

# Borradores de ECONOMÍA

Effects of the central bank's  
communications in Colombia. A  
content analysis.

Por: Luis E. Arango,  
Javier Pantoja,  
Carlos Velásquez



Núm. 1024  
2017



tá - Colombia - Bogotá - Colombia - Bogotá - Colombia - Bogotá - Colombia - Bogotá - Colombia - Bogotá - Colombia - Bogotá - Col



# Effects of the central bank's communications in Colombia: A content analysis

**Luis E. Arango**  
Banco de la República

**Javier Pantoja**  
Universidad EAFIT

**Carlos Velásquez\***  
Universidad EAFIT and  
Bancolombia

## Abstract

*We carry out a reading analysis that consists of two elements. First, we observe the coherence between monetary policy actions and press releases. In this case, we find that inflation and growth were significant factors in the adoption of policy measures between September 2004 and March 2016. Moreover, when inflation and economic growth both increase, the monetary policy tightens. Nevertheless, the coefficients of economic activity continue to be greater than those of inflation. Second, monetary authority goes beyond explanations in press releases in the sense that there are some traces of forward guidance in a number of communications with varying degrees of commitment. We also assess whether Colombia's central bank uses its communications as a complementary monetary policy tool and estimate the effectiveness of this strategy. To perform this assessment, we use machine learning to determine the semantic structure of the central bank's communications. This technique allows us to extract semantic factors that are then used in structural VAR models to identify and measure the impact of these communications on inflation expectations. Our results indicate that Colombia's central bank uses communications as a monetary policy tool and that this strategy influences market inflation expectations.*

**JEL classification:** C4, E4, E5.

**Keywords:** *text mining, content analysis, latent semantic analysis, central bank communications.*

---

\* The opinions expressed herein do not represent those of Banco de la República, Bancolombia or their respective boards of directors. The research assistance provided by María Paula Medina Pulido and Nataly Andrea Pedraza Jiménez is greatly valued. This paper has benefited from comments and suggestions of Andrés González and attendees of MMF at Heriot Watt University and EAFIT University. Any remaining errors are our own. Corresponding author: Luis E. Arango; [larangth@banrep.gov.co](mailto:larangth@banrep.gov.co); phone + 57 1 3430676; Carrera 7 No. 14-78, Banco de la República, Bogotá, Colombia.

*“The field of economics should be expanded to include serious quantitative study of changing popular narratives. To my knowledge, there has been no controlled experiment to prove the importance of changing narratives in causing economic fluctuations” (Shiller, 2017).*

## 1. Introduction

In addition to announcing specific inflation targets, the inflation-targeting strategy is characterized by high transparency, fluid and clear communication with the public, and explicit accountability mechanisms (see Hamann, Hofstetter and Urrutia, 2012).

Due to improvements in information-processing technology and more connected financial markets, market participants have a greater ability to anticipate central bank measures, and this situation has led to a loss in the effectiveness of monetary policy based on the element of surprise (Woodford, 2001).<sup>1</sup> In response, central banks have begun to change their strategy towards a more transparent approach that allows markets to know more about the monetary policy process and future decisions. In the monetary policy framework, transparency can be understood as the degree to which a central bank releases information about its economic outlook, objectives, strategy, future decisions, monetary policy rules and parameters, and other signals that can be used by markets to shape expectations and make decisions.<sup>2</sup> As Poole (2001) states, the presumption of the transparency approach is that agents can make more efficient decisions when they can correctly predict the actions of central banks. Transparency allows central banks to signal future policy intentions and can thus be regarded as an alternative policy instrument.

Eusepi and Preston (2007) suggest that within an inflation-targeting strategy, more information about the monetary policy process, such as the variables used and the parameters of monetary policy rules, should be released. Whereas Svensson (1998) and Neuenkirch (2012) find that transparency is welfare-improving, Walsh (2006) and Van der Cruysen, Eijffinger and Hoogduin (2010), who address the problem of establishing an optimal transparency policy, conclude that transparency is welfare-improving up to an optimum that depends on the characteristics of each market. Neuenkirch (2013) finds that an intermediate level of transparency is optimal.

Communications by monetary authorities about policy decisions aim to either explain the actions or to drive inflation expectations (see also Woodford, 2001). In this regard, Blinder, Ehrmann, Fratzcher, Haan and Jansen (2008) point out that “the evidence suggests that communication can be an important and powerful part of the central bank’s toolkit since it has the ability to move financial markets, to enhance the predictability of monetary policy decisions, and potentially to help achieve central banks’ macroeconomic objectives”.<sup>3</sup> Announcements are different from communications in

---

<sup>1</sup> Goodfriend (1986) summarizes the criticism of the Federal Reserve’s secrecy.

<sup>2</sup> Romer and Romer (2000) shows that central bank forecasts are better than those made by private institutions.

<sup>3</sup> Using a macroeconomic model, Blinder and his coauthors show that central bank communications would not be important in the case of three unrealistic assumptions. These are, in order of relevance, a stationary economy, symmetric information between market agents and central banks, and rational expectations. They explain why these assumptions are unrealistic: the economy clearly is not stationary, symmetric information has been rejected and, regarding expectations,

the sense that the former provide markets with information about tangible actions to be applied immediately such as, for instance, asset purchases and exchange rate management decisions. Communications, on the other hand, are normally associated with the economic outlook, objectives, strategies, future decisions and the reasons that support these (Blinder et al., 2008). Announcements are expected to have a more direct influence on actual market behavior than on expectations. Several papers have examined the effect of announcements on financial markets' behavior and volatility, while others assess this effect on exchange rate and commodities (Rigobon and Sack, 2006). In this article, we focus on communications instead of announcements, which requires the use of very different methodologies.

The economic downturn of the past decade, which drove interest rates in developed economies to historically low levels, showed that inflation-targeting countries might not be the only ones that can complement monetary policy with a good communication strategy. The zero-lower bound constrained the use of traditional monetary policy in such a way that a number of central banks explored unconventional policies, including promises of future policy actions, aimed at driving the expectations of households and the private sector.<sup>4</sup> Monetary policy communications sometimes can be used to improve and catalyze policy outcomes and sometimes can serve as the primary or only option for implementing monetary policy actions; the latter case exists under a zero-lower bound constraint (Campbell et al., 2012). This use of monetary policy communications has led to a new line of research that established that central bank communications are crucial to monetary policy as a mechanism to guide market expectations.

Monetary policy has been traditionally studied from a quantitative perspective, and in Colombia, little attention has been paid by academia to the role of the central bank's communications. However, the potential use of these communications as a tool to manage expectations stimulates our interest in evaluating the impact of such communications in the Colombian economy. To our knowledge, Castro (2012) is the only article that focuses on the effect of Colombia's central bank's communications.

This paper contributes to the existing literature in two primary ways. First, it investigates whether Colombia's central bank's communications are consistent with its policy actions. In this regard, we perform a content analysis of monetary policy communications issued between September 2004 and March 2016, selecting four main subject areas or topics (inflation and inflation expectations, economic activity, exchange rate, and international context) to test the hypothesis that there is a connection between the bank's policy communications and the measures taken. Second, we determine whether monetary policy communications are used as a complementary tool to monetary policy actions by evaluating the quantitative impact of Colombia's central bank's communications on the economic situation indicator (ISE) and on inflation expectations. This evaluation is performed using the structural VAR approach described below.

---

Blinder et al. (2008) have emphasized that a learning process is a more accurate way to describe how agents introduce monetary policy into their decisions.

<sup>4</sup> Given the zero-lower bound constraint, forward guidance has emerged as a complementary policy. This guidance can be either Delphic or Odyssean. The former exists when the board gives signals about future actions but makes no commitment to take those actions, while in the latter includes such a commitment.

Castro (2012) analyzes the effect of communications and concludes that monetary policy press releases are not significant in explaining yield curve movements. His scope of analysis is similar to ours; however, our approach differs with respect to the way in which we analyze communications and our selected variable of focus, which is inflation expectations rather than interest rates. We use an advanced machine-learning technique known as latent semantic analysis (LSA)<sup>5</sup> to evaluate the impact of communications within different structural VAR specifications. In contrast with Castro's conclusion, our results show that these press releases have an impact on the inflation expectations derived from instruments at different maturities.<sup>6</sup>

The paper develops as follows. The next section describes the content analysis performed and the results. Section 3 articulates the principles of LSA and shows the themes (factors) derived from the singular value decomposition. Section 4 presents and discusses the results of the structural VAR modeling. Finally, section 5 draws some preliminary conclusions.

## 2. Information content

In this article, we take a two-pronged approach to review the information content. First, we read the policy communications looking for possible embedded signals or guides. Second, we apply the LSA machine learning technique to determine feasible linguistic structures in Colombia's central bank communications. Determining these linguistic structures in turn allows the identification of latent semantic factors that are used within a structural VAR model to test the hypothesis that economic shocks linked to press releases regarding policy decisions can affect inflation expectations. To perform these tasks, we analyze the press releases about policy decisions issued by the monetary authority between September 2004 and March 2016.

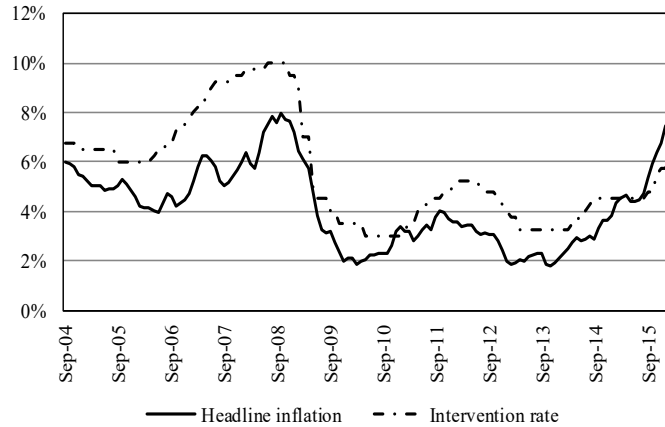
Although Colombia began its adoption of an inflation-targeting strategy in 1999 (Gómez et al., 2002; Hamann et al., 2012), it was only in 2001 that this monetary policy approach became fully operational. As part of the implementation, for the majority of the sampled period, the board met on the last Friday of each month to decide on actions related to the intervention (policy) rate. Figure 1 shows the behavior of both headline inflation and the policy rate. At first glance, there seems to be a comovement of the two variables, which suggests endogeneity of these variables.

Figure 2, on the other hand, presents headline inflation as well as the target and the upper and lower limits. We observe that the target as well as the upper and lower limits changes during the period depending on the observed inflation. This is the case in 2009 when, as part of the strategy to regain credibility in the upcoming years, the target moves upwards. However, this is not the only period in which the monetary authority misses the target; it happens again between February 2015 and the end of the sample period. In any case, it is important to note that the inflation target is established for December of each year.

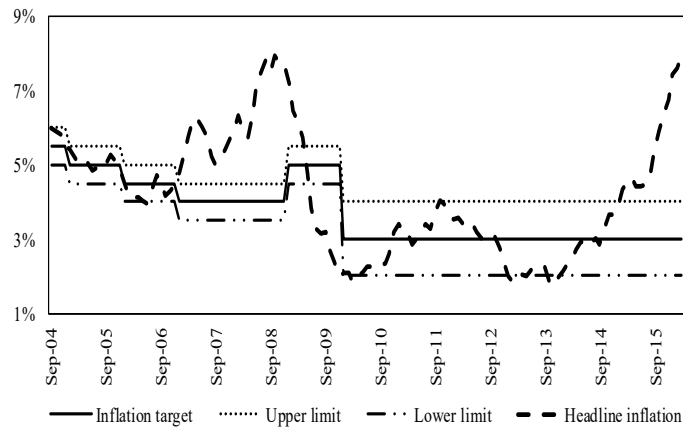
---

<sup>5</sup> See Bholat, Hansen, Santos and Schonhardt-Bailey (2015) for a primer on text-mining techniques applied to analyses of central banks. Blei, Ng and Jordan (2003) and Bholat et al. (2015), among many others, explain and use other text-mining techniques such as latent Dirichlet allocation and descending hierarchical classification.

<sup>6</sup> Flórez-Jiménez and Parra (2014) explore the effect of escape clauses under zero-lower bound conditions.

**Figure 1. Headline inflation and intervention rate**

Source: Banco de la República; authors' calculations.

**Figure 2. Headline inflation and intervention rate**

Source: Banco de la República; authors' calculations.

## 2.1. Reading approach

The main objective of the reading approach is to determine whether Colombia's central bank uses its communications to provide signals of current and future monetary policy actions; in other words, we are trying to assess any relationship between the measures taken and the content of the press releases issued. This approach relies on the identification of certain topics within the text of the communications, and we assign values to these themes based on the tone used to reference them in each document. We group the topics into three broad categories by tone: upwards, downwards, and neutral. Thus, without any loss of generality, we can assign these categories the values of 1, -1 and 0, respectively.<sup>7</sup> According to our observations from the reading approach, Colombia's central bank's communications typically reference four main topics: inflation and inflation expectations, economic

<sup>7</sup> For example, if the press document refers to increasing inflation we assign the value 1, but if the monetary authority refers to a decrease in inflation we assign -1, and so on with the rest of the variables.

activity, exchange rate, and international context, with the latter including commodity prices. Table A1 in the Appendix shows details of the references by themes.

The empirical model used to verify whether the measures of the central bank are associated to the topics in the press releases is:

$$\Delta i_t = \alpha_0 + \alpha_1 I_t + \alpha_2 EA_t + \alpha_3 ER_t + \alpha_4 IC_t + \mu_t,$$

where  $\Delta i_t$  are changes in the intervention rate (measured in basic points),  $I_t$  is inflation,  $EA_t$  stands for economic activity,  $ER_t$  is exchange rate,  $IC_t$  corresponds to international context, and  $\mu_t$  is the error process. Thus, this empirical model has the flavor of a qualitative Taylor's rule.

Table 1 shows the results of OLS times-series estimations of the change in the intervention rate of the different topics covered by the press release about a particular policy measure. Model (1) includes the four topics of interest; however only inflation and economic activity are significant. Unfortunately, according to the Durbin Watson statistic and the *F-probability* of an order-two autoregressive model [AR(2)] of the error process, this model, as well as model (2), lacks good autocorrelation properties. Even model (3), which includes lags of inflation and economic activity, does not improve the autocorrelation of the error process according to these two test statistics.

**Table 1. Policy response to selected topics: 09/2004 to 03/2016**

Factor	Dependent variable: Intervention rate variation measured in basic points								
	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (7)	Model (8)	Model (9)
<b>Inflation</b>	7.7546*** (2.0953)	7.5660*** (1.9847)	5.1476** (2.1535)	4.2491** (1.6232)	8.4682*** (2.5847)	2.5018 (1.6783)	3.1680* (1.6575)	2.3997 (1.6561)	6.3256** (2.8226)
<b>Inflation (t-1)</b>			5.2561** (2.1604)						
<b>Economic activity (growth)</b>	14.4085*** (2.2033)	14.2358*** (2.0829)	10.6860*** (2.7698)	6.6627*** (1.8719)	8.9638*** (2.1542)	3.0895 (2.1680)	4.9754** (1.9694)	3.2941 (2.0600)	6.9191*** (2.4160)
<b>Economic activity (growth) (t-1)</b>			4.7879*** (2.7684)						
<b>Exchange rate</b>	-2.4684 (3.5589)								
<b>International context</b>	-0.8041 (2.4382)								
<b>Inflation up × growth up</b>					-12.1547** (5.8394)				-8.4661 (6.1368)
<b>Inflation down × growth down</b>						-17.5340*** (5.8052)			
<b>Inflation up × growth down</b>							11.8290*** (4.9371)		9.4423* (5.2155)
<b>Inflation down × growth up</b>								18.3537*** (5.4364)	
<b>Intervention rate variation (t-1)</b>				0.4149*** (0.0849)	0.4104*** (0.0838)	0.3529*** (0.0845)	0.3696*** (0.0855)	0.3545*** (0.0836)	0.3756*** (0.0853)
<b>Intervention rate variation (t-2)</b>				0.2211*** (0.0796)	0.2023** (0.4682)	0.2368*** (0.0774)	0.2286*** (0.0782)	0.2302*** (0.0766)	0.2140*** (0.0787)
<b>Constant</b>	-3.7664* (2.1488)	-3.9270** (2.0029)	-3.7127* (2.0222)	-1.5043 (1.6126)	1.4024 (2.1184)	1.8732 (1.9236)	0.6129 (1.8142)	1.8891 (1.8496)	2.2109 (2.1472)
<b>Adjusted R<sup>2</sup></b>	0.3112	0.3187	0.3707	0.5783	0.5887	0.6028	0.6079	0.6235	0.6135
<b>Durbin-Watson</b>	1.0035	0.9934	0.9111	1.9761	1.9871	1.9825	1.9584	1.9975	1.9758
<b>AR(2) on errors. Prob(F)</b>	0.0000	0.0000	0.0000	0.8300	0.9500	0.9500	0.8800	0.9700	0.9700
<b>N</b>	139	139	138	137	137	137	137	137	137

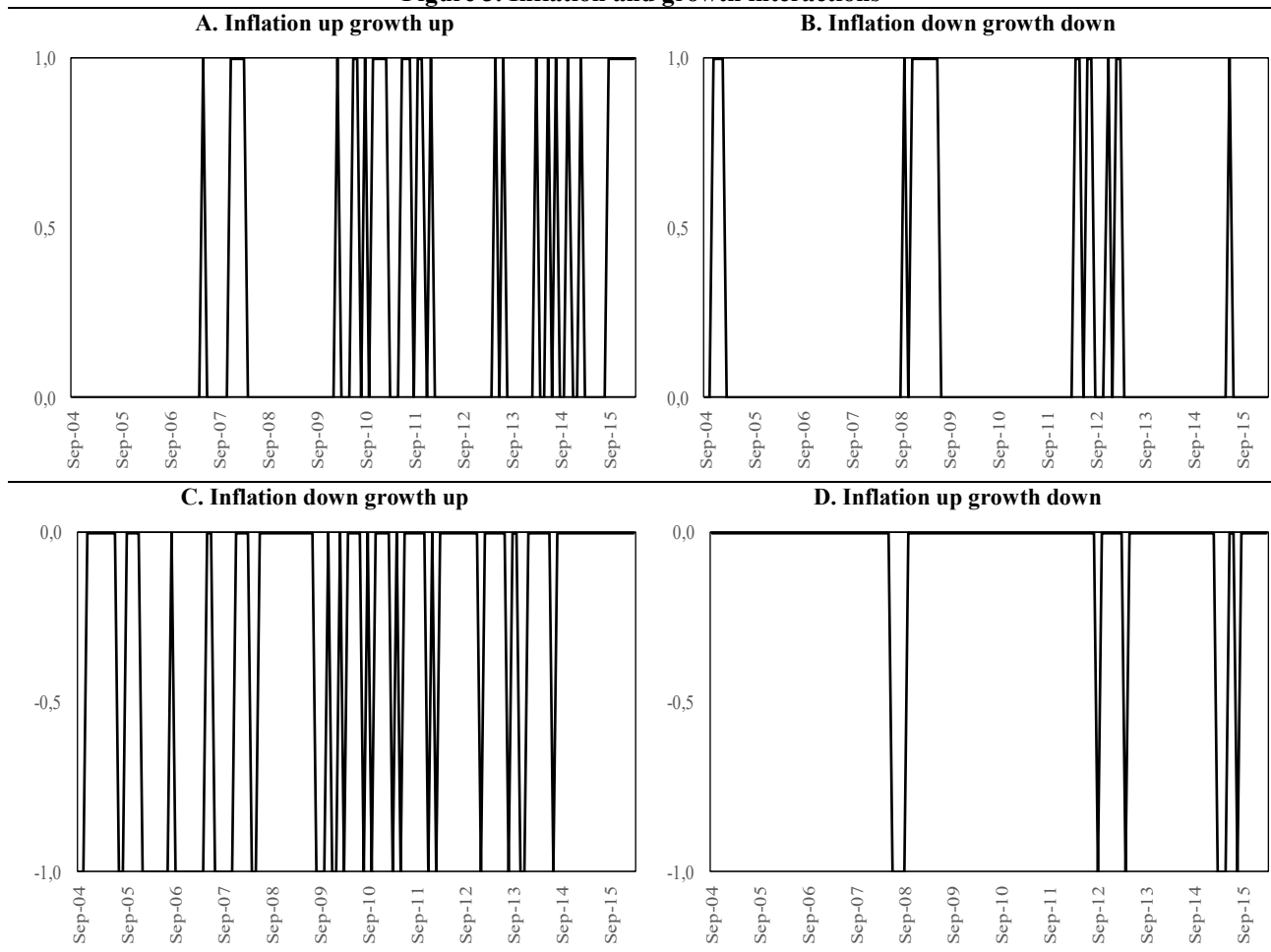
Notes: \*\*\* = significant at 99%; \*\* = significant at 95%; \* = significant at 90%. Source: Banco de la República's press releases and authors' interpretations (see Table A1 in the Appendix).

To reduce the remaining structure of the innovation process, model (4) includes two lags of the changes in the intervention rate while retaining the topics of inflation and economic activity, which are still significant. This means that when the monetary authority observes that either of these two variables is moving upwards, the intervention rate moves in the same direction. If either of them moves downwards, the intervention rate will change accordingly. Model (4) also shows the inertia of policy actions: once the monetary authority starts to intervene, it continues the same actions for several periods. In our estimates, the third lag is not significant.

In this content analysis, it is also important to consider the reaction of the monetary authority when there is simultaneous movement of inflation and economic activity, that is, the interaction between these two variables. In panel A of Figure 3, we observe the interaction when both variables are moving upward; in that case, as well as when both variables are moving downward (Panel B), the interaction is assigned the value 1. When the changes in the movements of the variables are at odds, the interaction is assigned the value -1 (see Panels C and D). Without  $ER_t$  and  $IC_t$ , the empirical model is now depicted as

$$\Delta i_t = \alpha_0 + \alpha_1 I_t + \alpha_2 EA_t + \alpha_3 \Delta i_{t-1} + \alpha_4 \Delta i_{t-2} + \alpha_j Interactions_t + \mu_t.$$

**Figure 3. Inflation and growth interactions**



Source: authors' calculations.

Model (5) in Table 1 also includes the interaction of inflation and economic activity when both move upwards simultaneously (and this interaction is assigned the value 1). When this occurs, the intervention rate still reacts to these two topics of interest, and the inertia in the actions remains significant; however, the sign assigned to the interaction suggests that the authority considers this movement a simultaneous occurrence. Model (6), on the other hand, shows that when both variables move downwards (and this interaction is assigned the value of 1) the monetary authority relaxes its policy stance by reducing the intervention rate.

Models (7) to (9) describe the reactions of the monetary authority under more challenging circumstances, namely, when inflation and economic activity are moving in different directions. In the first of these models, the interaction is assigned the value of -1 when inflation is moving upwards while the aggregate economy is declining. The monetary authority reduces the intervention rate in this case as well as in the case when the inflation is going down and economic activity is rising, which latter case corresponds to model (8). However, we note that stronger actions are adopted in the case of the interaction represented by model (7). Finally, model (9) illustrates the decisions of the monetary authority when inflation and economic growth are both increasing and when only the former is growing. In this case, the monetary authority reduces the impulse to increase the intervention rate suggested by the coefficient (6.33). It is important to note that, in all the models fitted, the coefficients associated with economic growth are greater than those linked to inflation, and whenever economic activity is declining, the monetary policy tends to loosen.

In sum, given the significance of coefficients, the results in Table 1 show some association between the monetary authority's policy actions and the topics covered in the press releases. Thus, there is some basis for continuing with the content analysis of the communications.

Apart from the topics emphasized in the central bank's communications, we also perform a content analysis to assess whether there are phrases in the communications that might somehow signal future policy actions. In our view, the central bank might have introduced some guidance, as a monetary policy mechanism, into 13 of 139 press releases. Table 2 reports 13 phrases included by Colombia's central bank in its monetary policy communications that we consider forward guidance signals (see also Table A1 in the Appendix).

The first of these phrases appears in January 2005; this communication states that the board would keep the contraction windows closed, meaning that the central bank would not increase the intervention rate in the following months. This same phrase appears in February and March 2005. The board does not alter the intervention rate until September of that year. In August 2007, the board publicizes its decision to pause rate increments, and the intervention rate thereafter remains unaltered until January 2008.

An escape clause event of forward guidance<sup>8</sup> is observed in June 2008. The board states its intention of "maintaining the current stance of monetary policy" but it introduces an escape clause: "However, if the inflation expectations begin to affect prices and wages, this position would need to

---

<sup>8</sup> Escape clause refers to a statement in which the board commits to do something under certain conditions, but if those conditions change, the board is no longer committed.

be revised.” Delphic forward guidance events are observed in September 2009 and July 2012, while Odyssean forward guidance events are observed in March 2011 and May 2011. Taken together, these 13 phrases suggest that Colombia’s central bank uses its communications not only to explain monetary policy measures but also as a crucial complementary tool of monetary policy.

**Table 2. Identified forward guidance signals**

Date	Signal of future actions	Subsequent decisions		
		$t+1$	$t+2$	$t+3$
Jan-05	... the board will continue its discretionary intervention in the exchange market and will keep the contraction windows closed...	0	0	0
Mar-05	... the board decided to keep the intervention rate unaltered... and will keep the contraction windows closed...	0	0	0
Aug-07	... the board decided to pause the rates increments to obtain more information about the incidence...	0	0	0
Jun-08	... it is prudent, therefore, to maintain the current stance of monetary policy. However, if the inflation expectations begin to affect prices and wages, this position would need to be revised ...	25	0	0
Sep-09	... intervention rate stability is expected in the near future	0	-50	0
Oct-09	... the board expects that the inflation target set for 2010 can be met without upward pressure on the intervention rate in the near future ...	-50	0	0
Mar-11	... the board considers appropriate and prudent to continue gradually reducing monetary stimulus ...	25	25	25
May-11	... all this suggests that the adjustment to a less expansionary monetary policy should continue.	25	25	25
Aug-11	... on balance, the board considered it prudent to pause in interest rate increases.	0	0	25
Sep-11	... therefore, the board considered appropriate to continue with the pause in interest rate increases intervention.	0	25	0
Oct-11	... if real domestic indicators continue with the current dynamism and no further spread of the external situation occurs, it is likely that the economy requires less monetary stimulus...	25	0	25
Jul-12	... according to the assessment of the current balance of risks, all members of the board considered appropriate to reduce the interest rate intervention. Some members proposed further reductions to the finally adopted.	-25	0	0

Note: Subsequent decisions refer to the intervention rate change in the first, second and third month after the forward guidance signal was released. Source: Banco de la República and authors’ interpretations.

## 2.2 Latent semantic analysis

Natural Language Processing (NLP) is a field of computer science that investigates and develops tools to facilitate the interactions between computers and humans. NLP uses several mathematical techniques to interpret texts and speeches in a way that resembles language processing by humans. The NLP approach has been widely used in academic and nonacademic contexts such as automatic

translation, text reduction, text simplification, text and speech segmentation, sentiment analysis, and semantic analysis [see Downey et al., (2007); Bengio et al., (2003); Collobert et al. (2011) and Bholat et al., (2015) for more insights about NLP].

In this paper, we use a linear algebra-based NLP method called latent semantic analysis (LSA), which is a statistical method used to represent the words that compose a text that was first used by Deerwester, Dumais, Furnas, Landauer and Harshman (1990); [see also Landauer et al., (1998) for its application in psychology]. This technique can be applied to the wording entered in the formal documents released by central banks to communicate monetary policy decision-making (see Boukus and Rosenberg, (2006); Hendry and Madeley, (2010); Takeda and Keida (2017), among others). The technique allows for the deduction of relationships between words based on their usage in different passages. Moreover, LSA allows for the creation of methods to link word-word, word-passage and passage-passage relationships in a way that simulates several human cognitive phenomena; it also suggests an approximation to human knowledge that can provide support for theories of reasoning and understanding.

The first step in the LSA consists simply of counting the number of times a word appears in a specific document. Thus, one can determine the importance of each word in that document or, from another perspective, which words best describe the document. For example, imagine that one is analyzing a medical report. In this case, one could expect the word “doctor” to appear more times than, let us say, the word “floor”, even though this latter word might appear in the document. So, if we find that the word “doctor” appears ten times while “floor” appears only once, it is likely that an accurate way to describe the content of the text would include the word “doctor”.

However, analyzing a single document is not the primary goal of NLP but rather analyzing a set of them. Thus, the next step is to repeat the counting of words across all documents. In this way, texts are transformed into a matrix-like structure referred to as a term document matrix (TDM), denoted by  $C_{m \times n}$ , in which each row represents a word and each column a document. Thus, the entry  $c_{i,j}$  is the number of times word  $i$  is found in document  $j$ . For example, if we are analyzing 10 medical reports and the word “doctor” appears 3 times in the first report, 5 times in the second one and twice in the third, the matrix will look like Table 3.

**Table 3. Term document matrix of medical reports**

<b>Word / document</b>	<b>Document 1</b>	<b>Document 2</b>	<b>Document 3</b>	<b>...</b>
Nurse	6	4	4	...
Doctor	3	5	2	...
Medication	10	1	3	...
Hospital	1	2	4	...
Room	2	3	1	...
Floor	0	1	0	...

Source: authors' design.

The TDM makes it possible to assess the relevance of each word within each document. For example, the word “medication” is especially important in document 1. Furthermore, the relevance of words can be compared across documents by normalizing the weights of words. Two types of

weights are considered: local and global weights. The former, denoted by  $lw_{i,j}$ , refers to the weight of word  $i$  in document  $j$ ; that is, the relative importance of word  $i$  in document  $j$ . This is represented by:

$$lw_{i,j} = \frac{f_{i,j}}{\max_t f_{i,j}} \quad (1)$$

where  $f_{i,j}$  represents the frequency with which word  $i$  appears in document  $j$ . The most frequent word in  $j$  will have a weight of 1 whereas infrequent words will have a weight close to 0. The global weight, denoted by  $gw_i$ , identifies the weight that word  $i$  has in all the  $n$  documents analyzed. It is computed as:

$$gw_i = \log \frac{n}{n_i} \quad (2)$$

where  $n_i$  is the number of documents in which word  $i$  appears. According to this measure, if a word appears in all documents, it will not be relevant in describing the differences among them; thus, the lower  $n_i$  is relative to  $n$ , the larger the global weight of the word.

The two types of weights are combined to obtain a third measure of the relevance of each word  $i$  in document  $j$ , adjusted by its global weight to avoid the predominating effect of large documents. Thus, we obtain:

$$x_{i,j} = \frac{gw_i \times lw_{i,j}}{\sqrt{\sum_{i=1}^m gw_i \times lw_{i,j}}} \quad (3)$$

Total weight,  $x_{i,j}$ , introduces a balance between the relevance of the word  $i$  for document  $j$  and the relevance of the word  $i$  across the entire set of documents. The entries of matrix  $X_{m \times n}$ ,  $x_{i,j}$  correspond to the transformed term document matrix, which is not necessarily squared or symmetric. Matrix  $X$  can be factorized using singular value decomposition (SVD) in the product of three characteristic matrices. This decomposition corresponds to

$$X = UDV^T, \quad (4)$$

where  $U_{m \times n}$  and  $V_{n \times n}$  are orthonormal vectors. Moreover, they are (left and right, respectively) singular vectors of  $X$  matrix or orthonormal eigenvectors of  $XX^T$  and  $X^T X$ , respectively. The singular values of  $X$ , determined uniquely by the SVD, are the positive square roots of the eigenvalues of  $XX^T$  and  $X^T X$ , placed by decreasing size in the diagonal of matrix  $D$ :  $\sigma_1 \geq \dots \geq \sigma_n$ .<sup>9</sup>

The  $m$ -rows of  $U$  are words and its  $n$ -columns are latent factors that represent specific subjects that appear throughout the documents. The element  $u_{i,j}$  of  $U$  is the marginal contribution of word  $i$  to factor  $j$ . Likewise, the  $n$ -rows of  $V$  are documents and its  $n$ -columns are the same factors; consequently, the  $i, j^{\text{th}}$  element of  $V$ ,  $v_{i,j}$ , represents the importance of subject  $j$  in document  $i$ . This fact is particularly interesting when documents are organized chronologically because in this case the columns of  $V$  represent time series that reflect the importance of each subject in the central bank's

---

<sup>9</sup> Thus, the  $\text{rank}(X)$  is the number of singular values of  $X$  different from zero; the absolute value of  $\det(X)$  is the product of singular values  $\sigma_1 \cdot \dots \cdot \sigma_n$ ; and,  $\sigma_1/\sigma_n$  is the conditional number of  $X$  if  $\sigma_n \neq 0$ .

communications. These time series, corresponding to the semantic structure of the communications, are then included in our SVAR. Finally,  $D$  is a diagonal matrix in which each entry represents the global importance of each subject across the entire set of documents. According to Hendry and Madeley (2010), this also indicates the importance of each subject in explaining the variance of meaning across the documents. The weights of matrix  $U$  guide the selection of the number of factors included in the VAR model.

We follow the methodology of Boukus and Rosenberg (2006) to extract the meaning of the monetary policy press releases.<sup>10</sup> These documents, which span the period between September 2004 and March 2016, are ordered chronologically and preprocessed before undergoing the analysis described above. As used here, preprocessing means omitting the lines that refer to the actual decision about the intervention rate as well as the systematic phrases in which the monetary authority says that the “Board will continue monitoring the evolution of the facts and maintain its commitment to maintaining inflation and inflation expectations anchored to the target”. We also clean up the documents by removing accent marks, some stop words, and unnecessary references such as “Board”. Then, we construct the TDM and perform the factorization.<sup>11</sup>

Figure 4 presents the words that shape the factors used in the SVAR model. This figure is based upon the ten words with the highest absolute values in the first 20 columns (factors) of matrix  $U$ . These 20 themes account for 44.4% of the variance across documents. A review of the words that we select for factorization indicates that the underlying factors mostly relate to prices, inflation, inflation expectations, monetary policy actions, aggregate economy and particular sectors.

We observe that the factors that emerge from our analysis give more weight to monetary policy, behavior of prices, inflation and expectations than to real activity, although these factors are also important. Thus, the press releases seem to show that the monetary authority in Colombia accords more weight to inflation than to any other variable in the context of press releases. Certain words, such as anchor, intervention, food, normalization, interest rate, economic activity, machinery, and stance, outline the themes. Interestingly, other words describing the phase of the cycle or the persistence of the shocks are also shown to be important (recall the results of section 2.1).

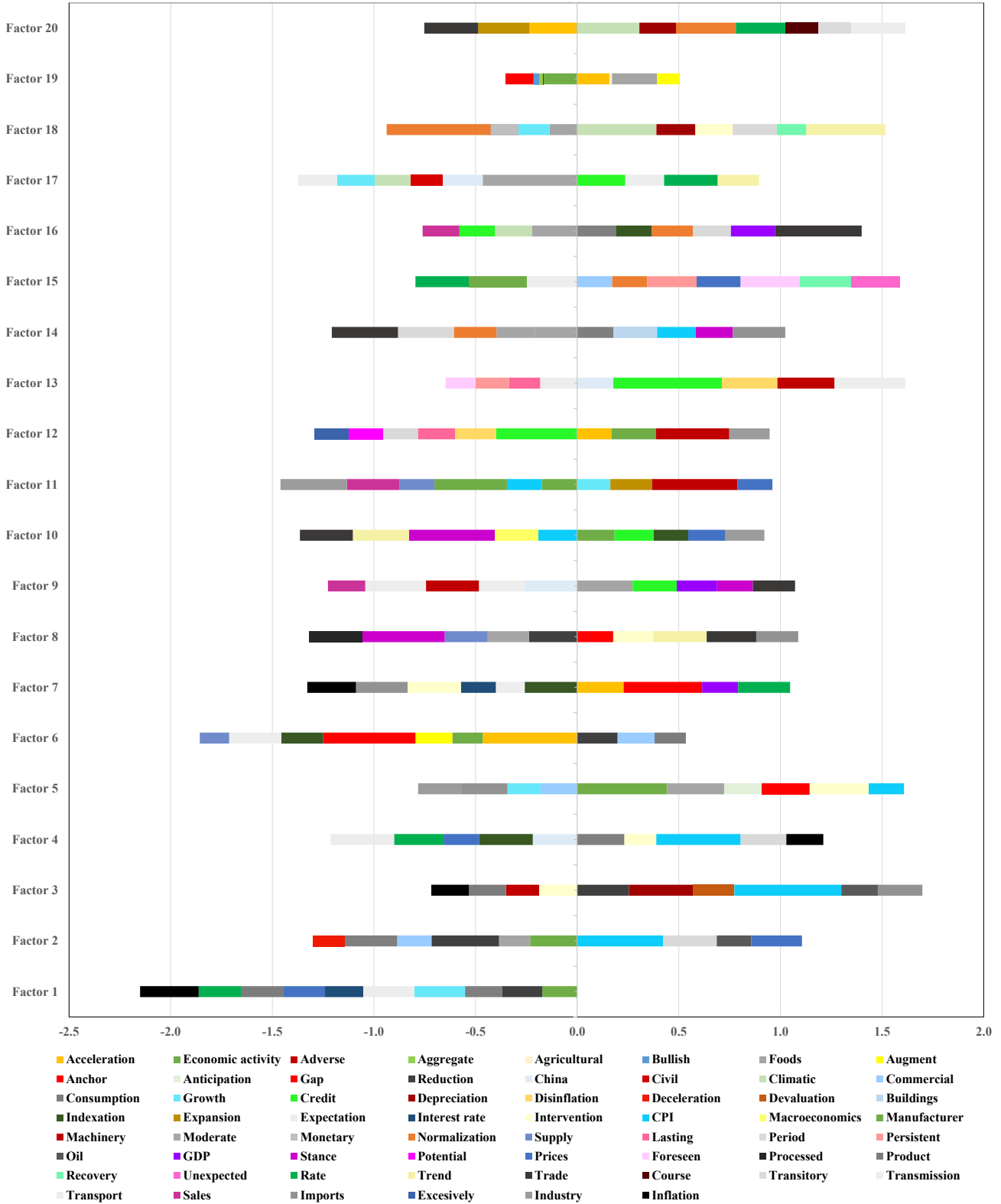
Four themes are of particular interest to us and are discussed in the empirical section below. These are factors 7, 9, 17 and 20. Theme 7 is highly related to monetary policy; it is shaped by the words acceleration, anchor, expectation, imports, indexation, inflation, interest rate, intervention, GDP, and rate. Factor 9, is outlined by the words foods, China, credit, expectation, machinery, GDP, stance, trade, transmission and sales. Factor 17, is shaped by the words foods, China, growth, credit, expectation, intervention, monetary, normalization, period, rate, trend, and transmission. Finally, factor 20 is shaped by the words acceleration, climatic, depreciation, expansion, normalization, rate, trade, course, transitory and transport. This last factor is more related to the business cycle.

---

<sup>10</sup> Press releases are used instead of minutes to avoid possible noise in the meaning extraction process. Press releases provide more concise information that allows the LSA to more easily extract the real factors embedded in the communications.

<sup>11</sup> The preprocessed press releases and the matrices are available from the authors upon request.

Figure 4. Underlying factors



Source: Banco de la República and authors' computations.

In the next section, we introduce these factors into a SVAR construct to observe whether communications, alone or accompanied by a policy measure, have any effect on inflation expectations.

### 3. Empirical analysis and results

We use a structural vector autoregression (SVAR) model to estimate the effect of shocks linked to communications about inflation expectations as measured by the break-even inflation.<sup>12</sup> The vector of the variables is given by:  $x_t = [\Delta y_t \quad \pi_t^e \quad f_t]$ , where  $y_t$  is the one-month variation of the log of the economic situation indicator (ESI), which is a proxy for the economic activity released monthly by the official bureau of statistics,  $\pi_t^e$  represents the break-even inflation expectations<sup>13</sup> computed using government instruments negotiated in the secondary debt market, and  $f_t$  is any of the factors derived from the method described above. The reduced form of these series can be written as:<sup>14</sup>

$$x_t = c + \sum_{k=1}^K F_k x_{t-k} + e_t, \quad (5)$$

while the structural model can be represented by an infinite-order moving-average process MA( $\infty$ ):

$$x_t = m + \sum_{k=0}^{\infty} A_k v_{t-k}, \quad (6)$$

where  $v_t$  represents a vector of three structural shocks: aggregate supply (or technology) shocks, aggregate demand shocks and shocks linked to the communication component of the inflation targeting strategy. We impose the following long-run identifying restrictions: the aggregate supply shocks have no long-run effects on the selected factor; inflation expectation shocks<sup>15</sup> have long-run effects on neither the log of ESI nor the factor; and finally, communication shocks have no long-run effects on the log of ESI. Accordingly, the identifying restrictions are:

$$\sum_{k=0}^{\infty} a_{12,k} = 0, \sum_{k=0}^{\infty} a_{13,k} = 0, \sum_{k=0}^{\infty} a_{31,k} = 0, \sum_{k=0}^{\infty} a_{32,k} = 0. \quad (7)$$

Given the structure of the SVAR model, we test that overidentifying restrictions are not rejected by the data. First, we use the break-even inflation expectations derived from the five-year maturity bonds and factor 7. The election of these two variables was made on the basis of no rejection of the overidentifying restrictions. This model generates the accumulated responses of the log of ESI, the five-years-ahead inflation expectations as measured by break-even inflation and factor 7 to the shocks shown in Figure 5.

The results indicate that aggregate supply shocks have long-run effects on our measure of economic activity while demand shocks have long-run effects on inflation expectations. Therefore, the central bank's communications are designed to counteract the effect of aggregate demand shocks

---

<sup>12</sup> This empirical application is done in the spirit of Smith and Becker (2015), who tested the effectiveness of forward guidance as compared with interest rate changes in the United States.

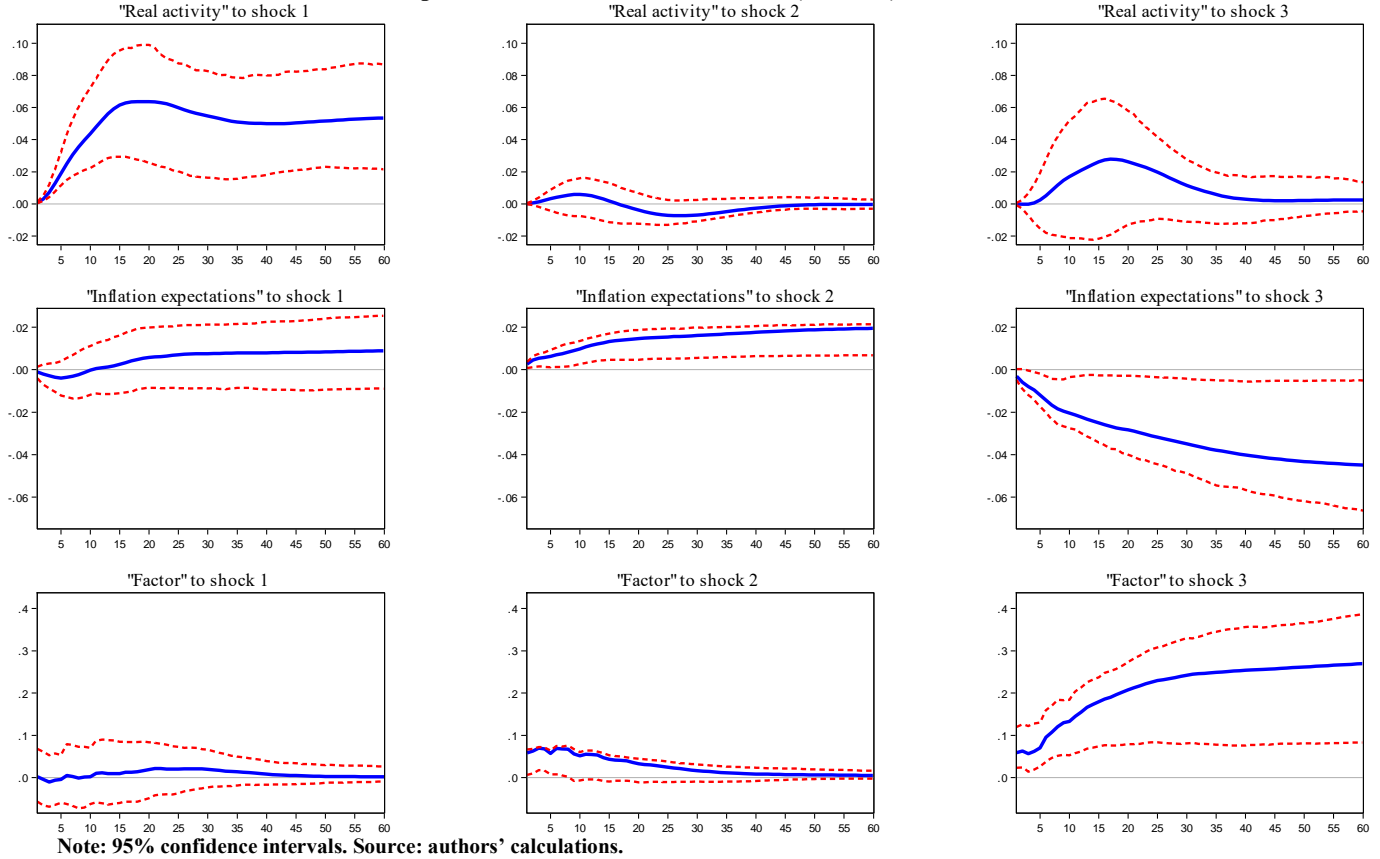
<sup>13</sup> For this variable, across all empirical exercises, we use break-even inflation expectations of one, five and ten years ahead.

<sup>14</sup> In fact, we use a difference of order twelve for the log of the economic situation indicator to obtain a smoother impulse response. However, the model is also supported by a monthly difference.

<sup>15</sup> Under some circumstances, these shocks could well be related to aggregate demand.

on inflation expectations. Thus, the press releases of the central bank not only explain the policy but also signal a commitment to help reduce the effect of demand shock on inflation expectations.

**Figure 5. Accumulated response to structural innovations of economic activity, five-years-ahead inflation expectations, and communications (factor 7).**



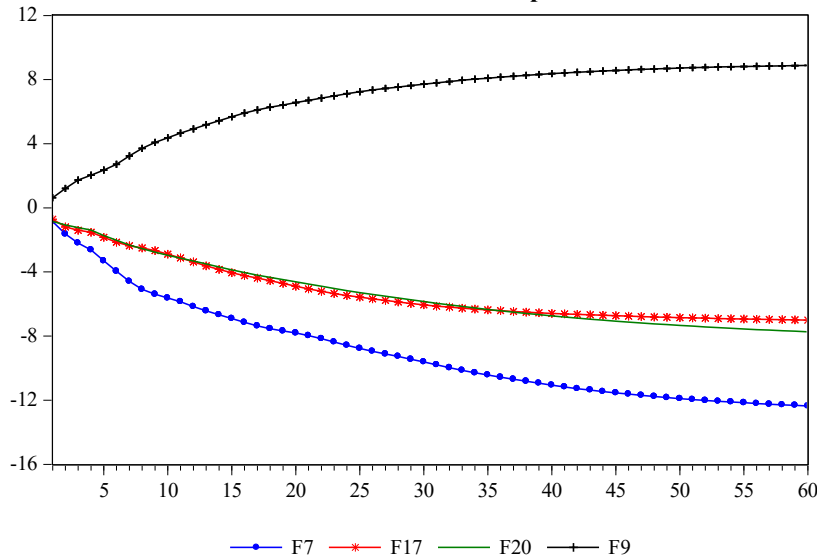
It is worth mentioning that some other factors, such as 9, 10, 11, 12, and 15, generate accumulated impulse responses that increase inflation expectations. Figure 6 shows the impulse response of inflation expectations to communication shocks. With factors 7, 17 and 20, communication shocks reduce inflation expectations while factor 9 has the opposite effect. This scenario could occur when the monetary authority tried to introduce inflation within the target range for 2010 and 2013, which are years in which inflation was rather low or when the press releases did not communicate information that the market was expecting.

As noted above, the meetings of the board were held the last Friday of each month. Thus, the press releases were published at the end of the month as along with the values for the other variables in the system. The few exceptions were the month of December when the communications were released in the middle of the month and a few other periods when the press releases were published at the beginning of the next month because the meeting date's proximity to the last day of the month. Nevertheless, recognizing that the engine of economic activity and the secondary debt market both

operated for the entire month and not just the day of the board meeting, we also run the SVAR analysis lagging one period the factors linked to the press releases and the results are essentially the same.

Despite the results, one might argue that the responses to inflation expectations seen in the previous SVAR specification are due to omitted variables, that is, that the model lacks certain controls such as the explicit intervention of the monetary authority. To account for this, the specifications of the following model include, in addition to the factors extracted from the communications of the central bank, the one-month variation interbank interest rate  $\Delta ibr_t$ , which is a proxy for the intervention (policy) rate.

**Figure 6. Accumulated response to structural innovations linked to communications of inflation expectations**



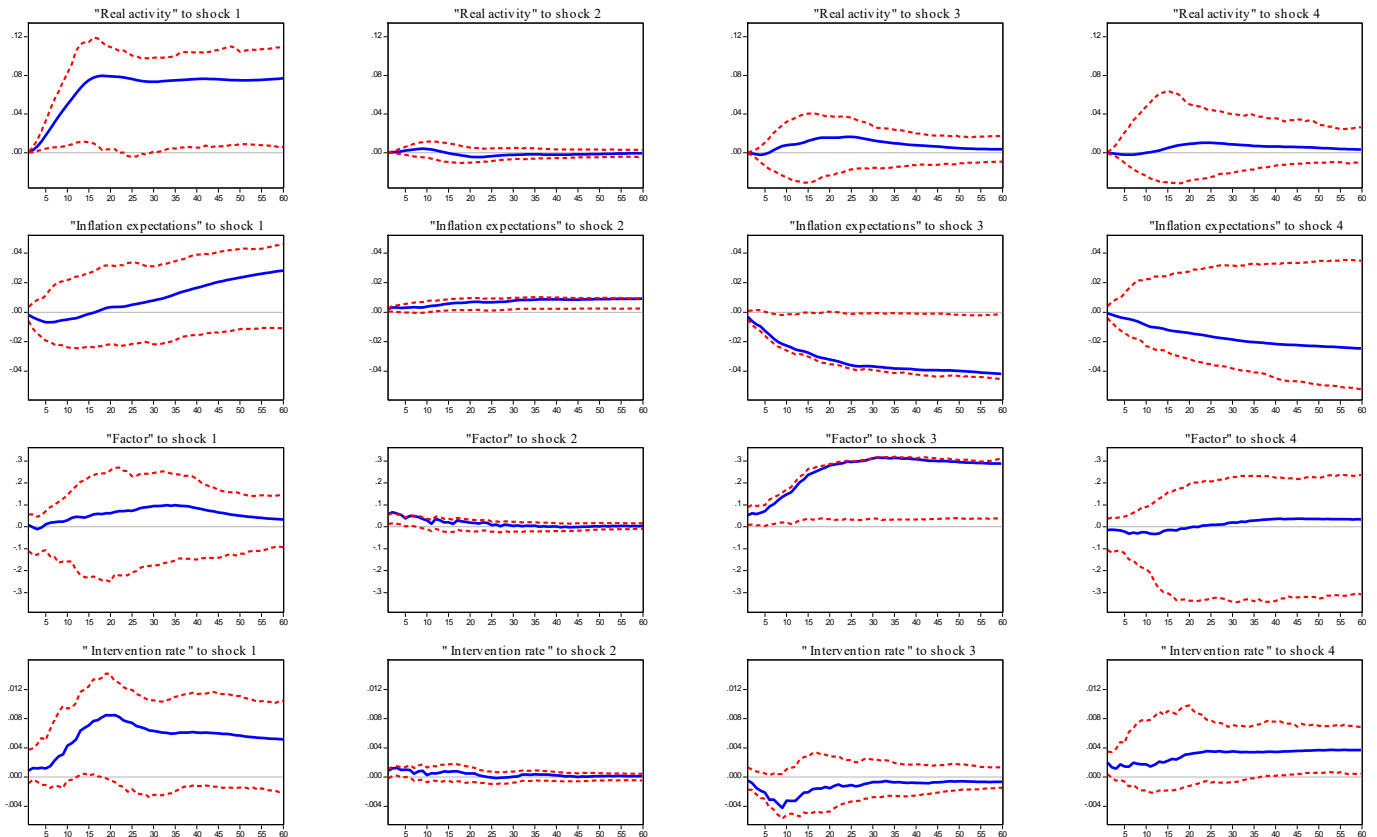
Note: Factor 20 corresponds to a model with inflation expectations one year ahead, factors 7 and 9 correspond to models with inflation expectations five years ahead and factor 17 corresponds to a model with inflation expectations ten years ahead. Source: authors' calculations.

In this model, the vector is represented by  $x_t = [\Delta y_t \quad \pi_t^e \quad f_t \quad \Delta ibr_t]$ , where  $ibr_t$  is the interbank interest rate as a proxy for the intervention rate. The following long-run identifying restrictions are imposed: only technology shocks have long-run effects on economic activity; shocks linked to inflation expectations have long-run effects on neither the selected factor nor the interbank interest rate; the selected factor does not respond to technology shocks; and the nominal interest rate is affected in the long run by technology and monetary policy shocks. The identifying restrictions are represented by:

$$\begin{aligned}
 \sum_{k=0}^{\infty} a_{12,k} &= 0, \quad \sum_{k=0}^{\infty} a_{13,k} = 0, \quad \sum_{k=0}^{\infty} a_{14,k} = 0, \\
 \sum_{k=0}^{\infty} a_{31,k} &= 0, \quad \sum_{k=0}^{\infty} a_{32,k} = 0, \quad \text{and} \\
 \sum_{k=0}^{\infty} a_{42,k} &= 0, \quad \sum_{k=0}^{\infty} a_{43,k} = 0.
 \end{aligned} \tag{8}$$

This set of restrictions implies that all shocks might have long-run effects on inflation expectations; we allow the data to tell us how long the effects of the shocks are. The model described above produces the responses shown in Figure 7. By again using factor 7 in the SVAR specification, the central bank's communications affect the path of inflation expectations. In Figure 7, five-years-ahead inflation expectations are affected by communications while the intervention rate can barely affect this variable. We could conclude that these two elements of an inflation-targeting strategy, in tandem, can generate the results sought by the monetary authority.

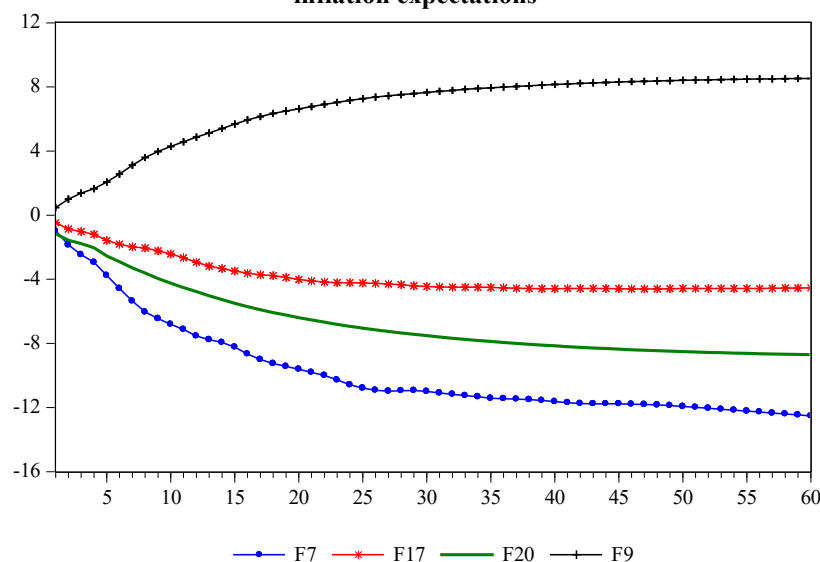
**Figure 7. Accumulated response to structural innovations of economic activity, five years-ahead inflation expectations, communications (factor 7) and intervention rate.**



Note: 95% confidence intervals. Source: authors' calculations.

Finally, Figure 8 shows the accumulated effects of shocks linked to communications of the central bank. As noted, shocks to communications factors affect inflation expectations at different horizons, but factor 9 increases the effect. Interestingly, this factor and factor 17 are both shaped by the word "foods". As we can see, shocks linked to factor 9 increase inflation expectations while shocks connected to factor 17 produce less impact than those associated with factors 7 and 20. Thus, the word "foods" might have special significance for market agents and should be used with some caution in press releases.

**Figure 8. Accumulated response to structural innovations linked to communications of inflation expectations**



Note: Factor 20 corresponds to a model with inflation expectations one year ahead, factors 7 and 9 correspond to models with inflation expectations five years ahead, and factor 17 corresponds to a model with inflation expectations ten years ahead.

## 4. Conclusions

Two of the pillars of an inflation-targeting strategy are transparency and communication. In this work, we provide evidence that press releases, which are the manifestation of these two pillars, are important in many respects. Our reading analysis consists of two elements. First, we observe the coherence between monetary policy actions and press releases and find that inflation and growth are significant factors in the adoption of policy measures. Moreover, when inflation and economic growth both increase, monetary actions become tighter. In this simple review of the association between intervention rate movements and press releases, economic activity nevertheless continues to have greater coefficients than those of inflation, and declining economic activity tends to coincide with reductions in the interest rate. Second, the monetary authority goes beyond explanations in the press releases. There are traces of forward guidance in a number of communications with varying degrees of commitment.

For the first time in Colombia, we also use latent semantic analysis to determine the semantic structure of the central bank's communications between September 2004 and March 2016. This machine-learning technique allows us to extract semantic factors or themes that are used in a structural VAR to identify and measure the impact of these communications on inflation expectations. Our results indicate that Colombia's central bank uses communications as a monetary policy tool and that this strategy influences market inflation expectations. Although more evidence is needed using different techniques, communications can be an important complement to monetary policy measures.

## References

- BENGIO, Y., DUCHARME, R., VINCENT, P., and JAUVIN, C. (2003). A neural probabilistic language model. *Journal of machine learning research*, 3 (2), 1137-1155.
- BHOLAT, D. M., HANSEN, S., SANTOS, P. M., and SCHONHARDT-BAILEY, C. (2015). Text mining for central banks: handbook. *Centre for Central Banking Studies* (33). 1-19.
- BLEI, D.M., NG, A.Y., JORDAN, M.I. (2003). Latent Dirichlet Allocation, *Journal of Machine Learning Research*, 3, 993-1022.
- BLINDER, A.S., EHRMANN, M., FRATZCHER, M., DE HAAN, J., and JANSEN, D.J. (2008). Central Bank Communication and Monetary Policy: A Survey of Theory and Evidence.
- BOUKUS, E. AND ROSENBERG, J.V. (2006). The information content of FOMC minutes. *Working Paper Federal Reserve Bank of New York*.
- CAMPBELL, J. R., EVANS, C. L., FISHER, J. D., AND JUSTINIANO, A. (2012) Macroeconomic effects of Federal Reserve forward guidance. *Brookings Papers on Economic Activity*, 1, 1-80.
- CASTRO, F., 2012, Señales de política monetaria y movimientos en la estructura a plazo de la tasa de interés en Colombia. *Archivos de Economía* 387.
- COLLOBERT, R., WESTON, J., BOTTOU, L., KARLEN, M., KAVUKCUOGLU, K., and KUKSA, P. (2011). Natural language processing (almost) from scratch. *Journal of Machine Learning Research*, 12(8), 2493-2537.
- DEERWESTER, S., DUMAIS, S. T., FURNAS, G. W., LANDAUER, T. K., and HARSHMAN, R. (1990). Indexing by latent semantic analysis. *Journal of the American society for information science*, 41(6), 391.
- DOWNEY, D., BROADHEAD, M., and ETZIONI, O. (2007). Locating Complex Named Entities in Web Text. Vol. 7. *IJCAI*. 2733-2739.
- EUSEPI, S. and PRESTON, B. (2007). Central Bank Communication and Expectations Stabilization. *NBER Working Paper* No. 13259.
- FLOREZ-JIMÉNEZ, M.L. and PARRA-POLANÍA, J.A. (2014). Forward Guidance with an escape clause: When a half promise is better than a full one. *Banco de la República de Colombia*.
- GÓMEZ, J., URIBE, J.D., and VARGAS, H. (2002). The Implementation of Inflation Targeting In Colombia, *Borradores de Economía*, 202, *Banco de la República de Colombia*.
- GOODFRIEND, M. (1986). Monetary Mystique: Secrecy and Central Banking. *Journal of Monetary Economics* 17, 63-92.
- HAMANN, F., HOFSTETTER, M., and URRUTIA, M. (2014). Inflation targeting in Colombia, 2002–12. *Economía*, 15(1), 1-37.
- HENDRY, S., and MADELEY, A. (2010). Text mining and the information content of Bank of Canada communications (No. 2010, 31). *Bank of Canada Working Paper*.

- LANDAUER, T.K., FOLTS, P.W. and LAHAM, D. (1998). An Introduction to Latent Semantic Analysis. *Discourse Processes*, 25, 259-284.
- NEUENKIRCH, M. (2012). Managing financial market expectations: The role of central bank transparency and central bank communication. *European Journal of Political Economy*, 28, 1–13.
- NEUENKIRCH, M. (2013). Central bank transparency and financial market expectations: The case of emerging markets. *Economic Systems*, 37, 598–609.
- POOLE, W. (2001). Expectations. *Federal Reserve Bank of St. Louis Review*, 83, 1, 1–10.
- RIGOBON, R., and SACK, B. (2006). Noisy Macroeconomic Announcements, Monetary Policy, and Asset Prices (No. 12420). *National Bureau of Economic Research, Inc.*
- ROMER, C.D. and ROMER, D.H. (2000). Federal Reserve Information and the Behavior of Interest Rates. *American Economic Review*, 90, 3, 429–457.
- SHILLER, R. (2017). Narrative Economics. *American Economic Review*, 107(4): 967–1004
- SMITH, A. L., AND BECKER, T. (2015). Has forward guidance been effective? *Economic Review-Federal Reserve Bank of Kansas City*, 57.
- SVENSSON, L. E. (1998). Inflation Targeting as a Monetary Policy Rule.
- TAKEDA, Y. and KEIDA, M. (2017). Computer-based narrative analysis of the Bank of Japan's Governor Kuroda. *VOX CEPR's Policy Portal*. Obtained from <http://voxeu.org/article/central-bank-communication-strategies>.
- VAN DER CRUIJSEN, C., EIJJFINGER, S., and HOOGDUIJN, L. (2010). Optimal central bank transparency. *Journal of International Money and Finance*, 29(8), 1482–1507.
- WALSH, C. E. (2006) Optimal Economic Transparency. Vol. 8. *In Workshop*, May, 10.
- WOODFORD, M., (2001) Monetary Policy in the Information Economy. *The National Bureau of Economic Research*. 297–370.

## Appendix

Table A1. Topic references derived from the reading approach

Date	Inflation	Economic growth	Exchange rate	International context	Signal	Intervention rate variation
01/09/2004	-1	1	-1	0		0
01/10/2004	-1	1	-1	1		0
01/11/2004	-1	-1	0	-1		0
01/12/2004	-1	-1	-1	0		-25
01/01/2005	-1	-1	0	0	1	0
01/02/2005	-1	0	0	0	1	0
01/03/2005	-1	0	0	0	1	0
01/04/2005	-1	0	0	0		0
01/05/2005	-1	0	0	0		0
01/06/2005	-1	0	0	0		0
01/07/2005	-1	1	0	0		0
01/08/2005	-1	1	0	0		0
01/09/2005	-1	0	0	0		0
01/10/2005	-1	0	0	0		0
01/11/2005	0	0	0	0		-50
01/12/2005	-1	0	0	0		0
01/01/2006	-1	1	0	0		0
01/02/2006	-1	1	0	0		0
01/03/2006	-1	1	0	0		0
01/04/2006	-1	1	0	0		25
01/05/2006	-1	1	0	0		0
01/06/2006	-1	1	0	0		25
01/07/2006	-1	1	0	0		0
01/08/2006	1	0	0	0		25
01/09/2006	-1	1	0	0		25
01/10/2006	-1	1	0	1		25
01/11/2006	-1	1	0	0		0
01/12/2006	-1	1	0	0		25
01/01/2007	-1	1	0	0		25
01/02/2007	-1	1	0	0		25
01/03/2007	-1	1	0	0		25
01/04/2007	-1	1	0	0		25
01/05/2007	1	1	0	0		25
01/06/2007	0	1	0	0		25
01/07/2007	-1	1	0	1		25
01/08/2007	-1	1	0	0	1	0
01/09/2007	-1	1	0	1		0
01/10/2007	-1	1	0	0		0
01/11/2007	-1	1	0	1		25
01/12/2007	1	1	0	0		0
01/01/2008	1	1	0	-1		0
01/02/2008	1	1	0	-1		25
01/03/2008	1	1	0	-1		0
01/04/2008	-1	1	0	-1		0
01/05/2008	-1	1	0	0		0
01/06/2008	1	-1	0	0	1	0
01/07/2008	1	-1	0	0		25
01/08/2008	1	-1	1	-1		0
01/09/2008	1	-1	0	-1		0
01/10/2008	-1	-1	1	0		0
01/11/2008	-1	0	0	0		0
01/12/2008	-1	-1	0	-1		-50
01/01/2009	-1	-1	0	-1		-50
01/02/2009	-1	-1	1	-1		-100
01/03/2009	-1	-1	0	-1		-100
01/04/2009	-1	-1	0	-1		-100
01/05/2009	-1	-1	0	1		-100
01/06/2009	-1	-1	0	1		-50
01/07/2009	-1	0	-1	1		0
01/08/2009	-1	1	0	1		0
01/09/2009	-1	1	0	0	1	-50
01/10/2009	-1	1	0	-1	1	0
01/11/2009	-1	0	0	1		-50
01/12/2009	-1	1	0	1		0
01/01/2010	-1	1	0	1		0
01/02/2010	1	1	0	1		0
01/03/2010	-1	1	0	1		0
01/04/2010	-1	0	0	1		-50
01/05/2010	1	0	0	1		0
01/06/2010	1	1	0	1		0

Source: Colombia's central bank communications; authors' interpretations.

Table A1 (continued). Topic references derived from the reading approach

Date	Inflation	Economic growth	Exchange rate	International context	Signal	Intervention rate variation
01/07/2010	1	1	-1	1		0
01/08/2010	-1	1	-1	1		0
01/09/2010	1	1	0	1		0
01/10/2010	-1	1	1	1		0
01/11/2010	1	1	1	1		0
01/12/2010	1	1	1	-1		0
01/01/2011	1	1	0	1		0
01/02/2011	1	1	0	-1		25
01/03/2011	-1	1	0	1	1	25
01/04/2011	0	1	0	1		25
01/05/2011	-1	1	0	0	1	25
01/06/2011	1	1	0	1		25
01/07/2011	1	1	0	-1		25
01/08/2011	1	1	0	-1	1	0
01/09/2011	0	1	0	-1	1	0
01/10/2011	1	1	0	-1	1	0
01/11/2011	1	1	0	-1		25
01/12/2011	-1	1	0	-1		0
01/01/2012	1	1	0	-1		25
01/02/2012	-1	1	0	-1		25
01/03/2012	0	-1	-1	-1		0
01/04/2012	-1	-1	-1	-1		0
01/05/2012	-1	-1	1	1		0
01/06/2012	0	-1	0	-1		0
01/07/2012	-1	-1	0	-1		-25
01/08/2012	-1	-1	0	-1		-25
01/09/2012	1	-1	0	-1		0
01/10/2012	0	-1	0	-1		0
01/11/2012	0	-1	0	-1		-25
01/12/2012	-1	-1	0	-1	1	-25
01/01/2013	-1	1	0	1		-25
01/02/2013	-1	-1	0	-1		-25
01/03/2013	-1	-1	0	-1		-50
01/04/2013	1	-1	0	-1		0
01/05/2013	1	1	1	-1		0
01/06/2013	0	-1	1	0		0
01/07/2013	1	1	1	0		0
01/08/2013	-1	1	1	-1		0
01/09/2013	0	1	0	1		0
01/10/2013	0	1	-1	1		0
01/11/2013	-1	1	0	1		0
01/12/2013	-1	1	0	1		0
01/01/2014	0	1	1	1		0
01/02/2014	0	1	0	1		0
01/03/2014	1	1	0	-1		0
01/04/2014	0	0	-1	1		25
01/05/2014	0	1	-1	1		25
01/06/2014	1	1	0	1		25
01/07/2014	-1	1	0	-1		25
01/08/2014	1	1	0	1		25
01/09/2014	0	1	1	-1		0
01/10/2014	0	1	1	-1		0
01/11/2014	1	1	1	-1		0
01/12/2014	0	-1	1	-1		0
01/01/2015	0	1	1	-1		0
01/02/2015	1	1	1	-1		0
01/03/2015	1	-1	1	1		0
01/04/2015	1	-1	-1	-1		0
01/05/2015	1	-1	1	-1		0
01/06/2015	-1	-1	1	-1		0
01/07/2015	0	0	1	-1		0
01/08/2015	1	-1	1	-1		0
01/09/2015	1	1	1	-1		25
01/10/2015	1	1	1	-1		50
01/11/2015	1	1	1	-1		25
01/12/2015	1	1	1	-1		25
01/01/2016	1	1	1	-1		25
01/02/2016	1	1	1	-1		25
01/03/2016	1	1	-1	0		25

Source: Colombia's central bank communications; authors' interpretations.

