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¿Cómo se Comunican los Bancos Centrales? Análisis de la Estrategia de Comunicación del Banco de México desde un Enfoque de Minería de Textos

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Master of Science in Data Science

How do Central Banks Communicate? Analysis of Banco de México's Communication Strategy from a Text Mining Approach

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Introduction

In the last two decades, there has been a paradigm shift among central banks (CBs) going from an absolute silence, in order to surprise market participants, to an increasing transparency and accountability about its actions, strategies and goals.[1] In this sense, CBs' communication strategy has become a key tool for achieving a high degree of transparency and accountability, both institutionally and individually by each committee member.[2] The majority of CBs over the world have increased and improved its communication with the public trying to achieve a high degree of credibility. Therefore, a lot of questions have arisen about the effectiveness of CBs' communication. Has it helped the public to understand the CBs' reaction function and actions?[3] Which are the desired characteristics of CBs' communication? How can we measure those characteristics? Does communication play a role when predicting future monetary policy rates? Does CBs' communication affect financial markets? And most importantly, does the monetary policy authority and market participants benefit from an improvement in the way CBs communicate with the public?

There is consensus among central bankers and academics about the benefits and importance of adopting a proper communication strategy.[4] First of all, through its communication tools a CB can enhance the predictability of upcoming rate decisions and, therefore, diminish monetary policy surprises reducing costs to market participants.[5] Second, a high degree of predictability and a proper

[1] See Lustenberger and Rossi (2018)

[2] Appendix A shows the glossary of acronyms and abbreviations for future reference.

[3] The reaction function of a CB indicates how it modifies its monetary policy response to specific economic developements.

[4] See, for example, Woodford, 2005; Blinder et al., 2008; Hayo and Neuenkirch, 2010; El-Shagi and Jung, 2015; Lustenberger and Rossi, 2018.

[5] Fracasso et al., 2003; Woodford, 2005; Ehrmann and Fratzscher, 2007b; Blinder et al., 2008; Hayo and Neuenkirch, 2010; Lustenberger and Rossi, 2018.

communication strategy contribute to an effective transmission of monetary policy, allowing CBs to influence market expectations which, at the end, define if it will be able to achieve its goals on the horizon in which monetary policy operates.[6] Third, a solid communication strategy is specially important for inflation targeters, whose monetary policy actions are directly related to the inflation forecasts; therefore, a clear communication on how those forecasts are obtained reduces market speculation.[7] Fourth, a frequent, timely and accurate communication can help to improve economic forecasts derived from theoretical models and thus, help to improve market participant's investment decisions.[8] Finally, a clear and simple communication can positively impact financial markets reducing volatility, specially during periods of high uncertainty since market participants can incorporate CBs' expectations and important risk factors for the economic outlook.[9] However, it must be recognized that some studies point out that more information can complicate the process of communication of CBs, possibly affecting its functions and credibility, and that a more complex communication could introduce unnecessary "noise" that might increase uncertainty for economic agents.[10] Notwithstanding the above, the empirical and theoretical evidence suggest that the beneficial effects of a clearer communication strategy based on transparency and accountability are greater.

CBs communicate through a wide variety of tools, each of which has an specific audience and purpose. Many tools derive from their legal provisions and are published periodically, such as post-meeting monetary policy statements, minutes, inflation reports and congressional hearings. Other tools, like speeches, interviews or webpage contents, aim to clarify the CBs' posture and/or complement the information given in periodical publications. Although most CBs use the same communication tools, there is no clear consensus on which are their desirable characteristics. However, these tools have some elements in common that contribute to improve the public understanding of CBs' functions and actions. In the first place, communication has to be simple and concise, providing economic agents only with relevant and necessary information.[11] Additionally, it has to be easy to read to avoid introducing unnecessary "noise" that could confuse the reader.[12] Second, CBs' communication should be structured and consistent over time to allow the reader to familiarize with the content and to rapidly notice

[6] Fracasso et al., 2003; Woodford, 2005; Blinder et al., 2008; El-Shagi and Jung, 2015; Lustenberger and Rossi, 2018; Haldane et al., 2019; Beaupain and Girard, 2020.

[7] Fracasso et al., 2003; Haldane et al., 2019.

[8] Hayo and Neuenkirch, 2010; El-Shagi and Jung, 2015; Lustenberger and Rossi, 2018.

[9] Ehrmann and Fratzscher, 2007a; Hayo et al., 2012; Lustenberger and Rossi, 2018.

[10] See Österholm et al., 2008; Coenen et al., 2017; Lustenberger and Rossi, 2018.

[11] Bernanke et al., 2004; Blinder, 2018; Haldane and McMahon, 2018; Haldane et al., 2019

[12] Haldane and McMahon, 2018; Haldane et al., 2019.

changes in the message.[13] Third, most CBs publish their economic forecasts in at least one periodic communication tool; however, the publication format —point forecasts, fan charts, tables and reference intervals— varies among them.[14] Fourth, it is important that CBs' communication states a clear tone since it helps to understand if the monetary policy strategy is predominantly on the tightening side or on the loosening side.[15] Lastly, it is desirable that CBs publish information on the voting record and/or dissident votes on each monetary policy decision (MPD) to give a notion of the level of consensus and/or dissent among the members of the committee about the economic outlook and risks.[16]

Given its importance, there is a vast and growing literature on CBs' communication.[17] The majority of documents in the literature, have analyzed the impact of communications in forecasting the monetary policy rate (MPR) and/or the yield curve using linear regression, ordered probit or Taylor Rule models.[18] Many others have explored how communications can influence volatility in financial markets and commodity prices using linear regression and GARCH models, as well as event study methods.[19] Also, few studies have focused on describing the characteristics of different communication tools.[20]

The literature covers some of ways of measuring CBs' communication. For example, many studies create a categorical variable from the observed change in the target rate to measure the quantitative communication of CB's; others use different indicators to measure the ease of reading of some communication tools, and some other studies create indexes to measure the tone of the monetary policy documents. However, most of the studies define their communication variables in a subjective and unstructured way. For example, Rosa (2011) manually codes on a numerical scale the tone of the Federal Reserve (Fed) regarding the future direction of its monetary policy; Hayo et al. (2010) manually classify documents as being related to monetary policy or economic outlook; and Fracasso et al. (2003) evaluate the inflation reports of 20 CBs using five readers who evaluate, in a numerical scale from one to ten, the degree of quality, clarity, quantity, overall trade-off, facility to find information, preparation and presentation of inflation

[13] Beaupain and Girard, 2020; Ehrmann and Talmi, 2020.

[14] Tarkka and Mayes, 2000; Geraats, 2001; Fracasso et al., 2003; Woodford, 2005.

[15] Cannon, 2015; Tobback et al., 2017.

[16] Gerlach-Kristen, 2004; Sibert, 2006; Blinder, 2007; Gersbach and Hahn, 2008; El-Shagi and Jung, 2015.

[17] The literature on CBs' communication is thoroughly reviewed in chapter 1.

[18] Fracasso et al., 2003; Kohn and Sack, 2003; Tabak, 2004; Pakko, 2005; Reeves and Sawicki, 2007; Hayo and Neuenkirch, 2010; El-Shagi and Jung, 2015; Lustenberger and Rossi, 2018.

[19] See Kohn and Sack, 2003; Connolly et al., 2004; Rosa and Verga, 2007; Hayo et al., 2010; Jansen, 2011; Rosa, 2011; Hayo et al., 2012.

[20] See Fracasso et al., 2003; Luangaram et al., 2017; Binette and Tchebotarev, 2019.

forecasts, as well as the overall assessment of the last inflation report; and then, use the mean and variance of those evaluations as input for their model. Moreover, all these studies assume that the arbitrarily constructed communication measures are correctly defined and/or correctly classified, but their definitions and/or classifications may still be influenced by personal judgment. Additionally, it should be pointed out that, even though there is an increasing interest on CB communication, the majority of the studies have focused on central banks of the major advanced economies, and there are just a few documents analyzing CB communications of emerging economies.[21]

This thesis attempts to solve the aforementioned problems by analyzing the communication characteristics of the central bank of Mexico, Banco de México (Banxico), and its relation with monetary policy using a text mining approach to objectively define and compute communication measures. Specifically, we want to address the following questions. What are the main characteristics of Banxico's communication tools? How have these characteristics evolved through time? Does Banxico's communication contain additional information different from that already provided by macroeconomic variables to help market participants predict future target rate movements? Are Banxico's communication characteristics and its relation with monetary policy similar to those of CBs of other economies? To answer these questions, we focus on the analysis of Banxico's main monetary policy documents: the post-meeting statements and the monetary policy meeting minutes. In this sense, this research work meets several objectives. First, we seek to construct a novel database of Banxico's main communication tools that allows us to analyze its characteristics, as well as to implement and/or extend the existing economic research on monetary policy. Second, we attempt to create objective communication measures that help evaluate the previously described desired characteristics, and then establish some stylized facts for Banxico's communication strategy. Third, we seek to address if Banxico's communication has had any relation with its conduct of monetary policy. Finally, we attempt to compare Banxico's communication characteristics and its relation to monetary policy with those of the Fed, which is one of the main reference worldwide in terms of monetary policy.

To this end, we first do web scrapping and download all the available monetary policy statements and minutes, in Spanish and English, from Banxico's webpage. Then, using regular expressions we extract relevant information from each document to create our Banxico's communication database.[22] This information

[21] See for example Nicolay and de Oliveira, 2019; Su et al., 2020; Vega et al., 2020.

[22] A regular expression (regex) is a sequence of characters that specifies a search pattern. Regex are often used to find (or replace) strings that match an specific patter.

includes the date of the MPD, the change on the target rate and its new level, the members of the Governing Board, the voting records including the name of the board members that voted in favor and against the monetary policy action, dissident votes (if any), and the complete text of the corresponding statement or minute from which communication measures will be extracted. Second, for each document we compute several existing measures of length and ease of reading, and we create three new communication indicators: i) to measure the degree of consistency, we create a text similarity index for two consecutive documents using the Jaccard similarity measure; ii) we create our own tone index, the Hawkish-Dovish Index (HD-Index), using a semantic orientation approach through the dictionaries technique in order to objectively measure if the language used in each statement and minute is predominantly on the tightening side (hawkish) or on the loosening side (dovish); iii) we make use of the minutes' drafting to create measures of the degree of consensus/dissent among the Governing Board. Third, following the most common approach in the literature, we estimate a Taylor Rule model with inflation and output gaps and augment it with our communication variables to examine if monetary policy statements and minutes provide additional significant information when estimating the monetary policy target rate. Finally, as an extension of this work, we repeat the complete methodology for the case of the Fed and compare the results for both CBs. This methodology has four main advantages: i) the use of objective communication measures eliminating the need for external readers and the incorporation of personal judgments; ii) the communication measures can easily be computed for other communication tools such as inflation reports, speeches and interviews; iii) it can be easily and systematically applied to future MPD; iv) it can be easily extended and applied to analyze the communications tools of other CBs.

This thesis contributes to the literature of CBs' communication in three specific ways. First, we create a novel database on CBs' communication through the development of an R package, "ComunicacionBCs", that provides the necessary tools to extract (with web scraping), clean, process, store and analyze, in a systematic and structured way, the relevant information available in statements and minutes. Even though this work covers only the case of Banxico and the Fed, by the time this thesis was finished, our R package contains the necessary tools to extract statements of seven CBs from advanced and emerging economies, including the Federal Reserve, European Central Bank (ECB), Bank of England (BoE), Reserve Bank of Australia, Banco de México, Banco de la República de Colombia and Banco Central Chile, as well as the minutes for Banco de México and the Federal Reserve.[23] Second, we use objective communication measures

[23]For now, the ComunicacionBCs R package is only available for local installation upon request. Ideally, when complemented to extract communication tools for the rest of CBs of

in our analysis, two of which, to the best of our knowledge, have not been used in previous research (text similarity and consensus/dissent). Additionally, the dictionaries used for our tone index strengthen those already found in the literature. Third, we are not aware of any studies that analyze the evolution of Banxico's communication characteristics nor to measure the relation between communication and its implementation of monetary policy.

The main results derived from this research project can be divided into empirical results and institutional impact. At the empirical level, through this research we find that Banxico and the Fed share some stylized facts about its communication strategy, pointing towards a clearer, simpler and more consistent communication to enhance transparency and accountability. As for the relation between communication and monetary policy, in the context of monetary policy rules, we find evidence that almost all of our communication measures provide additional information to that already contained in macroeconomic variables for both Banxico and the Fed. However, there are some differences in the sign and significance of the estimated coefficients for both CBs which may be due to the proper nature of their financial systems, as well as the difference in their mandates. Part of the work presented in this thesis has also had institutional impact. The analysis about the evolution of Banxico's communication characteristics was presented to the Governing Board to identify opportunity areas for a simpler and more clearer, transparent and effective communication with the public.

The rest of this thesis is structured as follows. Chapter 1 describes the role of communication in central banking, the purpose and specific audience of each available tool, as well as its desired characteristics. Additionally, this chapter provides a thorough review of the literature on the topic. Chapter 2 develops the length, ease of reading, text similarity index, tone index and consensus/dissent variables that we propose to measure CBs' communication. Chapter 3 provides a succinct review of Banxico's history and mandate, communication toolkit, and reforms to its communication strategy, and then focuses on describing the evolution of its communication characteristics. Chapter 4 gives a brief review on the Taylor Rule for monetary policy and reports the main results obtained from augmenting the baseline models with our communication variables for Banxico's communications. Additionally, this chapter presents a series of robustness tests. Chapter 5 extends this thesis to the case of the Fed comparing the evolution of its communication characteristics and its relation with monetary policy with that of Banxico. Lastly, conclusions are presented with a brief summary of the main results as well as possible extensions to this research work.

interest, it will be formally published as an R package in the Comprehensive R Archive Network (CRAN).

Chapter 1

The Role of Communication in Central Banking

1.1 Importance of Communication in Central Banking

About two decades ago, central bankers believed that, to maximize its impact, their MPD should take market participants by surprise. However, the independence of monetary policy institutions implies greater responsibility and demands major transparency and accountability from its committee members, both individually and as a whole, as a counterbalance (see Fracasso et al. (2003); Lustenberger and Rossi (2018); Beaupain and Girard (2020)). As a result, CBs' communication has recently shifted towards a policy of greater transparency with respect to the goals, strategies, data, and methodologies on which the MPD are taken (see El-Shagi and Jung (2015); Lustenberger and Rossi (2018); Beaupain and Girard (2020)). In summary, independent CBs have the duty of explaining not only their actions, but also the reasoning behind them.

Such transparency and accountability is directly related to the confidence that economic agents have in the CB and contribute to built on its credibility. Blinder (1998) notes that "credibility is painstakingly built up by a history of matching deeds to words. A CB that consistently does what is says, will acquire credibility

by this definition almost regardless of the institutional structure". In simple terms, "the main point of transparency and accountability is to teach market participants to think like the CB does", Lustenberger and Rossi (2018).

There is consensus among academics and central bankers on that a CB's communication strategy is important not only as a key instrument in the conduct of monetary policy, but also as a mechanism of transparency and accountability (see for example Blinder et al. (2008), Woodford (2005), Hayo and Neuenkirch (2010), Lustenberger and Rossi (2018), and El-Shagi and Jung (2015)). CBs have become more transparent in many forms, but the most important is through its communication with the public. To this end, they have taken a wide variety of actions: from changing the format of their publications, to increasing their frequency and/or implementing new ways of communicating with the public such as infographics, webinars or events oriented to promote that different organizations hear about how monetary policy affects peoples' daily life.[1] For example, according to Hayo and Neuenkirch (2010) it has become a common practice to indicate the future course of monetary policy in the post-meeting statements and inflation reports.

However, Österholm et al. (2008) point out that "more information is not always better". An excess of information can also complicate the process of communication and affect the functions and credibility of the CB. For instance, in a context of high uncertainty, economic agents could misunderstand the future monetary policy actions as a promise of the CB and, when unpredictable events affect those actions, the CB's credibility may be damaged. The literature also suggests that a complex communication can increase uncertainty in financial markets and may increase forecast errors (see Coenen et al. (2017); Lustenberger and Rossi (2018)). This is, complex communications result "noisy" and stop helping economic agents improve their macroeconomic forecasts. Finally, more openness can give the impression that the CB knows more than what it really does, and therefore economic agents may rely too much on its announcements, loosing their ability to incorporate other types of available information.

Notwithstanding the above, the empirical and theoretical evidence suggest that the beneficial effects of a clearer communication strategy based on transparency and accountability are greater. First of all, greater clarity and increased transparency can enhance the predictability of upcoming rate decisions and, therefore,

[1] See for example the "Fed Listens" initiative from the Federal Reserve Bank at `https://www.federalreserve.gov/monetarypolicy/review-of-monetary-policy-strategy-tools-and-communications-fed-listens-events.htm`, accessed on September 13, 2021.

diminish monetary policy surprises. If communication is well executed, it allows economic agents to recognize the objectives and strategies of the monetary policy authority, minimizing adjustment costs as they can take into account the expected path for the target rate. For example, Lustenberger and Rossi (2018) note that more certainty about when and how will the central bank change its target rate can reduce market interest rate's volatility, increasing CB's leverage over longer-term interest rates and smoothing the incorporation of policy actions into asset prices. Fracasso et al. (2003) study the inflation reports of 20 countries and find that greater clarity significantly reduces monetary policy surprises. Ehrmann and Fratzscher (2007b) show that a more dispersed communication about the Fed's monetary policy is associated with less predictable MPD for the short and medium term.

Second, a high degree of predictability contributes to an effective transmission of monetary policy. One way through which the CB impacts the economy is through the expectations channel. An improved communication could reduce uncertainty regarding the CB's reaction function and properly influence market expectations which, at the end, define if the CB will be able to achieve its goals on the horizon in which monetary policy operates.[2] Moreover, because the monetary policy authority can only move short-term rates with their MPD, a clear communication could help to translate those movements into longer-term rate movements, which are the ones that influence the investment decisions of businesses and consumers.[3] El-Shagi and Jung (2015) highlight that market participants completely ignore CB's signals once they lose confidence in their communications. In this sense, if a CB has a credible communication strategy it can assess a higher degree of predictability, contributing to an effective transmission of its monetary policy.

Third, a solid communication strategy is specially important for inflation targeters.[4] CBs with an inflation target regime relate their monetary policy actions

[2]Sousa and Yetman (2016) states that inflation expectations play two important roles in CB: i) as inputs into price and wage setting providing statistics of where inflation is likely to be headed, and ii) in assessing its credibility of the inflation target.

[3]The exception are those CB who implement Yield Curve Control, such as the Bank of Japan who states that "... the Bank decided to introduce Quantitative and Qualitative Easing (QQE) with Yield Curve Control, which is a new framework for strengthening monetary easing in which the Bank controls short- and long-term interest rates through market operations". Information from `https://www.boj.or.jp/en/mopo/outline/qqe.htm/`; accessed on September 03, 2021.

[4]A CB is said to be an inflation targeter if its primary goal is to maintain price stability. To this end, the CB defines a numerical inflation target and adjusts its monetary-policy strategy in order to achieve it. Additionally, the CB should unambiguously relate its policy actions to inflation forecasts, such that these are credible and not adjusted to justify the policy decisions. See Fracasso et al. (2003) and Svensson (2010).

to inflation forecasts, which are subject to uncertainty and will frequently turn out to be inaccurate. Therefore, publishing those forecast and/or giving detailed information on how forecasts are obtained could enhance transparency as well as institutional and individual accountability, so that those forecasts are credible and market participants do not think that committee members deliberately mislead them merely to justify the policy actions. As Fracasso et al. (2003) point out "inflation targeting is a precise framework with imprecise policy implications, and to be understood and generally accepted, it needs to be accompanied by clear and precise communication".

Fourth, if communication is used frequently, timely and accurately, it can help to improve economic forecasts (external to the CB) provided by theoretical models (see Hayo and Neuenkirch, 2010). El-Shagi and Jung (2015) highlights that market participants carefully listen to CBs' communications in order to obtain hints about the future course of monetary policy when deriving probabilities of the future interest rate path.

Fifth, a better communication can positively impact financial markets.Hayo et al. (2012) point out that CBs play the role of "financial markets psychologists" since, by communicating with the public, they can calm the markets. Many empirical studies support this idea. For example, Lustenberger and Rossi (2018) point out that transparency and communication reduce volatility in financial markets, and Ehrmann and Fratzscher (2007a) find that the European Central Bank's press conference has great effect in asset prices, possibly due to the fact that the Q&A session allows to clarify doubts. Additionally, communication is specially important during periods of high uncertainty, since market participants can incorporate the CB's expectations and important risk factors for the economic outlook reducing what is known as Knightian uncertainty.[5]

[5]Knightian uncertainty is defined as the lack of any quantifiable knowledge about some possible occurrence. Frank H. Knight clearly distinguishes between risk and uncertainty. He points out that risk is a situation in which we do not know the outcome but we can accurately measure the odds of the possible events; this is, risk is a quantity susceptible of measurement and form which one can protect from. In contrast, uncertainty is a situation in which we do not have all the information necessary to know the possible outcomes, and therefore, can not accurately measure the odds; this is, uncertainty is a lack of information and a not quantifiable measure. For more detail see Knight Frank (1921).

1.2 How do Central Banks Communicate with the Public?

Currently, CBs provide a large volume of information and communicate through various channels. Additionally, this information tends to be available more quickly, more frequently and for a larger audience. Therefore, CBs have a wide range of communication tools, each of which has an specific audience and purpose. Moreover, different aspects of the monetary policy strategy need to be communicated through different channels. Communication tools can be classified as infrequent or frequent (Hayo and Neuenkirch, 2010). Many of the infrequent tools, such as post-meeting monetary policy statements, minutes, inflation reports and congressional hearings, derive from the legal provisions of CBs; while frequent tools, like speeches, interviews and webpage contents, aim to clarify the CB's posture and/or complement the information given in the infrequent ones. We briefly describe the objectives and scope of each communication tool.

1.2.1 Monetary Policy Statements

The majority of CBs around the world announce their MPD to the general public through a monetary policy statement (MPS) or press release immediately after their monetary policy meetings. This is probably the most far-reaching communication tool of a CB since it explains, in a concrete way, the rationale behind its decisions and its assessment of the global and domestic economic conditions, as well as the outlook for inflation and growth. MPS is geared for a general audience and is a tool for institutional accountability.

1.2.2 Monetary Policy Minutes

The monetary policy minutes (MPM) is a post-meeting communication tool that provides detailed information about the reasons underlying the MPD, as well as the Committee's individual view of the future economic outlook and associated risks to inflation and economic growth. In this sense, MPM are an extension of the MPS which are usually published two to three weeks after the MPD. It is also a common practice to publish the voting records in the MPM to give information about the distribution of individual votes, as well as a rationale of those with a dissenting vote. In this sense, the MPM is viewed as a tool for individual accountability, however it also supports for collective accountability. Additionally, it is mainly geared for specialized audience because of its high technical level content.

1.2.3 Monetary Policy Transcripts

The monetary policy transcript is also a post-meeting communication tool that provides a detail record of the meeting preceedings. They are normally produced from the audio recording of the meeting and could be slightly edited to facilitate its reading. The Federal Reserve Bank, ECB, Bank of Japan, Bank of England, as well as the CBs of Norway, Mexico, Chile and Czech Republic make public the transcripts of their monetary policy meetings with a minimum lag of three years and a maximum lag of 30 years. Transcripts are a tool for individual accountability and mainly targeted for specialized audience.

1.2.4 Inflation Report

Inflation reports are commonly the central element of the communication strategy since they present all the data, model estimations, analysis, and forecasts used as inputs to provide the MPD, the decision process itself, and all risks associated to the economic outlook that could affect the chosen monetary policy strategy (see Fracasso et al., 2003). The majority of CBs publish their inflation reports in a quarterly basis and include three main components: the observed economic conditions, the CB's forecast for inflation and growth, and the risks to the economic outlook. This document is solely viewed as an institutional tool for accountability and it is geared for a specialized audience.

1.2.5 Press Conferences

A common practice of CBs is to give a press conference after the release of MPS. Normally, it is offered by the Committee's president and is used to explain the MPD, to comment and/or clarify on the monetary policy strategy, and to answer questions from journalists about the committee's view of the economic environment and how it may be affected by different factors. This tool is also a channel for institutional accountability and its geared for the general audience.

1.2.6 Congressional Hearings

By legal provision, some committee's presidents have to appear before commissions of their corresponding Congress each year to render a full report of the actions taken by the CB and to justify the fulfillment of its constitutional mandate.[6] This tool is specifically geared to government authorities and is a tool for institutional accountability only.

[6]Some CB, like the Bank of England, also issue letters to the corresponding government authorities when inflation moves away from the target.

1.2.7 Interviews and Speeches

Interviews and speeches by central bankers have turn into an important communication tool since they allow CBs to give important hints about the economic environment to financial market observers, specially in the intermeeting periods. The advantage is that the monetary authority can comment on the impact of new information of the state of the economy and diminish market speculation. They are generally oriented to all public and are a channel for both, institutional and individual, accountability.

1.2.8 Websites

With the technological progress, CBs adopted the use of websites to extend their means of communicating with the general audience. Through its website, the monetary policy authority not only publishes the documents (or transcripts) previously mentioned, but also publishes its mission, vision and objectives; technical reports and working papers; specific data like exchange rates or bond prices; and announcements, news and events. All these publications are intended to increase the transparency of the CB and to improve the public's understanding of its functions.

1.3 Characteristics of Cental Bank's Communication

Even though there's consensus among CBs in the benefits of improving their communication with the public, it is less clear which are the specific desired elements of an effective communication strategy. However, all the tools described in the previous section have some elements in common that would contribute to improve the public's understanding of CBs' functions and actions.

First of all, the literature suggests that an effective communication strategy should be simple and provide economic agents with relevant and necessary information. Even though most CBs' communications require a highly educated reader, its communication should be complete but concise, and based on facts. Additionally, it is important that their documents are easy to read to avoid confusing or misinforming the public.[7]

[7] See for example Bernanke (2004), Dale et al. (2018), Coenen et al. (2017), Haldane (2017b), Haldane (2017a), and Blinder (2018)

Second, it is desired that CBs' communications are consistent over time. A structured, consistent and continuous text allows the reader to easily identify important changes in the CB's message.[8] This is especially relevant for those banks which use forward guidance as a monetary policy tool. The best example of a CB with consistent communication over time is the Fed, whose consecutive MPS change in just a few words when required by the economic conditions.

A third common characteristic of CBs' communication strategy is the publication of economic forecasts. Economic forecasts are a direct and explicit reference easy to observe and evaluate by the public, improving its communication and, more importantly, the understanding about the scope of monetary policy.[9]

Fourth, the tone of the communications published by the CB is of great importance since the language used by the CB indicates if the monetary policy strategy is predominantly on the tightening side or on the loosening side.[10]

Fifth, it is a common practice among CBs to publish the voting results and dissident votes on each MPD in order to provide more information to the public. This kind of information gives a notion of the level of consensus and/or dissent among the members of the committee. Gersbach and Hahn (2008) note that making public the identity of voters directly contributes to CB's transparency and to the committee's individual accountability. Additionally, it contributes to improve market participants' ability to predict future MPD.[11]

1.4 Literature Review

The literature on CBs' communication is vast and covers a wide variety of topics, both theoretically and empirically. However, the majority of the literature focuses on CBs of the main advanced economies.

Some studies have focused on describing and analyzing the characteristics of certain communication tools. For example Fracasso et al. (2003) evaluate the qualitative characteristics of inflation reports for 20 inflation targeting CBs, Luangaram et al. (2017) examine the readability, key topics and tone of MPS for 22 CBs, and Binette and Tchebotarev (2019) analyze the most used terms, ease of reading and length of the Bank of Canada's Monetary Policy Report.

[8] See Beaupain and Girard (2020); Ehrmann and Talmi (2020).
[9] See Tarkka and Mayes, 2000; Geraats, 2001; Fracasso et al., 2003; Woodford, 2005.
[10] See Cannon, 2015; Tobback et al., 2017.
[11] See Gerlach-Kristen, 2004; Sibert, 2006; Blinder, 2007; El-Shagi and Jung, 2015.

Many other studies have analyzed the impact of communications in forecasting the MPR. For example, Pakko (2005) finds that qualitative information about the balance of risks is a statistically significant variable that helps predict the Fed Funds Rate. Lustenberger and Rossi (2018) run panel regressions to examine whether increased transparency and intensified communication by CBs affect the quality and cross-sectional distribution of monetary policy rate forecasts. Hayo and Neuenkirch (2010) find that the Federal Open Market Committee's (FOMC) informal communications contain useful information about future monetary policy that economic agents could not have acquired otherwise. El-Shagi and Jung (2015) find that information contained in the minutes and voting records of the BoE's Monetary Policy Committee regarding the change on the target rate and the disagreement among the Board provides additional information about the future course of monetary policy and help market participants to improve their short run expectations.

Similarly, some documents explore the influence of communication on the term structure of interest rates. For example, Fracasso et al. (2003) investigate whether the predictability of monetary policy is systematically related to the quality of inflation reports measuring the impact of the later in short-term market interest rates. Kohn and Sack (2003) and Bernanke et al. (2004) show that the publication of FOMC minutes affects interest rate expectations along the entire yield curve, while Reeves and Sawicki (2007) find that BoE's minutes only affect short-term interest rate expectations.

Many authors have focused on the impact of CBs' communication in financial markets. Connolly et al. (2004) explore different communication tools for the United States (US), Canada, Australia, United Kingdom, Euro Zone and New Zealand finding that information in inflation reports, press conferences and congressional hearings affect market expectations and the futures of interest rates. Kohn and Sack (2003), Rosa and Verga (2007), and Jansen (2011) find that MPS and speeches quickly move asset prices in financial markets. Likewise, Hayo et al. (2012) find that Fed's target rate changes and FOMC's communications have significant impact on European and Pacific equity market returns. Rosa (2011) investigates the real time effect on equity and volatility indexes of news originating from the FOMC balance of risk statement, and find that communication has statistically significant and economically relevant effect. Hayo et al. (2012) find that speeches and congressional hearings by the FOMC decrease the volatility on commodity prices.

As for the communication measures, there is also a wide variety of variables found in the literature. Some studies measure the ease of reading of CBs

communication with different indicators. Bulíř et al. (2013) uses the Flesch-Kincaid Grade Level to measure the clarity of different communication tools for seven CBs of advanced and emerging economies. Jansen (2011) uses the Flesch Reading Ease Score and the Flesch-Kincaid Grade Level to test whether clarity of FOMC's communication affects volatility in financial markets. Deslongchamps (2018) evaluates the readability of several documents of the Bank of Canada using the Gunning Fog Index and concludes that they could be simplified to reach a broader audience. Binette and Tchebotarev (2019) extend the previous work to average multiple measures of ease of reading using the Flesch-Kincaid Grade Level, Coleman Liau Index, Gunning Fog Index, Simple Measure of Gobbledygook Index, the Automated Readability Index and the Dale-Chall Score.[12]

The tone of communications is also measured in very different ways. Some studies arbitrarily assign the tone of the document, like Rosa (2011) who uses a narrative approach to "manually" code on a numerical scale the tone of the Fed regarding the future direction of its monetary policy as hawkish (positive), dovish (negative) or neutral (zero). Other studies make use of semantic orientation through the dictionaries technique to measure the tone of communications. For example, Tobback et al. (2017) assess the media's perception of the European Central Bank's press conference tone as hawkish, dovish or neutral with a self-built dictionary and Cannon (2015) classifies the tone of each FOMC discussion as positive, negative or neutral evaluating the orientation of each word in the comments. Lately, some studies have made use of machine learning algorithms to set the tone of CBs' communication. For example, Tobback et al. (2017) use Support Vector Machines to assign a hawkish, dovish or neutral tone to press articles and compare the results to those obtained through semantic orientation; and Binette and Tchebotarev (2019) apply a neural net algorithm to classify the Bank of Canada's Monetary Policy Report into positive, negative or neutral to create a sentiment index.

As for the consensus/dissent among the Committee/Governing Board members, the majority of the studies analyze the voting records published by CBs. For example, Riboni and Ruge-Murcia (2014) use the voting records of the Fed, BoE, and Riksbank to create a categorical variable classifying the vote of each member as 1 if it prefers a tighter policy than the committee, -1 if it prefers a looser policy than the committee and 0 otherwise, and then for each MPD they average this categorical variable to define a measure of dissent. Jansen and Moessner (2016) use the fraction of minority votes as dissent measure to explore if there is a relation between the minutes length and or readability for the Fed, BoE, Bank of Japan and Riksbank. Gerlach-Kristen (2009) use the voting records

[12]Chapter 2 provides more detail on these ease of reading measures.

of the BoE and find that outsiders dissent more often than insiders. Meade (2005) investigate how often was Greenspan's initial proposal the voted outcome using data on the second round discussion of the FOMC meetings. Belden (1989) uses the record of dissenting votes from the FOMC meetings to analyze if policy preferences of bank presidents differ from those of the Governing Board and to investigate if economic uncertainty influence the level of dissent among members. Meade et al. (2015) is the only report we found that uses the text of FOMC minutes to describe the diversity of views among Committee members using the frequency of specific counting words (for example "all", "most", "few", "one") that are used to express a wide range of opinions at the meetings.

The literature also includes other interesting communication measures related to the structure of their committees, mandate, objectives and informal communications. El-Shagi and Jung (2015) add the skew in votation results to include the diversity of views in the committee to their analysis of the BoE's MPM. Dincer and Eichengreen (2010) and Horváth and Vaško (2016) create transparency indexes for the political, economic, procedural, policy and operational aspects of monetary policy transparency to evaluate its impact in inflation. Lustenberger and Rossi (2018) find that the rotation rate of committee members, the number of speeches and interviews, as well as other factors such as central bank instability, implementation of inflation targeting and the use of explicit forward guidance do have an effect in the precision and distribution of forecasts for 73 CBs.

Lastly, as for the methodologies used in the literature to discuss to what extent communication can be used for explaining the target rate decisions of a CB, the majority of the studies use the monetary policy rule framework with a Taylor rule model. Lapp et al. (2003), Pakko (2005), Heinemann and Ullrich (2007), Hayo and Neuenkirch (2010) augment Taylor rule models incorporating different measures of CBs' communication to assess if they provide additional information to that contained on macroeconomic variables. However, other methodologies are also found in the literature. Lustenberger and Rossi (2018) use a fixed-effects regression model to explain the mean and standard deviation of forecast errors of inflation and growth rate in terms of the number of speeches given by each central bank and additional control variables. Hayo and Neuenkirch (2010) use a probit ordered model to explain target rate decisions using communication variables, and El-Shagi and Jung (2015) use the same methodology to forecast interest rates on the day before and after the publication of BoE's minutes and examine if they contain information about the correct direction of the next MPD. Hayo et al. (2010) and Hayo et al. (2012) use general autoregressive-distributed lag GARCH(1,1) with country-specific fixed effects models to examine the impact of all types of FOMC communication in financial markets.

Chapter 2

Communication Measures

This chapter provides a succinct description of the communication measures that will be used to assess the evolution of CB's communication and to address how these measures are related to monetary policy.

2.1 Length Measures

A first element for analyzing the clarity of communications is related to the length of the documents. The relationship between length and clarity in the documents is not direct: on one hand, writing a precise message in a context of high uncertainty typically requires a larger number of words and sentences in order to elaborate more complex ideas; on the other hand, the larger the communication, the higher the risk that the main message is less clear and gets lost. Nevertheless, the length of the documents is an element that provides information about the evolution of communications.

Several measures of length can be extracted from both MPS and MPM including: number of sentences, number of words, number of characters, number of punctuation signs, number of sentences per 100 words, number of letters per 100 words, average sentence length and average word length. Most of these measures can be constructed through different forms of tokenization of the text.[1]

[1] Tokenization is a way to divide a text into smaller units called tokens. Tokens can be words, characters or even sequences of n-characters or n-grams. See section 2.3 for more details.

2.2 Ease of Reading Measures

A more formal way to measure the clarity of communications is through the effort that the reader requires to understand the information contained on a given text. This indicator is known as Ease of Reading (ER). The majority of metrics for measuring the ER are linear models estimated using some characteristics of the text such as the metrics presented in the previous section. The intuition behind this indicator is that more words per sentence or more syllables per word produce a more complex text that is harder to read and that, to fully understand it, a high-educated reader is needed. The easier to read a text, the higher the ER measure is.

There exist several ways of measuring the ER, many of them are designed to approximate a representation of the United States grade level needed to comprehend a text. The Gunning Fog Index, developed by Robert Gunning (see Gunning, 1969) estimates the number of years of formal education needed to understand the text on the first reading. Under this measure, "universal understanding" requires an index less than eight. The Fry readability formula (see Fry, 1968) plots the average number of sentences (x axis) and syllables (y axis) per 100 words in a specific graph, and the intersection of both variables determines the reading level of the content. In contrast, the Automated Readability Index (see Senter and Smith, 1967) and the Coleman-Liau Index (see Coleman and Liau, 1975) use the number of characters per word, instead of the number of syllables per word, and the number of words per sentence to get the level needed to comprehend a text. The Dale-Chall readability formula (see Chall and Dale, 1995) uses a list of 3,000 words that American 4^{th} graders could reliably understand, while any word not on the list is considered to be difficult.

One of the most popular ER indicators is the Flesch Reading Ease Score (Flesch Scale hereafter, see Flesch, 1948) which was developed in 1948 by Rudolf Flesch. This measure, in contrast to the previous ones, ranges ER from 0 (very difficult to read) to 100 (very easy to read); where 0 is equivalent to what a 12^{th} grader can understand and 100 to what a 4^{th} grader can. The Flesch Scale formula was constructed as a regression model to predict the average grade level of a child who could answer 3/4 of test questions related to a given passage taking into account the word length (measured as the average number of syllables in a word) and the sentence length (measured as the average number of words per sentence of the passage). Intuitively, sentences that contain few and "short" words are easier to understand than large sentences using complicated words. Mathematically the

Flesch Scale can be obtained as

$$F = 206.8335 - 84.6\left(\frac{syllables}{words}\right) - 1.015\left(\frac{words}{sentences}\right);$$

thus, the ease of read is maximized when few simple words per sentence are used in a given text.

Many variations surged after the Flesch Scale trying to simplify the formula and/or to adjust the scale to specific tasks and languages. Particularly, in 1975 Peter Kincaid developed a recalculation of the Flesh scale, the Flesch-Kincaid Grade Level, under a contract with the U.S. Navy for assessing the difficulty of technical manuals (see Kincaid et al., 1975). The Flesch-Kincaid Grade Level is obtained as

$$FK = -15.59 + 11.8\left(\frac{syllables}{words}\right) + 0.39\left(\frac{words}{sentences}\right).$$

In 1993, as part of his doctoral dissertation, Francisco Szigriszt extended the Flesh Scale to other languages, in particular to Spanish (see Szigristz, 1992). The Flesh-Szigriszt Scale is computed as

$$FS = 207 - 62.3\left(\frac{syllables}{words}\right) - \left(\frac{words}{sentences}\right).$$

The aforementioned three indicators use the same core measures but with different weighting factors. However, the Flesch Scale (and Flesch-Szigriszt) have an inverse relationship with the Flesch-Kincaid Grade Level: a text with a low ER measured by the Flesch Scale (difficult text) should have a high score measured by the Flesch-Kincaid Grade Level and vice versa. Table 2.1 shows the score interpretation for each measure.

To gain some intuition of the meaning of these scales, Figure 2.1 shows the Flesh Scale and the Flesch Kincaid Scale for four different types of documents: an economic news in the Wall Street Journal,[2] the introduction of a scientific paper,[3]

[2]Fed's Powell Says U.S. Faces 'Tragic' Risks From Doing Too Little to Support Economy, available at `https://www.wsj.com/articles/feds-powell-says-u-s-faces-tragic-risks-from-doing-too-little-to-support-economy-11601995201?mod=searchresults&page=1&pos=8`; accessed on October 7, 2020

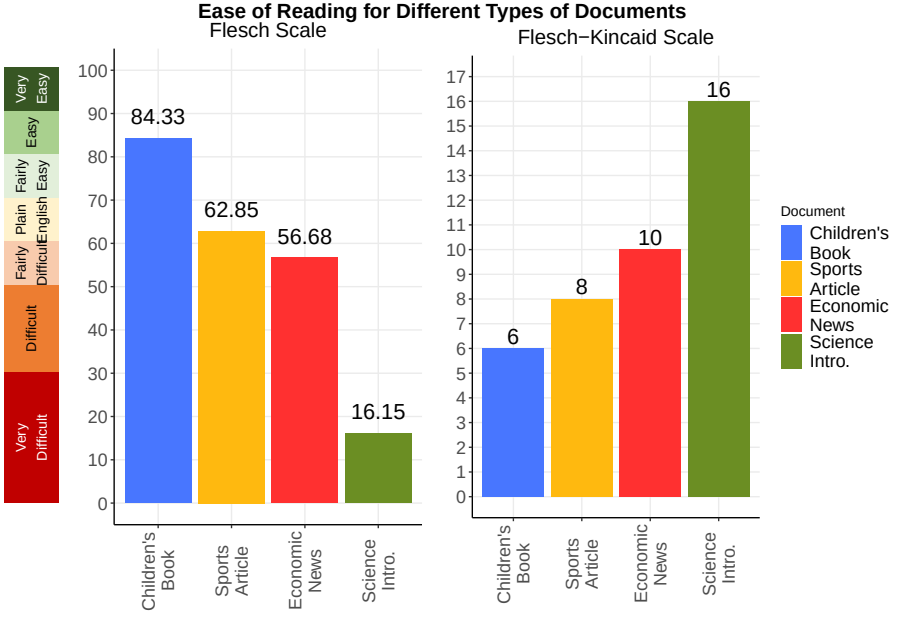
[3]Epifluorescence-based three-dimensional traction force microscopy - Hazeltt, L. et. al. (2020), abstract and introduction available at `https://www.nature.com/articles/s41598-020-72931-6`; accessed on October 7, 2020.

Table 2.1: Ease of Reading Measures Equivalence

	English		Spanish	
Score	Flesch	Flesch - Kincaid (Grade Level)	Flesch Szigriszt	Flesch-Szigriszt (Grade Level)
91-100	Very Easy	5^{th} grade	Very Easy	Basic Education
86-90	Easy	6^{th} grade		
81-85			Easy	Basic Education
76-80	Fairly Easy	7^{th} grade		
71-75			Fairly Easy	Basic Education
66-70	Plain English	8-9^{th} grade		
61-65			Standard	Middle-Basic Education
51-60	Fairly Difficult	10-12^{th} grade		
36-50	Difficult	College	Fairly Difficult	Middle-Superior Education
31-35			Difficult	University
16-30	Very Difficult	College Graduate		
0-15			Very difficult	University Graduate

Notes: This equivalence table was obtained from Szigristz (1992)

Figure 2.1: Comparison of Ease of Reading Measures



Source: Own calculations with information from The Wall Street Journal for the economic news (Fed's Powell Says U.S. Faces "Trag From Doing Too Little to Support Economy), Nature Scientific Reports for the scientific introduction (Epifluorescence−based three−d traction force microscopy − Hazeltt, L. et. al. (2020)), ESPN magazine for the sports article (CONCACAF Nations League: All you ne and Glozman Website for the children's book (Harry Potter and the Sorcerer's Stone).
Notes: All documents are written in English.

a sports article from the ESPN magazine,[4] and a children's book.[5] As any one could have imagined, the easiest document to read is the children's book which has an "easy" ER and can be understood by a 6^{th} grader. The sports article has a "plain English" ER and is easily read by an 8^{th} grader. The economic news is a "fairly difficult" document to read and needs at a grade 10 of education. Finally, and not surprising, the document with the lowest ER is the scientific introduction with a "very difficult" range and can only be understood by college graduates.

2.3 Text Similarity Measure

In order for the communication of a CB to be more effective, it is desirable that two consecutive documents are as similar as possible. This has the advantage that the general public gets familiarized with the content of each document so that they can easily detect when major changes in the CB's message occur as a result of shocks in the macroeconomic environment.[6]

As Vijaymeena and Kavitha (2016) mention, words can be similar in two ways: lexically and semantically. Words are lexically similar if they have a similar sequence of characters, while they are semantically similar if they have the same theme/meaning.[7] In this work we are interested in measuring to what degree are two documents lexically similar. For this purpose, many term-based measures such as the Block Distance, Cosine Distance, Euclidean Distance, Matching Coefficient, Jaccard Similarity, among others (for details see Huang, 2008 and Vijaymeena and Kavitha, 2016) can be estimated.

In particular, the Jaccard Similarity measures how similar is the union to the intersection of two sets. Intuitively, the more alike two sets are, the more similar their union and intersection will be. For two given sets, A and B, the Jaccard Similarity is given by

$$JS = \frac{|A \cap B|}{|A \cup B|}, \tag{2.1}$$

[4]CONCACAF Nations League: All you need to know, publicly available at `https://www.espn.com/soccer/concacaf-nations-league/story/3961558/concacaf-nations-league-all-you-need-to-know`; accessed on October 7, 2020.

[5]Harry Potter and the Sorcerer's Stone, publicly available in txt format at `http://www.glozman.com/textpages.html`; accessed on October r 7, 2020.

[6]See Beaupain and Girard, 2020; Ehrmann and Talmi, 2020.

[7]String-based algorithms are used to measure lexical similarity while corpus-based and knowledge-based algorithms are used to measure semantic similarity.

with $JS \in [0, 1]$ where 0 means that the two sets are completely different (i.e. there are no elements in the intersection) and 1 means that the two sets are identical (i.e. the intersection is equal to the union of the sets). This measure can easily be adapted to get a term-based measure for text analysis. To this end, we need to represent the documents as sets decomposing each of them into shingles or *n-grams*.[8] Thus, documents that are lexically similar have similar *n-grams*.

We compute a "Text Similarity Index" (TSI) to measure how alike is the content between two consecutive MPS or MPM based on the Jaccard Similarity. Note that the Jaccard Similarity was chosen for practicality and because we will only compare documents that have approximately the same length; if this was not the case, an alternative measure of text similarity would be the cosine similarity which is independent of the length of the document. As an example of how this index is used in our analysis, let $n = 4$ and let D_1 = "the dog is faster than the cat", D_2 = "the cat is faster than the dog" and D_3 = "the dog barks really loud". Clearly the text in documents D_1 and D_2 are more similar than the text in documents D_1 and D_3. If we would like to compare them with the TSI, first each document has to be represented as a set using, for example, shingles of size 4 (*4-grams*):[9]

D_1 = {"the ", "he d", "e do", " dog", "dog ", "og i", "g is", " is ", "is f", "s fa", " fas", "fast", "aste", "ster", "ter ", "er t", "r th", " tha", "than", "han ", "an t", "n th", " the", "he c", "e ca", " cat"},

D_2 = {"the ", "he c", "e ca", " cat", "cat ", "at i", "t is", " is ", "is f", "s fa", " fas", "fast", "aste", "ster", "ter ", "er t", "r th", " tha", "than", "han ", "an t", "n th", " the", "he d", "e do", " dog"},

D_3 = {"the ", "he d", "e do", " dog", "dog ", "og b", "g ba", " bar", "bark", "arks", "rks ", "ks r", "s re", " rea", "real", "eall", "ally", "lly ", "ly l", "y lo", " lou", "loud"}.

[8] The n-grams or shingles are sequences of characters of fixed size. For example, the phrase "central banks" can be decomposed in 10 n-grams of size 4 ("4-grams") as "cent", "entr", "ntra", "tral", "ral ", "al b", "l ba"," ban", "bank", "anks". For short documents such as tweets, shingles of length 4 or 5 are recommended; while for larger documents, shingles of length 9 or 10 should be used to allow for wider variations in the text. See chapter 3.2 "Shingling of Documents" in Leskovec et al. (2020) for more details.

[9] If a shingle is repeated in the same document, it is only counted once.

Then, we need to compute the cardinality of the intersections and unions. This is:

$D_1 \cap D_2 =$ { " the ", "he d", "e do", " dog", " is ", "is f", "s fa", " fas", "fast", "aste", "ster", "ter ", "er t", "r th", " tha", "than", "han ", "an t", "n th", " the", "he c", "e ca", " cat" } $\Rightarrow \quad |D_1 \cap D_2| = 23,$

$D_1 \cup D_2 =$ { " the ", "he d", "e do", " dog", "dog ", "og i", "g is", " is ", "is f", "s fa", " fas", "fast", "aste", "ster", "ter ", "er t", "r th", " tha", "than", "han ", "an t", "n th", " the", "he c", "e ca", " cat", "cat ", "at i", "t is"} $\Rightarrow \quad |D_1 \cup D_2| = 29,$

$D_1 \cap D_3 =$ { "the ", "he d", "e do", " dog", "dog "} $\Rightarrow \quad |D_1 \cap D_3| = 5,$

$D_1 \cup D_3 =$ { "the ", "he d", "e do", " dog", "dog ", "og i", "g is", " is ", "is f", "s fa", " fas", "fast", "aste", "ster", "ter ", "er t", "r th", " tha", "than", "han ", "an t", "n th", " the", "he c", "e ca", " cat", "og b", "g ba", " bar", "bark", "arks", "rks ", "ks r", "s re", " rea", "real", "eall", "ally", "lly ", "ly l", "y lo", " lou", "loud" } $\Rightarrow \quad |D_1 \cup D_3| = 43.$

Finally, we apply equation (2.1) to get the TSI:

$$TSI_{D_1,D_2} = \frac{|D_1 \cap D2|}{|D_1 \cup D_2|} = \frac{23}{29} = 0.79$$

and

$$TSI_{D_1,D_3} = \frac{|D_1 \cap D3|}{|D_1 \cup D_3|} = \frac{5}{43} = 0.11;$$

these numbers confirm that documents D_1 and D_2 are very similar, but documents D_1 and D_3 share only few words.

2.4 Hawkish-Dovish Tone Index

Cannon (2015) points out that individual words can have specific semantic orientation, meaning that they consistently convey a positive, negative or neutral sentiment regardless of the topic in which they are used. For the case of CB's communication, the tone of a message refers specifically as to being *"hawkish"* or *"dovish"*, where a hawkish tone means that the message is predominantly on

the tightening side of monetary policy (increases to the target interest rate), and a dovish tone means that it is predominantly on the loosening side (cuts to the target interest rate). Therefore, the words chosen for specific topics allow us to measure the tone of the overall message of the CB. Particularly, the tone of the MPS and MPM is directly related to the performance of the economy and how the Governing Board members perceive risks to the macroeconomic environment. Moreover, it is also related to the way the central bank engages with a greater transparency and the way the general public perceives the CB's message.

The literature includes three ways of measuring the tone of CB's communication: i) manually labeling each document as been hawkish, neutral or dovish, see for example Rosa (2011); ii) using dictionary techniques to find key words that indicate hawkishness or dovishness, see Tobback et al. (2017); and Cannon (2015) and iii) text classification algorithms, see for example Tobback et al. (2017) and Binette and Tchebotarev (2019).

We follow the approach of Tobback et al. (2017) and use semantic orientation to propose a Hawkish-Dovish Index (HD Index) to measure the degree of *"hawkishness"* and *"dovishness"* on MPS and MPM using self-constructed dictionaries, which can be found in Appendix B for documents in English and in Spanish. Note that, since we are using the semantic orientation approach with the dictionaries technique, the quality of the hawkish and dovish dictionaries could influence the accuracy of the HD Index. Additionally, it is important to bear in mind that dictionaries must be updated frequently since the way CB's communicate changes over time, thus new hawkish or dovish words could appear in future MPS or MPM. An alternative approach would be using text classification with, for example, a Support Vector Machine algorithm. Nevertheless, this would require that MPS and MPM were manually classified as "hawkish", "dovish" or "neutral", with the risk of personal judgments influencing the classification of documents. Although the inclusion of words in a dictionary may seem to involve personal judgment, our dictionary is the result of both knowledge on monetary policy and a comprehensive study of the relevant vocabulary used in the main monetary policy documents of CBs of advanced and emerging economies. Additionally, it has been reviewed by several monetary policy experts to avoid excluding important terms and, more importantly, applies equally to any text related to monetary policy. Therefore, we are confident that we are preserving the goal of having an objective communication measure.

To compute the HD Index we basically count the number of occurrences of hawkish and dovish words, based on our dictionaries, that appear in each document. First we remove stop words, apply some transformations to the text (for example use

stems) and split each document into sentences.[10] Each sentence is then tokenized into words. After this, we count the number of words in each sentence that match with the hawkish and dovish dictionaries that are not preceded by a negation word. When a hawkish or dovish word is detected to be followed or preceded by a negation word, we reverse the sentiment of that word. Finally, the HD Index is computed as

$$HDI = \frac{I_H - I_D}{I_H + I_D} \tag{2.2}$$

where $I_H = \sum_{i=1}^{n} H_i$ and $I_D = \sum_{i=1}^{n} D_i$ are, respectively, the sum of occurrences of hawkish and dovish words over the n sentences of the document. If a text only contains hawkish words, then $HDI = I_H/I_H = 1$, and if a text only contains dovish words, then $HDI = -I_D/I_D = -1$. When a text has the same number of occurrences of hawkish and dovish words we have $HDI = (I_H - I_H)/(I_H + I_H) = 0$ and we say that the document has a neutral tone. Note that when no hawkish or dovish words are found, the text is considered as being neutral and therefore $HDI = 0$.

To exemplify the way the HD Index works, Figure 2.2 shows three different fragments of MPS highlighting in **red** the identified hawkish words and in **green** the identified dovish words.

2.5 Consensus and Dissent Measures

The majority of CBs publish a detailed minute days after their monetary policy meeting, providing the public with more information about policy deliberations and the rationale behind their decisions. The minutes contain details of the Governing Board views on economic developments and risks to the outlook so that they summarize participants' discussion on such topics. Some CB also publish the voting records on its minutes and/or an accompanying voting record file.

Minutes play a fundamental role in CBs' communication strategy because the MPS, by itself, does not reflect the widespread uncertainty that meeting participants expressed when voting for the MPD nor the diversity of opinions among them. In this sense, statements and minutes are not perfect substitutes since the MPS is much more timely and it represents something closer to a consensus of

[10] Stop words refer to those words that are meaningless like articles, prepositions, pronouns, etc. A stem is the root of a word. This is, the stem is the part of a word which is responsible for its lexical meaning. For example, the words "economical" and "economics" have the stem "economic". For more details see de Groot (1949) and Lovins (1968).

Figure 2.2: Examples of Hawkish, Neutral and Dovish Documents

Hawkish Document[1]

"Information received since the Federal Open Market Committee met in May indicates that the labor market remains **strong** and that economic activity is **rising** at a moderate rate. Job gains have been **solid**, on average, in recent months, and the unemployment rate has remained low. Although growth of household spending appears to have **picked up** from earlier in the year, indicators of business fixed investment have been soft. On a 12-month basis, overall inflation and inflation for items other than food and energy are running below 2 percent."

$$I_H = 4,\ I_D = 1 \quad \Rightarrow \quad HDI = \tfrac{4-1}{4+1} = 0.6$$

Neutral Document[2]

"At today's meeting, which was held in Vilnius, the Governing Council of the European Central Bank (ECB) took the following monetary policy decisions: (1) The interest rate on the main refinancing operations and the interest rates on the marginal lending facility and the deposit facility will remain unchanged at 0.00%, 0.25% and -0.40% respectively. The Governing Council now expects the key ECB interest rates to remain at their present levels at least through the first half of 2020, and in any case for as long as necessary to ensure the continued sustained convergence of inflation to levels that are below, but close to, 2% over the medium term."

$$I_H = 0,\ I_D = 0 \quad \Rightarrow \quad HDI = 0$$

Dovish Document[3]

"Banco de México's Governing Board has decided to lower the target for the overnight interbank interest rate by 25 basis points to 7%. Economic slowdown, low inflation, accommodative monetary policies, and lower interest rates continue to prevail in the world economy. Although in this context global financial conditions have continued to loosen, the balance of risks for world economic activity remains biased to the downside due to several factors of uncertainty, including the effects of the recent coronavirus outbreak."

$$I_H = 0,\ I_D = 4 \quad \Rightarrow \quad HDI = \tfrac{0-4}{0+4} = -1$$

1/Fragment from the Federal Reserve June 19, 2019 MPS. Available at https://www.federalreserve.gov/newsevents/pressreleases/monetary20190619a.htm. 2/Fragment from the European Central Bank June 6, 2019 MPS. Available at https://www.ecb.europa.eu/press/pr/date/2019/html/ecb.mp190606-1876cad9a5.en.html. 3/Fragment from Banxico February 13, 2020 MPS. Available at https://www.banxico.org.mx/publications-and-press/announcements-of-monetary-policy-decisions/%7B0FC0B364-AD54-E408-0CA8-DD3150215BD0%7D.pdf. All documents were accessed on October 14, 2020.

the Governing Board, while MPM try to express the different points of views of committee members about economic developments and risks.

Since Banxico does not publish the voting records in any document, the MPM are the only available source of agreement or disagreement among board members. Therefore, we follow the approach of Meade et al. (2015) to compute informative indicators of how the diversity of views expressed in the MPM has evolved. Taking advantage of the way MPM are structured, we count the number of arguments that are supported by "all", "majority", "some" or "one" board members.[11] This indicator is relevant when analyzing the characteristics of CBs' communication because it gives the opportunity to examine the level of consensus or dissent among board members in each MPD.

We compute the consensus/dissent indicators as follows. First each MPM is splitted in sentences assuming each sentence corresponds to one argument of the Governing Board. Through Boolean search of specific terms or combination of words, each argument is then classified as **"A"** when expressed by all members, **"M"** when expressed by the majority of the members, **"S"** when expressed by some members or **"O"** when only expressed by one member.[12] Because of the way minutes are written, there could be sentences that have more than one classification.[13] It could also be the case that a sentence makes no direct reference to the number of members that supported the idea and therefore, the sentence is classified the same as the last classification of the previous sentence.[14]

[11]These words are used for the specific case of Banxico's MPM. Fed's MPM mention arguments supported by "all", "all but one", "almost all", "most", "many", "several", "some", "few", "two" or "one" member. To be able to compare between CBs, we group arguments supported by "all but one", "almost all", "most" and "many" members as "majority"; similarly, we group arguments supported by "several", "some", "few" and "two" members as "some". It is important to note that these words must be updated frequently for both CBs since the way they refer to board members in the minutes may change over time.

[12]Boolean searches allow you to combine words and phrases using the words AND, OR, NOT to limit, broaden, or define your search, see Burns, S. (2011) *"What is Boolean Search"*, New York Public Library; available at `https://www.nypl.org/blog/2011/02/22/what-boolean-search`. Specific terms include for example "all members", "the majority of members", "some + verb", "one member", "one participant", "one + verb", etc.

[13]For example, minute 64 of Banxico states that "Nevertheless, **some members** pointed out that in the major advanced economies inflation apparently has moderated its upward trend and **one member** added that it seems to have already reached its maximum levels in this cycle". This sentence contains two arguments, one expressed by some members and the other expressed by only one member; thus, this sentences is classified both as "S" and "O".

[14]For example, minute 79 of Banxico states that "In this context of global economic recovery, **most members** pointed out that economic activity forecasts for 2020 have been adjusted upwards, while those for 2021 have been revised downwards. **They mentioned** that the world economy is subject to several risks, including those associated with the pandemic." The first argument is clearly supported by "most" members and is then classified as "M". The second

Finally, let n be the number of different arguments (sentences) in the MPM, then four indicators are computed:

$$All = \frac{|A|}{|A| + |M| + |S| + |O|} * 100 \quad (2.3)$$

$$Majority = \frac{|M|}{|A| + |M| + |S| + |O|} * 100 \quad (2.4)$$

$$Some = \frac{|S|}{|A| + |M| + |S| + |O|} * 100 \quad (2.5)$$

$$One = \frac{|O|}{|A| + |M| + |S| + |O|} * 100 \quad (2.6)$$

where $|A|$, $|M|$, $|S|$, $|O|$ respectively denote the number of sentences classified as "A", "M", "S" and "O". Note that $|A| + |M| + |S| + |O| \geq n$ since a particular sentence can have more than one argument and, therefore, more than one classification. Finally, consensus can be viewed as the sum of arguments expressed by "all" and "majority" of the members, while dissent can be viewed as the sum of arguments expressed by "some" and "one" members. This is,

$$Consensus = All + Majority \quad (2.7)$$

$$Dissent = Some + One = 100 - Consensus. \quad (2.8)$$

sentence has no explicit quantifiers and it is then classified also as "M".

Chapter 3

Analysis of *Banco de México's* Communication Characteristics

This chapter derives from my participation on the internal technical report *Bazdresch B., Gabriel M. & Lelo de Larrea A. (Diciembre 2019) "Análisis de la Estrategia de Comunicación"* of *Banco de México* which is not publicly available.

3.1 Background on *Banco de México*

3.1.1 *Banco de México*'s History and Mandate[1]

In 1994 Banxico was given its autonomy meaning that no authority can demand credit from it and, thus, guaranteeing its complete control over the amount of money in circulation in the country. Banxico's autonomy rests on three pillars:

1. **Legal:** it consists of a constitutional mandate which establishes that its main goal is to foster the currency's purchasing power. This objective is also specified in Banco de México's current law (1993).

[1]Information on this section was obtained from *Banco de México*'s webpage, available at `https://www.banxico.org.mx/getting-to-know-banco-de-mexico/history-hierarchical-history-.html`; accessed on September 27, 2020.

2. **Governing Board and operating rules:** Banxico's Governing Board is a collegiate body comprised by a governor and four deputy governors who are appointed by the President and ratified by the Senate, but can not be removed at the discretion of the former. The governor serves between presidential terms during six years and deputy governors serve for eight years and are replaced alternatively every two years.

3. **Administrative autonomy:** the law confers administrative autonomy to the CB to guarantee its independence from the federal budget.

Along with the autonomy of the CB, in the 28^{th} article of the Political Constitution of the Mexican United States, it was established that the main goal of Banxico is "to preserve the value of Mexico's currency in the long term in order to improve Mexicans' well-being" (see Mexico Secretaría de Gobernación, 1917). Additionally, Article 2 of Banco de Mexico's law states that "Banco de Mexico's purpose will also be to promote a healthy development of the financial system and to promote the proper functioning of the payment systems" (see Banco de México, 1993).

After the 1995 financial crisis, Banxico adopted the so-called inflation targeting framework, known as IT, whose main virtue is to make monetary policy more effective and to reduce costs of fighting inflation. Additionally, it seeks to give credibility to the CB and its monetary policy since, once credibility is achieved, it is easier to control inflation and the benefits of stability spread faster to the overall economy. To this end, Banxico began to set annual inflation targets since 1996 and the adoption of the IT framework was officially announced in the 2001 Monetary Program. A year later, the CB agreed on a fluctuation margin of one percentage point above or below the long-term inflation target of 3%.

Within the IT framework, between September 1995 and April 2003 Banxico used as monetary policy instrument the accumulated balances regime (28 days), known as "corto", in order to control the price level an regain stability. From April 2003 to January 2008, it maintained the "corto" as monetary policy instrument, but changed to a daily balances regime. Finally, since February 2008, the CB adopted a benchmark rate —the overnight interbank funding rate— as its monetary policy instrument instead of the "corto". This change facilitated the understanding of monetary policy actions and brought its implementations into line with that of other CBs.

3.1.2 *Banco de México*'s Communication Toolkit

The effectiveness of the IT regime is based primarily in a clear communication of the CB's objectives, the disclosure of methods and procedures to achieve them, and the strict accountability of the results.[2] In this sense, Banxico has a wide variety of communication tools to achieve a high level of transparency and accountability that have helped to consolidate its credibility and to improve the effectiveness of its monetary policy, as well as the impact of its public policies.

Some of Banxico's communication tools derive from legal provisions (see Banco de México, 1993) include:

1. **Congressional Hearings:** Article 47 section XIII of *Banco de México's* Law states that the Governor has to appear before commissions of the Senate each year during the second regular period of sessions to render a report of the fulfillment of Banxico's mandate.

2. **Monetary Policy Program:** Article 51 of *Banco de México's* Law states that, in January of each year, the CB must send to both, the President and the Congress, the guidelines defining the monetary policy to be implemented during the year. This tool is available since 1994.

3. **Inflation Report:** Article 51 of *Banco de México's* Law also states that, no later than 45 days after the end of each quarter, the CB must present a report about inflation, the economic evolution of the country, the monetary policy actions and the general activities of the bank during that period.[3] The Inflation Report has been published quarterly since 2000.

Additionally, as part of its effort to increase accountability, build trust and gain credibility, Banxico discloses its objectives, instruments, forecasts and MPD through the following communication tools:

1. **Monetary Policy Calendar:** In order to reduce uncertainty in financial markets regarding its decisions, an official calendar announcing monetary policy actions to be implemented each year is released since 2003. At the beginning the Governing Board had 11 meetings a year, but in 2011 the number of meetings was reduced to eight per year.

[2] Fracasso et al. (2003)

[3] Originally, the law stated that Banxico had the obligation to submit an annual report in April of each year to the Federal Executive and the Congress. On January 10, 2014 the provision was eliminated and the legal obligation to present a quarterly report was established.

2. **Post-meeting Monetary Policy Statements:** The MPS has been officially published since January 2000. This is one of the most relevant documents since it provides the MPD taken at the Governing Board's meeting and the main reasons that lead to it. Statements for the current monetary policy target rate are available since February 2008.

3. **Minutes of Monetary Policy Decisions:** The MPM is a larger document that aims to explain the analysis and rationale behind the Governing Board's voting contributing to the institutional accountability and transparency of the decision making process. It also contributes to the individual accountability of the Governing Board members by presenting the diversity of opinions among them. MPM are available since the February 2011 MPD.

4. **Press Conferences, Presentations and Speeches:** The members of the Governing Board use these tools as an effective information platform to explain the bank's policies and help the message reach more people.

3.1.3 Reforms to *Banco de México*'s Communication Strategy

As previously established, a better communication with the public regarding the objectives, instruments, forecasts and the CB's decisions, contribute to making the monetary policy more predictable.[4] In this sense, Banxico has made a continuous effort to improve the way it communicates with the general public.

Reforms to the communication strategy have been made since 2000, mainly concerning the publication of new communication tools. Nevertheless, two major reforms have been implemented in the last three years, mainly aimed at making the CB's communication clearer, simpler, more transparent and effective, providing economic agents with relevant and necessary information for their decision-making process and, thus, avoiding misinformation and reducing uncertainty.

The first major reform was implemented in May 2018 and consisted of the following modifications:[5]

1. The minutes of the MPD will include the identity of voting members. In

[4] See for example Blinder et al. (2008), Woodford (2005).

[5] Press release of April 30, 2018; available at `https://www.banxico.org.mx/publications-y-prensa/miscelaneos/%7B57540DA5-0DF7-BA41-B32D-E6CDC4B60ED6%7D.pdf`; accessed on September 27, 2020.

case of dissent, an explanation of the reasons of that dissent will be included.

2. The complete transcripts of the Governing Board meetings in which the MPD is taken will be available to the public in the webpage three years after the corresponding meeting. Therefore, the first transcripts that will be available to the public are those of the May 2018 meeting and will be published in May 2021.

3. The monetary policy statements and minutes will be simultaneously published in Spanish and English with the aim of expanding the messages to a wider audience, facilitating their interpretation and ensuring that they adhere as closely as possible to Banxico's message.[6]

4. All the speeches and public presentations of the Governing Board will be published and the materials associated to those will be publicly available at the bank's webpage no later than two days after the event.

As a follow-up to the efforts made in terms of transparency and accountability, the Governing Board approved the following actions to continue improving its communication with the public:[7]

1. The General Communication Criteria of the Governing Board and Public Officials are updated and made public for the first time.[8]

2. The monetary policy statements and minutes will be made clearer and more concise in order to contribute to a better communication with the public and allowing to identify with greater clarity the main messages that Banxico seeks to convey.

3. The format of the minutes is modified to facilitate the reading and identification of topics by including section titles and bold format for those ideas expressed by all or the majority of the board members.

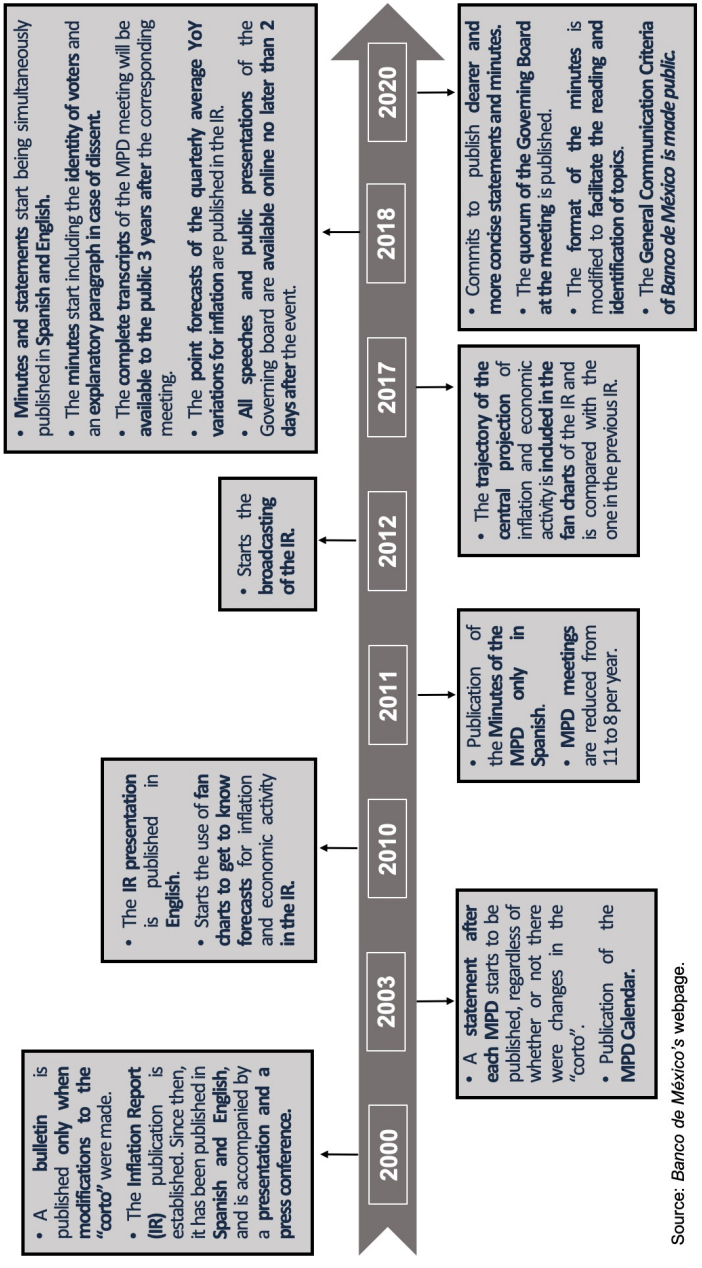
4. The quorum of the meeting will be published in the MPS.

[6] Up to the April 12, 2018 MPD, statements and minutes were only available in Spanish.

[7] Press release of February 10, 2020; available at `https://www.banxico.org.mx/publicaciones-y-prensa/miscelaneos/%7B4C09D772-2CDF-8BD6-3F04-65DE03CA6212%7D.pdf`; accessed on September 27, 2020.

[8] The General Communication Criteria of the Governing Board and Public Officials is available at `https://www.banxico.org.mx/conociendo-banxico/d/{74EF2D7B-3FBA-23DE-6424-DC88E5D9FCB9}.pdf`

Figure 3.1: Timeline of Banxico's Reforms to its Communication Strategy



Source: *Banco de México*'s webpage.

Figure 3.1 summarizes the timeline of reforms implemented to Banxico's communication strategy. This changes as a whole have reinforced the accountability and transparency mechanisms of the CB.

The rest of the analysis will focus only on the MPS and MPM since those are the main documents directly related to the communication of the MPD. The analysis of other communication tools is left for future research.

3.2 Evolution of Banco de México's Communication Characteristics

3.2.1 Data Processing

This thesis makes use of text mining techniques to extract data and to compute the different measures described in Chapter 2 in order to analyze, in an objective manner, the evolution of the characteristics of the MPS and MPM of Banxico and, as an extension, of the Fed.[9]

Text mining refers to algorithms that try to discover patterns in great volumes of text data, which can be found in very different formats such as webpages, e-mails, pdf documents and social media among others, with the main goal of systematically extracting useful and important information that can be transformed into a comprehensible structure for its analysis. Thus, as Bholat et al. (2015) states, these techniques make manageable a range of data sources that cannot be analyzed quantitatively by other means and that are important for assessing economic conditions. In general, a text mining process is divided in four stages: i) extraction, ii) pre-processing and cleaning, iii) storage, and iv) analysis.

The text extraction process is completed in two steps. First, we do web-scrapping of all the links for the MPS and/or MPM available in the CB's webpage.[10] Second, we do web-scrapping of the complete text of each document; some documents are available in pdf format and others in html format. The pre-processing and cleaning stage consists on unifying formats (for example, Banxico's MPS are published in a one column format, but MPM are published as a two-column format pdf); joining paragraphs that are separated by page breaks (in the case of

[9] In accordance with the Federal Copyright Law, *Banco de México* is the owner of the intellectual property rights over the codes and data of this thesis. They may be available upon request and under authorization of the corresponding authority.

[10] Webscrapping refers to the action of accurately and quickly extracting different types of data form a web site.

pdf's); deleting special characters (like accents in Spanish), page numbers and/or irrelevant information (such as headers); extracting elements of interest in each document, mainly the monetary policy meeting date, the MPD, the new level of the target rate, members of the Governing Board that attended the meeting, the voting rate, etc; and, for some indicators it is also needed to remove stop words and the tokenization of the text into words or sentences.[11] The information storage is carried out through a database in SQLite with one table per CB - document - language that can be easily administered in R. Finally, for the text analysis, we compute the communication measures described in the previous chapter.

One of the main contributions of this thesis is the creation of a novel database of CBs' communications through the development of an R package ***"ComunicacionBCs"*** that provides the necessary tools to extract (via web-scrapping), clean, process, store and analyze, in a systematic and structured way, the relevant information available in MPS and MPM.[12] For the case of Banxico and the Fed, the package contains 11 main functions and 30 auxiliary functions to extract the information of MPS and MPM, both in Spanish and English, for Banxico and in English for the Fed. Up to June 2021 a total of 223 statements (196 in Spanish and 27 in English) and 112 minutes (86 in Spanish and 26 in English) have been extracted for Banxico, and a total of 187 statements and 170 minutes for the Fed. Figure 3.2 details the content of the R package for these two CBs.

One of the main advantages is that this R package can be easily extended to extract information from the CBs of the main advanced and emerging economies in order to extend the analysis presented here. Additionally, it could be used by other researchers and/or institutions for a wide variety of research projects. Even though this work covers only the case of Banxico and the Fed, by the time this thesis was finished, the R package contains the necessary tools to extract statements of seven CBs from advanced and emerging economies, including the Federal Reserve, European Central Bank, Bank of England, Reserve Bank of Australia, Banco de México, Banco de la República de Colombia and Banco Central de Chile, as well as the minutes for Banco de México and the Federal Reserve. In its most recent version, the package consists of 15 main functions and more than 50 auxiliary functions.

[11] See Appendix C for the details on data processing.

[12] At the moment, the package is only available for local installation; ideally, when complemented for extracting communication tools for other CBs, it will be formally published as an R package in CRAN.

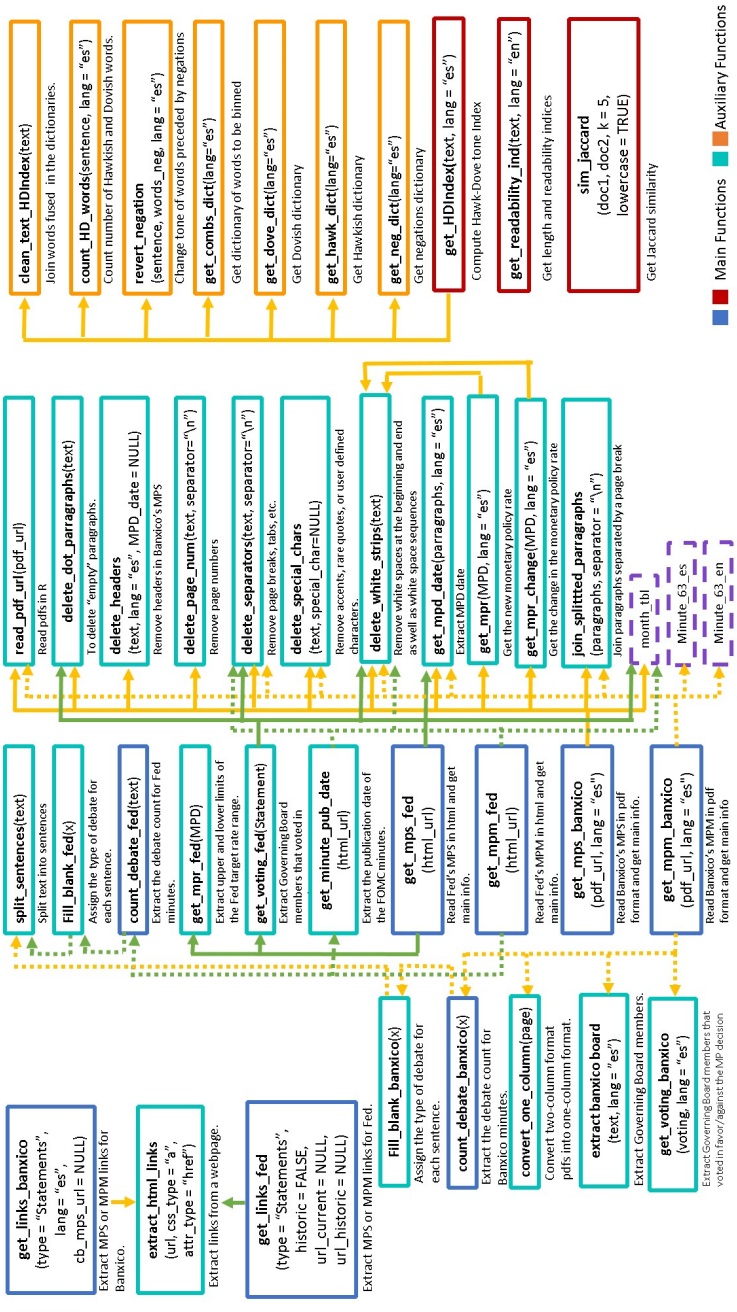


Figure 3.2: Description of the R package *"CommunicacionBCs"*

3.2.2 *Banco de México*'s Communication Data

The following sections describe in detail the evolution of the characteristics of Banxico's MPS and MPM. To this end, and using the R package described above, we extracted information from these documents, both in Spanish and in English, from when each of them is available until June 2020. It is worth noting that, in this section, information will be presented as a time series with a "monetary policy decision frequency"; this is, each point in time refers to a MPD.

The MPS are available in Spanish since January 2000 and in English since May 2018. Note that: i) before 2003, MPS were only published when changes to the "corto" were made, thus there are six MPS for 2000, three MPS for 2001 and four MPS for 2002; ii) between 2003 and 2007 MPD were taken monthly, thus there are 12 MPS each year; iii) between 2008 and 2010 MPD were taken every month except for December, thus there are 11 MPS each year, iv) since 2011, there are eight MPD every year and the months in which they are scheduled varies from year to year; and v) there have been two extraordinary MPD one in February 17, 2016 and one in May 14, 2020.

As for the MPM, they are available in Spanish since February 2011 and in English since May 2018. Banxico publishes eight MPM each year 2 weeks after the MPD. The only section of the MPM subject to analysis in this thesis is the "Analysis and Rationale Behind the Governing Board's Voting" section.

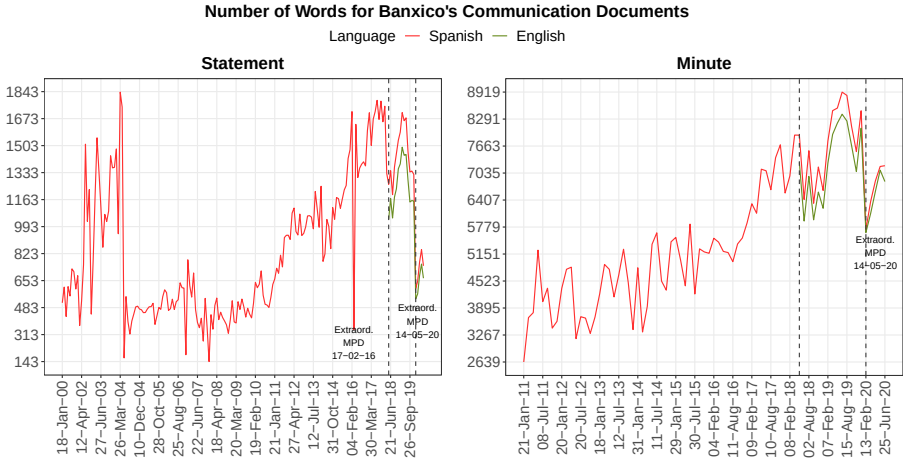
3.2.3 *Banco de México*'s Length Measures

As length measures, we analyze the evolution of the number of words as well as the average sentence length (ASL) for each MPS and MPM.

The left panel in Figure 3.3 shows the number of words per statement. Leaving out the first years of irregular publication of MPS, a general increasing trend in the length of this document can be observed in the period 2008-2017, which might be mainly derived from the global financial crisis. Additionally, this increase is consistent with the fact that the CB began to increase its level of transparency and communication with the public. Apart from the extraordinary decision of February 2016, significant drops in this indicator were registered for the MPS of April 2004, December 2006 and December 2007. After the 2018 communication reform, there was a brief period in which an effort for publishing shorter MPS was made, but a rebound in the length can be observed since October 2018. Finally, with the February 2020 reform, the length of the statement was reduced in 53.3%. However, a slight increase is reflected in the last observations due to

the Coronavirus pandemic because of the need of a larger explanation of the measures taken by the CB and the associated risks to the economic environment. The right panel of 3.3 shows the evolution of the number of words in the MPM, which is clearly a much larger document. MPM have followed the same general increasing trend as MPS, standing out that between 2013 and 2019 the length of the minutes almost tripled. It is also important to notice that the increase observed between the second half of 2016 and the end of 2017 is related to a period of increasing inflation. Nevertheless, with the February 2020 reforms the length of the minutes has significantly decreased in around 30%. As with the MPS, the last observations exhibit an increase due to the Coronavirus pandemic.

Figure 3.3: Number of Words in Banxico's Statements and Minutes

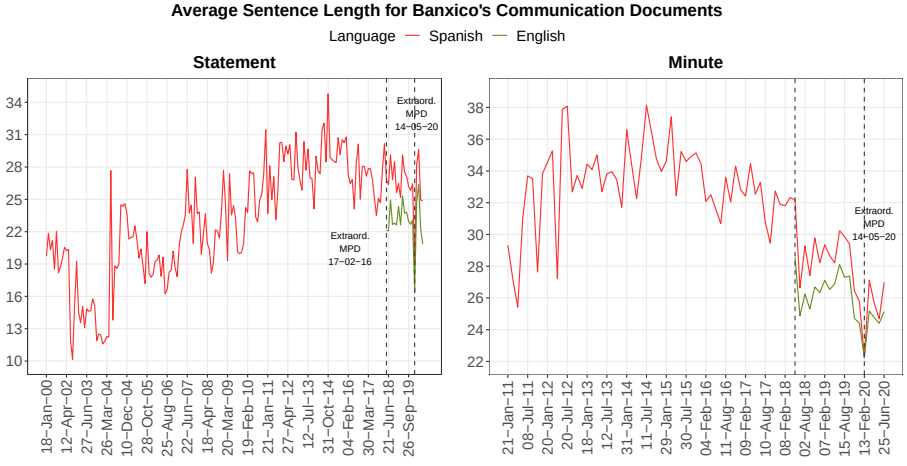


Source: own calculations with information from Banxico's webpage.
Notes: 1/No minute was published for the extraordinary monetary policy meeting of February 17, 2016. 2/The dashed vertical lines indicate the announcement of reforms to the communication strategy.

The left panel in Figure 3.4 shows the average sentence length for MPS. It can be observed that the ASL followed an upward trend before the first communication reform and thereafter has been stable in around 27 words per sentence for MPS in Spanish and in around 23 words per sentence for those in English. Similarly, as showed in the right panel of Figure 3.4, the MPM shows an upward trend at the beginning of the sample and a downward trend in the ASL since 2014. This reflects the effort of the CB to write simpler and more concise arguments so that the general public can better understand the diversity of views and opinions discussed in the monetary policy meetings. In fact, even though the MPM is a

much more complex document than the MPS, the last minutes present an ASL similar to that of the statements. It should be pointed out that international standards for publishing documents in English suggest that sentences should be 25 words or less in length in order to facilitate the reader's understanding.[13] Thus, the English versions of MPS and the most recent English versions of MPM are aligned to these international standards.

Figure 3.4: Average Sentence Length of Banxico's Statements and Minutes



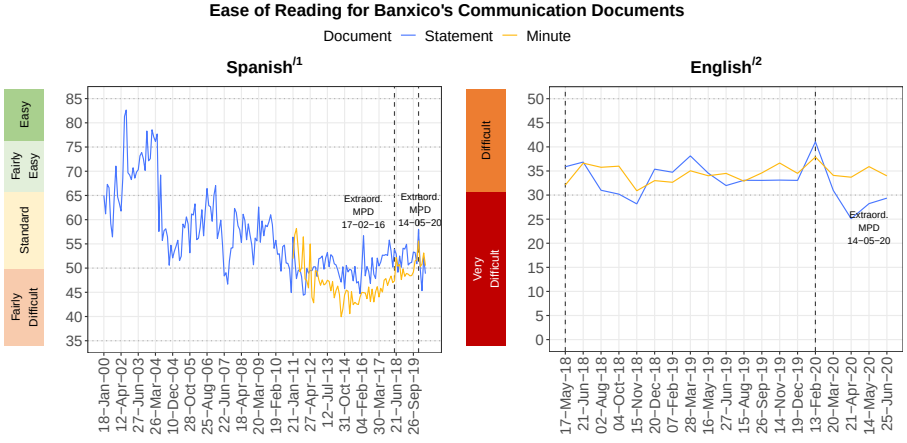
Source: own calculations with information from Banxico's webpage.
Notes: 1/No minute was published for the extraordinary monetary policy meeting of February 17, 2016. 2/The dashed vertical lines indicate the announcement of reforms to the communication strategy.

Additionally, it is worth mentioning that under the two length indicators, for both the MPS and MPM, publications in English are slightly shorter than in Spanish, but they have followed the same dynamic. This may be due to the characteristics of each language.

[13]See for example "Sentence length: why 25 words is our limit" for writing references of the UK government, available at `https://insidegovuk.blog.gov.uk/2014/08/04/sentence-length-why-25-words-is-our-limit/`; the "Style Manual" of the Australian Government available at `https://www.stylemanual.gov.au/format-writing-and-structure/clear-language-and-writing-style/sentences`; "The guidelines for document designers" of the American Institutes for Research, available at `https://redish.net/wp-content/uploads/Guidelines_for_Document_Designers_2014.pdf`; "Longer the Sentence, Greater the Strain" of the Readability Monitor available at `https://strainindex.wordpress.com/2012/04/30/longer-the-sentence-greater-the-strain/`; and "How many words make a sentence?" of the Technical Communicators Association, available at `https://techcomm.nz/Story?Action=View&Story_id=106`.

3.2.4 *Banco de México*'s Ease of Reading Measures

Figure 3.5: Ease of Reading of Banxico's Statements and Minutes



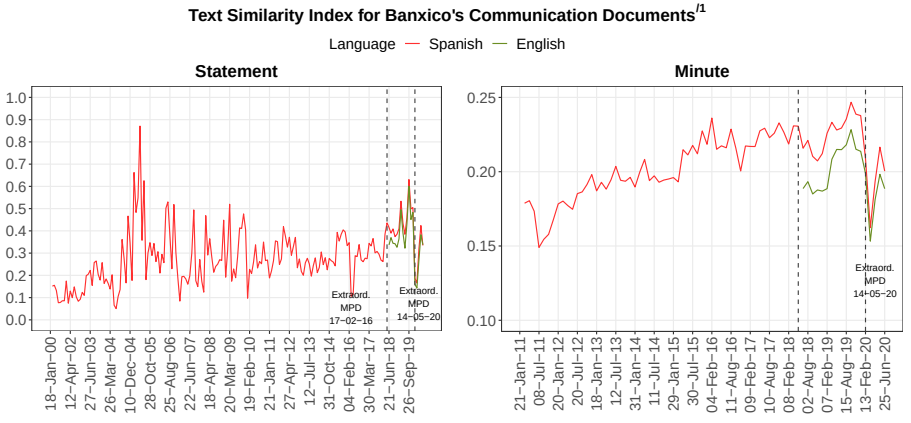
Source: Own calculations with data from Banxico's webpage.
Notes: 1/The Ease of Reading is based on the Flesch−Szigriszt Scale where, the higher the value in the scale, the easier to read is the document. 2/The Ease of Reading Scale is based on the Flesch Scale where, the higher the value in the scale, the easier to read is the document. 3/The dashed vertical lines indicate the announcement of reforms to the communication strategy.

The left panel of Figure 3.5 shows the Flesh-Szigriszt Ease of Reading for MPS and MPM in Spanish. It can be observed that up to the second half of 2014, the ease of reading for statements had a decreasing trend; this is, MPS were harder to read with each new decision, going from a "Fairly Easy" (when statements were irregularly published) and "Standard" levels to "Fairly Difficult", requiring at least a middle-superior education to understand their content. Two major drops in ease of reading occurred: one in the beginning of 2004 and one in 2008, the second being mainly related to the financial crisis and to how the CB communicated the change in the monetary policy instrument. It must be mentioned that, by construction, this decrease in ease of reading is directly related to the upward trend in the ASL presented in the previous section. Since 2014 and before 2020, it can be noted an effort to publish statements that are easier to read, returning to a "Standard" level, which is consistent with the two major reforms in the communication strategy. However, due to the coronavirus pandemic, the ease of reading decreased in 21.89% between February and April 2020 (extraordinary decision). As for the MPM, in general, they have a lower ease of reading index than MPS, reflecting the fact that minutes express more complex arguments. Additionally, they have followed the same pattern as MPS:

there was a decrease in the ease of reading from 2011 to the second half of 2014 with minutes being "Fairly Difficult", followed by an increased in this measure reaching a "Standard" level for the last observations. The right panel 3.5 shows the Flesh Ease of Reading for MPS and MPM in English. As can be noted, documents in English are more difficult to read than their corresponding versions in Spanish. MPS in English are mostly "Difficult" to read, but the last three statements are "Very Difficult". MPM in English have had an stable ease of reading around 35 which corresponds to a "Difficult" level.

3.2.5 *Banco de México*'s Text Similarity

Figure 3.6: Text Similarity of Banxico's Statements and Minutes



Source: own calculations with information from Banxico's webpage.
Notes: 1/The text similarity index is calculated using the Jaccard Similarity for consecutive Monetary Policy Statements or Minutes. The index has a value of zero for documents that are completely different, and a value of one for identical documents. 2/No minute was published for the extraordinary monetary policy meeting of February 17, 2016. 3/The dashed vertical lines indicate the announcement of reforms to the communication strategy.

Figure 3.6 shows the evolution of the text similarity index for Banxico's statements and minutes, both in Spanish and English. For the MPS (left panel), it can be observed that, previous to the communication reforms, text similarity fluctuated around 0.3, meaning that consecutive statements did not follow, in general, the same structure. There is one outlier for the MPS of April and May 2005 which almost reached a text similarity of 0.9; this was mainly derived from the fact that Banxico maintained the "corto" and that there were basically no changes in the economic environment, thus very few words of the MPS were modified. After the May 2018 reform, we observe a significant increase of 65%

in this indicator, going from a text similarity of 0.38 in April 2018 to 0.63 in September 2019. This is consistent with Banxico's commitment of improving its communication with the public. Additionally, a major drop in text similarity is observed between the December 2019 and the February 2020 MPS, mainly because the CB's communications started to reflect the Coronavirus pandemic and its effects. However, as the pandemic has stabilized, the similarity has recovered its increasing trend. In contrast, since the beginning of their publication, MPM have followed an increasing trend in the text similarity. However, the value of the index is smaller than 0.25, which is not surprising since, for being a document that expresses monetary policy arguments in detail, it is more difficult that the ideas remain the same minute after minute. The same drop in the indicator due to the pandemic can be observed at the end of the sample, with an increase in the last observations.

3.2.6 *Banco de México*'s Hawkish-Dovish Tone Index

The HD Index for MPS in Spanish is shown in the left panel of Figure 3.7.[14] The bars indicate if each statement is classified as hawkish (red) or dovish (green), the gray line corresponds to the moving average of eight MPD and the blue line is a reference rate for the monetary policy target rate.[15] As can be observed, the smooth HD Index reflects in a close manner the monetary policy cycles. In fact the HD Index starts to increase (hawkish MPS) just a few decisions before the CB starts the tightening part of the cycle (increases in the interest rate) and starts to decline (dovish MPS) just before the start of the easing part of the monetary policy cycle (cuts to the interest rate). Additionally, it can be observed that, for periods of constant rates, like the 2008-2009 financial crisis, the smooth HD Index is stable in the hawkish/dovish part with values really close to zero (Neutral). This leads us to believe that the tone of the statements, measured by the HD Index, could have a predictive power over the MPR. Analogously, the HD Index for MPM is shown in the right panel of Figure 3.7.[16] As can be observed, the tone of the MPM reflects to a lesser extent the monetary policy cycle. For the first years of publication, the HD Index correctly reflects the pause in the easing cycle after the 2008-2009 financial crisis. However, it does not precede the brief period of interest rate cuts (January 2013 to August 2014

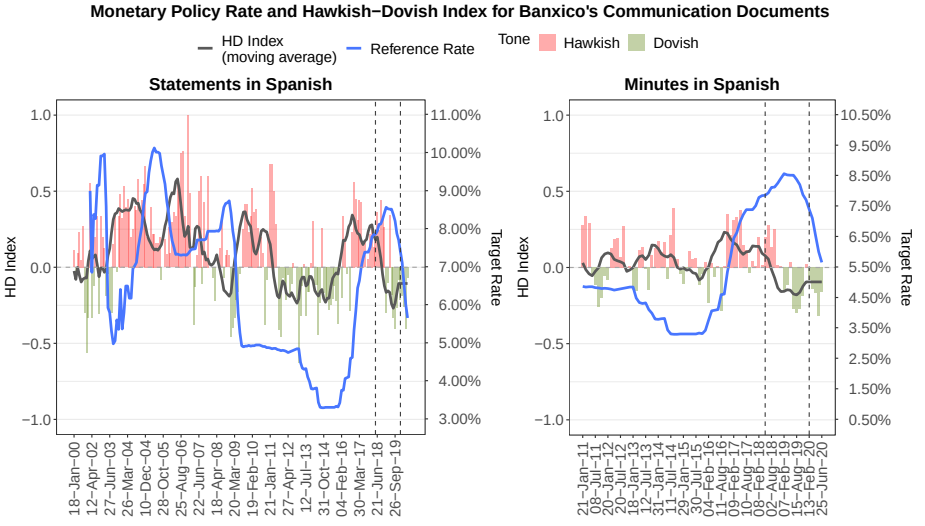
[14]The indicator for MPS in English is not plotted because of the few observations available. Results are similar to those in Spanish for the corresponding period.

[15]Instead of the monetary policy target rate, which is available since February 2008, we use the 28-days Equilibrium Interbank Interest Rate (TIIE for its acronym in Spanish), which is determined by Banxico based on quotes submitted by credit institutions, it co-moves really close to the target rate and thus, it is commonly used as a proxy for the target rate.

[16]The indicator for MPM in English is not plotted because of the few observations available. Results are similar to those in Spanish for the corresponding period.

approximately), since the HD Index is mostly in the hawkish part, but really close to zero. Nevertheless, since the end of 2014, the index properly precedes movements in the reference rate.

Figure 3.7: Hawkish-Dovish Index of Banxico's Statements and Minutes



Source: own calculations with information from Banxico's webpage.

Notes: 1/The plots correspond to MPS and MPM in Spanish only due to a very short time series for documents in English. 2/The Hawkish−Dovish Index (HD Index) is plotted in the left axis and denotes the tone of Banxico's Monetary Policy Statement or Minute. It is computed as HDI = (I_H−I_D)/(I_H+I_D) where I_H and I_D are the number of occurrences of hawkish and dovish words respectively. The index takes values from −1 (Dovish, green) to 1 (Hawkish, red). 3/The solid gray line corresponds to the moving average of the HD Index for eigth monetary policy decisions. 4/The solid blue line is the monetary policy reference rate (TIIE 28 days, right axis) which is a good proxy for the target rate. The first is plotted instead of the last since it is available for a longer period. 4/The hawkish and dovish dictionaries can be found in the appendix. 5/The dashed vertical lines indicate the announcement of reforms to the communication strateg

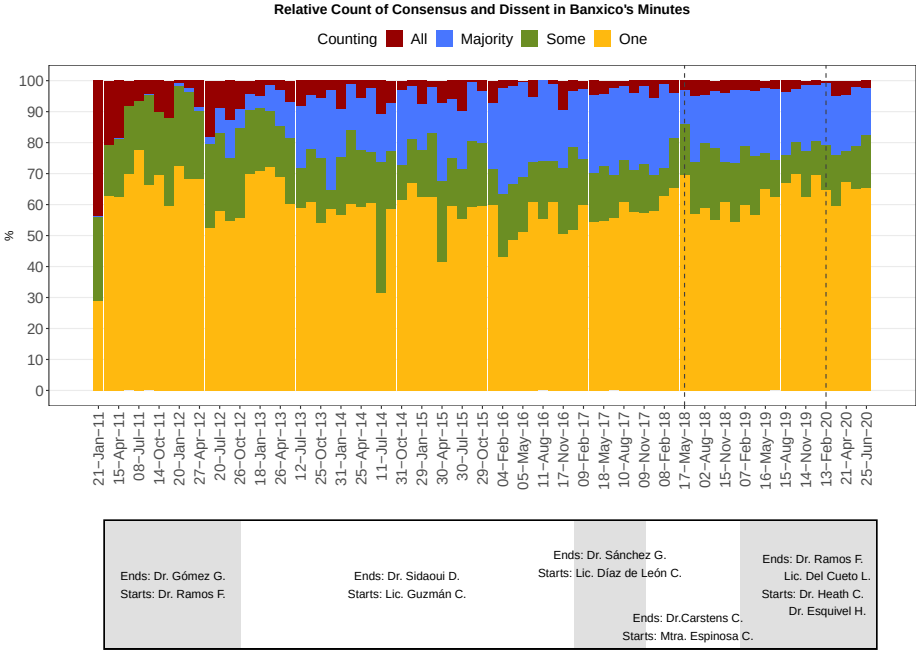
3.2.7 *Banco de México*'s Consensus and Dissent Measures

Lastly, Figure 3.8 shows the evolution of the consensus and dissent indicators for the monetary policy minutes in Spanish.[17] For the complete sample, it can be observed a mayor debate within the Governing Board, with few arguments supported by "all" members, and many supported by only "one" member. Nevertheless, between 2011 and 2017 there was an increasing trend of those supported by the "majority". Additionally, in the last few years, it can be observed a decrease in the consensus ("all" and "majority") and an increase of the dissent ("few" or "one"). It is worth noting that this increase in dissent coincides with

[17]The indicator for MPM in English is not plotted because of the few observations available. Results are identical to those in Spanish for the corresponding period.

an increase in the length (words) of the minutes, opening the possibility that, through time, more importance has been given to unique arguments as part of the individual accountability of the Governing Board.[18]

Figure 3.8: Consensus and Dissent in Banxico's Minutes



Source: own calculations with data from Banxico's webpage.
Notes: 1/Based on the monetary policy minutes, the evolution of the diversity of opinions of the members of the Governing Board during the monetary policy meeting were analyzed by counting the frequency of the number of members (all, majority, some , one) that support each of the different arguments. 2/The bar in the bottom shows changes to the governing board. 3/The dashed vertical lines indicate the announcement of reforms to the communication strategy.

[18]The correlation between the length of the MPM, measured in number of words, with the proportion of arguments expressed by only one member is 0.13.

Chapter 4

Communication and *Banco de México's* Monetary Policy

In this chapter we address the question of whether Banxico's communication contain additional information different from that already provided by macroeconomic variables through the implementation of a monetary policy rule methodology. First, we present a brief description of the most popular monetary policy rule, the Taylor rule, and its intuition. Second, we present and estimate the baseline model for the case of Mexico using inflation and output gaps. Third, we augment the baseline model with the communication indicators presented in chapter 2 and described in chapter 3 for Banxico's MPS and MPM in order to find which of these are useful when explaining the evolution of the Mexican monetary policy.

4.1 The Taylor Rule for Monetary Policy

A main concern related to the study of monetary policy is that of the analysis of the reaction function of CBs —also known as monetary policy rules— so that the main question is, what leads a CB to modify its monetary policy stance? Academics and private sector analysts have long been interested in understanding

the process through which the CB formulates its monetary policy in order to be able to anticipate its movements in a correct and timely manner. Nevertheless, the study of the reaction function is also of great interest to CBs themselves because it allows them to study the interaction between monetary policy and other variables that affect their MPD and, therefore, the macroeconomic development of the country. Torres García (2002) points out that "this type of analysis (monetary policy rules) has been especially important in countries that use inflation targeting to conduct monetary policy."

In general terms, a policy rule can be described as the study of deviations of the short-term nominal interest rate (i) from a baseline path (i^*) in proportion to deviations of a target variable z from its target z^*. This is,

$$i - i^* = \theta(z - z^*). \tag{4.1}$$

One of the first studies that provided examples for the methodology of monetary policy rules was Taylor (1993) who defined a monetary policy rule as a description of how the monetary policy instrument is modified by the monetary policy authority in response to variables such as inflation and economic activity. Specifically, Taylor (1993) mentions that the observed behavior of the US economy, particularly that of inflation and excess capacity, are the main determinants for the FOMC to set its interest rate target.[1] According to Hetzel (2000), "policy makers could adopt Taylor's proposed rule as a systematization of what has worked in practice rather than an ideal based solely on an abstract model of the economy".

Taylor (1993) proposed the following rule to characterize the monetary policy in the US during the 1987-1992 period:

$$i_t = i^* + \pi^* + \beta(\pi_t - \pi^*) + \gamma(y_t - y^*), \tag{4.2}$$

where i_t is the nominal short-term interest rate representing the monetary policy instrument at time t, i^* is the natural rate (or equilibrium rate), π_t is the observed inflation at time t, π^* is the CB's inflation target, y is the output, and y^* is the potential output.[2] Let $\hat{\pi}_t = \pi_t - \pi^*$ be the inflation gap and let $\hat{y}_t = y_t - y^*$

[1] For the FOMC, inflation and economic growth are the main operational objectives of monetary policy.

[2] The original Taylor rule is also known as "backward-looking" since it takes into account only observed values. Heinemann and Ullrich (2007) and Rosa and Verga (2007) are examples of studies estimating backward-looking Taylor rules. However, some studies incorporate the idea that interest rate changes affect economic variables with a lag and, therefore, monetary policy should be forward-looking. In this sense, the backward-looking Taylor rule can be modified replacing the observed values of economic variables with their corresponding expectations; see

be the output gap, then the third and fourth terms in equation (4.2) represent deviations of inflation and output from their respective targets. Also note that equation 4.2 is equivalent to equation 4.1 with $i^* + \pi^*$ equal to the baseline path for the short-term nominal interest rate (r^*), and with inflation and output gaps as the target variables (z).

In Taylor's model, the monetary policy rate should increase if the observed inflation rises above its target or if the output increases above its potential value. In this sense, the coefficient β represents how sensitive the policy rate is to deviations from the inflation target. A CB is expected to rise its interest rate when inflation is undesirably high, and to lower it when inflation is undesirably low. Therefore, β must be positive.[3] Likewise, the coefficient γ represents how sensitive is the policy rate to deviations of the output from its potential. A CB is expected to rise its interest rate when economic activity is strong, and to lower it when economic activity is weak.[4] Therefore, the γ coefficient must be positive. When the economy is in equilibrium ($\pi_t = \pi^*$ and $y_t = y_t^*$) the intercept incorporates the CB's estimate of the real interest rates of equilibrium, which is the sum of the natural rate and the inflation target. For the case of the US, Taylor assumes the natural rate to be a constant equal to 2%, and the coefficients β and γ equal to 1/2. Taking into account that the inflation target of the US is 2%, the classic Taylor rule that defines the US monetary policy is $i = 2 + \pi + \frac{1}{2}(\pi - 2) + \frac{1}{2}(y - y^*)$.

A main caveat of the original Taylor rule is that it requires information that may not be available for policymakers, for example the natural rate or the potential output. Hetzel (2000) points out that economists can only observe correlations between economic activity and interest rates that emerge out of the policy process; and therefore, both the CB's objectives and its strategy must be inferred. In this sense, Taylor's monetary policy rule is a simple alternative to characterize

for example Orphanides (2003), Jansen and De Haan (2009), Castro (2011), and Sturm and De Haan (2011). Additionally, some studies incorporate the idea that the CB adjusts interest rates smoothly and include an autorregresive term, as well as the target rate, as explanatory variables when modeling the dynamics of interest rates; however instead of directly using the target rate, they substitute it with the Taylor rule (see for example Sturm and De Haan, 2011). It is worth mentioning that this thesis is a first approach to the study of the relation between the CB communication on Mexican monetary policy using objective communication measures and a novel data base so that the main focus of this work is the data extraction and the development of the communication indicators. Therefore, although interesting, the use of forward-looking Taylor rules and interest rate smoothing is left for future research.

[3] When using a forward-looking Taylor rule, if inflation increases the nominal interest rate must increase more in order to raise the real rate and viceversa, thus β must be greater than one. This is known as the Taylor principle.

[4] Deviations of the output from its potential are also known as the output gap.

the CB's behavior consistent with those correlations. It should be noted that the consensus in the literature establishes that, even though Taylor's analysis encourage to move from discretion to explicit rules when formulating policies, policy makers must make a discretionary use and should not considered them as mechanical tools, but as a reference to avoid policies that could generate inflation pressures.

Torres García (2002) details that inflation and output jointly describe aggregated demand and supply and, therefore, they are the main macroeconomic variables to measure the overall performance of an economy. While it is true that these two variables relate to the MPD made by the CB through interest rates, it is also true that variations in the interest rate affect the evolution of inflation and output with a lag. Thus, the Taylor rule not only describes the process through which the CB formulates monetary policy, but it also implicitly incorporates the effects of monetary policy over the economy. Even though the original Taylor rule is based on the assumption that CBs use past or currents values of these two variables to set their policy rate, in practice they rely on a large list of additional available indicators. Therefore, many studies extend the Taylor rule to consider the effect of other variables in the conduct of monetary policy for advanced economies. For example, Castro (2011) incorporates a financial conditions index containing information from asset prices and financial variables for the Fed, ECB and BoE; Fourçans and Vranceanu (2004) find that the ECB's monetary policy responds to deviations of the exchange rate from its average; Fendel and Frenkel (2006) explore the impact of money supply and find that it does not directly affect the ECB's behavior, but it helps to predict future inflation; and Rotondi et al. (2005) augment the Taylor rule to show that the Fed reacts to stock market prices. Additionally, Torres García (2002) mentions that particularly for small and open economies, such as Mexico, there are other factors with which monetary policy has to interact; for example, they are very exposed to the volatility of international financial markets or to the effect of exchange rates over prices; thus some studies have also extended the Taylor rule to consider the effect of additional variables in the monetary policy of small open economies.[5]

In this sense, an augmented Taylor rule can be expressed as:

$$i_t = i^* + \pi^* + \beta(\pi_t - \pi^*) + \gamma(y_t - y^*) + \delta w_t, \tag{4.3}$$

with w_t the value of the additional variable of interest at time t and all the other variables as previously defined.

[5]See for example Ball (1999), Svensson (2000) and Torres García (2002).

4.2 Data Selection

To estimate Taylor rules in equations (4.2) and (4.3), we first need to define the monetary policy instrument, which for Banxico is the Overnight Interbank Funding Rate since February 2008. Secondly, we need to define the inflation and output gaps. We use the annual variation on the *Índice Nacional de Precios al Consumidor* (INPC for its acronym in Spanish) as our measure of headline inflation and subtract Banxico's inflation constant target of three percent to calculate the inflation gap.[6] The output gap is extracted from the annual variation on the *Indicador Global de la Actividad Económica* (IGAE for its acronym in Spanish), which is a proxy for the Mexican Gross Domestic Product that allows to know and monitor the monthly evolution of the real sector of the economy.[7]

In order to asses the question of interest, we need to augment the Taylor rule with the communication indicators presented in Chapter 3. MPS are available since January 2000, but MPM started to be published in 2011. To be able to compare the importance of both types of documents, we restrict the sample period to begin in February 2011 in both cases. Additionally, we decided to end the sample period in December 2019 to avoid the Covid-19 sanitary crisis since the magnitude and scope of its effects on the economy, as well as its duration, are still uncertain and could drastically influence the results.[8] Thus, for the main results presented in this chapter, the sample period will cover from February 2011 to December 2019 in a "monetary policy decision frequency"; this is, each point in time refers to a MPD.

Figure 4.1 compares the inflation and output gaps with Banxico's target rate. As can be observed, in the sample period there are three monetary easing cycles corresponding to i) the financial crisis of 2008-2009 (October 2008 - July 2009),

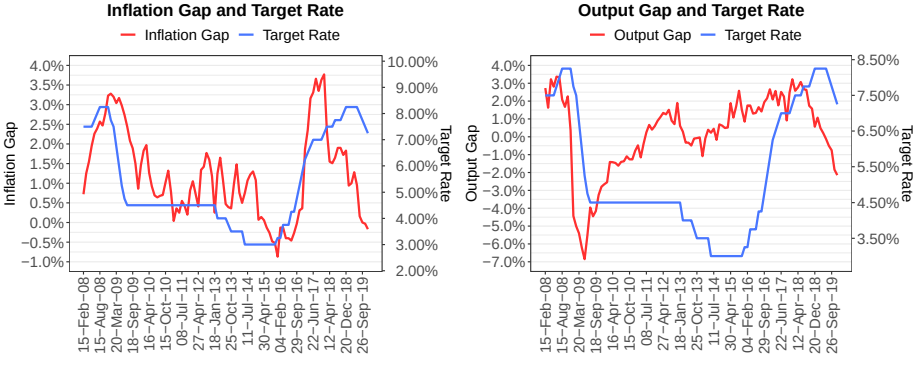
[6]Torres García (2002) conducts a study involving the estimation of monetary policy rules for Mexico in the period 1996-2001. At that time Banxico did not announced a target level for interest rates and used the "corto" as monetary policy instrument. Additionally, there was no constant inflation target. Thus the conclusions in this paper no longer hold.

[7]The IGAE incorporates primary, secondary and tertiary activities, except for fishing, forestry, corporate and other service activities. This measure was chosen above the GDP because it is availably in a monthly basis. The output gap is calculated as the difference between the annual variation on the IGAE and its tendency obtained through a Hodrick Presscot filter. For futher details see the April-June 2009 Quarterly Report of Banco de México, page 74.

[8]We only present estimates for documents in Spanish since documents in English started being published in May 2018 and, thus, there are only 14 MPS and MPM available prior to the end of the sample period. Additionally during the period May 2018 - December 2019, the inflation and output gaps show little variation exhibiting only a decreasing trend, and the MPR was held constant previous to start an easing cycle.In Section 4.5 we present some robustness tests including different sample periods.

ii) the January 2013 - July 2014 period, and iii) the September - December 2019 period (previous to the pandemic). The left panel of Figure 4.1 shows the target rate as well as the inflation gap. For most of the sample period, the inflation has been above the target with outstanding peaks at April 2009 and December 2017 and a valley in December 2015. Additionally, it can be observed the high co-movement between the target rate and the inflation gap: periods with a high inflation gap coincide with the tightening cycles, and periods with low (stable) inflation gap coincide with the easing cycles. Similarly, the right panel of Figure 4.1 shows the target rate and the output gap. During the financial crisis, the output gap showed its greatest fall reaching almost -7%. After the first half of 2009, and with the exception of the 2013 drop, the output gap started to recover showing an increasing trend until May 2018, and decreased thereafter. Additionally, and in contrast to the inflation gap, it can be observed that there is little co-movement between the output gap and the target rate. Nonetheless, major drops in the output gap coincide with easing monetary policy.

Figure 4.1: Banxico's Target Rate vs Inflation and Output Gaps.



Source: Own calculations with data from the Instituto Nacional de Estadística, Geografía e Informática (INEGI) and Banco de México
Notes: 1/The inflation gap is calculated as the difference between the anual variation in inflation and the inflation target rate. 2/The output gap is calculated as the difference between the annual variation on the IGAE and its tendency obtained through a Hodrick Presscot filter.

It is worth noting that this sample period includes episodes in which the monetary policy authority was "tested" since it faced internal and external unfavorable events, such as the 2008-2009 financial crisis, changes of government, and the oil crisis which particularly affected the Mexican Oil Mix during 2016 when its prices decreased to historical minimums. All these episodes required precise monetary policy actions to avoid inflation pressures and/or structural changes to inflation.

4.3 Baseline Model

To incorporate the idea that interest rate changes affect inflation and output with a sizable lag, instead of contemporaneous variables we use lags of the inflation and output gaps in equation (4.2), reflecting that the available information for the current MPD is that of the last decision.[9] Therefore, our baseline model is estimated as

$$i_t = \alpha + \beta\hat{\pi}_{t-1} + \gamma\hat{y}_{t-1} + \epsilon_t, \tag{4.4}$$

where i_t is the monetary policy instrument at time t, $\hat{\pi}_{t-1}$ is the inflation gap at time $t-1$, $\hat{y}_{t-1}$ is the output gap at time $t-1$ and ϵ_t is the error term at time t with $\epsilon_t \sim N(0,1)$. Note that under this specification the coefficient α is equal to the sum of the natural rate and the inflation target.

Given that some communication indicators, particularly the HD Index, reflect whether MPS and/or MPM indicate the possibility of a rate hike or cut, it is more intuitive to think that they are more likely to explain the change in the target rate rather than its level. Therefore, as our second baseline model we estimate a variation of equation (4.4) for the difference in the target rate (Δi_t) as follows:

$$\Delta i_t = \alpha + \beta\hat{\pi}_{t-1} + \gamma\hat{y}_{t-1} + \epsilon. \tag{4.5}$$

We use the Newey-West HAC variance-covariance estimator proposed by Newey and West (1987) for our estimations to avoid serially correlated error terms.[10]

Table 4.1 shows the estimated coefficients and standard errors for baseline models in equations (4.4) and (4.5). When estimating the target rate in levels, the β coefficient is positive and statistically significant with a 95% confidence, meaning that an increase of one percentage point in the inflation gap is related to an increase of 85 basis points in the target rate. As for the γ coefficient, even though positive, it is not statistically significant. This result is not surprising since

[9] More lags could be added to this specification to explore the persistance of MPD. However, and considering the number of observations, adding several lags will have the trade off of a less parsimonious model and/or could lead to estimation problems. This excercise is left for future research.

[10] Following Hanck et al. (2019), the error term in equations (4.4) and (4.5) may be serially correlated due to serially correlated determinants of the interest rate that are not included as regressors. This could lead to autocorrelated standard errors that may cause misleading inference. The solution proposed is the estimation of Heteroskedsticity and Autocorrelation Consistent (HAC) estimators of the variance-covariance matrix, which adjust for serially correlated errors. The Newey-West HAC variance-covariance estimator is implemented in R with the function NeweyWest from package sandwich.

Banxico is an inflation targeter CB and, as observed in the right panel of Figure 4.1, the target rate and the output gap are only highly correlated when the economy's performance is well below its potential. In contrast, for the change in the target rate the β coefficient is negative and not statistically significant, while the γ coefficient is positive and significant with a 95% confidence, meaning that an increase of one percentage point in the output gap is related to an increase of almost 10 basis points.

Table 4.1: Results for Banxico's Baseline Models (4.4) and (4.5)

Model	**Coef.**	**Intercept**	**Inf. Gap**	**Output Gap**	R^2	**Adj.** R^2
Levels	Estim	4.0862***	0.8523***	0.2175	0.31	0.29
Levels	S.D.	(0.6560)	(0.1985)	(0.3668)		
Differences	Estim	-0.0386	-0.0200	0.0987***	0.28	0.26
Differences	S.D.	(0.0316)	(0.0244)	(0.0267)		

Significance code: 0.001 → ***; 0.01 → **; 0.05 → *; 0.1 → +.

Notes:

1/ The sample period covers from February 2011 to December 2019 and data has 72 observations. Each point in time refers to a monetary policy decision.

2/ The baseline models presented are estimated for MPS with OLS implementing the Newey-West HAC variance-covariance estimator.

3/ Results for MPM are quite similar and just differ in that the sample period contains one less observation since there was no minute for the extraordinary meeting on February 17, 2016. Using the MPM sample, the estimated coefficients for the intercept, inflation and output gaps are 4.097, 0.8404 and 0.2267, respectively when the dependent variable is the level of the target rate and -0.0361, -0.0226 and 0.1007 when the dependent variable is the change in the target rate. Significance of coefficients remains as in the MPS case.

4/ The inflation gap is measured as the difference between the headline inflation and the inflation target rate.

5/ The output gap is measured as the difference between the annual variation on the IGAE and its tendency obtained through a Hodrick Presscot filter.

As far as we are aware, most of the studies that analyze Taylor rules for the case of Mexico use sample periods prior to the one we are using in this work, and/or apply different methodologies that incorporate a Taylor rule in the process. Therefore, given that previous to 2008 Banxico's monetary policy instrument was the "corto" and it did not have a constant inflation target, it is somewhat difficult to compare this baseline results with those in the literature of Taylor rule models for Mexico. For example, Best (2013) estimates a Dynamic Stochastic General Equilibrium (DSGE) model using Bayesian methods to address if Mexico observes real inflation targeting or fear of floating for the 1981-1994 and 1995-2005 periods. In this study the Taylor rule is one of the equations of the DSGE model. She finds that the inflation gap is positive and statistically significant in both periods, however it is greater than one (consistent with the Taylor

rule principle) just for the second period. As for the output gap, it is positive, less than one and statistically significant in both periods. Similarly, Cermeño et al. (2012) estimates a New Keynesian DSGE to model the behavior of the Mexican economy and the response of the CB during the 1998-2008 period. They also find that, under a forward-looking Taylor rule, inflation and output gaps are positive and statistically significant and that the inflation gap is consistent with the Taylor rule principle, concluding that the CB holds a preference for stabilizing the inflation around the target and for the output gap to remain close to zero. Torres (2003) examines if monetary policy has performed the role of nominal anchor for the Mexican economy estimating forward-looking Taylor rules for the 1997-2001 period. He also finds that inflation and output gaps are positive and statistically significant; however, in contrast to the previous studies, the output gap coefficient is greater than one. Reyna (2018) estimate a Structural VAR model to asses the Mexican monetary policy rate for the 2000-2015 finding that the monetary policy rate responds to GDP, inflation and the exchange rate. The most similar study to what we develop in this chapter (in terms of methodology) is Moura and de Carvalho (2010), who run 16 alternative specifications for the Taylor rule for the seven largest economies in Latin America during the 1999-2008 period (just before the start of our sample period). For the specific case of Mexico, the selected Taylor rule specification (which is the one that best predicts the interest rate setting) is a backward-looking Taylor rule with exchange rate, for which the inflation gap is positive, greater than one and statistically significant, and the output gap is positive, greater than one but not statistically significant. As a result they classify the Mexican monetary policy as "tough", together with that of Brazil. The most recent study that we are aware that incorporates Taylor rules for Mexico is Morais et al. (2019). They study the international credit and risk-taking channel of monetary policy through the 2001-2015 period, and calculate an augmented Taylor rule model with inflation and output as part of their methodology to get a Taylor rule-type shock for monetary rates; unfortunately the results on the Taylor rule estimation are not reported. Therefore, taking into account that we are analyzing the 2008-2019 period with a backward looking Taylor rule, our baseline results are mainly in line with those of Moura and de Carvalho (2010), and the difference in the magnitude of estimated coefficients may be due to the different sample periods examined.

4.4 Taylor Rules Augmented With Communication Variables

Greater clarity and disclosure over monetary policy is expected to lead to a greater predictability of the CB's actions (see Sturm and De Haan, 2011); therefore, we

focus in exploring to what extent Banxico's communication adds information compared to that provided by a Taylor rule model with inflation and output gaps. To this end, we augment the Taylor rule in equation (4.4) and its variation in equation (4.5) with the communication variables presented in Chapters 2 and 3, such that the Taylor rule with communication indicators is given by:

$$i_t = \alpha + \beta\hat{\pi}_{t-1} + \gamma\hat{y}_{t-1} + \delta w_{t-1} + \epsilon_t, \tag{4.6}$$

and its variation by:

$$\Delta i_t = \alpha + \beta\hat{\pi}_{t-1} + \gamma\hat{y}_{t-1} + \delta w'_{t-1} + \epsilon_t, \tag{4.7}$$

where w_{t-1} corresponds to one of the following communication indicators: length, ease of reading, text similarity index or consensus-dissent indicators (only for MPM), and w'_{t-1} corresponds to the HD Index. Models (4.6) and (4.7) are estimated separately for MPS and MPM.[11] We estimate the results for several measures of length, for both the Flesch Reading Ease Score and the Flesch-Kincaid Grade Level, the text similarity index and its moving averages for different lengths, as well as the HD Index and its moving average for different lengths. Only selected results are presented in this section and the alternative communication measures are discussed in section 4.5.1.

4.4.1 Results for Monetary Policy Statements

Table 4.2 shows the estimated results for model (4.6) when using information contained in the MPS. Compared to the estimations of the baseline model, in all cases the estimated coefficient for the inflation gap is slightly smaller, but remains positive and statistically significant. Additionally, the output gap remains non-significant.

As for the communication indicators, we find that the length of the MPS helps explain the MPD since both, the number of words and the ASL, are statistically significant with a 95% confidence. An increase of 100 words in the MPS is associated with an increase of 28 basis points of the target rate, this could mean that Banxico tends to explain the reasons behind the rate hikes in more detail than those behind the rate cuts. Additionally, an average increase of one word per sentence, which is normally interpreted as a more complex communication, is associated with a decrease of 23 basis points in the target rate. It is worth noting that augmenting the baseline model with the length indicators increases

[11] We estimate models (4.6) and (4.7) for all communication variables, but only report those results that are more intuitive; this is for model (4.6) when using length, ease of reading, text similarity index or consensus-dissent indicators and model (4.7) when using the HD Index. All results are available upon request.

the Adjusted R^2 in 0.18 and 0.07 points for the number of words and the ASL, respectively.

The estimated coefficient for the Flesch Scale is positive and statistically significant with a 95% confidence. We find evidence that the easiest the MPS, the higher is the level of the target rate. Since Banxico is an inflation targeter, usually the main reason for a rate hike is an increase in inflation, and thus "the explanation is simple". In contrast, there is no obvious reason for a rate cut. A CB could think of rate cuts when it faces economic crisis, less dynamism in growth, lower inflation expectations, or even a combination of these (and possibly other) situations, thus complicating the explanations and making monetary policy communication more complex. In this sense, we find that an increase of one point in the Flesch Scale (easier to read MPS) is associated with and increase of 22 basis points in the target rate. Augmenting the baseline model with this indicator increases the Adjusted R^2 in 0.08 points.

Text similarity is also found to be an important communication variable. The estimated coefficients for the different measures of text similarity are all positive and statistically significant. For instance, an increase of 0.01 in the text similarity index is related to an increase of 10 basis points in the target rate. Additionally, the coefficient is larger as the size of the moving average augments, reaching an increase of 20 basis points in the target for the moving average of one year of MPS (i.e. $k = 8$). This result could indicate that after periods when there are little or no changes to the MPS, we can expect a rate hike for the next MPD. Augmenting the baseline model with the text similarity indicators increases the Adjusted R^2 by up to 0.43 points.

Table 4.3 shows estimated results for augmented model (4.7) using the HD Index and its moving average for different window lengths. The inflation gap remains negative in all cases and non-significant in some of them, while the output gap remains positive and statistically significant as in the baseline estimation. As for the HD Index, all the estimated coefficients are positive and statistically significant with a 95% confidence. Since the HD Index indicates whether the MPS has a hawkish (suggesting rate hikes) or dovish (suggesting rate cuts) tone, we find that a completely hawkish(dovish) MPS, this is $HDI = 1(HDI = -1)$, suggests an increase(decrease) of 23 basis points in the target rate. Additionally, when incorporating information from previous MPS, the estimated coefficient for the moving average of the HD Index increases, suggesting a rate hike(cut) of up to 58 basis points. Additionally, the value of the Adjusted R^2 increases between 0.10 and 0.16 points compared to that of the corresponding baseline model.

Table 4.2: Results for Augmented Model (4.6) with Banxico's Statements

Coef.	**Intercept**	**Inflation Gap**	**Output Gap**	**Words**	**Av. Sent. Length**	**Flesch Scale**	**Text Similarity**	**Text Sim. (m.a. k=4)**	**Text Sim. (m.a. k=6)**	**Text Sim. (m.a. k=8)**	R^2	**Adj.** R^2
Estim	1.1302	0.6353*	-0.0679	0.0028*							0.49	0.47
S.D.	(1.2339)	(0.2823)	(0.3671)	(0.0013)								
Estim	10.5652***	0.7295***	0.2714		-0.2310*						0.38	0.36
S.D.	(2.7344)	(0.1882)	(0.3298)		(0.0884)							
Estim	-7.1422	0.6131**	0.2818			0.2254+					0.40	0.37
S.D.	(5.5063)	(0.2047)	(0.3221)			(0.1156)						
Estim	0.8040	0.8547***	0.1581				10.5344**				0.58	0.56
S.D.	(0.9919)	(0.2357)	(0.2482)				(3.3502)					
Estim	-0.8094	0.7809***	0.1042					15.8759***			0.69	0.68
S.D.	(0.9371)	(0.2174)	(0.2193)					(3.1564)				
Estim	-1.4295+	0.6642***	0.0976						18.1859***		0.71	0.70
S.D.	(0.7584)	(0.1861)	(0.2092)						(3.0050)			
Estim	-1.9957*	0.5680***	0.1026							20.1780***	0.73	0.72
S.D.	(0.7915)	(0.1499)	(0.2069)							(3.2039)		

Significance code: 0.001 → ***; 0.01 → **; 0.05 → *; 0.1 → +.

Notes:

1/ The sample period covers from February 2011 to December 2019 corresponding to 72 statements. Each point in time refers to a monetary policy decision.

2/ Each model is estimated with OLS implementing the Newey-West HAC variance-covariance estimator.

3/ The dependent variable is the level of the target rate.

4/ The inflation gap is measured as the difference between the headline inflation and the inflation target rate.

5/ The output gap is measured as thedifference between the annual variation on the IGAE and its tendency obtained through a Hodrick Presscot filter.

Table 4.3: Results for Augmented Model (4.7) with Banxico's Statements

Coef.	**Intercept**	**Inflation Gap**	**Output Gap**	**HD Index**	**HD Index (m.a. k=4)**	**HD Index (m.a. k=6)**	**HD Index (m.a. k=8)**	R^2	**Adj.** R^2
Estim	-0.0140	-0.0391+	0.0907***	0.2373**				0.39	0.36
S.D.	(0.0244)	(0.0210)	(0.0182)	(0.0750)					
Estim	0.0060	-0.0292	0.0663***		0.3908**			0.42	0.39
S.D.	(0.0303)	(0.0176)	(0.0174)		(0.1185)				
Estim	0.0286	-0.0262+	0.0468**			0.5404***		0.45	0.43
S.D.	(0.0307)	(0.0156)	(0.0173)			(0.1415)			
Estim	0.0335	-0.0242	0.0424**				0.5825***	0.45	0.42
S.D.	(0.0298)	(0.0172)	(0.0157)				(0.1437)		

Significance code: 0.001 → ***; 0.01 → **; 0.05 → *; 0.1 → +.

Notes:

1/ The sample period covers from February 2011 to December 2019 corresponding to 72 statements. Each point in time refers to a monetary policy decision.

2/ Each model is estimated with OLS implementing the Newey-West HAC variance-covariance estimator.

3/ The dependent variable is the change in the target rate.

4/ The inflation gap is measured as the difference between the headline inflation and the inflation target rate.

5/ The output gap is measured as the difference between the annual variation on the IGAE and its tendency obtained through a Hodrick Presscot filter.

4.4.2 Results for Monetary Policy Minutes

Table 4.4 shows the estimated results for model (4.6) when using information contained in the MPM. Compared to the estimations of the baseline model (Table 4.1), the estimated coefficient for the inflation gap is slightly smaller but remains positive and statistically significant. Additionally, the output gap remains non-significant except for the model including the ASL.

The length measures of the MPM are useful when explaining the target rate. Both, the number of words and the ASL, are statistically significant with greater confidence than that of the MPS. An increase of 100 words in the MPM is associated with an increase of eight basis points of the target rate. In line with the estimates for the MPS, this finding supports the idea that Banxico tends to explain with more detail (i.e. gives a larger explanation) rate hikes than rate cuts. It is worth noting that the estimated coefficient of the number of words is smaller for the MPM than for the MPS. This difference could arise from the nature of the documents since MPM are constructed as a more detailed version of the information presented in the MPS, thus complicated MPD require significantly larger explanations in the MPS, but not in the MPM. Additionally, an average increase of one word per sentence in the MPM is associated with a decrease of 36 basis points in the target rate. The Adjusted R^2 increases in 0.40(0.33) points when augmenting the baseline model with the number of words(ASL) of the MPM.

The ease of reading of MPM is positive and statistically significant with a 95% confidence, and its magnitude is similar to that of the MPS. We find evidence that a higher Flesch Scale (easier minute) is associated to a higher level of the target rate: an increase of one point in the ease of reading of MPM is associated with and increase of 20 basis points in the target rate. This finding is in line with the intuition that inflation targeters struggle more to explain rate cuts than rate hikes; i.e. rate cuts are much more complex to describe. Augmenting the baseline model with the Flesch Scale indicator increases the Adjusted R^2 for MPM in 0.13 points.

Although text similarity between consecutive MPM is not high, the estimated coefficients for the different measures of this indicator are all positive and most of them are statistically significant with a 95% confidence. We find that an increase of 0.01 in text similarity of minutes is related to an increase of the target rate of almost 40 basis points. Additionally, the coefficient is larger as the size of the moving average increases, reaching an equivalent rate hike of 43 basis points for the moving average of six minutes. Nevertheless, the significance decreases

when the moving average increases, such that the information of one year (eight minutes) is not statistically significant. Augmenting the baseline model with text similarity indicators for MPM increases the Adjusted R^2 between 0.12 and 0.18 points.

We also find evidence that the rate of agreement among Banxico's Governing Board, defined as the proportion of arguments in MPM mentioned by "all" and the "majority" of the members, is not statistically significant when explaining the target rate. This could be due to the fact that, when major rate hikes/cuts occur, they are usually reached unanimously and thus, there is no difference in the way the governing board discusses those movements. Additionally, even though different economic situations are discussed in a different level by each member, through the sample period the agreement rate has remained stable.

Lastly, Table 4.5 shows the estimated results for MPM when augmenting model (4.7) with the HD Index and its moving average for different window lengths. Estimated coefficients for inflation and output gaps are consistent with those of the baseline model. In contrast to MPS, we find evidence that the tone of the minutes is not statistically significant until the moving average for eight minutes (one year) is considered. This result may be derived from the fact that the tone of the MPM is bounded between -0.32 and 0.38, which is nearer to a "neutral" tone than to a hawkish/dovish tone. We find that eight consecutive hawkish(dovish) minutes, would suggest an increase(decrease) of 57 basis points in the target rate. Additionally, the Adjusted R^2 increases only by 0.04 points compared to the corresponding baseline model.

It should be noted that the response of interest rates should be carefully analyzed since the sample period shows inflation stability. Moreover, its worth mentioning that a caveat of the estimations presented in this document is that their are not backed up by a theoretical model of any sort. Hence, when interpreting the results one must keep in mind that they represent correlations between variables and, therefore, a series of stylized facts rather than showing any type of causality between communication variables and the target rate. Future research in this topic should focus its attention in proposing theoretical models that explore the mechanisms through which communication affects monetary policy and its transmission, as well as the feedback effects of monetary policy to CB's communication.

Table 4.4: Results for Augmented Model (4.6) with Banxico's Minutes

Coef.	**Intercept**	**Inflation Gap**	**Output Gap**	**Words**	**Av. Sent. Length**	**Flesch Scale**	**Text Similarity**	**Text Sim. (m.a. k=4)**	**Text Sim. (m.a. k=6)**	**Text Sim. (m.a. k=8)**	**Agreement Rate**	R^2	**Adj.** R^2
Estim	0.1745	0.5268**	0.0468	0.0008***								0.71	0.69
S.D.	(0.7806)	(0.1973)	(0.1856)	(0.0001)									
Estim	15.9913***	0.7267***	0.3571+		-0.3676***							0.64	0.62
S.D.	(3.3121)	(0.1299)	(0.2050)		(0.0928)								
Estim	-5.4961	0.7077***	0.4489			0.2020*						0.45	0.42
S.D.	(3.4678)	(0.1507)	(0.3024)			(0.0771)							
Estim	-3.6782	0.7984**	-0.0190				39.2410*					0.49	0.47
S.D.	(3.7264)	(0.2718)	(0.3280)				(19.0142)						
Estim	-4.1680	0.7772**	-0.0688					41.8023+				0.48	0.45
S.D.	(4.3059)	(0.2762)	(0.3748)					(22.1277)					
Estim	-4.4555	0.7765**	-0.1078						43.2902+			0.46	0.43
S.D.	(4.7625)	(0.2675)	(0.4166)						(24.8217)				
Estim	-4.8931	0.7929**	-0.1396							45.3597		0.44	0.42
S.D.	(5.2469)	(0.2547)	(0.4501)							(27.4604)			
Estim	3.8937***	0.8344***	0.2193								0.0098	0.31	0.28
S.D.	(0.4948)	(0.2093)	(0.3790)								(0.0200)		

Significance code: 0.001 → ***; 0.01 → **; 0.05 → *; 0.1 → +.

Notes:

1/ The sample period covers from February 2011 to December 2019 corresponding to 71 minutes. Each point in time refers to a monetary policy decision.

2/ Each model is estimated with OLS implementing the Newey-West HAC variance-covariance estimator.

3/ The dependent variable is the level of the target rate.

4/ The inflation gap is measured as the difference between the headline inflation and the inflation target rate.

5/ The output gap is measured as the difference between the annual variation on the IGAE and its tendency obtained through a Hodrick Presscot filter.

Table 4.5: Results for Augmented Model (4.7) with Banxico's Minutes

Coef.	**Intercept**	**Inflation Gap**	**Output Gap**	**HD Index**	**HD Index (m.a. k=4)**	**HD Index (m.a. k=6)**	**HD Index (m.a. k=8)**	R^2	**Adj.** R^2
Estim	-0.0324	-0.0314	0.0976***	0.1726				0.31	0.28
S.D.	(0.0284)	(0.0228)	(0.0221)	(0.1448)					
Estim	-0.0321	-0.0272	0.0904***		0.2765			0.32	0.28
S.D.	(0.0328)	(0.0253)	(0.0223)		(0.2267)				
Estim	-0.0302	-0.0284	0.0844***			0.4595		0.34	0.31
S.D.	(0.0322)	(0.0230)	(0.0211)			(0.2782)			
Estim	-0.0336	-0.0279	0.0843***				0.5758*	0.36	0.33
S.D.	(0.0284)	(0.0193)	(0.0182)				(0.2570)		

Significance code: 0.001 → ***; 0.01 → **; 0.05 → *; 0.1 → +.

Notes:

1/ The sample period covers from February 2011 to December 2019 corresponding to 71 minutes. Each point in time refers to a monetary policy decision.

2/ Each model is estimated with OLS implementing the Newey-West HAC variance-covariance estimator.

3/ The dependent variable is the change in the target rate.

4/ The inflation gap is measured as the difference between the headline inflation and the inflation target rate.

5/ The output gap is measured as the difference between the annual variation on the IGAE and its tendency obtained through a Hodrick Presscot filter.

4.5 Robustness Tests

In Appendix D we present a wide variety of results showing that the main findings are robust to a number of changes in the estimation. In particular, we show that alternative communication measures are also statistically significant and that results hold when using different monetary policy instruments. Additionally, we present coincidences and differences when varying the sample period and the model specification.

4.5.1 Alternative Communication Measures

Tables D.1, D.2, D.3 and D.4 show the results for alternative communication measures.

For the length indicators (number of sentences and characters) in Tables D.1 and D.3, estimated coefficients are also positive and have the same significance level as the main results for both, MPS and MPM. As for the ease of reading indicators, the estimated coefficient when using the Grade Level instead of the Flesch Scale are now negative, but remain statistically significant. The change of sign arises naturally since a more difficult to read document (lower Flesch Scale) requires more years of study (higher Grade Level). Additionally, the estimated coefficient for MPS and MPM are of similar magnitude as happens in the main results.

The alternative communication indicators for text similarity include the different moving averages that where not included in the main results. For the MPS (Table D.1), results confirm that text similarity is an important communication variable, since all estimated coefficients are positive and statistically significant. Additionally, the magnitude of coefficients is larger as the size of the moving average increases. In contrast, while estimated coefficients for MPM are positive (Table D.3), their significance decreases with the size of the moving average. Looking to this results, it would be worthy to add the text similarity index contemporaneous to the target rate and explore if changes to the current MPS/MPM are related to major changes in the target rate.

For the HD Index we also present as alternative measures the different moving averages that where not included in the main results. Results confirm that, when incorporating information from previous MPS (Table D.2), the estimated coefficient for the moving average of the HD Index increases and so does its significance. As for MPM (Table D.4), contrary to what was thought in section 4.4.2, the evidence suggests that incorporating information on the tone of some of

the previous minutes (specifically two, three and seven) can provide information on the target rate level.

Lastly, Table D.3 shows the relation of different levels of consensus/dissent in the MPM with the target rate. Evidence suggests that an increase of ten percentage points in the proportion of arguments expressed by "some" members is related to a decrease of 73 basis points in the target rate. This result has no clear intuition behind.

4.5.2 Alternative Monetary Policy Instruments

As a second robustness test, we change the monetary policy instrument used in the model. Instead of the target rate, we re-run models (4.6) and (4.7) using the overnight (1 day) Interbank Equilibrium Interest Rate (TIIE), the 28 day TIIE, and the Banking Funding Rate as dependent variables.[12]

Table D.5 shows the baseline results (i.e. models (4.4) and (4.5)) for the alternative monetary policy instruments. The sign, magnitude and significance of estimated coefficients, as well as the value of the adjusted R^2 hold for the three different rates. When augmenting the models with communication indicators, results are also quantitatively and qualitatively similar to the main results presented for MPS and MPM as observed in Tables D.6,D.7, D.8 and D.9.

4.5.3 Alternative Sample Periods

As previously mentioned, the sample period for the main results covers from February 2011 to December 2019 to match sample periods for both MPS and MPM, and to avoid the unknown effects of the Covid-19 sanitary crisis. Nevertheless, all the models where also re-estimated for alternative sample periods for both types of documents.

For MPS, alternative sample periods seek to include documents since Banxico adopted the Overnight Interbank Funding Rate as monetary policy instrument

[12]The overnight TIIE funding rate is calculated by Banxico using one-day repo operations on government, IPAB, and Banxico's securities traded by banks and brokerage firms in the wholesale market settled through INDEVAL's DVP system (securities clearing house). The 28 day TIIE is calculated by Banxico using commercial bank quotes as stipulated in the Official Gazette of March 2nd 2012. The Banking Funding Rate is the representative interest rate on one day repo and one day outright operations with certificates of deposit, bank notes and banker's acceptances, traded by banks and stockbrokerage firms in the wholesale market settled through the delivery versus payment system in INDEVAL. Source: Banxico's webpage, available at `http://anterior.banxico.org.mx/SieInternet/defaultEnglish.do`; accessed on April 27, 2021.

(February 2008) and/or the first months of the Covid-19 crisis (June 2020). Table D.10 shows the baseline results for the following alternative sample periods: i) Feb. 2008 - Dec. 2019, ii) Feb. 2008 - Jun. 2020, and iii) Feb. 2011 - Jun. 2020. For models with the target rate in levels as dependent variable, results are quantitatively and qualitatively similar for the inflation gap, but the main differences arise when comparing estimated values for the output gap:

i) If we extend the sample period backwards (Feb. 2008 - Dec. 2019) it remains positive and now it is statistically significant with a 95% confidence. This result is in line with previous studies described in section 4.3. Additionally this model explains 42% of the variation.

ii) Adding the first half of 2020 to scenario i) results in a positive output gap that is again not statistically significant. This result is equivalent to that presented in the main results, but with a shrinked coefficient.

iii) Lastly, only extending the sample period forward (February 2011 - June 2020) results in a negative and statistically significant output gap coefficient, but with a lower R^2 value.

This differences mainly derive from the fact that the output gap and the target rate have a strong co-movement downwards for the financial crisis of 2008-2009 and the recent sanitary crisis of 2020.

As for the baseline models with the difference in the target rate as dependent variable, results are qualitatively similar for both the inflation and output gaps, but estimated coefficients for the output gap are somewhat smaller.

Table D.11 shows results for alternative sample periods when extending the baseline models in Table D.10 for MPS in levels. In contrast with the main results, using the number of words in the MPS as length indicator is not important when explaining the target rate if we include February 2008 - January 2011 in the sample period; nevertheless, the ASL remains negative and statistically significant. Results for the ease of reading of MPS are quantitatively and qualitatively similar for two of the alternative sample periods (Feb. 2008 - Dec. 2019 and Feb. 2011 - June 2020). The strongest results are for the text similarity indicators, which are all consistent with the observations for the main results. Additionally, it is worth noting that, compared to the corresponding baseline model, adding communication variables to equation (4.6) for the Feb. 2011 - June 2020 period results in a non-significant output gap.

As for the model in differences, Table D.12 shows that the tone of the MPS is important when explaining the change in the target rate independent of the sample period. Compared to the corresponding baseline scenario, adding the different measures of the HD Index results in a negative, but statistically significant inflation gap for both sample periods that include the financial crisis. Even though a relationship is found, this result is counterintuitive since we would expect that greater inflation output is related to a mayor change in the target rate.

For MPM, we only considered as alternative sample period the one including the start of the Covid-19 crisis, i.e. February 2011 - June 2020.[13] Tables D.13 and D.14 show the estimated results for augmented models with alternative sample periods. Evidence suggests that results are robust when adding the first half of 2020 to the sample period. Moreover, results are stronger for the different measures of the text similarity index and for the HD Index, suggesting that during crisis periods the consistency and the clarity of CB's communication is extremely important to accurately explain the economic environment and to justify the CB's actions.

4.5.4 Alternative Model Specifications

Some policy makers often refer to core inflation instead of headline inflation since it is a measure that excludes changes in food and energy prices, whose volatility makes it difficult to predict future overall inflation. In this sense, for the last robustness test we modify the specification of models (4.6) and (4.7) substituting the inflation gap for the core inflation gap.

Table D.15 shows the baseline results when using core inflation to compute the inflation gap. We find that, under this specification, results are qualitatively similar to those presented on Table 4.1. Additionally, we find that the inflation gap coefficient is larger when using core inflation in the model that explains the target rate level since an increase of one percentage point in core inflation gap is associated to a change of almost 200 basis points in the target rate.

Tables D.16 and D.17 show the results when estimating the augmented models with communication indicators of the MPS with core inflation gap. All the results

[13] Baseline results are practically identical to those presented in Table D.10 for MPS, and just differ in that the sample period contains one less observation since there was no minute for the extraordinary meeting on February 17, 2016.

are qualitatively similar to those in Section 4.4. The main difference is that the magnitude of coefficients (in absolute value) is bigger for all the indicators.

Finally, Tables D.18 and D.19 show that results are robust to the core inflation gap for augmented models with communication indicators of the MPM. For the model explaining the level of the target rate, estimated coefficients are equivalent to those presented in the main results: the coefficients of communication variables are somewhat smaller but more significant. As for the model explaining the change in the target rate, HD Index indicators are still not significant until information from the last eight minutes is taken into account.

4.5.5 Other Robustness Tests

Results for all possible combinations of robustness tests presented in the previous subsections, for example results for one day TIIE with core inflation gap during the February 2008 - December 2019 period, are not included in the Appendix but are available upon request.

Chapter 5

Extension: The Case of the Federal Reserve

As an extension of the work presented in this thesis, we present the analysis of chapters 3 and 4 for the case of the Federal Reserve. The following sections present a brief background on the Fed, the analysis of its communication characteristics, and the main results on the relation between its communication strategy and its conduct of monetary policy.

5.1 Background on the Federal Reserve[1]

5.1.1 Federal Reserve's History and Mandate

The Fed is the CB of the US and it was created by the Congress in 1913 to provide a safer, more flexible, and more stable monetary and financial system. The Federal Reserve Act provided for a central banking "system" with three main features: i) a central governing board, ii) a decentralized operating structure of 12 Reserve Banks, and iii) a combination of public and private characteristics. Therefore, the Fed is independent from the Executive and the Congress, and its main structure is formed by the Board of Governors, the Federal Reserve Banks and the FOMC.

[1]Information on this section was obtained from the Fed's webpage, available at `https://www.federalreserve.gov`; accessed on October 31, 2020.

The Board of Governors is the governing body of the Fed and is run by seven members nominated by the U.S. President and confirmed by the Senate. Each governor is appointed for a 14-year term in a staggered manner, except for the Chair and Vice Chair who serve only for a four-year term and may be reappointed to an additional four-year term.

The country was divided geographically into 12 Districts, each with a separately incorporated Reserve Bank which operates independently, but with the supervision of the Board of Governors. Each Reserve Bank has a nine-member board of directors, six of which are elected by commercial banks, and the three remaining are appointed by the Board of Governors. Each Reserve Bank gathers data and information about the communities in its region and feeds that information to the Board of Governors and the FOMC.

The FOMC is responsible for open market operations and for setting the national monetary policy. It consists of twelve members: the seven members of the Board of Governors, the president of the Federal Reserve Bank of New York, and four of the remaining eleven Reserve Bank presidents, who serve one-year terms on a rotating basis. Non-voting Reserve Bank presidents attend the meetings, participate in the discussions, and contribute to the Committee's assessment of the economy and policy decisions.

The Federal Reserve Act of 1913 states that the Board of Governors and the FOMC should conduct monetary policy "so as to promote effectively the goals of maximum employment, stable prices and moderate long-term interest rates". Additionally, the Fed promotes the stability of the financial system, the safety and soundness of individual financial institutions, fosters the payment and settlement systems, and promotes consumer protection and community development. In January 2012 the FOMC released its "Statement on Longer-Run Goals and Monetary Policy Strategy" establishing an annual rate of increase of 2% in the price index for personal consumption expenditures as the longer-run goal for inflation to promote both, maximum employment and price stability. This goal is reaffirmed each year in its January statement.

Recently, the FOMC announced updates to its Statement on Longer-Run Goals and Monetary Policy Strategy, where it: i) emphasized that maximum employment is a broad-based and inclusive goal, and that its policy decision will be informed by its "assessments of the shortfalls of employment from its maximum level", instead of "deviations from its maximum level"; and ii) adjusted its strategy for achieving its longer-run inflation goal by noting that it "seeks to achieve inflation that averages 2% over time" and stating that "following periods

when inflation has been running persistently below 2%, appropriate monetary policy will likely aim to achieve inflation moderately above 2% for some time".[2]

The FOMC holds eight regularly scheduled meetings per year in which they review economic and financial conditions, assess risks to the economy and determine the stance of monetary policy by setting the target for the Federal Funds Rate (FFR).[3] In addition to adjusting the target rate, the FOMC can influence financial conditions by other means, such as asset purchases, reserve requirements, term deposits, credit facilities, among others; and by communicating to the public how it intends to adjust policy in the future. This last policy tool is known as "forward guidance" and has been used since March 2009 when the FFR was effectively at its lower bound.[4]

5.1.2 Federal Reserve's Communication Toolkit

While the use of forward guidance as a policy tool is relatively new, the Fed has largely been committed to communicate regularly with the public and Congress in order to foster transparency and accountability. Among its communication tools, the Fed currently uses the following:

1. **Congressional Hearings:** By statute, the Fed Chair has to testify twice each year on economic developments and monetary policy before congressional committees. The Board of Governors delivers the Semiannual Monetary Policy Report to Congress discussing the conduct of monetary policy, economic outlook, and prospects for the future.

2. **Agendas:** For each meeting, the FOMC Secretariat produces an agenda that includes topics that will be covered at the meeting and special topics.

3. **Post-meeting Monetary Policy Statements:** After each meeting, the FOMC releases a statement summarizing the Committee's judgment about the appropriate conduct of monetary policy. The first statement was published for the February 1994 meeting, and statements were only published when changes in the stance of monetary policy were made. Finally,

[2]See August 27, 2020 press release. Available at `https://www.federalreserve.gov/newsevents/pressreleases/monetary20200827a.htm`; accessed on November 4, 2020.

[3]The Federal Funds Rate is the interest rate for overnight borrowing between banks.

[4]The lower bound, or most commonly known the "zero lower bound", occurs when the target rate (or the short-term interest rate) is at or near to zero limiting the capability of the CB to alter the target rate in order to stimulate the economy.

since January 2000 they have been regularly published after each meeting regardless of whether there has been a change in monetary policy or not.

4. **Summary of Economic Projections:** Since October 2007, in each meeting corresponding to the end of the quarter, FOMC meeting participants submit their individual economic projections together with the MPS.

5. **Minutes of Monetary Policy Decisions:** They provide a timely summary of significant policy issues discussed during the monetary policy meetings. Minutes have been published in their present form since February 1993. At the beginning they were published three days after the subsequent meeting, but since December 2004 the released takes place three weeks after each MPD.

6. **Transcripts:** They contain a detailed record of FOMC meetings and are available since 1994.

7. **Tealbooks:** Tealbooks A and B contain a full analysis of current economic and financial conditions and projections, as well as background and context on monetary policy alternatives. They are produced by the staff and constitute the "Report to the FOMC on Economic Conditions and Monetary Policy".

8. **Beige Books:** It contains a summary of information on current economic conditions on each Federal Reserve Bank's District. They are produced by the staff and delivered approximately two weeks prior to each meeting.

9. **Press Conferences, presentations and speeches:** The FOMC uses these tools as an effective information platform to explain the bank's policies and help the message reach more people. For example, the Chairman holds a press conference after each meeting, and Reserve Bank's presidents and Board members frequently speak in public events.

Note that transcripts, Tealbooks, and Agendas are available to the public five years after each MPD meeting.[5]

[5]Additional documents that are no longer published can be consulted in the Fed's webpage. See `https://www.federalreserve.gov/monetarypolicy/fomc_historical.htm` for more information.

5.2 Evolution of the Federal Reserve's Communication Characteristics

The Fed has constantly improved the way it communicates with the public mainly through the publication of different documents, and improving their content and format. Todd (2016) makes an extensive revision on the history of FOMC's communication strategy up to 2000. In the following sections, we will only focus on the evolution of the Fed's MPS and MPM communication characteristics.

5.2.1 Federal Reserve's Communication Data

As for Banxico, using the R package developed, we extracted Fed's MPS and MPM from February 2000 and until June 2020.[6] Fed's MPM can be divided in three main sections: information presented by the staff, discussion of participants, and discussion of voting members. We only take into account the participants and voting members sections in order to be consistent with Banxico's analysis.

5.2.2 Federal Reserve's Length Measures

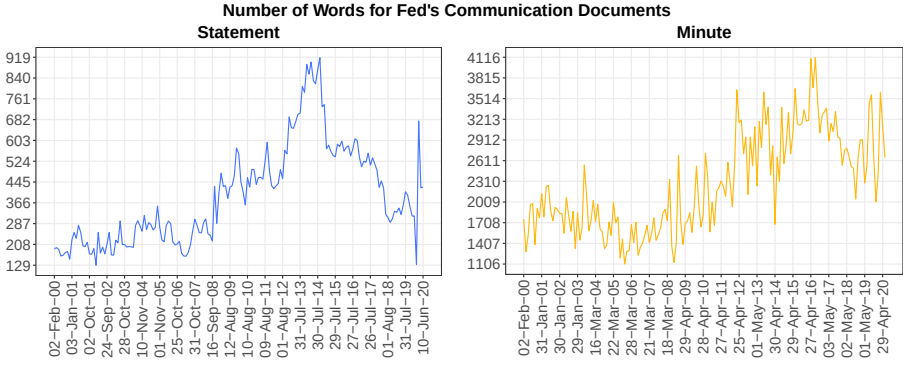
The left panel of figure 5.1 shows the number of words in the MPS. It can be observed an increasing trend in the length of MPS since 2000 and up to the end of 2013, with the number of words almost quintupled. The strongest increase coincides with the period of the 2008-2009 financial crisis in which the Fed had to introduce the forward guidance. After this period, and as economic and financial conditions improved, there was an effort to reduce the length of MPS to pre-crisis levels. As with Banxico, an increase in the length of the MPS can be appreciated due to the Covid-19 crisis. It highlights the March 3th, 2020 statement which corresponds to an extraordinary meeting in which the FOMC cut the target because of the imminent risks that the pandemic represented for the economy. Compared with Banxico's MPS, the median (mean) number of words in Fed's MPS is 48.4% (45.5%) smaller; part of this difference could be derived from the nature of the language.[7] As for the length of MPM, the right panel of Figure 5.1 shows the evolution of its number of words. Naturally, MPM are larger than MPS and have followed the same pattern: an increasing trend from 2005 to the beginning of 2016, followed by a decreasing period and a rebound in recent months due to the need of a deeper explanation of the implications and risks of the pandemic. Compared to Banxico's MPM, the median (mean) of the number

[6] Fed's MPS and MPM are only published in English. The Fed started to publish MPS regularly since February 2000, thus this date is selected as starting point for the sample period.

[7] Here we compare the number of words in Banxico's MPS in Spanish versus Fed's MPS in English because MPS in English for Banxico are only available since May 2018, and there are only a few observations available.

of words in FOMC's MPM is 40.5% (39.1%) smaller; again we should mention that part of this difference could derived from the nature of the language.[8].

Figure 5.1: Number of Words in Fed's Statements and Minutes



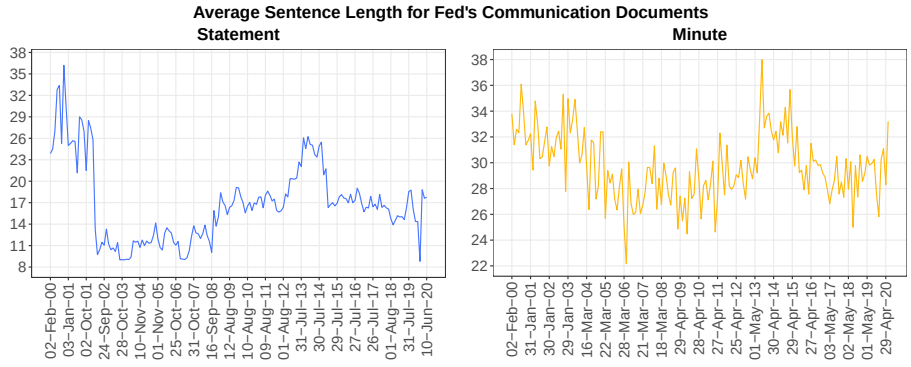
Source: own calculations with information from Federal Reserve's webpage.
Notes: 1/For minutes, length indicators were computed for both the participants and voting members sections. 2/There is no minute for the statements of January 03, 2001; April 18, 2001; September 17, 2001; January 22, 2008; June 25, 2008; October 8, 2008; and March 03, 2020.

The left panel in Figure 5.2 shows that the length of MPS measured by the ASL has been less volatile than when measured by the number of words. Except for the first two years in the sample, the number of words per sentence of the MPS has been between 9 and 25 on average, with a peak for the MPD of 2013.[9] Additionally, Fed's MPS are within the international standard of maximum 25 words per sentence for publishing documents in English. Contrary to the number of words, Banxico's and Fed's MPS have a similar distribution. The right panel of Figure 5.2, shows that the ASL of Fed's MPM has also been relatively stable through the sample period, with around 30 words per sentence, higher than the international standard. MPM of May 2006 have the minimum words per sentence (22 words), and September 2013 the maximum (38 words). Banxico's MPM ASL median (32.5) is slightly above Fed's (29.68).

[8]Here we compare the number of words in Banxico's MPM in Spanish versus Fed's MPM in English because MPM in English for Banxico are only available since May 2018, and there are only a few observations available.

[9]The first two years of MPS are characterized by few paragraphs with long sentences. In particular, the paragraph explaining Fed's monetary policy previsions was strucutred as a single sentence, thus incrementing the ASL.

Figure 5.2: Average Sentence Length of Fed's Statements and Minutes



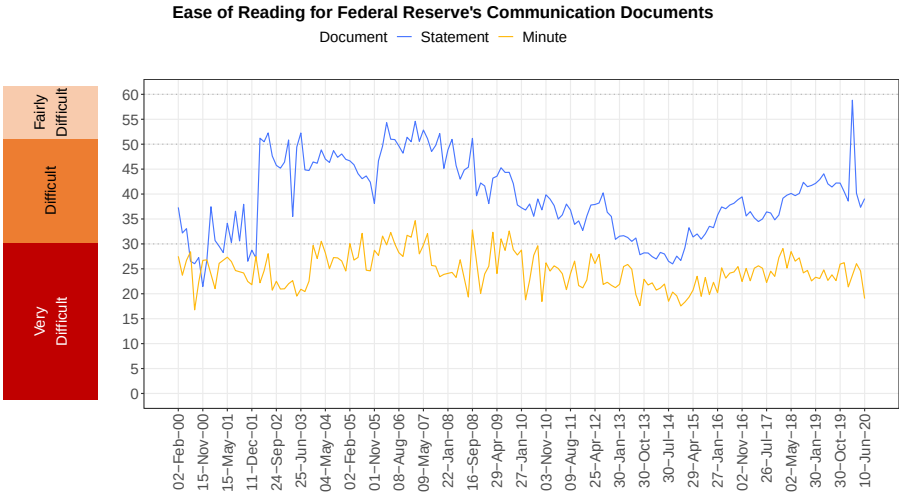
Source: own calculations with information from Federal Reserve's webpage.
Notes: 1/For minutes, length indicators were computed for both the participants and voting members sections. 2/There is no minute for the statements of January 03, 2001; April 18, 2001; September 17, 2001; January 22, 2008; June 25, 2008; October 8, 2008; and March 03, 2020.

5.2.3 Federal Reserve's Ease of Reading Measures

Figure 5.3 shows the ease of reading for Fed's MPS and MPM. MPS have been mainly "Difficult" to read. There are few MPS "Fairly Difficult" to read, mainly in the period previous to the 2008-2009 financial crisis. Additionally, the extraordinary MPS of March 3th, 2020 has the highest ease of reading, this is due, in part, to the fact that this statement was particularly small, contributing to a higher Flesch Scale. During the financial crisis and the post-crisis period it can be noted a short decreasing trend in ease of read with MPS reaching a "Very Difficult" to read level through 2013 and 2014. Comparing Fed's MPS with the English version of Banxico's MPS we can observe that, even though both of them are mainly "Difficult" to read, Banxico's statement has a smaller Flesch Scale meaning that it's English version is harder to read. This could arise from the fact that Banxico's English versions are a direct translation of the messages in Spanish, and therefore, they could use a more complicated language than if the text was initially written in English.[10] Fed's MPM have been mainly in the "Very Difficult" to read level with a Flesch Scale around 25. There have been occasional moments when MPM reached the bottom part of the "Difficult" range. In contrast to MPS, the median of the English version of Banxico's MPM Flesch Scale is 34.49 ("Difficult") while Fed's is 24.58 ("Very Difficult"); this is, Banxico's minutes are much easier to read.

[10]We only compare statements from May 2018 to June 2020.

Figure 5.3: Ease of Reading of Fed's Statements and Minutes



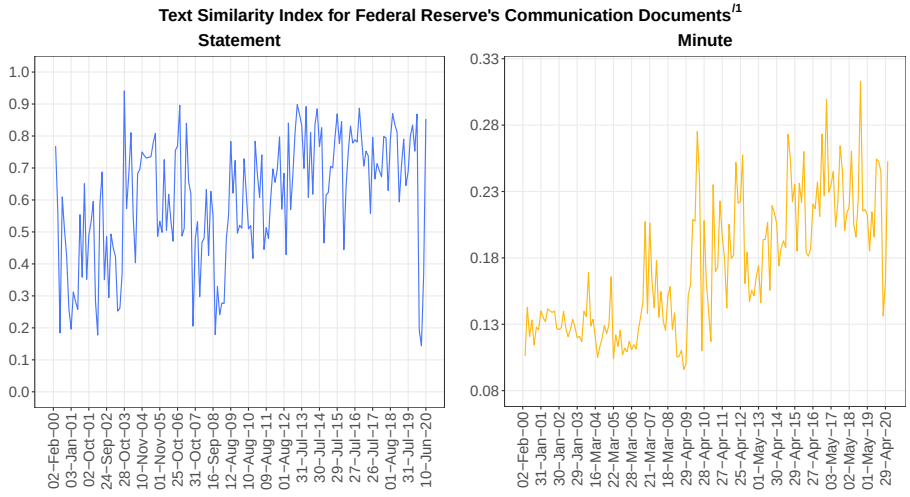
Source: Own calculations with data from Federal Reserve's webpage.
Notes: 1/For minutes, the Ease of Reading Scale indicator was computed for both the participants and voting members sections. 2/There is no minute for the MPS of January 03, 2001; April 18, 2001; September 17, 2001; January 22, 2008; June 25, 2008; October 8, 2008; and March 03, 2020. 3/The Ease of Reading Scale is based on the Flesch Scale where, the highest the value in the scale, the easiest to read is the document.

5.2.4 Federal Reserve's Text Similarity

Figure 5.4 shows, in the left panel, that consecutive Fed's MPS have been quite similar throughout the sample period. Previous to the 2008-2009 financial crisis, the index values varied between 0.17 and 0.94 and with a median value of 0.51. Between 2010 and 2019, with the introduction of forward guidance and with a higher commitment with transparency and accountability, the text similarity index has been more stable with values between 0.41 and 0.89. Its worth mentioning that major drops in this index are related to specific changes in the forward guidance or to changes in the Fed's asset purchase program. The major drop at the end of the sample period corresponds to the comparison between March 03, 2020 (extraordinary) and March 15, 2020 MPS. Again this is related to the pandemic and how suddenly the statement had to incorporate the FOMC's view of its implications and risks to the economy. Compared to Banxico's MPS, the Fed's MPS are written in a more consistent way, preserving the structure and changing just a few words from statement to statement. In the right panel of Figure 5.4 it can be observed an increasing trend in the text similarity for consecutive MPM. However, the value of the index is very small

ranging between 0.09 and 0.31. It is reasonable that MPM are far less similar than MPS because economic and financial conditions can change drastically between monetary policy meetings, which is reflected in the arguments explained in the minutes. Similar values of text similarity are observed for minutes of both Banxico and the Fed.

Figure 5.4: Text Similarity of Fed's Statements and Minutes



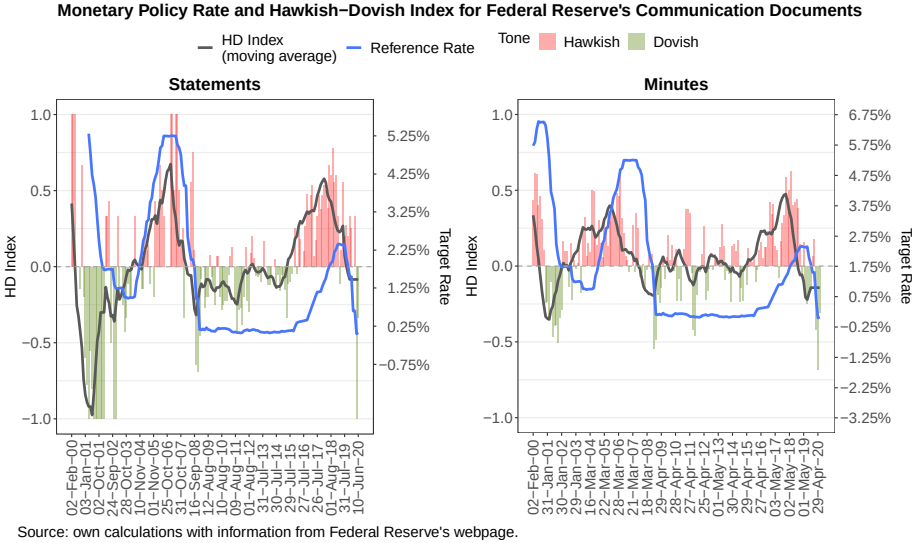
Source: own calculations with information from Federal Reserve's webpage.
Notes: 1/Text Similarity Index is calculated using the Jaccard Similarity for consecutive statements or minutes. The index has a value of zero for documents that are completely different, and a value of one for identical documents. 2/For minutes, text similarity was computed for both the participants and voting members sections. 3/There is no minute for the MPS of January 03, 2001; April 18, 2001; September 17, 2001; January 22, 2008; June 25, 2008; October 8, 2008; and March 03, 2020.

5.2.5 Federal Reserve's Hawkish-Dovish Tone Index

The HD Index for Fed's MPS is shown in the left panel of figure 5.5. The bars indicate if each MPS is classified as hawkish (red) or dovish (green), the gray line corresponds to the moving average of eight MPD and the blue line is the FFR. Here the smooth HD Index increases (hawkish MPS) a few decisions before the FOMC starts the tightening part of the cycle, and declines (dovish MPS) just before the easing part, appropriately reflecting the monetary policy cycles. Additionally, it can be observed that in 2008-2015, when the target reached the Zero Lower Bound (ZLB), the smooth HD Index is stable in the hawkish/dovish part with values very close to zero, meaning a neutral tone. This supports the

hypothesis that the tone of MPS, measured by our HD Index, could have a predictive power over the MPR. It should be noted that Banxico's and Fed's monetary policy cycles are quite similar since 2008, the only exception is the 2013-2015 period when Banxico was able to continue the cycle of rate cuts, but the Fed had already reached the ZLB. As for Fed's MPM, the right panel of Figure 5.5 shows that the tone of MPM also approximates the monetary policy cycle. However, values of the HD Index for MPM are much smaller than those of the MPS.

Figure 5.5: Hawkish-Dovish Index of Fed's Statements and Minutes



Source: own calculations with information from Federal Reserve's webpage.

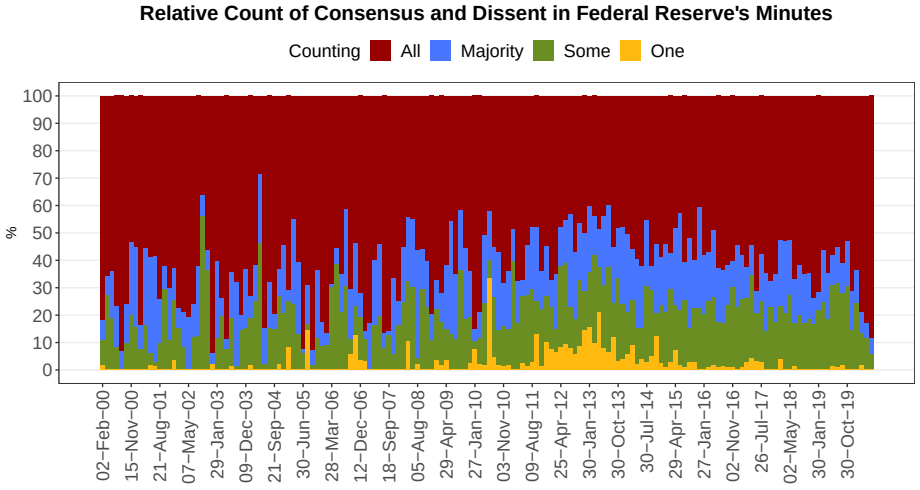
Notes: 1/The Hawkish−Dovish Index (HD Index) is plotted in the left axis and denotes the tone of Federal Reserve's monetary policy statement or minute. It is computed as HDI = (I_H−I_D)/(I_H+I_D) where I_H and I_D are the number of occurrences of hawkish and dovish words respectively. The index takes values from −1 (dovish, green) to 1 (hawkish, red). 2/The solid gray line corresponds to the moving average of the HD Index for 8 monetary policy decisions. 3/The solid blue line is the Federal Funds Rate (right axis) which is a proxy of the monetary policy rate. 4/The hawkish and dovish dictionaries can be found in the appendix. 5/For minutes the HD Index indicator was computed for both the participants and voting members sections. 6/There is no minute for the MPS of January 03, 2001; April 18, 2001; September 17, 2001; January 22, 2008; June 25, 2008; October 8, 2008; and March 03, 2020.

5.2.6 Federal Reserve's Consensus and Dissent Measures

Figure 3.8 shows the evolution of the consensus and dissent indicators for MPM. In contrast with Banxico, it can be observed a minor debate within FOMC's participants and voting members. For the last years there has been an increasing

number of arguments supported by "all" members and a decrease in arguments supported by only "one" member.

Figure 5.6: Consensus and Dissent Indicators in Fed's Minutes



Source: own calculations with data from Federal Reserve's webpage.
Notes: 1/Based on the Monetary Policy Minutes, the evolution of the diversity of opinions of members of the Federal Open Market Committee during the monetary policy meeting were analyzed by counting the frequency of the number of members (all, majority, some, one) that support each of the different arguments. 2/ To be able to compare between CBs, we group arguments supported by ''all but one", ''almost all", ''most" and ''many" members as ''majority"; similarly, we group arguments supported by ''several", ''some", ''few" and ''two" members as ''some". 3/Indicators were computed for both the participants and voting members sections. 4/There is no minute for the MPS of January 03, 2001; April 18, 2001; September 17, 2001; January 22, 2008; June 25, 2008; October 8, 2008; and March 03, 2020.

5.3 Communication and the Federal Reserve's Monetary Policy

As with Banxico, we want to address the question of whether Fed's communication strategy is related to its monetary policy using the monetary policy rule methodology. Additionally, we want to investigate if the same stylized facts found for Banxico hold true for the Fed.

As stated by the Fed "the Taylor rule can be written in terms of the gap between the actual level of the unemployment rate and the level of the unemployment

rate that corresponds to full employment. An empirical relationship known as Okun's law indicates that a one percentage point increase in GDP relative to its potential level will result in a decline of the unemployment rate of 0.5%".[11] Therefore, the Taylor rule and Okun's law can be combined to create a new monetary policy rule for the Fed in which the output gap is replaced for the unemployment gap. In words of the Fed "this formulation is more directly related to the Fed's statutory mandate of promoting maximum employment and price stability".[12] Therefore, in contrast to what already presented in Chapter 4, we estimate the baseline model using inflation and unemployment gaps for the US, and we then augment this model using the communication indicators described in Section 5.2 for Fed's MPS and MPM.

5.3.1 Federal Reserve's Data Selection

For the Fed we use the upper limit of the target of the FFR as the monetary policy instrument and the constant inflation target of two percent to estimate our monetary policy rules. As for inflation in the U.S., it is usually measured with two different indexes: the Consumer Price Index (CPI), produced by the Bureau of Labor Statistics, and the Personal Consumption Expenditure (PCE), produced by the Bureau of Economic Analysis. This two measures are constructed differently and behave differently over time.[13] In the Taylor Rule literature we can find studies using only the CPI, only the PCE or both.[14]. Moreover, the Fed's web page states that "if policymakers wanted to follow a policy rule strictly, they would have to determine which measure of inflation should be used (for example, they could choose the rate at which the consumer price index is rising, the growth rate of the price index for personal consumption expenditures, inflation measures net of food and energy price inflation, or even measures of wage inflation) [...]"; thus it does not have preference for a specific measure.[15] Therefore, we consider both measures of inflation presenting estimations using the CPI in the main results and estimations using the PCE as robustness test (see section 5.4).

[11]Source: Fed's webpage, available at `https://www.federalreserve.gov/monetarypolicy/principles-for-the-conduct-of-monetary-policy.htm`; accessed on April 30, 2021.

[12]Source: Fed's webpage, available at `https://www.federalreserve.gov/monetarypolicy/principles-for-the-conduct-of-monetary-policy.htm`; accessed on April 30, 2021.

[13]For the detail on the difference between both indicators see *"Differences between the Consumer Price Index and the Personal Consumption Expenditures Price Index"* published by the U.S. Bureau of Labor Statistics (Focus on Prices and Spending, May 2011, vol. 2, no. 3) available at `https://www.bls.gov/opub/btn/archive`.

[14]See for example Mehra and Minton (2007), Petersen (2007)) and Kahn et al. (2010)

[15]Source: `https://www.federalreserve.gov/monetarypolicy/principles-for-the-conduct-of-monetary-policy.htm`; accessed on September 10, 2021.

As for the unemployment gap, we compute de difference between the unemployment rate published by the U.S. Bureau of Labor Statistics and the natural rate of unemployment for the long term published by the U.S. Congressional Budget Office.[16]

Fed's MPS are available since January 2000 in a regular basis and MPM since 1993. In order to be able to compare the importance of both types of documents with the results obtained for Banxico, we restrict the sample period to begin in January 2010 (immediately after the end of the financial crisis), and to end in December 2019 to avoid the Covid-19 sanitary crisis.

5.3.2 Federal Reserve's Baseline Model

As before, we use lags of the inflation and unemployment gaps to incorporate the idea that interest rate changes affect macro-variables with a sizable lag. Therefore, the baseline model for the Fed is estimated as

$$i_t = \alpha + \beta\hat{\pi}_{t-1} + \gamma\hat{u}_{t-1} + \epsilon, \tag{5.1}$$

where $\hat{u}_{t-1}$ is the unemployment gap at time $t-1$, and all other variables as previously defined. We also estimate the variant with the change in the interest rate as dependent variable for the specific case of the HD Index, this is:

$$\Delta i_t = \alpha + \beta\hat{\pi}_{t-1} + \gamma\hat{u}_{t-1} + \epsilon. \tag{5.2}$$

Models (5.1) and (5.2) are again estimated implementing the Newey-West HAC variance-covariance estimator, and results are shown in Table 5.1. For the sample period, the β coefficient is statistically significant with a 95% confidence for the target rate in levels, meaning that an increase of one percentage point in the inflation gap is related to an increase of 32 basis points in the target rate. This effect is smaller than that of Banxico, but in the same direction. As predicted by the Okun's law, the the γ coefficient is negative and statistically significant with a 95% confidence. An increase of one percentage point in the unemployment gap is associated to a decrease of 31 basis points in the target rate. In contrast, for the change in the target rate neither the β nor the γ coefficients are statistically significant; nevertheless, both signs are consistent with the theory. The result for the inflation gap is in line with that of Banxico.

[16]The unemployment rate and the natural rate data are retrived from the FRED Economic Data of the Federal Reserve Bank of St. Louis. The unemployment rate represents the number of unemployed as a percentage of the labor force (people of 16 years of age and older, who currently reside in one of the 50 states or the District of Columbia, who do not reside in institutions, and who are not on active duty in the Armed Forces). The natural rate of unemployment (NAIRU) is the rate of unemployment arising from all sources except fluctuations in aggregate demand.

Table 5.1: Results for Fed's Baseline Models (5.1) and (5.2)

Model	**Coef.**	**Intercept**	**Inf. Gap**	**Unemp. Gap**	R^2	**Adj.** R^2
Levels	Estim	1.3418***	0.3289**	-0.3153***	0.66	0.65
Levels	S.D.	(0.2031)	(0.0971)	(0.0727)		
Difference	Estim	0.0383	0.0154	-0.0096	0.05	0.02
Difference	S.D.	(0.0317)	(0.0123)	(0.0095)		

Significance code: 0.001 → ***; 0.01 → **; 0.05 → *; 0.1 → +.

Notes:

1/ The sample period covers from Jan. 2010 to Dec. 2019 and data has 79 observations. Each point in time refers to a monetary policy decision.

2/ The baseline models presented are estimated for MPS with OLS implementing the Newey-West HAC variance-covariance estimator

3/ The inflation gap is measured as the difference between the headline inflation and the inflation target rate.

4/ The unemployment gap is measured as the difference between the observed unemployment rate and the natural rate of unemployment in the longer run.

As far as we are aware, similarly to the case of Mexico, most of the studies that analyze Taylor rules with inflation and unemployment gaps for the U.S. use sample periods prior to the one we are using in this work. However, results in Table 5.1 are consistent with those in the literature, see for example Blinder and Reis (2005); Rudebusch et al. (2009, 2010); Castro (2011); Kim et al. (2015). In these studies, the inflation gap is positive and statistically significant with estimated coefficients between 0.1983 and 2.43, and the unemployment gap is negative and statistically significant with estimated coefficients between -2 and -0.038.

5.3.3 Taylor Rules Augmented With Federal Reserve's Communication Variables

As before, we augment the baseline models with communication variables to address to what extent the Fed's communication adds information compared to that of a monetary policy rule. We therefore estimate the following models:

$$i_t = \alpha + \beta\hat{\pi}_{t-1} + \gamma\hat{u}_{t-1} + \delta w_{t-1} + \epsilon, \tag{5.3}$$

and its variation:

$$\Delta i_t = \alpha + \beta\hat{\pi}_{t-1} + \gamma\hat{u}_{t-1} + \delta w'_{t-1} + \epsilon, \tag{5.4}$$

with all variables as previously defined. We estimate the results for several measures of length, ease of reading, text similarity, tone and consensus-dissent, but only selected results are presented in this section.

5.3.3.1 Results for Federal Reserve's Monetary Policy Statements

Table 5.2 shows the estimated results for model (5.3) when using information contained in the Fed's MPS. We find that the length of MPS helps to explain Fed's MPD since both, the number of words and ASL, are statistically significant with a 95% confidence. An increase of 100 words in the MPS is associated with a decrease of 21 basis points in the target rate, meaning that the Fed explains in a more detailed way the rate cuts than the rate hikes. This result is contrary to that of Banxico, where an increase of 100 words in MPS is associated with an increase of 28 basis points in the target rate. Additionally, an average increase of one word per sentence is related to a decrease of the target rate of 7 basis points. This coefficient is of smaller magnitude, but in the same direction than that of Banxico (-23 basis points). Additionally, augmenting the baseline model with the length indicators increases the adjusted R^2 in 0.18 and 0.09 points for the number of words and the ASL, respectively.

We find evidence that the easiest the Fed's MPS, the higher is the level of the target rate. The estimated coefficient for the Flesch Scale Ease of Reading is positive and statistically significant with a 95% confidence. An increase of one point in the Flesch Scale (easier to read MPS) is associated with an increase of seven basis points in the target rate. This result is congruent with those of Banxico, and since both CBs are inflation targeters, it is likely that rate hikes have a "simpler explanation". Augmenting the baseline with the Flesch Scale indicator increases the adjusted R^2 in 0.17 points.

Text similarity is also found to be an important communication variable for the Fed, but in a minor way than for Banxico and in the opposite direction. The estimated coefficients for the different measures of text similarity of Fed's MPS are all negative and only moving averages of six and eight statements are statistically significant. An increase of 0.01 in the moving average of text similarity for six(eight) MPS is related to a decrease of 1.65(2.74) basis points in the target rate. Taking into account the fact previously found of the Fed explaining the rate cuts with much more detail than the rate hikes, and the well known fact that the Fed is one of the most consisting CBs when communicating the reasons behind its monetary policy actions, its natural to think that major changes to MPS will be made when rate cuts are implemented. Augmenting the baseline model with text similarity indicators increases the adjusted R^2 by up to 0.05 points.

Table 5.2: Results for Augmented Model (5.3) with Fed's Statements

Coef.	**Intercept**	**Inflation Gap**	**Unemp. Gap**	**Words**	**Av. Sent. Length**	**Flesch Scale**	**Text Similarity**	**Text Sim. (m.a. k=4)**	**Text Sim. (m.a. k=6)**	**Text Sim. (m.a. k=8)**	R^2	**Adj.** R^2
Estim	2.4148***	0.2086*	-0.2792***	-0.0021***							0.83	0.82
S.D.	(0.3427)	(0.0868)	(0.0374)	(0.0005)								
Estim	2.6514***	0.2877**	-0.2892***		-0.0749**						0.74	0.73
S.D.	(0.5715)	(0.1024)	(0.0562)		(0.0265)							
Estim	-1.3218*	0.1961**	-0.2642***			0.0720***					0.82	0.82
S.D.	(0.5272)	(0.0671)	(0.0355)			(0.0166)						
Estim	1.7544***	0.3221**	-0.3296***				-0.5549				0.67	0.66
S.D.	(0.3926)	(0.1008)	(0.0713)				(0.4141)					
Estim	2.3104**	0.3093**	-0.3443***					-1.3097			0.67	0.66
S.D.	(0.8098)	(0.1049)	(0.0740)					(0.9748)				
Estim	2.5510***	0.3002**	-0.3449***						-1.6586+		0.68	0.67
S.D.	(0.6678)	(0.1061)	(0.0647)						(0.8784)			
Estim	3.3295***	0.2874**	-0.3564***							-2.7419*	0.70	0.69
S.D.	(0.7905)	(0.1030)	(0.0598)							(1.0850)		

Significance code: 0.001 → ***; 0.01 → **; 0.05 → *; 0.1 → +.

Notes:

1/ The sample period covers from January 2010 to December 2019 corresponding to 79 statements. Each poin in time refers to a monetary policy decision.

2/ Each model is estimated with OLS implementing the Newey-West HAC variance-covariance estimator.

3/ The inflation gap is measured as the difference between the headline inflation and the inflation target rate.

4/ The unemployment gap is measured as the difference between the observed unemployment rate and the natural rate of unemployment in the longer run.

Table 5.3 shows estimated results for the augmented model (5.4) using different indicators of the HD Index. As for Banxico, all estimated coefficients are positive and almost all are statistically significant, however the magnitude of the coefficients are slightly smaller. For the Fed, the evidence suggests an increase(decrease) of up to 27 basis points in the target rate for completely hawkish(dovish) statements. The value of the Adjusted R^2 increases up to 0.15 points compared to that of the corresponding baseline model. This results reinforce the possibility of the tone of previous MPS being one of the main drivers for the future target rate.

5.3.3.2 Results for Federal Reserve's Monetary Policy Minutes

Table 5.4 shows the estimated results for model (5.3) when using information contained in the MPM. As for MPS, both, the number of words and the ASL, are negative and statistically significant. An increase of 100 words in MPM is associated with a decrease of four basis points in the target rate. This reaffirms the fact that the Fed tends to explain with more detail rate cuts than rate hikes. As with Banxico, the magnitude of the estimated coefficient of the number of words is smaller for MPM than for MPS, due mainly to the nature of these documents. Additionally, an average increase of one word per sentence in MPM is associated with a decrease of 6.5 basis points in the target rate. The Adjusted R^2 increases in 0.08(0.05) points when augmenting the baseline model with the number of words(ASL) of MPM.

We find evidence that an easier minute is associated with a higher level of the target rate. The ease of reading of Fed's MPM is positive and statistically significant with a 95% confidence, and its magnitude is slightly smaller than that of MPS. An increase of one point in the ease of reading of MPM is associated with an increase of five basis points in the target rate. This result is in line with that of Banxico. Augmenting the baseline model with the Flesch Scale indicator increases the adjusted R^2 for MPM in 0.03 points.

Consecutive Fed's minutes do not have a high text similarity; nevertheless, the estimated coefficients for the different measures of this indicator are all negative (in contrast with the positive sign for Banxico, but in line with results for Fed's MPS), and most of them are statistically significant with a 95% confidence. We find that an increase of 0.01 in text similarity for consecutive MPM is related to a decrease of the target rate of between seven and 15 basis points. In contrast with Banxico, the significance of the indicators increases with the increase of the moving average. Additionally, the Adjusted R^2 increases between 0.03 and 0.08 points when augmenting the baseline model with text similarity indicators.

Table 5.3: Results for Augmented Model (5.4) with Fed's Statements

Coef.	**Intercept**	**Inflation Gap**	**Unemp. Gap**	**HD Index**	**HD Index (m.a. k=4)**	**HD Index (m.a. k=6)**	**HD Index (m.a. k=8)**	R^2	**Adj.** R^2
Estim	0.0215	0.0090	-0.0031	0.0598				0.06	0.02
S.D.	(0.0291)	(0.0108)	(0.0091)	(0.0369)					
Estim	-0.0137	0.0012	0.0103		0.1860**			0.12	0.09
S.D.	(0.0364)	(0.0121)	(0.0122)		(0.0605)				
Estim	-0.0160	0.0039	0.0112			0.2007**		0.13	0.09
S.D.	(0.0369)	(0.0115)	(0.0124)			(0.0652)			
Estim	-0.0324	0.0024	0.0172				0.2728**	0.20	0.17
S.D.	(0.0412)	(0.0119)	(0.0141)				(0.0937)		

Significance code: 0.001 → ***; 0.01 → **; 0.05 → *; 0.1 → +.

Notes:

1/ The sample period covers from January 2010 to December 2019 corresponding to 79 statements. Each point in time refers to a monetary policy decision.

2/ Each model is estimated with OLS implementing the Newey-West HAC variance-covariance estimator.

3/ The inflation gap is measured as the difference between the headline inflation and the inflation target rate.

4/ The unemployment gap is measured as the difference between the observed unemployment rate and the natural rate of unemployment in the longer run.

Table 5.4: Results for Augmented Model (5.3) with Fed's Minutes

Coef.	**Intercept**	**Inflation Gap**	**Unemp. Gap**	**Words**	**Av. Sent. Length**	**Flesch Scale**	**Text Similarity**	**Text Sim. (m.a. k=4)**	**Text Sim. (m.a. k=6)**	**Text Sim. (m.a. k=8)**	**Agreement Rate**	R^2	**Adj.** R^2
Estim	2.5987***	0.2496**	-0.3683***	-0.0004*								0.73	0.72
S.D.	(0.6141)	(0.0820)	(0.0632)	(0.0002)									
Estim	3.2700***	0.2717**	-0.3140***		-0.0653*							0.70	0.68
S.D.	(0.7875)	(0.0970)	(0.0662)		(0.0250)								
Estim	0.1506	0.2742**	-0.3087***			0.0500**						0.69	0.68
S.D.	(0.4486)	(0.0868)	(0.0677)			(0.0162)							
Estim	1.5179***	0.3302***	-0.3232***				-0.7878					0.66	0.65
S.D.	(0.3629)	(0.0956)	(0.0730)				(1.2949)						
Estim	2.9360**	0.3498***	-0.3890***					-7.0813+				0.69	0.68
S.D.	(0.9942)	(0.0942)	(0.0937)					(3.9655)					
Estim	3.8937**	0.3658***	-0.4273***						-11.3608*			0.71	0.70
S.D.	(1.2478)	(0.0929)	(0.1007)						(5.1041)				
Estim	4.9073**	0.3721***	-0.4633***							-15.8981*		0.74	0.73
S.D.	(1.5078)	(0.0846)	(0.0998)							(6.3490)			
Estim	1.0204*	0.3268**	-0.3131***								0.0042	0.66	0.65
S.D.	(0.4996)	(0.0981)	(0.0722)								(0.0068)		

Significance code: 0.001 → ***; 0.01 → **; 0.05 → *; 0.1 → +.

Notes:

1/ The sample period covers from January 2010 to December 2019 corresponding to 79 minutes. Each point in time refers to a monetary policy decision.

2/ Each model isestimated with OLS implementing the Newey-West HAC variance-covariance estimator.

3/ The inflation gap is measured as the difference between the headline inflation and the inflation target rate.

4/ The unemployment gap is measured as the difference between the observed unemployment rate and the natural rate of unemployment in the longer run.

We find evidence that the rate of agreement among the FOMC members is not statistically significant when explaining the target rate. This result is consistent with that of Banxico.

Finally, table 5.5 shows estimated results for MPM when augmenting model (5.2) with the HD Index and its moving average for different window lengths. In contrast to Banxico's MPM, we find evidence that the tone of the Fed's MPM is statistically significant independently of the window length. We find that if the last MPM has a hawkish(dovish) tone, an increase(decrease) of almost 20 basis points is probable. Additionally, eight consecutive hawkish(dovish) MPM, would suggest an increase(decrease) of 32 basis points in the target rate. Moreover, the Adjusted R^2 increases between 0.16 and 0.23 points compared to the corresponding baseline model. These results, together with that of the MPS, suggest that the tone of the Fed's communication tools is a good predictor of its monetary policy actions, specially when the monetary policy cycle is about to change.

Its worth recalling that estimations presented in this document represent correlations between variables and are not supported by any theoretical model. Therefore, we mainly present a series of stylized facts and not causality between Fed's communication variables and its target rate.

5.4 Federal Reserve's Robustness Tests

We also run several robustness tests and conclude that the majority of our main findings for the Fed are robust to changes in the estimation. In particular, we run robustness test for: i) the alternative communication measures presented in Section 4.5.1; ii) alternative monetary policy instruments using the Effective Fed Funds Rate and the Shadow Rate instead of the target rate; iii) alternative sample periods including Jan. 2000 - Dec. 2019, Jan. 2000 - June 2020 and Jan. 2010- June 2020, to include historical documents and/or the pandemic; and iv) alternative model specifications substituting the CPI inflation gap with the Core CPI, PCE, and Core PCE inflation gaps, as well as substituting the unemployment gap with the output gap. These results are available upon request.

Table 5.5: Results for Augmented Model (5.4) with Fed's Minutes

Coef.	**Intercept**	**Inflation Gap**	**Unemp. Gap**	**HD Index**	**HD Index (m.a. k=4)**	**HD Index (m.a. k=6)**	**HD Index (m.a. k=8)**	R^2	**Adj.** R^2
Estim	0.0053	0.0006	-0.0005	0.1947**				0.21	0.18
S.D.	(0.0263)	(0.0127)	(0.0079)	(0.0720)					
Estim	-0.0006	0.0059	0.0013		0.2551**			0.24	0.21
S.D.	(0.0262)	(0.0109)	(0.0080)		(0.0771)				
Estim	0.0000	0.0092	0.0007			0.2839**		0.25	0.22
S.D.	(0.0271)	(0.0107)	(0.0080)			(0.0890)			
Estim	-0.0027	0.0094	0.0010				0.3229**	0.28	0.25
S.D.	(0.0273)	(0.0103)	(0.0078)				(0.1059)		

Significance code: 0.001 → ***; 0.01 → **; 0.05 → *; 0.1 → +.

Notes:

1/ The sample period covers from January 2010 to December 2019 corresponding to 79 minutes. Each point in time refers to a monetary policy decision.

2/ Each model is estimated with OLS implementing the Newey-West HAC variance-covariance estimator.

3/ The inflation gap is measured as the difference between the headline inflation and the inflation target rate.

4/ The unemployment gap is measured as the difference between the observed unemployment rate and the natural rate of unemployment in the longer run.

Conclusions

Through this thesis we have examined the role of CBs' communication with a text mining approach focusing on Banxico's post-meeting statement and minutes, and extending our research to the case of the Fed.

To this end, we have created and calculated a number of variables to measure the characteristics of CB's communication including length indicators, ease of reading measures, a text similarity index, a Hawkish-Dovish tone index and measures of consensus and dissent among the Governing Board members. Analyzing the evolution of this measures through time, we find some shared stylized facts of Banxico's and Fed's communication tools pointing towards a clearer, simpler and more consistent (i.e. more similar decision to decision) communication strategy to enhance transparency and accountability. Particularly, we find that in the last years Banxico's MPS and MPM have decreased in length, as well as increased in ease of reading and text similarity, which is consistent with its announced efforts to improve the quality of its communication with the general public. Additionally, we find that our HD Index accurately reflects and precedes the monetary policy cycles, increasing (hawkish tone) just a few decisions before the start of the cycle of rate hikes, and decreasing (dovish tone) just before the start of the cycle of rate cuts. Also, we find a mayor debate within Banxico's Governing Board through the last decade, with a decreasing number of arguments supported by "all" and the "majority" of members, but an increasing number of arguments supported by "some" and "one" member only. As for the Fed, we find that its communication's characteristics have also evolved in a similar fashion, except for the degree of consensus among its committee members, which shows an increasing trend.

Regarding the relation between communication and monetary policy, we implemented the methodology of monetary policy rules augmenting a Taylor rule model with our communication measures to address to what extent communication

tools provide market participants with additional information to that already contained in macroeconomic variables. Specifically, we estimated an augmented Taylor rule model with inflation and output gaps for Banxico and an augmented Taylor rule model with inflation and unemployment gaps for the Fed. We find evidence that most of our communication tools provide additional information to that already contained in macroeconomic variables. Particularly, we find that the length, ease of reading, and text similarity of Banxico's MPS have a statistically significant relation with the level of the target rate and that augmenting the Taylor rule with the communication variables helps to increase the variability explained by the baseline model in all cases, reaching an increase of 0.43 points for the text similarity index. We also find that the tone of MPS is statistically significant when explaining the change in the target rate and helps to increase the variability explained by the corresponding baseline model in more than 0.10 points. As for Banxico's MPM, we find that the length, ease of reading, and text similarity have a statistically significant relation with the level of the target rate and that augmenting the Taylor rule with these indicators helps to increase the variability explained by the baseline model by up to 0.40 points for the length measure. Additionally, we find that the tone of MPM is statistically significant when explaining the change in the target rate, although the increase in the variability explained by the corresponding baseline model is smaller (0.04 points). We also provide a number of robustness tests that support our main findings such as the use of alternative communication measures, alternative monetary policy instruments, alternative sample periods and alternative model specifications.

Similarly, we find evidence that the Fed's communication measures provide additional information when estimating the target rate; however there are some differences in the sign and significance of estimated coefficients for both CBs. This differences may arise from the fact that Banxico is the CB of an emerging economy, while the Fed is the CB of an advanced economy, thus their macroeconomic environments might be distinct. Moreover, there is an important difference between their mandates: while Banxico's mandate is focused only on the inflation level, the Fed's mandate is dual and has to balance between inflation and unemployment. Therefore, communication explaining the strategy and decisions for achieving a single goal may be very different from one explaining how to achieve two goals.

As policy recommendation, although there is great advance in terms of the evolution of CB's communication strategy, there is still room for progress. Particularly, Banxico could make and effort to reach a broader audience using forms of communication that do not require an advanced reader, for example making a broader use of infographics or short videos explaining in a simple way the reasons

behind each MPD. In addition, Banxico and market participants could greatly benefit from a more similar communication decision to decision, in order to be able to transmit and understand important changes in the CB's message.

It is worth noting that this work is a first approach to the study of the relation between communication and the Mexican monetary policy, as well as of which Banxico's communication characteristics provide useful evidence of its beneficial effects, if any, over monetary policy implementation and transmission. Therefore the main focus of this work was the data extraction to create a novel database on CB's communications and the development of the communication measures. Therefore, one limitation of this study is that it only implements a simple econometric analysis which may not consider, for example, economic and financial factors that may affect the setting of the target rate, nor other non-linear functional forms of the true data generating process that could give a better scope on the topic.

Our methodology, findings and contributions raise a number of additional questions and open the door to a wide range of future research projects. From the CB perspective, it would be useful to apply the communication measures developed in this work to other tools such as inflation reports, speeches, interviews and the congressional hearings. It would also be of the CB's interest to extend this analysis to CBs of the main advanced and emerging economies and explore if communication characteristics vary between these two groups and/or if its relation can be generalized.

From the data science perspective, first it would be interesting to implement machine learning algorithms such as Support Vector Machines or Neural Networks as an alternative to the semantic approach to re-estimate some of our communication measures and/or to create new ones, for example an uncertainty index derived from the balance of risks section in MPS and MPM. Second, applying topic models such as Latent Dirichlet Allocation could allow us to classify the different paragraphs on MPS and MPM, and use the topic distribution per paragraph as a measure of the text structure over time. Third, it would be useful to apply self-supervised learning using, for example, transformer models such as GPT, BERT, BART or RoBERTa to improve our version of the HD-Index or consensus variables without the need to label our communication data.[17]

[17]Transformer models are pre-trained on a large corpus to develop a statistical understanding of the language, this process normally requires lots of time and resources. However, after the pre-training, fine-tuning can be done with a specific data set for the task to solve, demanding less time and resources. Additionally, this process has the advantage to generate better results that when training a model from the scratch with the original data. See "Transformers" on Huggingface

From the econometric perspective, first it would be worth it to re-estimate our Taylor rules using a forward looking approach to incorporate data on inflation and output expectations. Second, economic variables tend to show asymmetric adjustments to the business cycle, therefore it would be useful to estimate a non-linear Taylor rule to assign different weights to negative and positive deviations from inflation and/or output. Third, it would be interesting to estimate linear dynamic models to asses how has the relation between the target rate and the communication variables changed through time. Fourth, it would also be useful to estimate ordered probit models to calculate the probability of a rate hike or a rate cut for future MPD.

Finally, future research on this topic should, in general, focus its attention in proposing theoretical models that explore the mechanisms through which communication affects monetary policy and its transmission, as well as the feedback effects of monetary policy to CB's communication.

for more information, available at `https://huggingface.co/transformers/index.html`.

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Appendix A Glossary

Table A.1: Glossary of Acronyms & Abbreviations

Acronym/Abbreviation	Meaning
ASL	Average sentence length
Banxico	*Banco de México*
BoE	Bank of England
CB	Central bank
CPI	Consumer Price Index
CRAN	Comprehensive R Archive Network
DSGE	Dynamic Stochastic General Equilibrium
ECB	European Central Bank
ER	Ease of Reading
Fed	Federal Reserve
FFR	Federal Funds Rate
FOMC	Federal Open Market Committee
HAC	Heteroskedasticity and Autocorrelation Consistent
HDI	Hawkish-Dovish Index
INEGI	*Insituto Nacional de Estadística Geografía e Informática*
INPC	*Indice Nacional de Precios al Consumidor*
MPD	Monetary policy decision
MPM	Monetary policy minutes
MPR	Monetary Policy Rate
MPS	Monetary policy statement
NAIRU	Natural rate of unemployment
PCE	Personal Consumption Expenditure
QQE	Quantitative and Qualitative Easing
Regex	Regular expression
TIIE	*Tasa Interbancaria de Interés de Equilibrio*
TSI	Text Similarity Index
US	United States
ZLB	Zero Lower Bound

Appendix B
Hawkish-Dovish Dictionaries

Table B.1 presents the main words in the dictionaries used to construct the HD-Index developed in section 2.4. All terms derived from these words (like plurals and conjunctions) are also taken into account when calculating the HD-Index for each document.

Table B.1: Hawkish-Dovish Index Dictionaries

Documents in Spanish			**Documents in English**		
extbfHawkish	extbfDovish	extbfNegation	extbfHawkish	extbfDovish	extbfNegation
acelerar	a la baja	improbable	augment	abate	not
acentuar	abajo	ni	boost	accommodate	not expected to
acrecentar	acomodaticia	no	bump up	contain	unlikely to
alto	amortiguar	no hay razon para	climb	cut	fail to
alza	astringir	no obstante	elevate	damp	no reason to
anticipar presiones	atenuar	no se espera que	expand	decelerate	
apretar	atrasar	revertir	go up	decline	
arriba	ausencia de presiones	tampoco	hawkish	decrease	
ascender	bajar		head up	depress	
ascenso	caer		high	deteriorate	
aumentar	ceder		hike	diminish	
dinamismo mayor	contraer		improve	disappoint	
efectos positivos	debajo		increase	dovish	
elevar	débil		lift	down	
exacerbar	decepcionar		move up	downward	
exceder	declinar		pick up	drop	
excesivo	deprimir		put up	ease	
expandir	desacelerar		raise	go down	
expansión	descender		rebound	head down	
favorable	desfavorable		rise	loose	
favorecer	deterioro		solid	low	
fortalecer	dinamismo menor		strong	moderated	
fuerte	disminuir		strength	move down	
grande	efecto negativo		tight	put down	
hacia arriba	endeble		upward	reduce	
halcón	estancar			shave	
impacto favorable	estrecho			slash	
incrementar	flojo			slice	
levantar	frágil			slow	
magnificar	hacia abajo			subdue	
mayor	laxo			underutil	
mejor	lento			weak	
mejorar	menor				
potenciar	menos				
reactivar	paloma				
rebotar	paulatino				
recuperar	pausar				
repuntar	pequeño				
sesgo positivo	pérdida de dinamismo				
severo	pérdida de vigor				
sólido	poco				
subir	por debajo de				
superior	recortar				
vigoroso	reducir				
	relajar				
	sesgo negativo				
	subutilizar				

Notes:
1/ This table presents the main words in the dictionaries used to construct the Hawkish-Dovish Index developed in section 2.4.
2/ All terms derived from these words are also included in the dictionaries.
3/ The selection of these words was based on Tobback et al. (2017) dictionaries which were strengthened by the author of this thesis and are the result of both knowledge on monetary policy and a comprehensive study of the relevant vocabulary in central bank's monetary policy documents.

Appendix C Data Processing

Figures C.1 and C.2 show an example of Banxico's and Fed's original documents, respectively. For each document, we show the relevant elements to be extracted such as the monetary policy meeting date, members of the Board of Governors, the main text, etc; as well as the irrelevant information to be removed and or the main difficulties to clean the text.

Figure C.1: Data Cleaning Process for Banxico's Documents

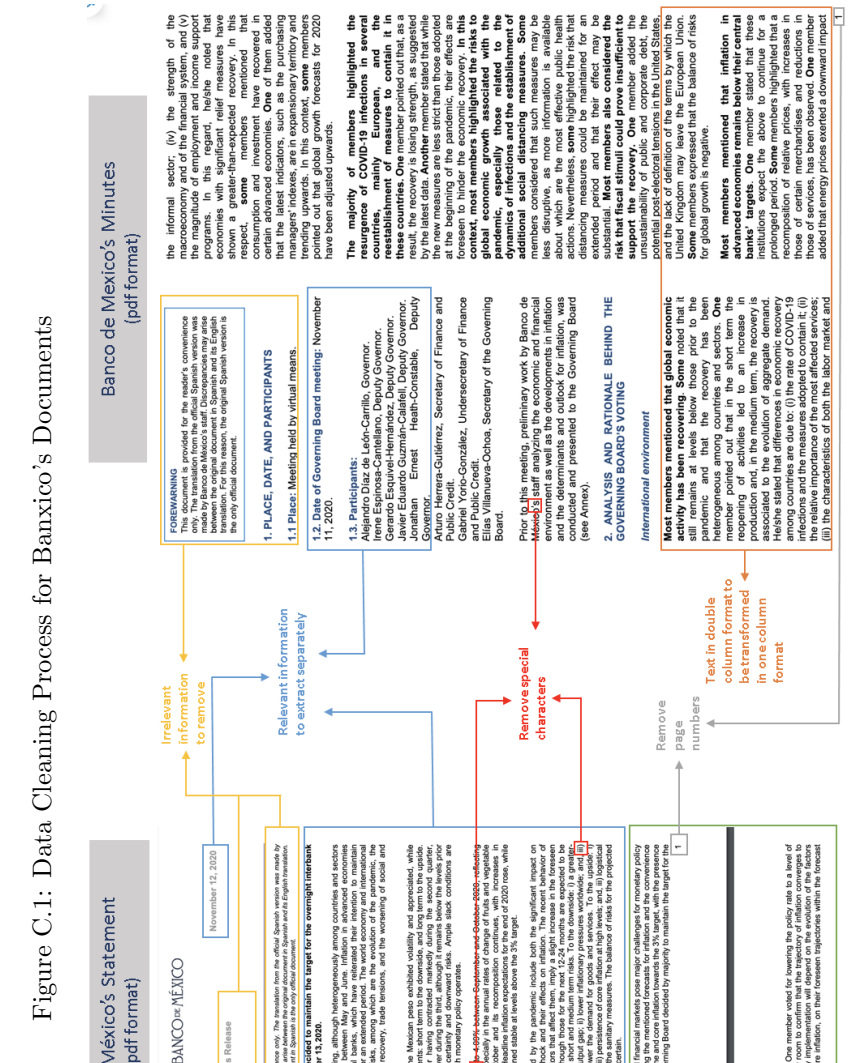
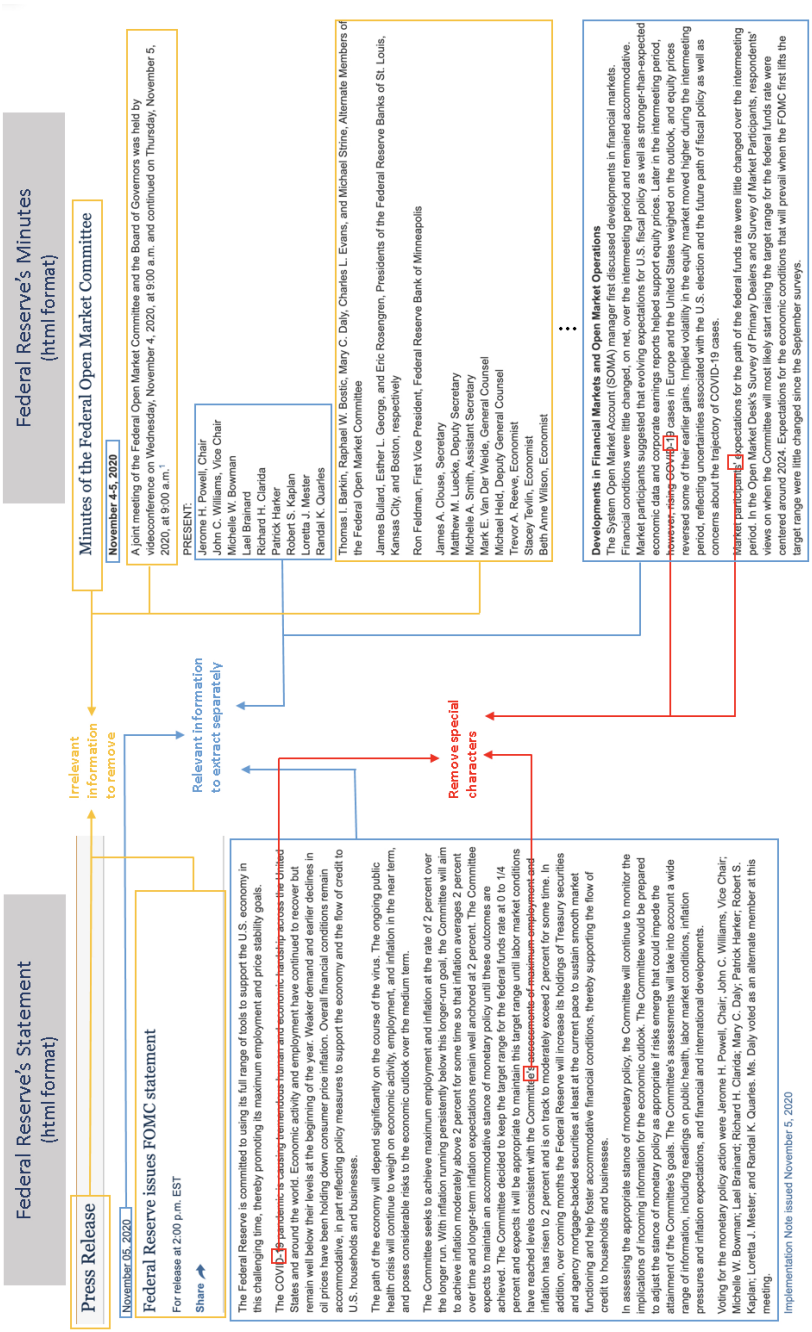


Figure C.2: Data Cleaning Process for Fed's Documents



Appendix D Robustness Test

D.1 Alternative Communication Measures

Table D.1: Results for Augmented Model (4.6) with Banxico's Statements and Alternative Communication Measures

Coef.	Intercept	Inflation Gap	Output Gap	Sentences	Characters	Grade Min.	Text Sim. (m.a. k=2)	Text Sim. (m.a. k=3)	Text Sim. (m.a. k=5)	Text Sim. (m.a. k=7)	R^2	Adj. R^2
Estim	1.2489	0.5459+	-0.0350	0.0757*							0.52	0.50
S.D.	(1.0654)	(0.2945)	(0.3413)	(0.0319)								
Estim	1.1550	0.6508*	-0.0666		0.0004*						0.49	0.47
S.D.	(1.2430)	(0.2822)	(0.3704)		(0.0002)							
Estim	8.3802**	0.6251**	0.2880			-0.3700+					0.38	0.36
S.D.	(2.8494)	(0.2131)	(0.3251)			(0.2065)						
Estim	0.0220	0.8539***	0.1857				12.8310***				0.65	0.64
S.D.	(0.9854)	(0.2369)	(0.2188)				(3.1770)					
Estim	-0.4641	0.8240***	0.1547					14.5114***			0.68	0.67
S.D.	(0.9506)	(0.2276)	(0.2140)					(3.0937)				
Estim	-1.1281	0.7230***	0.0905						17.0938***		0.70	0.69
S.D.	(0.8308)	(0.2027)	(0.2146)						(3.0295)			
Estim	-1.6800*	0.6186***	0.0951							19.0990***	0.72	0.71
S.D.	(0.7321)	(0.1677)	(0.2124)							(3.0318)		

Significance code: 0.001 → ***; 0.01 → **; 0.05 → *; 0.1 → +.

Notes:

1/ The sample period covers from February 2011 to December 2019 corresponding to 72 statements. Each point in time refers to a monetary policy decision."

2/ Each model is estimated with OLS implementing the Newey-West HAC variance-covariance estimator.

3/ The inflation gap is measured as the difference between the headline inflation and the inflation target rate.

4/ The output gap is measured as the difference between the annual variation on the IGAE and its tendency obtained through a Hodrick Prescot filter.

Table D.2: Results for Augmented Model (4.7) with Banxico's Statements and Alternative Communication Measures

Coef.	**Intercept**	**Inflation Gap**	**Output Gap**	**HD Index (m.a. k=2)**	**HD Index (m.a. k=3)**	**HD Index (m.a. k=5)**	**HD Index (m.a. k=7)**	R^2	**Adj.** R^2
Estim	0.0003	-0.0426*	0.0807***	0.3623***				0.47	0.45
S.D.	(0.0279)	(0.0198)	(0.0187)	(0.0913)					
Estim	0.0040	-0.0356+	0.0724***		0.3867***			0.45	0.43
S.D.	(0.0288)	(0.0182)	(0.0183)		(0.1098)				
Estim	0.0184	-0.0269	0.0546**			0.4780***		0.44	0.42
S.D.	(0.0318)	(0.0166)	(0.0177)			(0.1387)			
Estim	0.0337	-0.0261	0.0434**				0.5711***	0.45	0.43
S.D.	(0.0297)	(0.0159)	(0.0160)				(0.1436)		

Significance code: 0.001 → ***; 0.01 → **; 0.05 → *; 0.1 → +.

Notes:

1/ The sample period covers from February 2011 to December 2019 corresponding to 72 statements. Each point in time refers to a monetary policy decision.

2/ Each model is estimated with OLS implementing the Newey-West HAC variance-covariance estimator.

3/ The inflation gap is measured as the difference between the headline inflation and the inflation target rate.

4/ The output gap is measured as the difference between the annual variation on the IGAE and its tendency obtained through a Hodrick Presscot filter.

Table D.3: Results for Augmented Model (4.6) with Banxico's Minutes and Alternative Communication Measures

Coef.	Intercept	Inflation Gap	Output Gap	Sent.	Chars.	Grade Min.	Text Sim. (m.a. k=2)	Text Sim. (m.a. k=3)	Text Sim. (m.a. k=5)	Text Sim. (m.a. k=7)	All Rate	Majority Rate	Some Rate	One Rate	R^2	Adj. R^2
Estim	0.4356	0.4966**	0.1280	0.0237***											0.81	0.80
S.D.	(0.5563)	(0.1652)	(0.1324)	(0.0026)												
Estim	0.2700	0.5418**	0.0358		0.0001***										0.71	0.69
S.D.	(0.7903)	(0.1984)	(0.1887)		(0.0000)											
Estim	8.4610***	0.8520***	0.2904			-0.3539+									0.35	0.32
S.D.	(2.0917)	(0.1813)	(0.3647)			(0.1952)										
Estim	-3.9772	0.7893**	-0.0121				40.6229*								0.50	0.47
S.D.	(3.9341)	(0.2803)	(0.3257)				(19.8769)									
Estim	-4.1234	0.7803**	-0.0324					41.4170+							0.49	0.47
S.D.	(4.1110)	(0.2806)	(0.3416)					(20.8581)								
Estim	-4.2736	0.7759**	-0.0933						42.3991+						0.47	0.44
S.D.	(4.5269)	(0.2716)	(0.4005)						(23.4826)							
Estim	-4.6832	0.7837**	-0.1252							44.3807+					0.45	0.42
S.D.	(5.0076)	(0.2616)	(0.4341)							(26.1649)						
Estim	4.3753***	0.8462***	0.1614								-0.0378				0.32	0.29
S.D.	(0.9056)	(0.1971)	(0.4128)								(0.0488)					
Estim	3.7561***	0.8286***	0.1632									0.0255			0.32	0.29
S.D.	(0.3635)	(0.2176)	(0.4324)									(0.0337)				
Estim	5.4923***	0.7832***	0.2420										-0.0734+		0.36	0.33
S.D.	(1.3719)	(0.2227)	(0.3320)										(0.0427)			
Estim	2.3993*	0.8358***	0.2541											0.0282	0.32	0.29
S.D.	(1.1856)	(0.1949)	(0.3504)											(0.0208)		

Significance code: 0.001 → ***; 0.01 → **; 0.05 → *; 0.1 → +.

Notes:

1/ The sample period covers from February 2011 to December 2019 corresponding to 71 minutes (MPM). Each point in time refers to a monetary policy decision.

2/ Each model is estimated with OLS implementing the Newey-West HAC variance-covariance estimator.

3/ The inflation gap is measured as the difference between the headline inflation and the inflation target rate.

4/ The output gap is measured as the difference between the annual variation on the IGAE and its tendency obtained through a Hodrick Presscot filter.

Table D.4: Results for Augmented Model (4.7) with Banxico's Minutes and Alternative Communication Measures

Coef.	**Intercept**	**Inflation Gap**	**Output Gap**	**HD Index (m.a. k=2)**	**HD Index (m.a. k=3)**	**HD Index (m.a. k=5)**	**HD Index (m.a. k=7)**	R^2	**Adj.** R^2
Estim	-0.0288	-0.0367	0.0911***	0.3621**				0.35	0.33
S.D.	(0.0278)	(0.0230)	(0.0200)	(0.1284)					
Estim	-0.0312	-0.0308	0.0910***		0.3038+			0.33	0.30
S.D.	(0.0315)	(0.0257)	(0.0222)		(0.1748)				
Estim	-0.0316	-0.0271	0.0877***			0.3473		0.32	0.29
S.D.	(0.0329)	(0.0243)	(0.0219)			(0.2612)			
Estim	-0.0307	-0.0292	0.0832***				0.5494+	0.36	0.33
S.D.	(0.0312)	(0.0221)	(0.0197)				(0.2771)		

Significance code: 0.001 → ***; 0.01 → **; 0.05 → *; 0.1 → +.

Notes:

1/ The sample period covers from February 2011 to December 2019 corresponding to 71 minutes. Each point in time refers to a monetary policy decision.

2/ Each model is estimated with OLS implementing the Newey-West HAC variance-covariance estimator.

3/ The inflation gap is measured as the difference between the headline inflation and the inflation target rate.

4/ The output gap is measured as the difference between the annual variation on the IGAE and its tendency obtained through a Hodrick Presscot filter.

D.2 Alternative Monetary Policy Instruments

Table D.5: Results for Banxico's Baseline Models (4.4) and (4.5) with Alternative Monetary Policy Instruments

Model	**M.P. Instrument**	**Coef.**	**Intercept**	**Inf. Gap**	**Output Gap**	R^2	**Adj.** R^2
Levels	1 day TIIE	Estim	4.1263***	0.8612***	0.1737	0.30	0.28
Levels	1 day TIIE	S.D.	(0.6665)	(0.1893)	(0.3744)		
Levels	28 day TIIE	Estim	4.3913***	0.8776***	0.1764	0.31	0.29
Levels	28 day TIIE	S.D.	(0.6583)	(0.1911)	(0.3705)		
Levels	BFR	Estim	4.1174***	0.8651***	0.1689	0.30	0.28
Levels	BFR	S.D.	(0.6704)	(0.1909)	(0.3765)		
Differences	1 day TIIE	Estim	-0.0401	-0.0179	0.1004**	0.34	0.33
Differences	1 day TIIE	S.D.	(0.0258)	(0.0237)	(0.0299)		
Differences	28 day TIIE	Estim	-0.0384	-0.0180	0.0978**	0.31	0.29
Differences	28 day TIIE	S.D.	(0.0275)	(0.0250)	(0.0318)		
Differences	BFR	Estim	-0.0414	-0.0174	0.1011**	0.34	0.32
Differences	BFR	S.D.	(0.0256)	(0.0240)	(0.0299)		

Significance code: 0.001 → ***; 0.01 → **; 0.05 → *; 0.1 → +.

Notes:

1/ The sample period covers from February 2011 to December 2019 and data has 72 observations. Each point in time refers to a monetary policy decision.

2/ The baseline models presented are estimated for MPS with OLS implementing the Newey-West HAC variance-covariance estimator.

3/ Results for MPM are quite similar and just differ in that the sample period contains one less observation since there was no minute for the extraordinary meeting on February 17, 2016.

4/ The inflation gap is measured as the difference between the headline inflation and the inflation target rate.

5/ The output gap is measured as the difference between the annual variation on the IGAE and its tendency obtained through a Hodrick Presscot filter.

Table D.6: Results for Augmented Model (4.6) with Banxico's Statements and Alternative Monetary Policy Instruments

Rate Type	Coef.	Intercept	Inflation Gap	Output Gap	Words	Av. Sent. Length	Flesch Scale	Text Similarity	Text Sim. (m.a. k=4)	Text Sim. (m.a. k=6)	Text Sim. (m.a. k=8)	R^2	Adj. R^2
1 day TIIE	Estim	1.1462	0.6424*	-0.1140	0.0028*							0.49	0.46
1 day TIIE	S.D.	(1.2428)	(0.2799)	(0.3794)	(0.0014)								
1 day TIIE	Estim	10.3284***	0.7437***	0.2253		-0.2211*						0.37	0.34
1 day TIIE	S.D.	(2.8602)	(0.1856)	(0.3405)		(0.0921)							
1 day TIIE	Estim	-7.2772	0.6183**	0.2390			0.2289+					0.39	0.36
1 day TIIE	S.D.	(5.5582)	(0.2031)	(0.3283)			(0.1172)						
1 day TIIE	Estim	0.7606	0.8636***	0.1128				10.8022**				0.58	0.56
1 day TIIE	S.D.	(0.9461)	(0.2182)	(0.2397)				(3.2500)					
1 day TIIE	Estim	-0.8947	0.7880***	0.0575					16.2826***			0.70	0.69
1 day TIIE	S.D.	(0.9308)	(0.2041)	(0.2143)					(3.1740)				
1 day TIIE	Estim	-1.4772+	0.6701***	0.0519						18.4751***		0.71	0.70
1 day TIIE	S.D.	(0.7644)	(0.1733)	(0.2085)						(3.0700)			
1 day TIIE	Estim	-2.0343*	0.5733***	0.0574							20.4390***	0.73	0.72
1 day TIIE	S.D.	(0.8033)	(0.1401)	(0.2044)							(3.2918)		
28 day TIIE	Estim	1.4901	0.6647*	-0.1036	0.0027*							0.49	0.46
28 day TIIE	S.D.	(1.2404)	(0.2781)	(0.3753)	(0.0013)								
28 day TIIE	Estim	10.7557***	0.7570***	0.2294		-0.2269*						0.38	0.35
28 day TIIE	S.D.	(2.8066)	(0.1860)	(0.3353)		(0.0909)							
28 day TIIE	Estim	-6.9025	0.6370**	0.2411			0.2267+					0.40	0.37
28 day TIIE	S.D.	(5.5354)	(0.2032)	(0.3258)			(0.1163)						
28 day TIIE	Estim	1.1033	0.8800***	0.1169				10.5527**				0.58	0.56
28 day TIIE	S.D.	(0.9979)	(0.2237)	(0.2454)				(3.3872)					
28 day TIIE	Estim	-0.5357	0.8058***	0.0624					15.9774***			0.70	0.69
28 day TIIE	S.D.	(0.9271)	(0.2059)	(0.2146)					(3.1288)				
28 day TIIE	Estim	-1.1266	0.6894***	0.0565						18.1926***		0.71	0.70
28 day TIIE	S.D.	(0.7367)	(0.1785)	(0.2043)						(2.9351)			
28 day TIIE	Estim	-1.6888*	0.5935***	0.0616							20.1719***	0.73	0.72
28 day TIIE	S.D.	(0.7919)	(0.1426)	(0.2018)							(3.2099)		
BFR	Estim	1.1365	0.6463*	-0.1189	0.0028*							0.48	0.46
BFR	S.D.	(1.2530)	(0.2815)	(0.3818)	(0.0014)								
BFR	Estim	10.3892***	0.7463***	0.2210		-0.2236*						0.36	0.34
BFR	S.D.	(2.8707)	(0.1873)	(0.3421)		(0.0925)							
BFR	Estim	-7.3677	0.6205**	0.2347			0.2305+					0.39	0.36
BFR	S.D.	(5.5974)	(0.2047)	(0.3302)			(0.1180)						
BFR	Estim	0.7349	0.8676***	0.1077				10.8562**				0.58	0.56
BFR	S.D.	(0.9530)	(0.2197)	(0.2412)				(3.2643)					
BFR	Estim	-0.9250	0.7916***	0.0521					16.3518***			0.70	0.69
BFR	S.D.	(0.9386)	(0.2051)	(0.2155)					(3.1934)				
BFR	Estim	-1.5141+	0.6730***	0.0465						18.5674***		0.71	0.70
BFR	S.D.	(0.7725)	(0.1741)	(0.2094)						(3.0892)			
BFR	Estim	-2.0752*	0.5757***	0.0519							20.5452***	0.73	0.72
BFR	S.D.	(0.8113)	(0.1408)	(0.2051)							(3.3103)		

Significance code: 0.001 → ***; 0.01 → **; 0.05 → *; 0.1 → +.

Notes:

1/ The sample period covers from February 2011 to December 2019 corresponding to 72 statements. Each point in time refers to a monetary policy decision.

2/ Each model is estimated with OLS implementing the Newey-West HAC variance-covariance estimator.

3/ The inflation gap is measured as the difference between the headline inflation and the inflation target rate.

4/ The output gap is measured as the difference between the annual variation on the IGAE and its tendency obtained through a Hodrick Presscot filter.

Table D.7: Results for Augmented Model (4.7) with Banxico's Statements and Alternative Monetary Policy Instruments

Rate Type	**Coef.**	**Intercept**	**Inflation Gap**	**Output Gap**	**HD Index**	**HD Index (m.a. k=4)**	**HD Index (m.a. k=6)**	**HD Index (m.a. k=8)**	R^2	**Adj.** R^2
1 day TIIE	Estim	-0.0092	-0.0419+	0.0904***	0.2985**				0.54	0.52
1 day TIIE	S.D.	(0.0261)	(0.0232)	(0.0229)	(0.0878)					
1 day TIIE	Estim	0.0028	-0.0267	0.0693***		0.3758*			0.49	0.47
1 day TIIE	S.D.	(0.0298)	(0.0181)	(0.0194)		(0.1431)				
1 day TIIE	Estim	0.0220	-0.0237	0.0525**			0.4990**		0.51	0.49
1 day TIIE	S.D.	(0.0293)	(0.0149)	(0.0174)			(0.1557)			
1 day TIIE	Estim	0.0232	-0.0216	0.0511**				0.5109**	0.49	0.47
1 day TIIE	S.D.	(0.0291)	(0.0169)	(0.0175)				(0.1491)		
28 day TIIE	Estim	-0.0032	-0.0453+	0.0864***	0.3397***				0.55	0.53
28 day TIIE	S.D.	(0.0271)	(0.0230)	(0.0230)	(0.0892)					
28 day TIIE	Estim	0.0096	-0.0279	0.0629**		0.4209**			0.49	0.46
28 day TIIE	S.D.	(0.0299)	(0.0184)	(0.0190)		(0.1428)				
28 day TIIE	Estim	0.0290	-0.0243	0.0458**			0.5416***		0.50	0.48
28 day TIIE	S.D.	(0.0289)	(0.0153)	(0.0165)			(0.1549)			
28 day TIIE	Estim	0.0316	-0.0221	0.0433**				0.5646***	0.48	0.46
28 day TIIE	S.D.	(0.0279)	(0.0175)	(0.0162)				(0.1492)		
BFR	Estim	-0.0100	-0.0417+	0.0909***	0.3027**				0.54	0.52
BFR	S.D.	(0.0266)	(0.0236)	(0.0229)	(0.0895)					
BFR	Estim	0.0018	-0.0262	0.0697***		0.3785*			0.49	0.46
BFR	S.D.	(0.0303)	(0.0185)	(0.0194)		(0.1456)				
BFR	Estim	0.0209	-0.0231	0.0530**			0.5004**		0.51	0.49
BFR	S.D.	(0.0300)	(0.0153)	(0.0172)			(0.1592)			
BFR	Estim	0.0218	-0.0211	0.0518**				0.5104**	0.49	0.46
BFR	S.D.	(0.0295)	(0.0173)	(0.0171)				(0.1523)		

Significance code: 0.001 → ***; 0.01 → **; 0.05 → *; 0.1 → +.

Notes:

1/ The sample period covers from February 2011 to December 2019 corresponding to 72 statements. Each point in time refers to a monetary policy decision.

2/ Each model is estimated with OLS implementing the Newey-West HAC variance-covariance estimator.

3/ The inflation gap is measured as the difference between the headline inflation and the inflation target rate.

5/ The output gap is measured as the difference between the annual variation on the IGAE and its tendency obtained through a Hodrick Presscot filter.

Table D.8: Results for Augmented Model (4.6) with Banxico's Minutes and Alternative Monetary Policy Instruments

Rate Type	Coef.	Intercept	Inflation Gap	Output Gap	Words	Av. Sent. Length	Flesch Scale	Text Similarity	Text Sim. (m.a. k=4)	Text Sim. (m.a. k=6)	Text Sim. (m.a. k=8)	Agreement Rate	R^2	Adj. R^2
1 day TIIE	Estim	0.1104	0.5228**	0.0014	0.0008***								0.72	0.71
1 day TIIE	S.D.	(0.7694)	(0.1870)	(0.1809)	(0.0001)									
1 day TIIE	Estim	16.0661***	0.7310***	0.3170		-0.3685***							0.63	0.61
1 day TIIE	S.D.	(3.4165)	(0.1224)	(0.2113)		(0.0952)								
1 day TIIE	Estim	-5.4294	0.7126***	0.4080			0.2016*						0.44	0.41
1 day TIIE	S.D.	(3.5713)	(0.1426)	(0.3105)			(0.0798)							
1 day TIIE	Estim	-3.9390	0.8018**	-0.0711				40.7927*					0.49	0.47
1 day TIIE	S.D.	(3.7547)	(0.2662)	(0.3322)				(19.2488)						
1 day TIIE	Estim	-4.4756	0.7796**	-0.1238					43.5941+				0.48	0.46
1 day TIIE	S.D.	(4.3100)	(0.2700)	(0.3821)					(22.2307)					
1 day TIIE	Estim	-4.7442	0.7791**	-0.1633						44.9883+			0.46	0.43
1 day TIIE	S.D.	(4.7310)	(0.2603)	(0.4259)						(24.7502)				
1 day TIIE	Estim	-5.1546	0.7964**	-0.1945							46.9150+		0.44	0.42
1 day TIIE	S.D.	(5.2108)	(0.2470)	(0.4613)							(27.3880)			
1 day TIIE	Estim	3.9236***	0.8386***	0.1783								0.0105	0.30	0.27
1 day TIIE	S.D.	(0.4961)	(0.1989)	(0.3869)								(0.0199)		
28 day TIIE	Estim	0.4675	0.5464**	0.0085	0.0008***								0.71	0.70
28 day TIIE	S.D.	(0.7828)	(0.1885)	(0.1845)	(0.0001)									
28 day TIIE	Estim	16.3638***	0.7469***	0.3202		-0.3696***							0.64	0.63
28 day TIIE	S.D.	(3.3232)	(0.1231)	(0.2057)		(0.0929)								
28 day TIIE	Estim	-5.4147	0.7254***	0.4167			0.2068*						0.45	0.43
28 day TIIE	S.D.	(3.5157)	(0.1425)	(0.3044)			(0.0784)							
28 day TIIE	Estim	-3.3970	0.8192**	-0.0578				39.3845*					0.49	0.47
28 day TIIE	S.D.	(3.7490)	(0.2648)	(0.3312)				(19.1597)						
28 day TIIE	Estim	-3.8655	0.7981**	-0.1069					41.8381+				0.48	0.45
28 day TIIE	S.D.	(4.3116)	(0.2683)	(0.3802)					(22.1894)					
28 day TIIE	Estim	-4.1196	0.7976**	-0.1447						43.1577+			0.46	0.43
28 day TIIE	S.D.	(4.7451)	(0.2591)	(0.4228)						(24.7680)				
28 day TIIE	Estim	-4.5005	0.8143**	-0.1741							44.9413		0.44	0.41
28 day TIIE	S.D.	(5.2222)	(0.2462)	(0.4572)							(27.3895)			
28 day TIIE	Estim	4.2212***	0.8558***	0.1824								0.0089	0.31	0.28
28 day TIIE	S.D.	(0.4901)	(0.1998)	(0.3826)								(0.0197)		
BFR	Estim	0.0921	0.5261**	-0.0039	0.0008***								0.72	0.70
BFR	S.D.	(0.7811)	(0.1888)	(0.1833)	(0.0001)									
BFR	Estim	16.1428***	0.7342***	0.3130		-0.3712***							0.63	0.61
BFR	S.D.	(3.4276)	(0.1237)	(0.2117)		(0.0956)								
BFR	Estim	-5.5713	0.7148***	0.4061			0.2044*						0.44	0.41
BFR	S.D.	(3.5881)	(0.1433)	(0.3115)			(0.0802)							
BFR	Estim	-3.9366	0.8058**	-0.0752				40.7317*					0.49	0.47
BFR	S.D.	(3.7860)	(0.2679)	(0.3352)				(19.4059)						
BFR	Estim	-4.4625	0.7837**	-0.1274					43.4787+				0.48	0.45
BFR	S.D.	(4.3495)	(0.2715)	(0.3853)					(22.4310)					
BFR	Estim	-4.7280	0.7832**	-0.1667						44.8568+			0.45	0.43
BFR	S.D.	(4.7765)	(0.2618)	(0.4292)						(24.9817)				
BFR	Estim	-5.1323	0.8005**	-0.1976							46.7537+		0.44	0.41
BFR	S.D.	(5.2612)	(0.2486)	(0.4648)							(27.6444)			
BFR	Estim	3.9251***	0.8430***	0.1738								0.0100	0.29	0.26
BFR	S.D.	(0.4975)	(0.2002)	(0.3890)								(0.0199)		

Significance code: 0.001 → ***; 0.01 → **; 0.05 → *; 0.1 → +.

Notes:

1/ The sample period covers from February 2011 to December 2019 corresponding to 71 minutes. Each point in time refers to a monetary policy decision.

2/Each model is estimated with OLS implementing the Newey-West HAC variance-covariance estimator.

3/ The inflation gap is measured as the difference between the headline inflation and the inflation target rate.

4/ The output gap is measured as the difference between the annual variation on the IGAE and its tendency obtained through a Hodrick Presscot filter.

Table D.9: Results for Augmented Model (4.7) with Banxico's Minutes and Alternative Monetary Policy Instruments

Rate Type	**Coef.**	**Intercept**	**Inflation Gap**	**Output Gap**	**HD Index**	**HD Index (m.a. k=4)**	**HD Index (m.a. k=6)**	**HD Index (m.a. k=8)**	R^2	**Adj.** R^2
1 day TIIE	Estim	-0.0320	-0.0336	0.0979***	0.2553*				0.40	0.37
1 day TIIE	S.D.	(0.0264)	(0.0291)	(0.0268)	(0.1152)					
1 day TIIE	Estim	-0.0336	-0.0251	0.0922***		0.2755			0.38	0.35
1 day TIIE	S.D.	(0.0291)	(0.0267)	(0.0216)		(0.2577)				
1 day TIIE	Estim	-0.0320	-0.0260	0.0872***			0.4327		0.41	0.38
1 day TIIE	S.D.	(0.0288)	(0.0235)	(0.0198)			(0.3221)			
1 day TIIE	Estim	-0.0354	-0.0251	0.0883***				0.4982	0.41	0.39
1 day TIIE	S.D.	(0.0265)	(0.0215)	(0.0201)				(0.3292)		
28 day TIIE	Estim	-0.0291	-0.0365	0.0942**	0.3111**				0.39	0.36
28 day TIIE	S.D.	(0.0275)	(0.0299)	(0.0275)	(0.1079)					
28 day TIIE	Estim	-0.0310	-0.0262	0.0872***		0.3361			0.36	0.33
28 day TIIE	S.D.	(0.0309)	(0.0277)	(0.0219)		(0.2549)				
28 day TIIE	Estim	-0.0300	-0.0264	0.0835***			0.4587		0.38	0.35
28 day TIIE	S.D.	(0.0309)	(0.0248)	(0.0203)			(0.3218)			
28 day TIIE	Estim	-0.0336	-0.0255	0.0846***				0.5337	0.39	0.36
28 day TIIE	S.D.	(0.0288)	(0.0227)	(0.0205)				(0.3266)		
BFR	Estim	-0.0332	-0.0332	0.0985***	0.2579*				0.40	0.37
BFR	S.D.	(0.0263)	(0.0288)	(0.0258)	(0.1125)					
BFR	Estim	-0.0348	-0.0246	0.0927***		0.2792			0.38	0.35
BFR	S.D.	(0.0292)	(0.0271)	(0.0215)		(0.2581)				
BFR	Estim	-0.0334	-0.0254	0.0880***			0.4275		0.40	0.38
BFR	S.D.	(0.0289)	(0.0241)	(0.0196)			(0.3269)			
BFR	Estim	-0.0367	-0.0245	0.0892***				0.4890	0.41	0.38
BFR	S.D.	(0.0266)	(0.0223)	(0.0200)				(0.3223)		

Significance code: 0.001 → ***; 0.01 → **; 0.05 → *; 0.1 → +.

Notes:

1/ The sample period covers from February 2011 to December 2019 corresponding to 71 minutes. Each point in time refers to a monetary policy decision.

2/ Each model is estimated with OLS implementing the Newey-West HAC variance-covariance estimator.

3/ The inflation gap is measured as the difference between the headline inflation and the inflation target rate.

4/ The output gap is measured as the difference between the annual variation on the IGAE and its tendency obtained through a Hodrick Presscot filter.

D.3 Alternative Sample Periods

Table D.10: Results for Banxico's Baseline Models (4.4) and (4.5) with Alternative Sample Periods

Model	**Period**	**Coef.**	**Intercept**	**Inf. Gap**	**Output Gap**	R^2	**Adj.** R^2	**# Obs.**
Levels	2008-2019	Estim	4.0412***	0.9756***	0.2984***	0.42	0.41	104
Levels	2008-2019	Std. Dev	(0.4849)	(0.2119)	(0.0727)			
Levels	2008-2020	Estim	4.4518***	0.7721***	0.0468	0.26	0.25	109
Levels	2008-2020	Std. Dev	(0.5064)	(0.2181)	(0.0849)			
Levels	2011-2020	Estim	4.3863***	0.8921***	-0.0540+	0.26	0.24	77
Levels	2011-2020	Std. Dev	(0.4763)	(0.1911)	(0.0301)			
Differences	2008-2019	Estim	0.0149	-0.0251	0.0602***	0.38	0.37	104
Differences	2008-2019	Std. Dev	(0.0330)	(0.0197)	(0.0121)			
Differences	2008-2020	Estim	0.0284	-0.0344	0.0384***	0.36	0.35	109
Differences	2008-2020	Std. Dev	(0.0360)	(0.0253)	(0.0093)			
Differences	2011-2020	Estim	-0.0037	0.0043	0.0313***	0.30	0.28	77
Differences	2011-2020	Std. Dev	(0.0402)	(0.0229)	(0.0080)			

Significance code: 0.001 → ***; 0.01 → **; 0.05 → *; 0.1 → +.

Notes:

1/ Each point in time refers to a monetary policy decision.

2/ The baseline models presented are estimated for MPS with OLS implementing the Newey-West HAC variance-covariance estimator.

3/ Results for MPM are quite similar and just differ in that the sample period contains one less observation since there was no minute for the extraordinary meeting on February 17, 2016.

4/ The inflation gap is measured as the difference between the headline inflation and the inflation target rate.

5/ The output gap is measured as the difference between the annual variation on the IGAE and its tendency obtained through a Hodrick Presscot filter.

Table D.11: Results for Augmented Model (4.6) with Banxico's Statements and Alternative Sample Periods

Sample Period	Coef.	Intercept	Inflation Gap	Output Gap	Words	Av. Sent. Length	Flesch Scale	Text Similarity	Text Sim. (m.a. k=4)	Text Sim. (m.a. k=6)	Text Sim. (m.a. k=8)	R^2	Adj. R^2	# Obs
2008-2019	Estim	3.7482***	0.9827***	0.2709+	0.0003							0.43	0.41	104
2008-2019	S.D.	(0.8656)	(0.2219)	(0.1428)	(0.0010)									
2008-2019	Estim	8.5148***	0.8097***	0.3319***		-0.1617**						0.49	0.48	104
2008-2019	S.D.	(1.3509)	(0.1865)	(0.0685)		(0.0512)								
2008-2019	Estim	-3.7303	0.7246***	0.3694***			0.1547**					0.50	0.49	104
2008-2019	S.D.	(2.4093)	(0.2085)	(0.0641)			(0.0477)							
2008-2019	Estim	1.8172*	1.0002***	0.2752***				7.0839*				0.56	0.54	104
2008-2019	S.D.	(0.8580)	(0.1987)	(0.0730)				(3.0537)						
2008-2019	Estim	0.5106	0.9381***	0.2506**					11.5863**			0.61	0.60	104
2008-2019	S.D.	(1.0576)	(0.2097)	(0.0869)					(3.8458)					
2008-2019	Estim	-0.0211	0.8698***	0.2359**						13.5952**		0.62	0.61	104
2008-2019	S.D.	(1.0451)	(0.2341)	(0.0888)						(4.0324)				
2008-2019	Estim	-0.5123	0.8176**	0.2223*							15.3674***	0.63	0.62	104
2008-2019	S.D.	(1.0656)	(0.2449)	(0.0921)							(4.1354)			
2008-2020	Estim	3.5911***	0.8204***	0.0145	0.0008							0.29	0.27	109
2008-2020	S.D.	(0.9265)	(0.2077)	(0.0932)	(0.0009)									
2008-2020	Estim	8.3961***	0.6190**	0.0631		-0.1423+						0.32	0.30	109
2008-2020	S.D.	(2.0411)	(0.1916)	(0.0897)		(0.0771)								
2008-2020	Estim	-0.4828	0.5923**	0.0622			0.0988					0.29	0.27	109
2008-2020	S.D.	(3.6603)	(0.2029)	(0.0960)			(0.0715)							
2008-2020	Estim	2.1889**	0.8150***	0.0473				7.1177**				0.41	0.39	109
2008-2020	S.D.	(0.7785)	(0.1997)	(0.0768)				(2.4691)						
2008-2020	Estim	0.5038	0.7716***	0.0646					12.7142***			0.50	0.48	109
2008-2020	S.D.	(0.9236)	(0.2094)	(0.0656)					(3.1237)					
2008-2020	Estim	-0.3233	0.7077**	0.0528						15.6004***		0.53	0.51	109
2008-2020	S.D.	(0.8445)	(0.2159)	(0.0651)						(3.1178)				
2008-2020	Estim	-1.0144	0.6644**	0.0534							17.9185***	0.56	0.55	109
2008-2020	S.D.	(0.8218)	(0.2082)	(0.0598)							(3.0756)			
2011-2020	Estim	1.5658	0.6358*	-0.1069**	0.0025*							0.43	0.41	77
2011-2020	S.D.	(1.0791)	(0.2808)	(0.0353)	(0.0010)									
2011-2020	Estim	10.0881***	0.7910***	-0.0347		-0.2032*						0.33	0.30	77
2011-2020	S.D.	(2.2580)	(0.1845)	(0.0298)		(0.0787)								
2011-2020	Estim	-5.2490	0.6974***	-0.0470			0.1938*					0.33	0.30	77
2011-2020	S.D.	(4.5083)	(0.1926)	(0.0321)			(0.0934)							
2011-2020	Estim	1.3847	0.8834***	-0.0426				9.4852***				0.50	0.48	77
2011-2020	S.D.	(0.8964)	(0.1823)	(0.0378)				(2.6624)						
2011-2020	Estim	-0.4623	0.7682***	-0.0065					15.4285***			0.62	0.61	77
2011-2020	S.D.	(0.8606)	(0.1886)	(0.0386)					(2.7405)					
2011-2020	Estim	-1.3898*	0.6580***	-0.0178						18.6107***		0.68	0.66	77
2011-2020	S.D.	(0.6935)	(0.1879)	(0.0294)						(2.5673)				
2011-2020	Estim	-2.0939**	0.5624***	-0.0083							20.9633***	0.72	0.70	77
2011-2020	S.D.	(0.7348)	(0.1575)	(0.0230)							(2.6407)			

Significance code: 0.001 → ***; 0.01 → **; 0.05 → *; 0.1 → +.

Notes:

1/ Each point in time refers to a monetary policy decision.

2/ Each model is estimated with OLS implementing the Newey-West HAC variance-covariance estimator.

3/ The inflation gap is measured as the difference between the headline inflation and the inflation target rate.

4/ The output gap is measured as the difference between the annual variation on the IGAE and its tendency obtained through a Hodrick Presscot filter.

Table D.12: Results for Augmented Model (4.7) with Banxico's Statements and Alternative Sample Periods

Sample Period	**Coef.**	**Intercept**	**Inflation Gap**	**Output Gap**	**HD Index**	**HD Index (m.a. k=4)**	**HD Index (m.a. k=6)**	**HD Index (m.a. k=8)**	R^2	**Adj.** R^2	**# Obs**
2008-2019	Estim	0.0312	-0.0429*	0.0547***	0.3138***				0.52	0.50	104
2008-2019	S.D.	(0.0335)	(0.0184)	(0.0081)	(0.0855)						
2008-2019	Estim	0.0243	-0.0407**	0.0578***		0.4820***			0.59	0.58	104
2008-2019	S.D.	(0.0231)	(0.0139)	(0.0078)		(0.0944)					
2008-2019	Estim	0.0230	-0.0406**	0.0619***			0.5461***		0.60	0.59	104
2008-2019	S.D.	(0.0189)	(0.0126)	(0.0088)			(0.0896)				
2008-2019	Estim	0.0233	-0.0408**	0.0656***				0.5686***	0.58	0.56	104
2008-2019	S.D.	(0.0213)	(0.0150)	(0.0104)				(0.0967)			
2008-2020	Estim	0.0449	-0.0525*	0.0337***	0.3314***				0.49	0.48	109
2008-2020	S.D.	(0.0364)	(0.0257)	(0.0084)	(0.0883)						
2008-2020	Estim	0.0425	-0.0525**	0.0361***		0.5163***			0.57	0.56	109
2008-2020	S.D.	(0.0257)	(0.0187)	(0.0078)		(0.0896)					
2008-2020	Estim	0.0429+	-0.0529**	0.0376***			0.5511***		0.55	0.54	109
2008-2020	S.D.	(0.0250)	(0.0194)	(0.0090)			(0.0836)				
2008-2020	Estim	0.0443+	-0.0531*	0.0387***				0.5391***	0.51	0.50	109
2008-2020	S.D.	(0.0266)	(0.0212)	(0.0099)				(0.0908)			
2011-2020	Estim	0.0204	-0.0190	0.0281***	0.2730*				0.40	0.37	77
2011-2020	S.D.	(0.0455)	(0.0263)	(0.0074)	(0.1093)						
2011-2020	Estim	0.0309	-0.0209	0.0273***		0.5222**			0.51	0.49	77
2011-2020	S.D.	(0.0376)	(0.0205)	(0.0042)		(0.1587)					
2011-2020	Estim	0.0371	-0.0208	0.0261***			0.6380***		0.54	0.52	77
2011-2020	S.D.	(0.0299)	(0.0155)	(0.0033)			(0.1489)				
2011-2020	Estim	0.0367	-0.0184	0.0256***				0.6669***	0.52	0.50	77
2011-2020	S.D.	(0.0308)	(0.0176)	(0.0037)				(0.1498)			

Significance code: 0.001 → ***; 0.01 → **; 0.05 → *; 0.1 → +.

Notes:

1/ Each point in time refers to a monetary policy decision.

2/ Each model is estimated with OLS implementing the Newey-West HAC variance-covariance estimator.

3/ The inflation gap is measured as the difference between the headline inflation and the inflation target rate.

4/ The output gap is measured as the difference between the annual variation on the IGAE and its tendency obtained through a Hodrick Presscot filter.

Table D.13: Results for Augmented Model (4.6) with Banxico's Minutes and Alternative Sample Periods

Sample Period	**Coef.**	**Intercept**	**Inflation Gap**	**Output Gap**	**Words**	**Av. Sent. Length**	**Flesch Scale**	**Text Similarity**	**Text Sim. (m.a. k=4)**	**Text Sim. (m.a. k=6)**	**Text Sim. (m.a. k=8)**	**Agreement Rate**	R^2	**Adj.** R^2	**# Obs**
2008-2020	Estim	0.1805	0.5241**	0.0120	0.0008***								0.70	0.69	76
2008-2020	S.D.	(0.7401)	(0.1757)	(0.0254)	(0.0001)										
2008-2020	Estim	15.5909***	0.8039***	0.0782+		-0.3491***							0.60	0.59	76
2008-2020	S.D.	(2.5472)	(0.1130)	(0.0403)		(0.0751)									
2008-2020	Estim	-4.0236	0.8204***	0.0065			0.1786+						0.38	0.35	76
2008-2020	S.D.	(4.1779)	(0.1704)	(0.0438)			(0.0914)								
2008-2020	Estim	-3.1806	0.7801**	-0.0659+				37.4323**					0.45	0.43	75
2008-2020	S.D.	(2.7803)	(0.2286)	(0.0345)				(13.7943)							
2008-2020	Estim	-3.7800	0.7368**	-0.0687+					40.4507*				0.44	0.41	75
2008-2020	S.D.	(3.5297)	(0.2669)	(0.0355)					(17.7353)						
2008-2020	Estim	-4.1495	0.7307**	-0.0848*						42.2232*			0.42	0.40	75
2008-2020	S.D.	(3.8361)	(0.2693)	(0.0349)						(19.3700)					
2008-2020	Estim	-4.4176	0.7376**	-0.0755*							43.3043*		0.41	0.38	75
2008-2020	S.D.	(3.9753)	(0.2611)	(0.0337)							(20.0094)				
2008-2020	Estim	4.1139***	0.8744***	-0.0530+								0.0133	0.25	0.22	76
2008-2020	S.D.	(0.4638)	(0.2043)	(0.0305)								(0.0183)			

Significance code: 0.001 → ***; 0.01 → **; 0.05 → *; 0.1 → +.

Notes:

1/ Each point in time refers to a monetary policy decision.

2/ Each model is estimated with OLS implementing the Newey-West HAC variance-covariance estimator.

3/ The inflation gap is measured as the differencebetween the headline inflation and the inflation target rate.

4/ The output gap is measured as the difference between the annual variation on the IGAE and its tendency obtained through aHodrick Presscot filter.

Table D.14: Results for Augmented Model (4.7) with Banxico's Minutes and Alternative Sample Periods

Sample Period	**Coef.**	**Intercept**	**Inflation Gap**	**Output Gap**	**HD Index**	**HD Index (m.a. k=4)**	**HD Index (m.a. k=6)**	**HD Index (m.a. k=8)**	R^2	**Adj.** R^2	**# Obs**
2011-2020	Estim	0.0012	-0.0079	0.0291**	0.2216				0.32	0.29	76
2011-2020	S.D.	(0.0472)	(0.0266)	(0.0085)	(0.1805)						
2011-2020	Estim	-0.0019	-0.0116	0.0266***		0.5553*			0.38	0.35	76
2011-2020	S.D.	(0.0445)	(0.0277)	(0.0067)		(0.2743)					
2011-2020	Estim	-0.0029	-0.0138	0.0253***			0.7538*		0.41	0.39	76
2011-2020	S.D.	(0.0401)	(0.0252)	(0.0063)			(0.3252)				
2011-2020	Estim	-0.0081	-0.0112	0.0256***				0.8546*	0.42	0.40	76
2011-2020	S.D.	(0.0367)	(0.0240)	(0.0062)				(0.3546)			

Significance code: 0.001 → ***; 0.01 → **; 0.05 → *; 0.1 → +.

Notes:

1/ Each point in time refers to a monetary policy decision.

2/ Each model is estimated with OLS implementing the Newey-West HAC variance-covariance estimator.

3/ The inflation gap is measured as the difference between the headline inflation and the inflation target rate.

4/ The output gap is measured as the difference between the annual variation on the IGAE and its tendency obtained through a Hodrick Presscot filter.

D.4 Alternative Model Specifications

Table D.15: Results for Banxico's Baseline Models (4.4) and (4.5) with Core Inflation

Model	**Coef.**	**Intercept**	**Core Inf. Gap**	**Output Gap**	R^2	**Adj.** R^2
Levels	Estim	4.3317***	1.9951***	0.1041	0.57	0.55
Levels	S.D.	(0.3968)	(0.4192)	(0.2609)		
Differences	Estim	-0.0489*	-0.0159	0.0953***	0.28	0.26
Differences	S.D.	(0.0238)	(0.0297)	(0.0259)		

Significance code: 0.001 → ***; 0.01 → **; 0.05 → *; 0.1 → +.

Notes:

1/ The sample period covers from February 2011 to December 2019 and data has 72 observations. Each point in time refers to a monetary policy decision.

2/ The baseline models presented are estimated for MPS with OLS implementing the Newey-West HAC variance-covariance estimator

3/ Results for MPM are quite similar and just differ in that the sample period contains one less observation since there was no minute for the extraordinary meeting on February 17, 2016.

4/ The inflation gap is measured as the difference between the core inflation and the inflation target rate.

5/ The output gap is measured as the difference between the annual variation on the IGAE and its tendency obtained through a Hodrick Presscot filter.

Table D.16: Results for Augmented Model (4.6) with Banxico's Statements and Core Inflation

Coef.	**Intercept**	**Core Inf. Gap**	**Output Gap**	**Words**	**Av. Sent. Length**	**Flesch Scale**	**Text Similarity**	**Text Sim. (m.a. k=4)**	**Text Sim. (m.a. k=6)**	**Text Sim. (m.a. k=8)**	R^2	**Adj.** R^2
Estim	2.3202*	1.6249***	-0.0612	0.0019+							0.64	0.62
S.D.	(1.0132)	(0.4001)	(0.2757)	(0.0010)								
Estim	8.0736***	1.8379***	0.1430		-0.1342+						0.59	0.57
S.D.	(2.1305)	(0.4192)	(0.2617)		(0.0779)							
Estim	-3.8302	1.7426***	0.1438			0.1624*					0.61	0.59
S.D.	(3.6522)	(0.3872)	(0.2436)			(0.0739)						
Estim	1.9394*	1.7517***	0.1084				7.7962**				0.70	0.69
S.D.	(0.7581)	(0.3128)	(0.1607)				(2.5746)					
Estim	0.4605	1.5937***	0.0741					12.6283***			0.79	0.78
S.D.	(0.9220)	(0.2993)	(0.1420)					(2.9272)				
Estim	-0.2690	1.4897***	0.0528						15.0884***		0.82	0.81
S.D.	(0.8619)	(0.2829)	(0.1388)						(2.7871)			
Estim	-0.7604	1.3515***	0.0584							16.7140***	0.82	0.81
S.D.	(0.8539)	(0.2505)	(0.1434)							(2.8540)		

Significance code: 0.001 → ***; 0.01 → **; 0.05 → *; 0.1 → +.

Notes:

1/ The sample period covers from February 2011 to December 2019 corresponding to 72 statements. Each point in time refers to a monetary policy decision.

2/ Each model is estimated with OLS implementing the Newey-West HAC variance-covariance estimator.

3/ The inflation gap is measured as the difference between the core inflation and the inflation target rate.

4/ The output gap is measured as the difference between the annual variation on the IGAE and its tendency obtained through a Hodrick Presscot filter.

Table D.17: Results for Augmented Model (4.7) with Banxico's Statements and Core Inflation

Coef.	**Intercept**	**Core Inf. Gap**	**Output Gap**	**HD Index**	**HD Index (m.a. k=4)**	**HD Index (m.a. k=6)**	**HD Index (m.a. k=8)**	R^2	**Adj.** R^2
Estim	-0.0316*	-0.0498*	0.0879***	0.2340**				0.38	0.35
S.D.	(0.0140)	(0.0243)	(0.0201)	(0.0804)					
Estim	-0.0044	-0.0441+	0.0641***		0.4061**			0.41	0.39
S.D.	(0.0250)	(0.0243)	(0.0159)		(0.1391)				
Estim	0.0210	-0.0428+	0.0444**			0.5627***		0.45	0.43
S.D.	(0.0282)	(0.0220)	(0.0163)			(0.1562)			
Estim	0.0262	-0.0382	0.0400**				0.6028***	0.45	0.42
S.D.	(0.0253)	(0.0243)	(0.0145)				(0.1541)		

Significance code: 0.001 → ***; 0.01 → **; 0.05 → *; 0.1 → +.

Notes:

1/ The sample period covers from February 2011 to December 2019 corresponding to 72 statements. Each point in time refers to a monetary policy decision.

2/ Each model is estimated with OLS implementing the Newey-West HAC variance-covariance estimator.

3/ The inflation gap is measured as the difference between the core inflation and the inflation target rate.

4/ The output gap is measured as the difference between the annual variation on the IGAE and its tendency obtained through a Hodrick Presscot filter.

Table D.18: Results for Augmented Model (4.6) with Banxico's Minutes and Core Inflation

Coef.	**Intercept**	**Core Inf. Gap**	**Output Gap**	**Words**	**Av. Sent. Length**	**Flesch Scale**	**Text Similarity**	**Text Sim. (m.a. k=4)**	**Text Sim. (m.a. k=6)**	**Text Sim. (m.a. k=8)**	**Agreement Rate**	R^2	**Adj.** R^2
Estim	1.1383+	1.2644***	0.0243	0.0006***								0.78	0.77
S.D.	(0.6561)	(0.3472)	(0.1249)	(0.0001)									
Estim	13.3172***	1.5429***	0.2660		-0.2773**							0.73	0.72
S.D.	(2.9048)	(0.2815)	(0.1784)		(0.0837)								
Estim	-1.9481	1.7405***	0.2723			0.1319+						0.62	0.60
S.D.	(3.5542)	(0.4132)	(0.2790)			(0.0763)							
Estim	-1.3119	1.7832***	-0.0453				28.5802*					0.66	0.64
S.D.	(2.1780)	(0.4049)	(0.2035)				(11.2034)						
Estim	-1.9973	1.7931***	-0.1010					32.0435*				0.66	0.64
S.D.	(2.6992)	(0.4093)	(0.2360)					(13.7811)					
Estim	-2.6462	1.8318***	-0.1567						35.3132*			0.66	0.64
S.D.	(3.0160)	(0.3955)	(0.2623)						(15.4870)				
Estim	-3.2616	1.8693***	-0.1968							38.3160*		0.66	0.64
S.D.	(3.3838)	(0.3956)	(0.2800)							(17.4608)			
Estim	4.1857***	1.9863***	0.0998								0.0070	0.56	0.54
S.D.	(0.4065)	(0.4249)	(0.2736)								(0.0162)		

Significance code: 0.001 → ***; 0.01 → **; 0.05 → *; 0.1 → +.

Notes:

1/ The sample period covers from February 2011 to December 2019 corresponding to 71 minutes. Each point in time refers to a monetary policy decision.

2/ Each model is estimated with OLS implementing the Newey-West HAC variance-covariance estimator.

3/ The inflation gap is measured as the difference between the core inflation and the inflation target rate.

4/ The output gap is measured as the difference between the annual variation on the IGAE and its tendency obtained through a Hodrick Presscot filter.

Table D.19: Results for Augmented Model (4.7) with Banxico's Minutes and Core Inflation

Coef.	**Intercept**	**Core Inf. Gap**	**Output Gap**	**HD Index**	**HD Index (m.a. k=4)**	**HD Index (m.a. k=6)**	**HD Index (m.a. k=8)**	R^2	**Adj.** R^2
Estim	-0.0482*	-0.0256	0.0936***	0.1331				0.29	0.26
S.D.	(0.0234)	(0.0312)	(0.0268)	(0.1500)					
Estim	-0.0463+	-0.0216	0.0868***		0.2483			0.30	0.27
S.D.	(0.0253)	(0.0328)	(0.0230)		(0.2356)				
Estim	-0.0454	-0.0210	0.0804***			0.4271		0.33	0.30
S.D.	(0.0276)	(0.0313)	(0.0214)			(0.2970)			
Estim	-0.0485+	-0.0191	0.0797***				0.5462+	0.35	0.32
S.D.	(0.0276)	(0.0297)	(0.0192)				(0.3020)		

Significance code: 0.001 → ***; 0.01 → **; 0.05 → *; 0.1 → +.

Notes:

1/ The sample period covers from February 2011 to December 2019 corresponding to 71 minutes. Each point in time refers to a monetary policy decision.

2/ Each model is estimated with OLS implementing the Newey-West HAC variance-covariance estimator.

3/ The inflation gap is measured as the difference between the core inflation and the inflation target rate.

4/ The output gap is measured as the difference between the annual variation on the IGAE and its tendency obtained through a Hodrick Presscot filter.