausibly reflects premia related to other factors affecting yield curves, such as inflationary and liquidity risks. To overcome limitations associated with separating market inflation expectations from said factors, our estimations employ a BEI measure for Colombia proposed by Espinosa-Torres et al. (2017) which removes inflationary and liquidity risk premia.

The second measure comes from the Quarterly Survey of Economic Expectations (QSEE) conducted by the CBoC, where firm managers from the retail, industrial, and transportation sectors provide forecasts for macroeconomic variables of interest[1]. By directly reflecting expectations held by agents involved in the determination of prices, survey-based measures reduce the need for indirect measurements and capture changes in the drivers of inflation not observable to policymakers or professional forecasters (Bernanke, 2007; Adam & Padula, 2011; Henzel & Wollmershäuser, 2008). However, relying on forecasts from a diverse group of agents leads to biases caused by shocks affecting specific economic sectors, hindering the effectiveness of survey-based measures in reflecting aggregate changes in inflation expectations (Clements, 2019; Pesaran & Weale, 2006). To overcome this limitation, we aggregate forecasts across the economic sectors polled in the QSEE.

Our measure of inflation corresponds to the annualized variation in core inflation (Core 15), which excludes the 15% most volatile items from the CPI each period using the root mean-squared-error (RMSE) as the criterion (González et al., 2020). This measure provides a better signal of inflationary pressures driven by fundamental factors, improves forecast accuracy by minimizing volatility caused by goods and services with uncertain dynamics (e.g., food and energy prices), and limits biases arising from possible correlations between expectations and shocks (e.g., climate or commodity price shocks) affecting headline inflation (Vargas-Herrera et al., 2009; Vargas-Herrera, 2016). Furthermore, the Core 15 captures 88% of the variation in headline inflation in Colombia during our study period, thus reflecting a significant proportion of the variation in total CPI.

[1] Between 2009 and 2018, the QSEE was answered by an average of 170 firm managers each quarter. The distribution of respondents from each economic sector was the following: 43% industry; 12% retail; and 15% transportation.

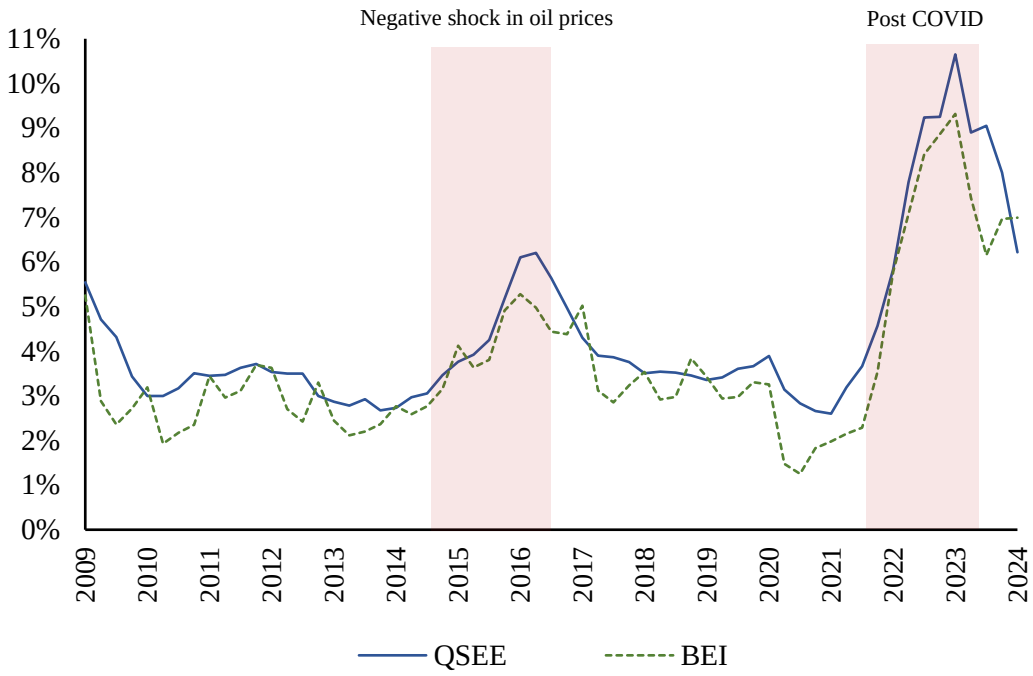


Figure 2. Inflation Expectations in Colombia (2009-2024)

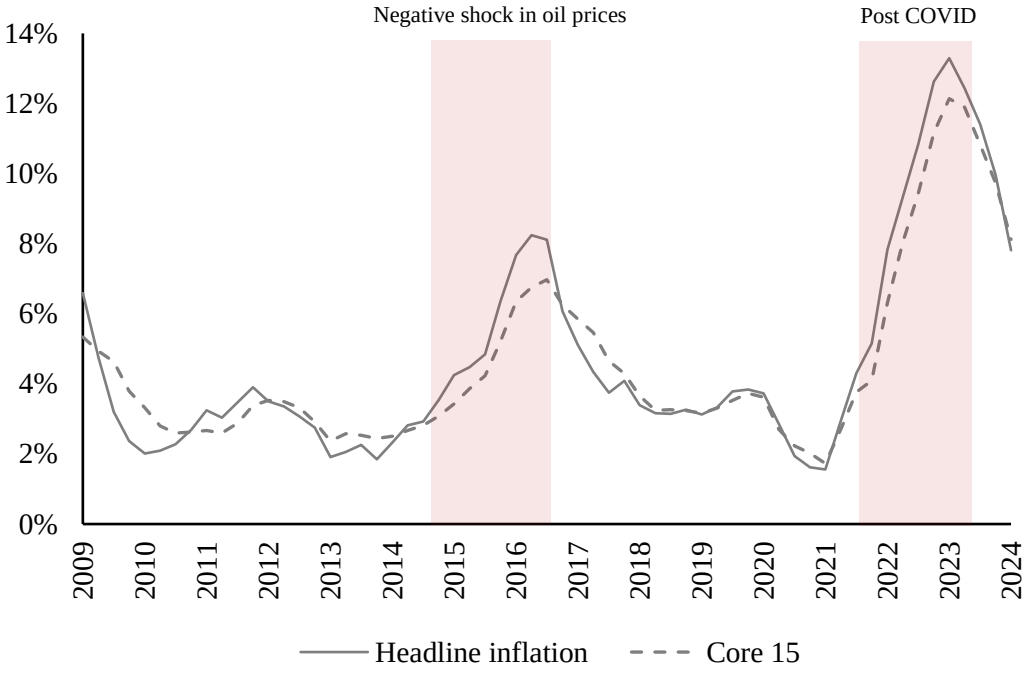


Figure 3. Headline and Core Inflation in Colombia (2009-2024)

3. Empirical Strategy

3.1. Empirical Specification: New-Keynesian Phillips Curve (NKPC)

We examine the passthrough of expectations using the hybrid NKPC proposed by Galí and Gertler (1999), which represents a prominent theoretical framework in macroeconomics for understanding short-run inflation dynamics. This structural model states that inflation in each period depends on past inflation, expected future inflation, and an indicative measure of economic slack (e.g., output gap, real marginal costs, or unemployment gap)[2]. The structural equation for the NKPC is expressed as follows:

$$\pi_t = \gamma_b \pi_{t-1} + \gamma_f E_t \pi_{t+1} + \lambda x_t + \epsilon_t$$

where π_t is inflation in period *t*; x_t reflects economic slack; $E_t\{\pi_{t+1}\}$ represents inflation expectations for the following period, and ε_t is an error-term.

Several empirical studies have found that the NKPC is a reasonable representation of inflation dynamics in the U.S. (Sbordone, 1998; Gali & Gertler, 1999; Lindé, 2005). Estimates for various countries yield statistically significant coefficients for expectations and past inflation, with median effects of 0.67 and 0.45 pp, respectively[3]. Economic slack mostly lacks statistical significance and exerts a negligible effect on inflation. Studies estimating the NKPC for Colombia report statistically significant estimates for inflation expectations ranging from 0.46 to 0.95 (Gómez et al., 2002; Bejarano, 2005; Galvis, 2010; Cháves, 2011)[4].

3.2. Estimation procedure: Generalized Method of Moments (GMM)

We perform our estimations for the period 2009-2024 using the GMM with quarterly data. This estimation procedure mitigates endogeneity that potentially arises from measurement error or reverse causality by including instruments that are highly correlated with inflation expectations but lack correlation with the error term. Measurement error could arise because inflation expectations are not directly observable (Pesaran & Weale,

[2] Our measures of economic slack reflect inflationary pressures in the economy caused by excess demand for goods and services and cost-push factors that result in price markups.
[3] These values correspond to the average of estimates reported by empirical studies that estimate the NKPC.
[4] Appendix A1 shows a review of empirical studies that have estimated the NKPC between 1949 and 2016, providing a range for the expected coefficients of the NKPC components.

2006). Reverse causality arises when shocks affecting inflation cause changes in expectations. Our choice of instruments includes 2-5 lags of inflation and inflation expectations. In total, we estimated 24 equations for the NKPC, which vary according to the measure of inflation expectations, economic slack, and the number of lags on the instrumental variables.

The rationale for choosing these instruments lies on the elevated degree of inflation persistence in Colombia, coupled with the anchoring of expectations during our study period, such that past values of inflation constitute a good predictor of inflation expectations (Vargas *et al*., 2009; Echavarría *et al*., 2011; González-Molano *et al*. 2011; López *et al*., 2016). By instrumenting expectations using past values for this variable, we mitigate differences caused by the revision of expectations among economic agents, particularly financial market analysts[5].

Variable	Measure	Calculation
Inflation	Annualized variation in core CPI	Core CPI excluding the 15% most volatile prices each period.
Market-based expectations	Breakeven Inflation (BEI)	BEI: difference between the price of fixed nominal rate government bonds and inflation-indexed government bonds of equivalent maturities.
Survey-based expectations	Inflation expectations in the QSEE	One-year-ahead forecast for inflation among respondents of a quarterly economic survey.
Output gap	CBoC estimation for the output gap	Difference between real GDP and its estimated potential level
Real marginal costs	Labor share of income	Ratio of real total wages to real GDP, multiplied by the marginal product of labor.
Unemployment gap	CBoC estimation for the unemployment gap	Difference between the unemployment rate and the NAIRU

Table 1. Variables Description

3.3. Instrument Validity, Explanatory Power, and Forecasting Accuracy

We conducted several checks to ensure that any differences in the passthrough of expectations are not related to the validity or relevance of instruments, differences in

[5] Financial market expectations are generally available at a higher frequency, increasing their responsiveness to macroeconomic developments (Sousa & Yetman, 2016).

explanatory capacity of estimations, or variations in the forecast precision. Our first check consisted of Hansen's Over-Identification (OI) test, which tests for correlation between regressors and the error term[6]. Second, we compare the goodness-of-fit by considering the median r-squared and median RMSE of our estimations. Lastly, we perform the Fisher (FT) and Pesaran-Timmerman (PT) tests to examine the forecast precision of the measures of expectations[7]. Although our GMM estimations for the NKPC use valid instruments and attain high explanatory capacity, this estimation procedure potentially suffers from endogeneity related to the use of weak instruments, which results in unreliable statistical inference (Staiger & Stock, 1997). We checked the relevance of our instruments by conducting the Kleibergen-Paap (KP) test for weak instruments[8].

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
BEI	100%	0.968	0.468	0.000	0.000	75%	12
QSEE	100%	0.986	0.307	0.000	0.000	0%	12

(1) Percentage of estimations with valid instruments

(2) Median r-squared

(3) Median RMSE

(4) P-value FT test

(5) P-value PT test

(6) Estimations with weak instruments

(7) Number of estimations

Table 2. Specification Checks

According to our specification checks, all estimations used valid instruments, attained high explanatory capacity, and exhibited equivalent forecasting precision. We accepted the null hypothesis of joint validity of instruments in 100% of cases. Both measures achieved a median r-squared of 96.8% –or above– and similar RMSE. We rejected the

[6] The null hypothesis for Hansen's OI test establishes that there is no correlation between regressors and the error term. Failure to reject the null hypothesis indicates that the proposed empirical specification uses valid instruments.

[7] The FT test examines if inflation expectations and actual inflation series are independent. The PT test establishes if the sign of changes in inflation expectations corresponds to the sign of changes in actual inflation. A rejection of the null hypothesis in either test implies that the measure of expectations being tested correctly predicts changes in inflation.

[8] The Kleibergen-Paap test is used to check for the presence of weak instruments in instrumental variables (IV) and Generalized Method of Moments (GMM) estimations by examining the correlation between the endogenous regressors and the instrumental variable.

null hypothesis of the FT and PT tests for both measures. All estimations for the QSEE used instruments that are not weak. However, the KP tests indicated that we were using weak instruments in 75% of BEI estimations, which we accounted for by including weak-instrument-robust confidence intervals in these cases[9].

Robustness Check: SVAR Estimation

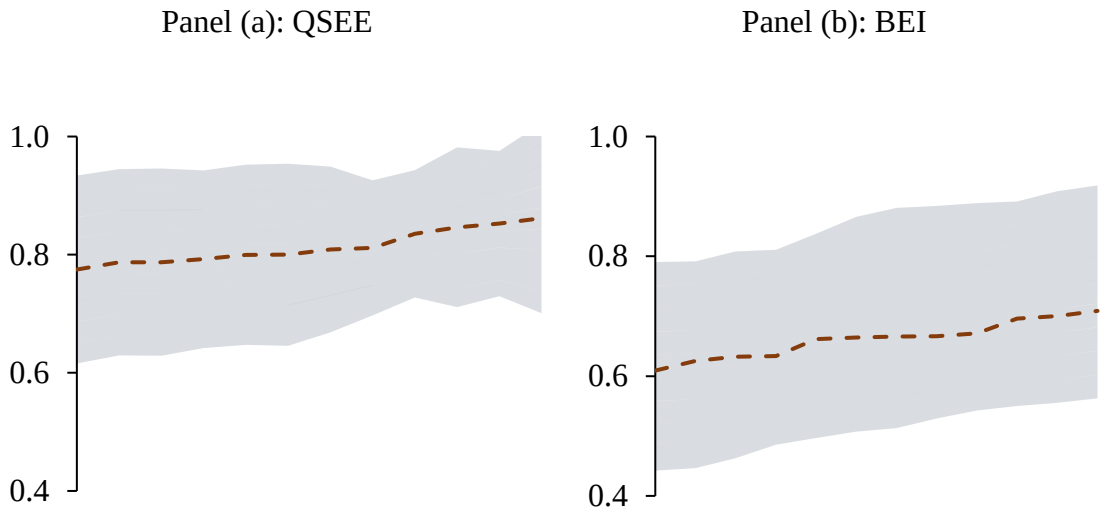
To check the overall validity of our GMM results, we examined the passthrough of expectations using a SVAR model, accounting for the endogeneity in the NKPC. Based on existing empirical evidence indicating a significant effect of shocks to commodity prices on inflation in Colombia, we instrumented the structural shock in our SVAR through a shock on international oil prices (BRENT). In addition to the variables used in our GMM estimations of the NKPC, our SVAR system includes the nominal effective exchange rate (NEER) and the monetary policy rate (MPR). The inclusion of NEER is supported by the monetary policy regime in Colombia, where the NEER buffers external shocks to the economy (Gómez et al., 2023). The MPR was included based on its relevance in facilitating the enactment of monetary policy. To corroborate the robustness of our SVAR results, we used real GDP growth (GDP) instead of the output gap (GAP) as the measure of real economic activity, obtaining equivalent findings[10].

Shocks in BRENT impact NEER via changes in terms-of-trade, affecting the current account deficit and therefore GAP. The passthrough of NEER towards inflation (INF) is channeled through variations in the relative price of imported inputs. MPR affects NEER by influencing capital flows, since changes in the policy rate determine the return of foreign investments in local currency sovereign debt (Toro et al., 2023). It also affects GAP by influencing economic activity as the main policy tool used by the CBoC. Finally, changes in INF cause MPR to change as the CBoC reacts to deviations of inflation from the long-tern target.

[9] We used the Conditional Likelihood Ratio (CLR) method for adjusting confidence intervals whenever the KP test results indicated we were potentially using weak instruments, ensuring robust and reliable inference.
[10] All series used in the estimation of the SVAR model are stationary. All roots of the SVAR model lie outside the unitary circle, and residual terms exhibit a normal distribution according to the results of a Jarque-Bera test.

4. Results

Figure 4 and Table 3 show the estimates of the passthrough of inflation expectations in Colombia between 2009 and 2024 using GMM estimates of the NKPC as well as the SVAR model. Our findings show that inflation expectations exert a statistically significant effect on inflation in Colombia, with estimates for this variable ranging from 0.61 to 0.89, consistent with the empirical evidence[11]. The passthrough of expectations depends on the measurement of this variable: when we use survey data our results indicate that a one percentage-point (pp) increase in expectations leads to a median increment of 0.8 pp in inflation, which diminishes to 0.67 pp when using financial market data.



This figure shows GMM estimates of the passthrough of inflation expectations in Colombia between 2009 and 2024. In total, there are 24 estimates: 12 for each measure of inflation expectations. Each estimation is performed using alternative measures of economic slack and 2-5 lags for the instrumental variables. For each measure of expectations, this figure shows the 95% confidence intervals for the estimates. Appendix A2 shows the GMM estimates for the other components of the NKPC.

Figure 4. Passthrough of Inflation Expectations in Colombia (2009-2024)

[11] According to the information shown in Figure 1, the coefficient for inflation expectations should lie between 0.1 and 1.3 and should be statistically significant.

	BRENT	QSEE	MPR	NEER	GAP	INF
BRENT	1	-	-	-	-	-
QSEE	-	1	-	-	-	-0.005 (0.216)
MPR	-	-	1	-	-	-2.306 *** (0.165)
NEER	-11.507 *** (0.217)	-	0.048 (0.309)	1	-	-
GAP	-6.741 *** (1.521)	-	-1.277 *** (0.305)	0.178 (0.132)	1	-
INF	1.207 (2.23)	0.885 *** (0.157)	-2.602 *** (0.303)	0.071 (0.188)	-0.149 (0.184)	1
R-squared	0.153	0.516	0.973	0.174	0.524	0.540
RMSE	0.152	0.476	0.522	3.469	1.831	0.553
AIC	11.579					
SC	13.058					

	BRENT	BEI	MPR	NEER	GAP	INF
BRENT	1	-	-	-	-	-
BEI	-	1	-	-	-	-0.130 (0.225)
MPR	-	-	1	-	-	-2.292 *** (0.164)
NEER	-12.070 *** (0.172)	-	0.614 * (0.324)	1	-	-
GAP	-6.861 *** (1.609)	-	-0.972 *** (0.329)	0.151 (0.134)	1	-
INF	0.233 (2.790)	0.680 *** (0.151)	-2.419 *** (0.289)	0.109 (0.204)	-0.160 (0.200)	1
R-squared	0.153	0.215	0.969	0.145	0.521	0.502
RMSE	0.152	0.733	0.561	3.530	1.837	0.576
AIC	13.105					
SC	14.584					

Note: Significance: *p<0.1, **p<0.05, ***p<0.01
Standard errors in ()

Appendix A3 shows the SVAR estimates when using GDP growth as a measure of real economic activity.

Table 3. SVAR Results for BEI and QSEE using the output gap as measure of economic slack

Possible explanations for the differences in the passthrough of expectations relate to asymmetric losses in forecast errors, variations in forecasting costs, and information rigidities. Financial analysts are compensated based on the accuracy of their forecasts since the real return on financial securities depends on uncertain values for future inflation (Schuh, 2001). To hedge against inflationary risk related to the underprediction of inflation, which would result in negative real returns, investors overshoot their

expectations when negotiating sovereign debt (Capistrán & Timmerman, 2009). In fact, the empirical evidence shows that the yields of inflation-protected securities exceed the inflation-adjusted interest rate (D'Amico, Kim, and Wei, 2018). Plausibly, our BEI measure does not completely filter out inflationary –or even liquidity– risk, leading to biases that plausibly explain differences in the passthrough of expectations with respect to the QSEE.

Financial analysts have access to specialized extensive experience in financial asset trading and datasets that enable the use of sophisticated forecasting methods, while consumers and firms predominantly form their expectations based on indexation to past prices and the behavior of relevant prices, such as wages, food or energy prices (Mankiw et al., 2003; Bernanke, 2007; Blanchflower & MacCoille, 2009; Sousa and Yetman, 2016; Coibion et al., 2018). When selecting forecasting methods, not all agents face the same cost, with specialized predictors demanding more resources, prompting agents to select distinct forecasting methods (Brock and Hommes, 1997; Branch, 2004).

Disagreement in expectations could also be explained by staggered information updates regarding future economic activity (Mankiw *et al*., 2003). According to Mankiw and Reis (2002), these information rigidities arise due to costs of collecting and processing information, leading certain agents to employ outdated information when forming expectations. Financial analysts constantly monitor and update their expectations based on macroeconomic developments, while consumers and firms gradually acquire information from specialized forecasters by occasionally reading news reports (Carroll, 2003; Sousa and Yetman, 2016).

5. Conclusion

Our study provides empirical evidence showing that the effect of inflation expectations on inflation dynamics in Colombia depends on the measurement of this variable. We find a higher passthrough for survey-based expectations compared to market-based expectations, suggesting fundamental differences in the formation of expectations among economic agents. These findings have important implications for monetary policy, as central banks must carefully consider the distinctive passthrough of various measures of inflation expectations to implement effective policy responses and avoid unintended effects.

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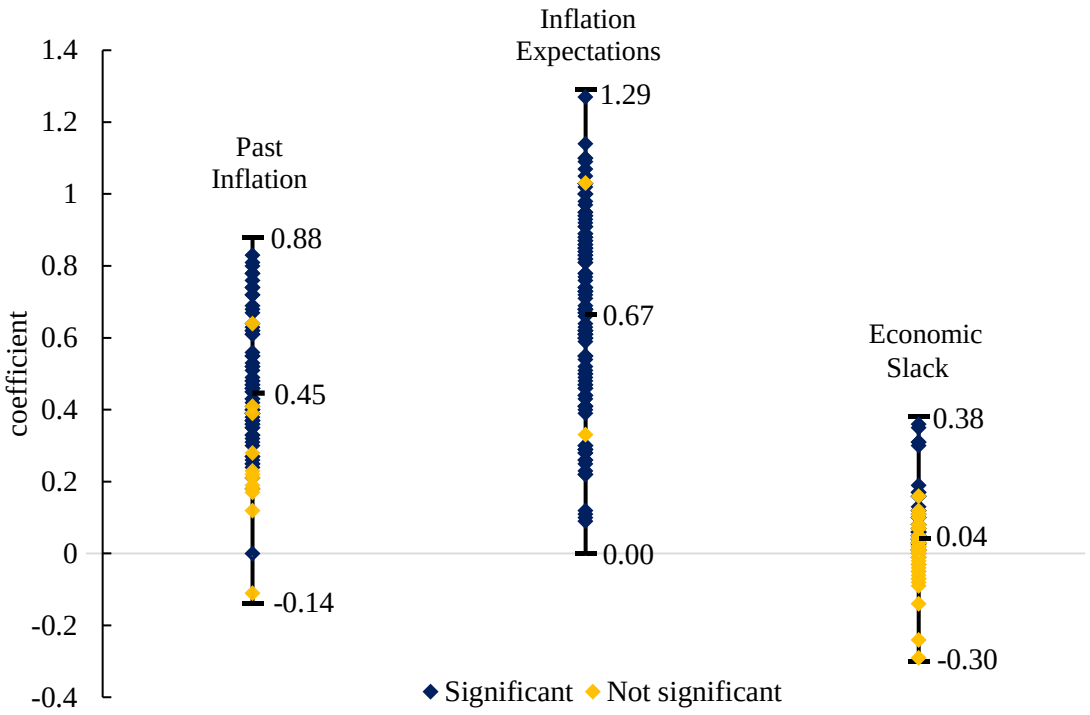
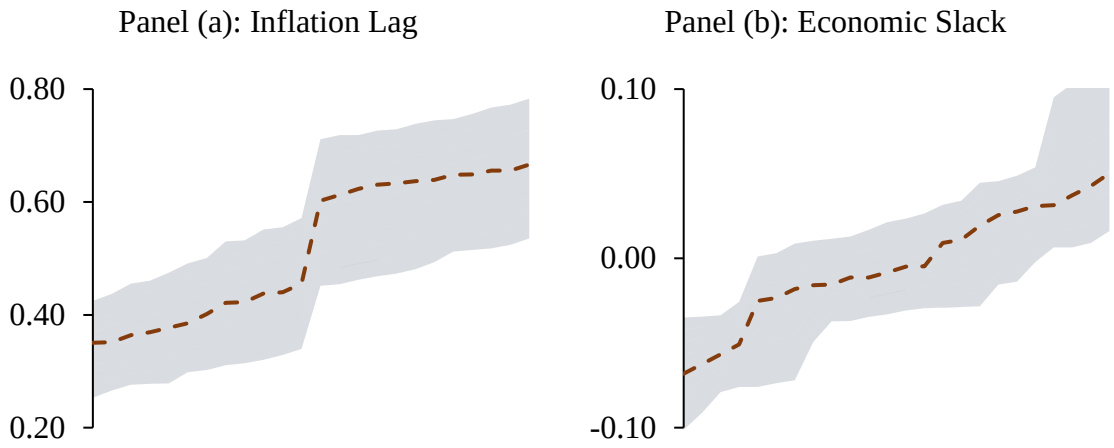


This figure summarizes a literature review regarding estimations of the NKPC between 1949 and 2016. For each component of the NKPC we indicate the median value of the coefficient and its statistical significance at a 95% confidence level. We reviewed 19 empirical studies which report a total of 121 estimates for inflation expectations, 83 for past inflation, and 120 for economic slack. These vary according to the estimation method, country sample, measurement of inflation expectations and real economic activity, and empirical specification.

Appendix A1. Estimates for the NKPC (1949-2016)



Each point in this figure represents an estimate for one of the components of the NKPC in Colombia between 2009 and 2024. The estimations are performed using the GMM, alternative measures of inflation expectations, and various proxies for economic slack. In total, there are 24 estimates.

Appendix A2. Estimates for the NKPC in Colombia (2009-2024)

	BRENT	QSEE	MPR	NEER	GROWTH	INF
BRENT	1	-	-	-	-	-
QSEE	-	1	-	-	-	-0.045 (0.219)
MPR	-	-	1	-	-	-2.322 *** (0.165)
NEER	-11.184 *** (0.212)	-	0.002 (0.317)	1	-	-
GROWTH	-11.877 *** (1.462)	-	-0.935 *** (0.320)	0.239 * (0.131)	1	-
INF	0.232 (3.092)	0.831 *** (0.155)	-2.760 *** (0.272)	0.091 (0.194)	-0.001 (0.190)	1
R-squared	0.079	0.506	0.973	0.169	0.083	0.540
RMSE	0.158	0.481	0.523	3.481	2.976	0.553
AIC	12.725					
SC	14.294					

	BRENT	BEI	MPR	NEER	GROWTH	INF
BRENT	1	-	-	-	-	-
BEI	-	1	-	-	-	-0.181 (0.229)
MPR	-	-	1	-	-	-2.304 *** (0.165)
NEER	-11.843 *** (0.162)	-	0.574 * (0.344)	1	-	-
GROWTH	-11.943 *** (1.556)	-	-0.666 ** (0.348)	0.206 (0.132)	1	-
INF	-0.472 (3.524)	0.618 *** (0.150)	-2.507 *** (0.260)	0.118 (0.213)	-0.035 (0.211)	1
R-squared	0.072	0.214	0.968	0.131	0.078	0.499
RMSE	0.159	0.734	0.565	3.559	2.985	0.577
AIC	14.219					
SC	15.698					

Note: Significance: *p<0.1, **p<0.05, ***p<0.01
Standard errors in ()

Appendix A3. SVAR Results for BEI and QSEE using GDP growth rate to approximate economic activity

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