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Monetary Policy Press Releases: An International Comparison*

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Abstract
Around the world, several countries have adopted inflation targeting as their monetary policy framework. These institutions set their target interest rates in monetary policy meetings. The policy decisions are then circulated through press releases that explain those decisions. The information contained in these press releases includes current policies, economic outlook, and signals about likely future policies. In this paper, we examine and compare the information contained in the monetary press releases of a group of inflation targeting countries using linguistic methods, such as Latent Dirichlet Allocation (LDA), an automated linguistic method. In addition, using Semi-automated Content Analysis, we create a measure that we call the Sentiment Score index based on this information for each of the countries in the sample. We use this index to compare the communication strategy of the central banks and how predictable monetary policy movements are based on the information given in the press releases.

Resumen
Actualmente, un número importante de bancos centrales han adoptado el esquema de metas de inflación como su marco de política monetaria. Estas instituciones fijan su tasa de política monetaria en sus reuniones de política monetaria que se realizan periódicamente. Estas instituciones dan a conocer y explican las decisiones tomadas en dichas reuniones a través de comunicados de prensa. La información contenida estos comunicados incluye políticas actuales, la situación económica, y señales acerca de posibles políticas futuras. En este trabajo, examinamos y comparamos la información contenida en estos comunicados para un grupo de países con metas de inflación usando técnicas lingüísticas como Latent Dirichlet Allocation (LDA). Adicionalmente, usamos Análisis Semi-Automático de Contenido para construir lo que llamamos Índice de Sentimiento para cada uno de los países de la muestra. Usando este índice comparamos la estrategia de comunicación de los banco centrales y analizamos que tan predecible son los movimientos de tasa basados en la información entregada en los comunicados.

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1 Introduction

The amount of research work on monetary policy communication has seen rapid growth in the last two decades. This growth reflects a change in the way policymakers think about announcing their decisions and the importance of managing expectations and providing insights into the economy. Policymakers have increasingly emphasized the dual role of communication, first, as a tool that reinforces traditional monetary policy instruments. Also, communication can act as a monetary policy instrument that can move financial markets, decrease monetary policy decisions' surprises, and help reach central banks' macroeconomic objectives. A recent strand of this literature has incorporated Linguistic tools and analysis to otherwise traditional economic analysis tools. Most of the research work has also focused on individual countries, especially the U.S.

Our current project builds on previous work by examining the monetary policy press releases of inflation-targeting central banks with a relatively long set of disseminated policy documents. We focus on Australia, Brazil, Canada, Chile, Hungary, Iceland, Indonesia, Israel, New Zealand, Norway, Peru, The Philippines, Poland, Romania, South Africa, South Korea, Sweden, and Thailand. We conduct a linguistic analysis of the monetary policy press releases to compare their structure and readability and check whether these have changed over time. We also conduct a Semi-Automated Content Analysis approach to create a continuous sentiment index for each central bank press release set.

We utilize a linguistic analysis to examine the characteristics of the press releases. We evaluate the documents' length and complexity and assess the educational outcome necessary to read the documents. Our findings indicate that for most countries, the complexity of the press releases requires some college education. For the remaining countries, their press releases need at least a tenth-grade high school education to comprehend the documents. Moreover, we also find that the length of the press releases seems to be converging, with the shorter press releases increasing in length while the initially longer press releases declining in the average number of words.

As for applying the Semi-Automated Content Analysis, we follow the methodology presented

by Tadle (2021) and Gonzalez and Tadle (2020) in which an evaluator creates a computer algorithm based on the observed structure and word choices of policy documents to extract the qualitative information from policy statements. The main advantage of this method is that it is more transparent and replicable, and it accounts for the context of the documents. The resulting analysis is more effective in quantifying the policy document information. It is also less subjective, especially when compared to completely heuristic methods. Adopting this approach allows us to examine each press release and determine whether the document sentiment generally leans toward contractionary or expansionary monetary policy. This perceived policy tilt depends on how inflationary pressures and economic conditions are described in the policy text.

Using the continuous sentiment index for each set of policy documents, we study if the monetary policy press releases contain enough information to anticipate monetary policy movements. We also examine if the monetary policy sentiments are correlated at the international level using principal components analysis. We found a heightened amount of co-movement in the policy sentiments during the Global Financial Crisis. The co-movement decreased but remained much higher than the sentiment variance in the pre-crisis period.

This paper is mainly connected to two strands of literature. The first strand focuses on using linguistic tools in economics to evaluate the qualitative content of text documents by transforming them into a more quantitative format.[1] Although this type of methodology is imperfect since we are still not able to capture all of the details from the documents, the current approach is an important step forward. This methodology has been used to analyze communication, construct GDP nowcasting indexes, study social media, and construct uncertainty indexes, among other uses.

The next strand of literature examines how well central banks communicate their monetary policy decisions.[2] This work focuses on how central bank announcements create news, influence expectations, and affect asset prices.[3] They not only evaluate the frequency of communication but focus mainly on the contents of widely-distributed central bank communication.

[1] See Lucca and Trebbi (2009) for an example.

[2] Blinder et al. (2008) presents an excellent survey of this literature.

[3] Pescatori (2018) serves as an illuminating example as he examines the importance of policy predictability and efficacy.

We contribute to these literature strands mainly in three ways. First, we study and compare the readability of the monetary policy press releases by a broad group of central banks. Although other papers have studied the communication of a group of central banks, their focus is different from ours. Previous work has focused either on other central banks or on other topics about inflation-targeters.[4] Our work evaluates the readability of the press releases and the predictability of monetary policy decisions. We also build a dictionary specifically designed to capture the monetary policy sentiment.[5]

The rest of our paper is structured as follows. Section 2 explores the literature on central bank communication. Section 3 then details the inflation-targeting countries and the press releases selected for each country. Section 4 explains the linguistic analysis methodology for document readability and the content analysis approach used to calculate the continuous sentiment indices for each set of press releases. Section 5 presents the results. Finally, section 6 discusses some robustness and extensions to the analysis while section 7 presents some concluding remarks.

2 Related Literature

Recently, there has been a surge in the literature that studies central banks' communication strategy, especially since communication has become an integral tool in a central bank's arsenal. Much of the research has focused on measuring the information content of monetary policy documents. Early examples of this are Rosa (2011), which uses a manual approach to extract information from policy documents, and Lucca and Trebbi (2009), which utilize an automated method to analyze the FOMC statements and the VAR framework to estimate the effect of these statements on the macroeconomy.

Building on the need to develop more systematic approaches for examining policy documents, Hansen and McMahon (2016) were the first to adopt the use of Latent Dirichlet Allocation (LDA) to analyze economic policy documents.[6] Hansen et al. (2017) further use this methodology to

[4]International Monetary Fund (2018) study and compare central bank communication in Latin American central banks. Moreover, Armelius et al. (2020) evaluate the spillover of the monetary policy sentiment among 23 inflation-targeting countries. They find that only the US has a strong influence on the sentiment of other countries.

[5]Unlike other dictionaries, our dictionary is divided into keywords, words that narrow the topic of a sentence, and modifiers, words that give intention to a sentence.

understand how transparency affects the deliberation of monetary policymakers.

Following this line of research, many more projects that use LDA in analyzing monetary policy documents have emerged. These include Lee et al. (2018) who use LDA to analyze the Bank of Korea's minutes. They build a text-based indicator that helps explain current and future monetary policy decisions. Kawamura et al. (2019) also use LDA to analyze the ambiguity of expressions in Bank of Japan's Monthly Monetary Report. The authors find that ambiguous expressions tend to appear more frequently in recessions. Using a similar LDA approach, Hansen et al. (2019) examine the effect of Fed communication on long-run rates. Their study concludes that monetary policy communication affects long-run uncertainty, which in turn affects the long-run premium and long-run rates.

A growing body of work uses other linguistic tools to analyze communication materials from central banks. Hendry and Madeley (2010) extract information from the Bank of Canada statements using Latent Semantic Analysis to find the type of information that affects returns and volatility of interest rate markets over the 2002-2008 period. For Brazil, Carvalho et al. (2013) use Google search queries to build a time series that measures whether each monetary policy statement is perceived as more *hawkish* or *dovish*. They examine the impact of these time series on the changes in the term structure of interest rates. Nardelli et al. (2017) use two different approaches, semantic orientation and Support Vector Machines, to construct an index that measures the tone perceived by the media regarding ECB press conferences. Gonzalez and Tadle (2020) utilize the dictionary method to build a tone index for the Central Bank of Chile. They then use that index to establish its relationship with the monetary policy rate and its effect on the Chilean financial markets and macroeconomy. The results show that the tone index precedes the monetary policy rate movements by about twelve months, that it has a strong effect on the stock market after 2008, and that it has a decreasing effect on the yield curve.

Although there has been a burgeoning interest in examining policy documents, only a handful of papers look at the communication documents of central banks from an international perspective. The closest to our work is Armelius et al. (2020), who utilize LDA to evaluate the policy communication from 23 central banks over the 2002-2017 period. They found that

[6]LDA is a Bayesian model used to analyze a group of data, specifically text information.

central bank sentiments generate spillovers to other countries in terms of sentiment, policy rate, and macroeconomic variables. In contrast to our work, they look at the speeches from board members while we look at monetary policy meeting press releases. Another paper that is closely related to our work is the research by International Monetary Fund (2018). They assess the minutes and monetary press releases of five Latin American countries. Using the Latent Dirichlet Allocation methodology, they build a tone index, similar to our Sentiment score index, to analyze the relationship between press releases and monetary policy changes. Their results show that the tone is a good predictor of future monetary policy changes. They also find that the tone of press releases explains a significant share of the market rates' variation.

3 Data

3.1 Data

Our data is comprised of the monetary policy press releases that are published shortly after monetary policy meetings. We use those that inform the public about monetary policy rate (MPR) decisions. In addition, we use the effective MPR and the expected MPR according to the survey in Bloomberg.

When choosing the countries to analyze, we use three criteria. First, the selected countries must have adopted inflation targeting in their monetary policy framework by 2005. Second, the monetary policy press releases must be published in English or translated to English by the central bank. Finally, the central bank must have regularly published informative monetary policy press releases by 2009. Those documents that we refer to as informative press releases are those that not only mention the monetary policy decision but also the main reasons for these decisions. These explanations include the current economic outlook, both domestic and international, and the expected future developments. With this criteria, we ended up with 18 countries: Australia, Brazil, Canada, Chile, Hungary, Iceland, Indonesia, Israel, New Zealand, Norway, Peru, The Philippines, Poland, Romania, South Africa, South Korea, Sweden, and Thailand.

We collected a total of 3184 press releases. Referring to the descriptions of these press

releases in Table 1, we found some interesting observations about the change in monetary policy communication. For example, Australia adopted an IT framework in 1993 but did not systematically publish informative press releases until November 1997. Before that, it only delivered an informative press release when it changed its MPR. Without any MPR changes, the press releases state the policy decision without economic explanations. Another interesting case is Israel, which started publishing monetary press releases in Hebrew in 1997 but waited until June 1999 to deliver a translated version of their press releases. We also found similar cases for Mexico and Colombia, which started publishing press releases in English only after 2009. For this reason, these countries were excluded from our sample.

Table 2 shows the different formal communications tools used by each of the central banks in the sample. Most countries have between 8 and 12 monetary policy meetings per year. The only exceptions are Sweden and South Africa, both of which have six policy meetings, New Zealand with 7, and Hungary with 24. This fact leads us to transform all data into quarterly frequency for our econometric analysis.

4 Methodology

IIn our current work, we conduct three distinct types of analyses. First, we run a linguistic analysis to measure the length and readability of the press releases. This analysis is conducted to understand how the structure of the documents varies by country. We then conduct sentiment analysis to measure the evolution of the policy bias or sentiment in the monetary press releases. We use the Dictionary Method of Content Analysis since it is widely used in measuring document sentiment in the finance literature.[7] It has also been used in previous economics work evaluating the impact of policy documents and social media text.[8] As Hansen and McMahon (2016) points out, the main benefit of this approach is that it is scalable to a given type of document with much less concern about consistency and transparency. At the same time, our approach incorporates the context and usual syntax of the policy documents so that more of the nuances that are lost with fully automated methods are captured in our methodology.

[7]See Tetlock et al. (2008) and Loughran and McDonald (2014) for additional references.

[8]For additional examples, see Rosa (2011).

Table 1: Press Releases Descriptive Statistics

Country	Year IT Adopted	Press release avalaible in.... since... Native	English	Informative since	Total number of press releases
Australia	1993	Jan-90	Jan-90	Nov-07	183
Brazil	1999	Mar-06	Mar-06	Mar-06	111
Canada	1991	Jun-97	Jun-97	Jan-01	155
Chile	1999	Sep-97	Sep-97	Feb-98	222
Hungary	2001	Dec-01	Jan-03	Apr-03	316
Iceland	2001	Mar-01	Mar-02	Mar-09	89
Indonesia	2005	Aug-05	Aug-05	Aug-05	169
Israel	1997	Nov-97	Jun-99	Nov-97	234
New Zealand	1989	Dec-96	Dec-96	Dec-96	173
Norway	2001	Mar-01	Mar-01	Mar-01	123
Peru	2002	Jan-02	Jan-02	Jan-02	201
The Philippines	2002		Dec-01	Dec-01	174
Poland	1998	Feb-98	Jan-01	Jul-98	220
Romania	2005	Jul-05	Jul-05	Jul-05	120
South Africa	2000	Jan-00	Jan-00	Jan-00	129
South Korea	1998	Jan-99	Dec-99	Jan-99	229
Sweden	1993	Jan-96	Jan-96	Nov-98	162
Thailand	2000	Apr-00	Sep-00	Jul-00	174
Total					3,184

Table 2: Main Central Bank Communication Tools

	Adopted on	Meetings per year		Press	Minutes (weeks	MP Report	MPR
		Current	Previous (time)	Release	after meeting)		Forecast
Australia	06-1993	11		Yes*	2	Feb, May, Aug, Nov	No
Brazil	06-1999	8		Yes	4	Mar, Jun, Sep, Dec	No
Canada	02-1991	8	not defined	Yes	No	Jan, Apr, Jul, Oct	No
Chile	06-1999	8	12 (02-17)	Yes	2	Mar,Jun, Sep, Dec	No
Hungary	06-2001	24		Yes	20-15 days	Mar, Jun, Sep, Dec	No
Iceland	03-2001	8		Yes	2	Feb, May, Aug, Nov	Yes
Indonesia	07-2005	12		Yes	No	Jan, May, Aug, Nov	No
Israel	06-1997	8	12 (97-17)	Yes	2	Feb, Aug	No
New Zealand	12-1989	7	8 (99-15)	Yes	No	Feb, May, Aug, Nov	Yes
Norway	03-2001	8	6 (13-17)	Yes	No	Mar, Jun, Sep, Dec	Yes
Peru	01-2002	12		Yes	2	Mar, Jun, Sep, Dec	No
The Philippines	01-2002	8	9 (07-10)	Yes	4	4	No
Poland	02-1998	11	12 (01-09)	Yes	4	Jan, Apr, Jul, Oct	No
Romania	08-2005	8		Yes	1	Feb, May, Aug, Nov	No
South Africa	02-2000	6	5-9 (00-02)	Yes	No	Apr, Oct	Yes
South Korea	04-1998	8	12 (00-16)	Yes	2	4	No
Sweden	01-1993	6	8 (00-05)	Yes	10 days after	Feb, Apr, Jul, Sep, Oct, Dec	Yes
Thailand	05-2000	8	9 (00-03)	Yes	2 (since 2011)	Feb, May, Aug, Nov	No

Source: Web page of central banks

This analysis is becoming more common in the literature and consists of classifying the sentences in a particular document into corresponding sentiments. To do this, we first construct a dictionary used to classify the sentences in the press releases. We utilize Latent Dirichlet Allocation to select nouns and frequency analysis for the choice of verbs and adjectives.

Although there are several dictionaries for the analysis of document sentiments, ours contain two innovations. It is the first to evaluate the press releases of inflation-targeting central banks. It is also built exclusively for the analysis of monetary policy press releases. A related dictionary to ours is built by Loughran and McDonald (2011) and Henry (2008), but their focus is on finance and accounting. Still, since these dictionaries are used extensively in the literature, we also re-calculate our sentiment indexes with the help of these dictionaries as a robustness check.

Finally, we use the sentiment index calculated for each country to conduct more traditional econometric analyses. In these analyses, we include a correlation, OLS regressions, and logit regressions. We also apply Principal Components Analysis to examine how the sentiments of the press releases of different central banks move together over time.

4.1 Linguistic Analysis

For each country, we measure basic statistics related to the press releases' length and complexity: number of sentences, number of words, number of words per sentence, and word length. As can be expected, this analysis is straightforward, but it indicates the comparisons among the amount of information provided by each central bank and the level of difficulty of understanding each central bank press release.

We evaluate the average number of sentences for each set of press releases. We identify a sentence as the textual unit between two periods. For the number of words per sentence, we count the words, including single letter words, in a sentence and then take the average by country. Finally, as a proxy for word length, we count the number of syllables of the words in the press releases and then take the average by press release set.

To measure the readability of the press releases, we use three common measures: The Gunning Fog Score, the SMOG Score, the Flesch-Kincaid index, and the Flesch Reading Ease Score.[9] These indexes are calibrated to measure the readability of a document in terms of years

of education needed to understand it. Therefore, a document with a score of 12 indicates that it requires 12 years of education to read and understand it. Although these indexes are seldom used in economics, they are used extensively in other fields of research.[10]

The Gunning Score is defined by

$$\text{GFS} = 0.4 \left[\left(\frac{\text{words}}{\text{sentences}} \right) + 100 \left(\frac{\text{complex words}}{\text{sentences}} \right) \right], \tag{1}$$

where *words* and *sentences* refer to their numbers in each of the press releases.*Complexwords* refers to the number of words that have three or more syllables. With the given specification, Equation (1) implies that lengthy sentences and documents with longer words are harder to read.

The SMOG score is given by

$$\text{SMOG} = 1.0430 \sqrt{\text{polysyllables} \times \frac{30}{\text{sentences}}} + 3.1291, \tag{2}$$

where *polysyllables* refers to the number of words that have three or more syllables. The intuition of equation (2) coincides with (1) since it interprets the inclusion of longer words in a document as harder to read.

The Flesch-Kincaid Grade level (FKGL) index is defined by

$$\text{FKGL} = 0.39 \left(\frac{\text{words}}{\text{sentences}} \right) + 11.8 \left(\frac{\text{syllables}}{\text{words}} \right) - 15.59, \tag{3}$$

where *words* and *sentences* have the same definition as in (1). On the other hand, *syllables* refers to the total number of syllables in a document.

Finally, the Flesch Reading Ease (FRE) score is given by

$$\text{FRE} = 206.835 - 1.015 \left(\frac{\text{words}}{\text{sentences}} \right) - 84.6 \left(\frac{\text{syllables}}{\text{words}} \right), \tag{4}$$

[9]See Armstrong (1982), Mc Laughlin (1969), and Kincaid et al. (1975) for references.

[10]Some recent examples include Ajina et al. (2016), Kayam (2018), Fitzsimmons et al. (2010), and Kasabwala et al. (2012).

where *words*, *sentences*, and *syllables* have the same definition as in (1) and (3). The intuition of (4) is similar to the other measures, i.e. longer words and longer sentences are interpreted as harder to read. The main difference is that the results from (4) must be interpreted using Table 3, where the score goes from 0 to 100 and is later translated into years of education.

Table 3: Flesch Reading Ease Table

Score	School Level
100-90	5th Grade
90-80	6th Grade
80-70	7th Grade
70-60	8th and 9th Grades
60-50	10th to 12th Grade
50-30	College
30-10	College Graduate
10-0	Professional
Source:	Flesch (1979)

4.2 Sentiment Analysis: Dictionary

As an initial step to conducting our Content Analysis, we modified the text to ensure a consistent approach. We removed the capitalization of words, separated the sentences, and removed all punctuation and stop words. We chose not to stem the words, however, to maintain the semantic meaning of the terms.

Our implementation of the Dictionary method requires that a selection of words are classified into two types: *Keywords* and *Modifiers*. Our chosen *Keywords* are the nouns that indicate the economic subject of the sentences. On the other hand, the *modifiers* we utilize are adjectives and verbs that state what is happening to the sentence's subject.

To build the *keywords* dictionary, we run a country by country analysis using Latent Dirichlet Allocation (LDA). LDA, which was developed by Blei et al. (2003), is a probabilistic approach to text analysis. In this methodology, each set of documents has a probability distribution of

terms over a specified number of topics. [11] As a result, keywords in each document set receive topic assignments. Then, conditional on the topic, a given keyword is assigned a weight relative to how semantically significant it is to the topic. In terms of economics, this methodology has been used by Hansen et al. (2017) and Hansen and McMahon (2016), among others. The main advantage of this methodology is that it is a fully probabilistic method. Therefore, it allows words to be assigned to more than one topic, making the approach more flexible than deterministic methods.

For each set of central bank policy documents, we then choose the number of topics that maximizes the Coherence Score, which objectively evaluates how semantically interpretable the given sets of words are as topics.[12] In particular, we examine the range of results from two to thirty topics and choose the topic number that leads to the highest Coherence Score.

After conducting the LDA method using the chosen topic number for each country, we interpret the semantic topics based on the terms connected to them and then collect the topics related to inflation, economic growth, and financial markets. From the words within the topics, we compile a set of nouns that have relevant economic meanings.[13]

On the other hand, the *modifiers* are positive or negative words that provide information about the *Keywords*. In our study, the *modifiers* are adjectives and verbs. We combined all the press releases in the sample and selected all the verbs and adjectives that could have economic meaning in the context of a monetary policy press release. Once we obtained an initial list of modifiers, we added all of the verbs' different tenses to the list. In addition, we added the British spelling variant of the verbs and adjectives when they existed. We then categorized the modifiers as being positive or negative depending on the semantic meaning of the words in the policy discussions.[14]

There are two reasons for building separate dictionaries for each set of press releases. The

[11] In particular, we use the Gibbs Sampling method to establish the posterior distribution of words in each topic.

[12] A brief explanation of the Coherence Score appears in the Appendix.

[13] We discard proper nouns. Although they may be relevant in another context, we believe they are not in our current work.

[14] As a robustness check, we combined the dictionaries by Loughran and McDonald (2016) and Hendry and Madeley (2010). These lists are used in economics and finance papers conducting sentiment analysis on textual information.

first considers the method we use. The algorithm searches for the presence of a *keyword* in a sentence. If it finds a *keyword*, then it searches for *modifiers*. Therefore, when using *keywords* in our methodology, we want to use the most important words in the press releases by country. Once a sentence is selected to be analyzed, we then want to make sure that the modifiers convey the messages about the economic subjects that the press releases discuss.

A second reason is that using a single dictionary for all countries may lead to other issues. We tried creating a dictionary by combining those used in Tadle (2021) and Gonzalez and Tadle (2020). However, we found that a significant number of relevant sentences were missed as this combination did not have the keywords specific for each country. The results showed us that to have the appropriate dictionary for a given set of policy documents, it has to be built based on the words used by the policymakers of that specific country.

4.3 Sentiment Analysis: Index

When calculating the sentiment index, we adopt a similar methodology used in Tadle (2021) and Gonzalez and Tadle (2020). We define three distinct sentiments for each of the sentences of a press release. The first sentiment refers to a higher likelihood of contractionary monetary policy since its semantic meaning positively correlates to escalated inflationary pressures. We refer to these as hawkish-leaning and call them *hawkish*, for simplicity.

On the other hand, the second type of sentiment is dovish-leaning as it conveys lower inflationary pressures and leans more toward expansionary monetary policies. Sentiments that fall under this category are denoted as *dovish*. Finally, we also categorize sentences as neutral, and those refer to sentences that do not have a clear sentiment.

Each individual *keyword* is categorized as either *hawkish* or *dovish*. The categorization of each of the keywords depends on the policy tilt that results when it is associated with a positive *modifier*. For instance, the keyword 'wage' is categorized as a hawkish key term since it signals more support for contractionary policy. This is because when the term 'wage' is attached to a positive modifier, such as 'improving,' we have the phrase 'improving wage,' which signals higher inflationary pressures. In contrast, when the term 'wage' is attached to the negative term 'declining,' we obtain 'declining wage,' which relates to more subdued inflationary pressures.

The opposite effect occurs to the semantic meaning of dovish keys when attached to positive and negative modifiers.

Once we have categorized the *keywords* for each country, we analyze the press releases by separating them into individual sentences. For a given sentence, if it has a hawkish *keyword* and more positive than negative modifiers, then its sentiment is taken as hawkish and is given a score of '+1'. If the sentence with a hawkish *keyword* has more negative than positive modifiers, then its sentiment is taken as dovish and is given a score of '-1'. The opposite scoring is given for a sentence with a dovish *keyword*. For this sentence, if there are more positive than negative modifiers, it is deemed dovish and given a score of '-1'. If it has relatively more negative modifiers, it is treated as hawkish and is given a score of '+1'. Sentences with the same number of positive and negative modifiers are given a zero score, while those with both hawkish and dovish keys are scored the same as sentences with only hawkish keys.

Table 4: Example of Sentence Evaluations

Sentence Example 1

'global economic $\underbrace{\text{growth}}_{\text{hawkish}}$ continues to $\underbrace{\text{improve}}_{\text{positive}}$'

- Source: Reserve Bank of New Zealand's February 8, 2018 Policy Statement
- Sentence Score: +1 (hawkish keyword and more positive than negative modifiers)

Sentence Example 2

'but the near-term outlook for the $\underbrace{\text{global}}_{\text{hawkish}}$ $\underbrace{\text{economy}}_{\text{hawkish}}$ is the $\underbrace{\text{weakest}}_{\text{negative}}$ for many years'

- Source: Reserve Bank of Australia's February 3, 2009 Policy Statement
- Sentence score: -1 (hawkish keywords and more negative than positive modifiers)

Table 4 presents some examples of the sentence-level evaluations. In Sentence Example 1 extracted from the February 8, 2018, Policy Statement of the Reserve Bank of New Zealand, we observe one hawkish keyword and only one positive modifier. Based on the scoring metric, this sentence receives a score of '+1' for its hawkish-leaning sentiment. In contrast, the second

sentence example from the February 3, 2009, Policy Statement of the Reserve Bank of Australia has two hawkish keywords and one negative modifier. Following the scoring procedure, this sentence receives a score of '-1' due to the dovish sentiment of its information.

After conducting the sentence-level scoring, we aggregate the individual sentence scores for each document. We then divide the sum by the number of evaluated sentences. We scale the resulting value by 100 to create a continuous sentiment measure that ranges from -100 to 100.

5 Results

In this section, we present the results of the linguistic analysis, the building of the dictionary, and the sentiment score analysis. We also present the results of using traditional econometric tools with the sentiment score to understand how each country publishes its monetary policy decision.

5.1 Results: Linguistic Analysis

As we discussed earlier, we evaluate the reading difficulty of the press releases. We then compare the differences among the countries in the sample. The main results of this evaluation appear in Table 5. We show several statistics related to the length of the documents and the reading difficulty statistics for the full sample. It can be seen that the size of the press releases varies significantly among the countries. While Brazil has the shortest press releases with 246 words, South Africa issues press releases that are almost ten times as big as the ones from Brazil with 2132 words. Altogether, the average length of the press release for the whole sample is 687 words.

In terms of sentence length, we find that most of the countries issued press releases with similarly sized sentences of around 21 words. This would imply a similar structure in the way they present the information. The only exceptions are Romania and Israel, whose sentences are 34 and 28 words long, respectively.

We also examine the word length. We find that the average word length by each press release are close to the overall average length of 5 syllables. This observation lends some support to the

Table 5: Linguistic Analysis Results: Full Sample

	Beginning of sample	Number of words (mean)	Number of Sentences (mean)	Words per Sentence (mean)	Word Length	Gunning Score	SMOG Score	Flesch-Kinkaid Score	Flecsch Score
Australia	Jan-90	497	26	19	5.2	15	13	11	10th-12 G
Brazil	Mar-03	246	11	20	5.3	15	14	12	College
Canada	Mar-99	423	19	23	5.1	17	15	12	College
Chile	Jan-01	272	14	20	5.4	18	16	13	College
Hungary	Jan-03	488	24	18	5.2	15	14	11	College
Iceland	Mar-09	377	19	20	5.2	16	14	12	College
Indonesia	Jul-05	970	45	21	5.5	18	16	14	College
Israel	Jun-99	1447	55	28	5.1	18	16	14	College
Korea	Jan-00	366	17	21	5.4	18	16	13	College
New Zealand	Dec-96	364	17	22	5.4	16	15	13	College
Norway	Oct-10	1368	77	18	5.1	14	13	10	10th-12 G
Peru	Feb-01	426	31	14	5.0	14	13	9	10th-12 G
The Philippines	Dec-01	324	13	25	5.5	19	17	15	College
Poland	Jan-01	827	38	22	5.1	17	15	12	College
Romania	Oct-03	725	22	34	5.3	23	19	18	College grad
South Africa	Jul-14	2132	101	21	5.1	15	14	12	College
Sweden	Jun-98	728	44	17	4.9	14	13	10	10th-12 G
Thailand	May-00	391	21	18	5.5	17	15	12	College
Average		687	33	21	5	17	15	12	
Max		2132	101	34	5	23	19	18	

Source: Authors' calculations

idea that the vocabulary that central banks use are similar.[15]

Accounting for the composition of the press releases, we have analyzed their reading difficulty. We find that the countries in our study publish press releases that require an advanced level of education to understand it appropriately. Most of them require at least some college education.

Since there has been a growing interest in central bank communication, we study if there has been any relevant change in these statistics. For this exercise, we separate the sample into two. The first part starts at the beginning of the sample of each country and ends in December 2017. The second part begins in January 2018 and ends in December 2019. Separating the sample this way allows us to check if there has been an important change in the structure of the documents in the last two years of our evaluation.

[15]Examining the extent of the similarity is beyond the scope of our current work.

The results of this exercise can be seen in Table 6. The table shows that, on average, the press releases are longer than the prior period. However, this increase in the average size of the documents is driven by the fact that the press releases that were shorter - such as those from Brazil, Chile, and The Philippines - are longer in the more recent period. On the other hand, longer press releases - such as those from South Africa, Israel, and Norway - are now shorter. This can be seen not only in the average size of the press release but also in the drop in the standard deviation of the press releases from 505 words to 395 words. The format of the monetary press releases seems to be converging, at least in terms of size.[16]

Table 6: Linguistic Analysis Results: Recent Changes

	Number of words (mean)	Number of Sentences (mean)	Words per Sentence (mean)	Word Length	Gunning Score	SMOG Score	Flesch-Kinkaid Score
Australia	231	11	2	0.0	0	0	0
Brazil	596	26	3	-0.1	2	2	1
Canada	72	7	-4	0.1	-2	-1	-1
Chile	463	19	2	-0.3	-1	-1	-1
Hungary	866	43	2	0.2	2	1	1
Iceland	-90	-3	-2	0.0	-1	-1	-1
Indonesia	596	22	2	0.2	1	1	2
Israel	-146	4	-6	0.1	-2	-1	-2
Korea	272	9	4	-0.1	0	0	1
New Zealand	166	5	4	0.3	2	2	2
Norway	-598	-28	-2	0.1	0	0	0
Peru	-11	1	-1	0.1	1	0	0
The Philippines	-32	-2	1	0.1	1	1	1
Poland	-435	-18	-2	0.1	0	0	-1
Romania	239	8	-2	-0.2	-3	-2	-2
South Africa	-584	-9	-4	0.1	-1	-1	-1
Sweden	157	15	-2	0.1	0	0	0
Thailand	500	20	4	0.3	2	2	2
Average	126	7	0	0.1	0	0	0
Max	866	43	4	0.3	2	2	2

Source: Authors' calculations

In contrast, there is no real change in reading difficulty when comparing the average difficulty in 2018-2019 and the previous part of the sample. Anecdotal evidence from those who prepare

[16]We present some analogous observations to table 6 for the first half of the sample in the appendix.

these documents indicates that this finding is not surprising as the preparation of policy documents aims to explain the technical reasons for monetary policy decisions. Furthermore, this document is aimed at people working in the financial market, academics, and other professionals, most of whom have at least a college degree.[17]

5.2 Results: Dictionary

For each country, we run the LDA using the number of topics that maximize the coherence score.[18] We then analyzed the words in the LDA topics and selected those that are related to economic and financial conditions. The results of this analysis appear in tables 7 and 8.

We also find some interesting observations about the dictionaries. First, the size of each dictionary differs broadly among the countries. This variation may arise since the optimal number of topics, given by the coherence score, differ broadly among countries. Second, we categorized more keywords as *hawkish* than *dovish*. We do not think this is a problem as this categorization depends on how we classify the modifiers.

The sets of modifiers appear in Table 9. We notice that there are 215 words in the positive modifiers category and 229 words in the negative modifiers section, making the dictionary relatively balanced. Although some of the words in the modifiers list were not used in this study, the dictionary was built as general as possible, so it can be used in the future for studies that analyze policy documents.

5.3 Results: Sentiment Index and Econometric Analysis

We present the results of building the sentiment scores using our methodology. We show them as six-month moving averages since the gross indexes show high volatility. These sentiment scores, along with their respective monetary policy rate, are shown in Figures 1 and 2. Referring to Figure 1, we show the results for Australia, Brazil, Chile, Hungary, Iceland, Indonesia, Israel, Norway, and New Zealand. We find that these indices are more volatile than their respective

[17]This finding opens up an avenue for further research to understand the other ways of communicating that the central banks use to reach a broader audience.

[18]We also examined the results using the same number of topics for all countries. However, we found that many relevant sentences were missed as they did not have the appropriate keywords for each country. The results showed us that building a dictionary must be created separately for each country.

Table 7: Dictionary Analysis Results: Coherence Score and Keywords

	Hawkish	Dovish	Number of topics
Australia	business, businesses,commodity_price, condition, confidence, credit, demand, economic, economy, employment, exchange_rate, expansion, expect, expected, expectation,financial_market, global, growth, household, housing, housing_market, inflation, international, investment, lending, market, pressure, price, prospect, recovery, spending, stance, trade, trend, wage, world	risk, spare_capacity, uncertainty	23
Brazil	economy,economic_activity, expectation, inflation, inflation_projection, inflation_prospect, inflation_trajectory, recovery supply, total_cpi, trade	disinflation, monetary_easing	7
Canada	activity, anticipate, bank, condition, core_inflation, demand, deposit_rate, economy, global, growth, inflation, price,		11
Chile	inflation, growth, price		2
Hungary	activity, assessment, condition, consumer_price, core_inflation, cost, cost_shock, councils_assessment, demand, development, domestic, domestic_demand, economic_agent, economic_growth, economy, euro_area, financial_market, growth, household_consumption, hungarian_economy, inflation, inflation_expectation, inflation_target, inflationary_pressure, labour_market, market, output, price, price_stability, private_sector, wage	disinflationary_in reduction, risk, slowdown, unused_capacity	28
Iceland	appreciation, banks_forecast, capital_account, current_account, demand, domestic_demand, economic_activity, economic_development, economic_recovery, economy, exchange_rate, foreign_currency, foreign_exchange, growth, inflation, inflation_expectation, inflation_outlook, krona, labour_market, market, monetary_stance, output, output_growth, private_consumption, recovery	demand_pressure, disinflation, risk, slack, spare_capacity, uncertainty	27
Indonesia	banking_industry, banking_system, capital_adequacy, consumption, core_inflation, credit_expansion, credit_growth, current_account, demand, development, domestic_economic, economic, economic_growth, economic_recovery, economy, exchange_rate, financial_market, financial_system, foreign_capital, global_economic, global_economy, global_financial, growth, inflation, inflation_target, inflationary_pressure, inflow, investment, market, price, recovery, rupiah, surplus	debt, import, risk, volatile_food	24
Israel	activity, government, growth, inflation, interest, interest_rate, market		5
New Zealand	activity, annual_cpi, bank, capacity, commodity, commodity_price, confidence, construction_sector, consumption, cost, demand, depreciation, dollar, economic_activity, economy, employment, exchange_rate, export, export_commodity, export_price, firm, fuel, growth, headline_inflation, house_price, housing, housing_market, income, inflation, inflation_expectation, inflation_pressure, investment, market, ocr, oil, pace, price, rate_ocr, reconstruction, recovery,repair, resource, sentiment, spending, supply, tradables_inflation, trade, upside, view	import	29

Source: Authors' calculations

Table 8: Dictionary Analysis Results: Coherence Score and Keywords

	Hawkish	Dovish	Number of topics
Norway	activity, assessment, bank, consumer_price, development, economy, employment, euro_area, expectation, growth, house_price, inflation, inflation_report, interest_rate, norway, norwegian, norwegian_economy, outlook, price, project, projection, wage_growth	risk	15
Peru	credit, dollar, domestic, domestic_currency, domestic_demand, economic_activity, financial_system, food_product, foreign_currency, foreign_exchange, global_economic, growth, inflation, inflation_determinant, inflation_forecast, international_financial, market, price, recovery, supply_shock		28
The Philippines	assessment, growth, inflation, inflation_outlook, price	pressure, risk	2
Poland	activity, demand, deposit, economic_condition, economy, employment, exchange_rate, growth, growth_rate, household, inflation,inflation_expectation, interest, loan, price, price_growth, production, wage	deposit_rate	21
Romania	banking_system, consumer_price, credit, credit_institution, current_account, development, domestic, economic, economic_growth, financial_stability, foreign_currency, foreign_exchange, global_economic, growth, inflation_expectation, inflation_report, lending, liquidity, loan, price, stability	deficit, disinflation, risk, uncertainty	23
South Africa	bank, consumption_expenditure, core_inflation, country, cpix_inflation, demand, development, domestic, economy, electricity, employment, environment, exchange_rate, expenditure, food, food_price, forecast, global, growth, inflation, inflation_expectation, inflation_outlook, inflation_target, inflationary_pressure, mining_sector, outlook, petrol_price, price, rand, recovery, upside_risk		24
South Korea	consumer, consumption, demand, expectation, export, financial, growth, housing, inflation, lending, liquidity, market, oil, petroleum, price, recovery, sentiment, stock, surplus	risk, slowdown, uncertainty,	22
Sweden	assessment, demand, development, economic_activity, economic_development, economy, energy_price, growth, inflation,inflation_report, inflationary_pressure, market, price, recovery, resource_utilisation, swedish_economy		19
Thailand	recovery, economy, export, policy_rate, growth, expect, investment, outcome		2

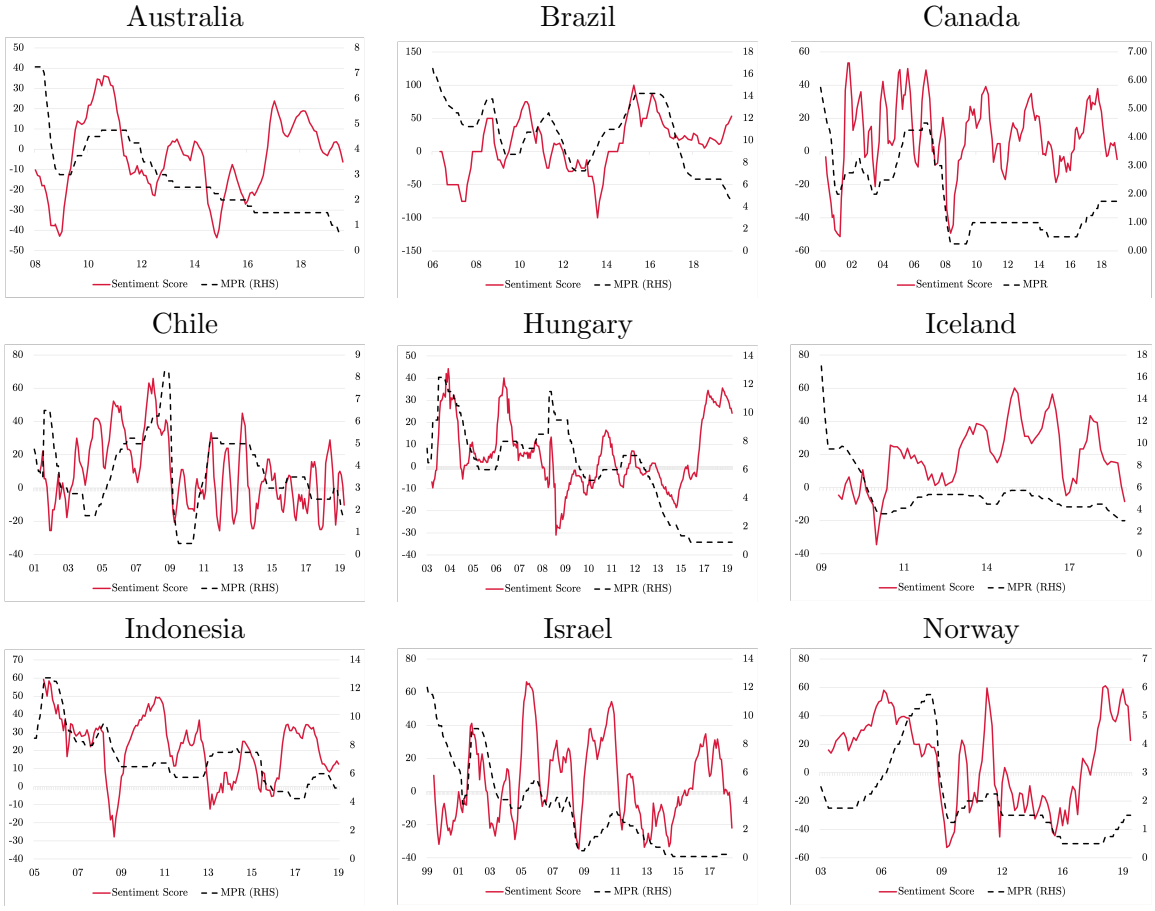
Source: Authors' calculations

Table 9: Modifiers Dictionary

Positive Modifiers: 215
above, accelerate, accelerated, accelerates, accelerating, accommodate,accommodated, accommodates, accommodating, added, augment, augmented,augmenting, augments, benign, best, better, biggest, boost, boosted, boosting, boosts, brighter, buoy, buoyant, buoyed, buoying, buoys, calm, calmed, calming, calms, climb, climbed, climbing, climbs, depreciate, depreciated, depreciates, depreciating, dynamic, elevate, elevated, elevates, elevating, encouraging, escalate, escalated, escalates, escalating, exceed, exceeded, exceeding, exceeds, expand, expanded, expanding, expands, expansionary, expansive, fast, faster, fastest, favorable, favourable, firmer, good, great, greater, greatest, grew, grow, growing, grown, grows, healthier, high, higher, highest, improve, improved, improves, improving, impulse, impulsed, impulses, impulsing, increase, increased, increases, increasing, inflationary, large, larger, largest, lift, lifted, lifting, lifts, loose, loosen, loosened, loosening, loosens, looser, maximum, mitigate, mitigated, mitigates, mitigating, more, mount, mounted, mounting, mounts, optimistic, outperform, outperformed, outperforming, outperforms, peak, peaked, peaking, peaks, pick, picked, picking, picks, positive, raise, raised, raises, raising, ramp, ramped, ramping, ramps, rapid, recover, recovered, recovering, recovers, reinforce, reinforced, reinforces, reinforcing, restore, restored, restores, restoring, rise, risen, rises, rising, rose, satisfactory, skyrocket, skyrocketed, skyrocketing, skyrockets, spike, spiked, spikes, spiking, spur, spurred, spurring, spurs, stabilise, stabilised, stabilises, stabilising, stabilize, stabilized, stabilizes, stabilizing, stable, steady, stimulate, stimulated, stimulates, stimulating, stimulative, stimulatory, strengthen, strengthened, strengthening, strengthens, strong, stronger, strongest, successful, surge, surged, surges, surging, swifter, upper, upside, upswing, upswinging, upswings, upswung, uptrend, upturn, upturned, upturning, upturns, upward, vigorous, widen, widened, widening, widens, wider
Negative Modifiers: 229
adverse, aggravate, aggravated, aggravates, aggravating, appreciate, appreciated, appreciates, appreciating, appreciatory, bad, bottom, bottomed, bottoming, bottoms, concern, concerned, concerning, concerns, conservative, constrain, constrained, constraining, constrains, contract, contracted, contracting, contractionary, contracts, cut, cuts, cutting, dampen, dampened, dampening, dampens, decelerate, decelerated, decelerates, decelerating, decline, declined, declines, declining, decrease, decreased, decreases, decreasing, deepen, deepened, deepening, deepens, deflationary, descend, descended, descending, descends, destabilizing, deteriorate, deteriorated, deteriorates, deteriorating, difficult, diminish, diminished, diminishes, diminishing, disappointing, disinflationary, dovish, down, downside, downsize, downsized, downsizes, downsizing, downward, downwards, drop, dropped, dropping, drops, erode, eroded, erodes, eroding, fade, faded, fades, fading, fail, failed, failing, fails, fall, fallen, falling, falls, fell, fewer, flatten, flattened, flattening, flattens, fluctuate, fluctuated, fluctuates, fluctuating, fragile, harm, harmed, harming, harms, inconsistent, jeopardise, jeopardised, jeopardises, jeopardising,jeopardize, jeopardized, jeopardizes, jeopardizing, lackluster, least, less, low, lower, lowered, lowering, lowers, lowest, mild, minimal, minimum, minor, moderate, moderated, moderates, moderating, modest, negative, pessimistic, poor, recessionary, reduce, reduced, reduces, reducing, restrictive, riskier, risky, sank, shorten, shortened, shortening, shortens, shrink, shrinking, shrinks, shrunk, shrunken, sink, sinking, slow, slowed, slower, slowest, slowing, slows, sluggish, small, smaller, smallest, soften, softened, softening, softens, speculate, speculated, speculates, speculating, stress, stressed, stresses, stressing, stringent, subdued, subprime, sunk, suppress, suppressed, suppresses, suppressing, threaten, threatened, threatening, threatens, tighten, tightened, tightening, tightens, tighter, tougher, turbulent, uncertain, unclear, undermine, unfavorable, unfavourable, unstable, volatile, vulnerable, wane, waned, wanes, waning, weak, weaken, weakened, weakening, weakens, weaker, weakest, worse, worsen, worsened, worsening, worsens, worst

Source: Authors' Calculations

Figure 1: Sentiment Scores

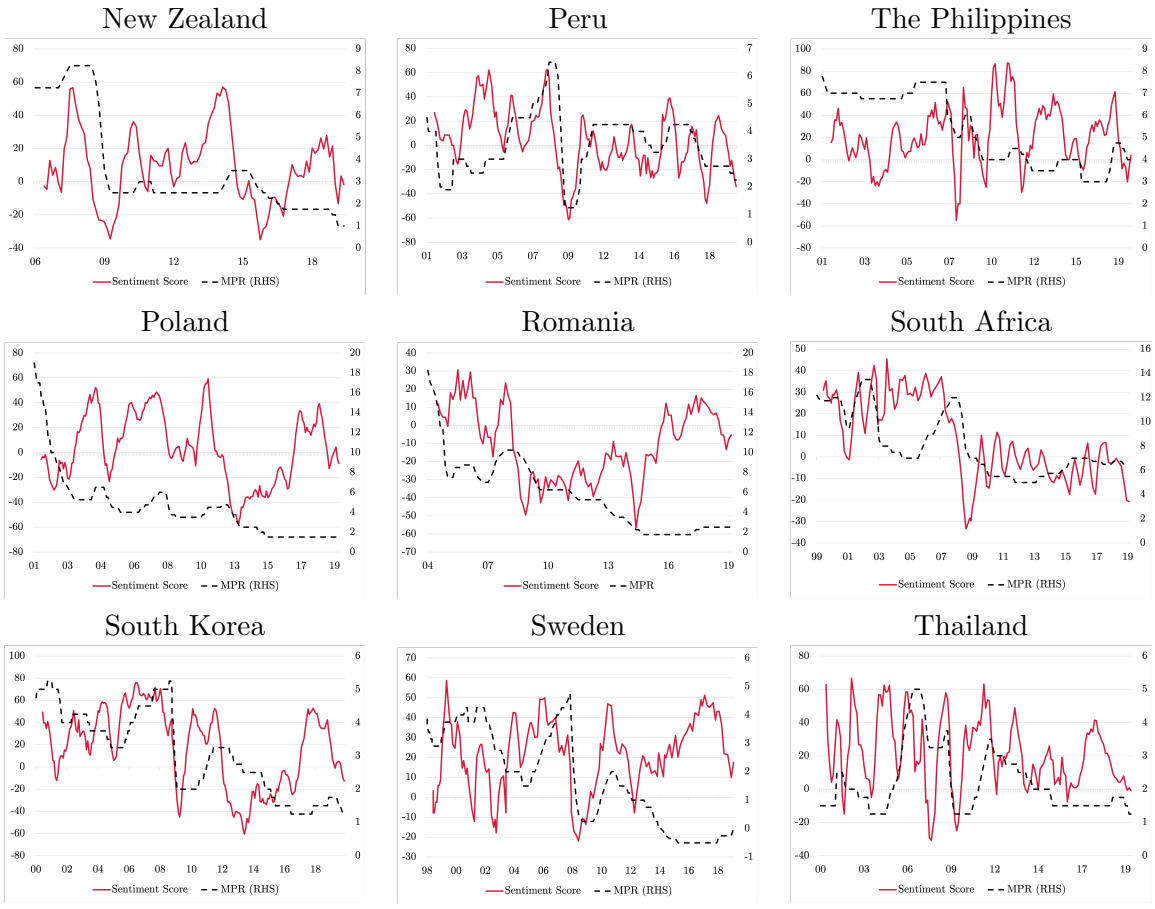


MPR. This difference in volatility may be driven by the fact that each press release varies with every meeting because it is expected that there would be some variation in the evolution of these indexes.

Interestingly, the countries that show the highest volatility are Chile and Israel, which are the countries that have the smallest sets of keywords. This may be due to the coherence score indicating that their LDA should run with only two and five topics, respectively. The low number of keywords and, therefore, evaluated sentences for the corresponding press releases may push the volatility higher.

Despite this high volatility, some patterns can be obtained with visual analysis. First, there is a significant decrease in the index in all countries during the Global Financial Crisis, signaling higher monetary policy expansion in 2008. In most cases, this period saw the single

Figure 2: Sentiment Scores



most substantial decrease in the index. This drop towards increased monetary expansion is usually followed by an increase in the index, signaling possible increases in the MPR. After this increase, there is a period of decreased volatility, starting around 2010, when most countries have maintained relatively stable MPRs.

Similar dynamics can be found in Figure 2, which shows the sentiment score indexes and MPR for Peru, The Philippines, Poland, Romania, South Africa, South Korea, Sweden, and Thailand. As before, the countries whose indexes show higher volatility are those with the smallest dictionaries: The Philippines and Thailand. As in Chile's case, examining the coherence scores indicates that both countries should have only two topics.

Consistent with earlier observations, the evolution of each country's sentiment score is related to the evolution of the MPR. Recall that central banks not only publish their decision in the monetary policy press releases, but they also explain the reasons for that decision. Noting this, the central banks are communicating relevant information that allows the public to evaluate their assessments of the economy. Such information can also help predict the future evolution of the MPR.

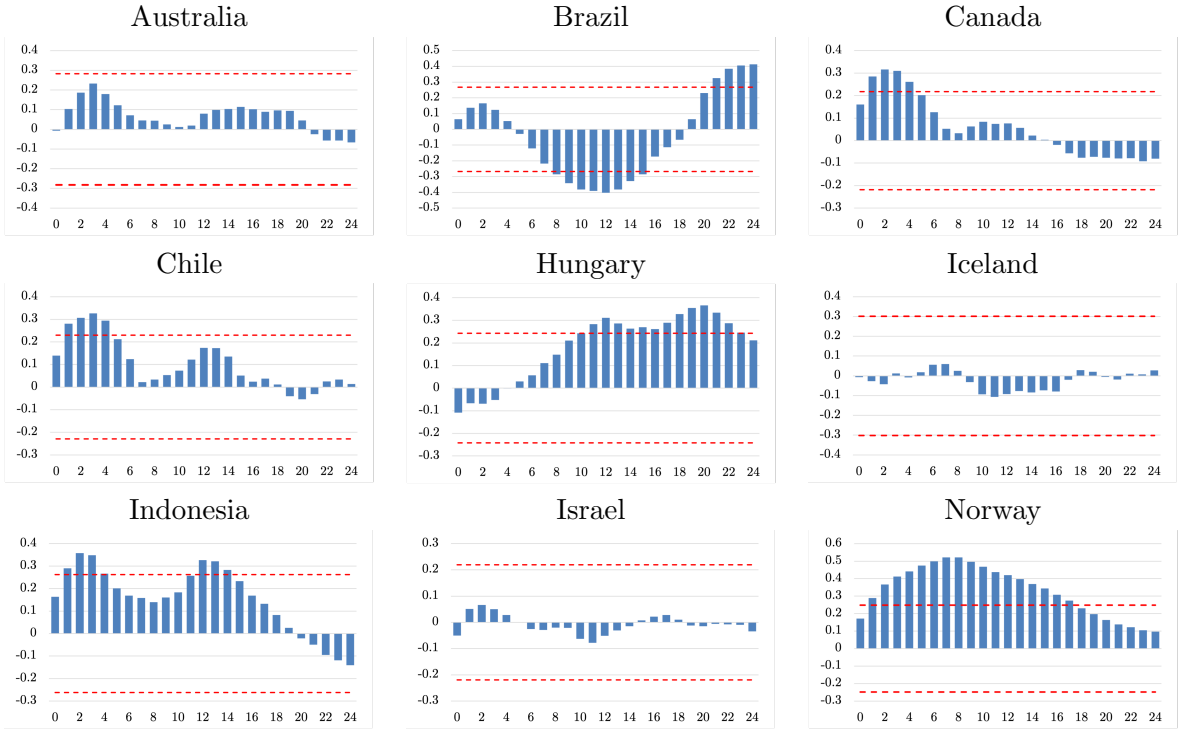
To analyze the informational content in the monetary policy press releases, we calculate the cross correlograms between the MPR and the Sentiment Score in quarterly frequency, Figure 3 and Figure 4.[19]

These figures also show the upper and lower confidence bounds that reflect values that are two standard deviations away from 0. They help objectively evaluate the statistical relationship between the sentiment score and the MPR. If a central bank first announces its intention to increase its monetary policy rate and act on those intentions, the sentiment score will then lead the movement of the MPR with a positive and significant correlation coefficient.

Figure 3 shows the cross-correlogram for the first set of countries: Australia, Brazil, Canada, Chile, Hungary, Iceland, Indonesia, Israel, and Norway. For many of these countries, the graphs show that the movements of their sentiment scores anticipate the movements in their respective MPR. For example, the correlogram of Canada is maximized at the third quarter.

[19]We change the frequency of the correlograms to quarterly frequency because the timing of the monetary policy press releases is different across countries and comparing these policy documents becomes difficult without quarterly aggregation.

Figure 3: Sentiment Score and MPR Cross-Correlation



Note: Quarterly Frequency
Source: Author's calculations

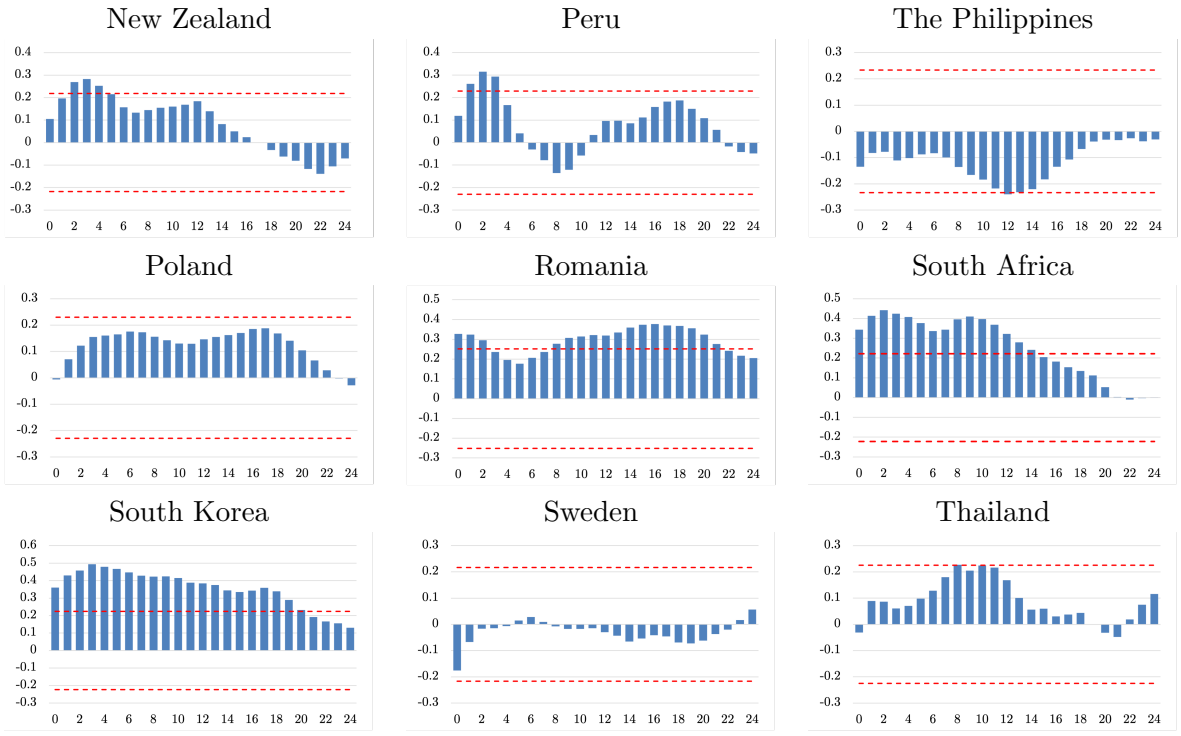
This finding implies that movements on the sentiment score are followed by movements on the MPR three quarters ahead. This finding suggests that the monetary press releases contain enough information to anticipate movements of the MPR.

We also find that although the correlogram is positive for Australia, it is not statistically significant. In addition, Iceland and Israel show correlograms that are close to zero. This observation points to the lack of a statistically significant relationship between the sentiment index and their MPR for these two countries.[20]

Figure 4 shows the cross-correlogram graphs for the second set of countries: New Zealand, Peru, The Philippines, Poland, Romania, South Africa, South Korea, Sweden, and Thailand. In this case, New Zealand, Peru, Romania, South Africa, South Korea, and Thailand show a positive and significant correlation between the movements of their MPR and the respective

[20]Brazil's case is puzzling since it initially had a negative and statistically significant relationship that turned positive and statistically significant over time.

Figure 4: Sentiment Score and MPR Cross-Correlation



Note: Quarterly Frequency
Source: Author's calculations

sentiment scores, while The Philippines, Poland, and Sweden show no significant correlation.[21]

Also, we make a brief assessment of whether there is a global factor that moves all of the sentiment scores analyzed. We conduct a simple principal component analysis to obtain what we call the Global Sentiment Score.[22] For this, we use 15 out of the 18 countries, leaving out Australia, Brazil, and Iceland because of their shorter sentiment score series. We define the Global Sentiment Score as the first principal component of the 15 sentiment scores starting in June 2005. This can be seen in the left panel of Figure 5. We can see that the sample starts hawkish but decreases to the most dovish point in the sample for the 2008-2009 Crisis. Then it stays relatively constant between 2012 and 2016. It began to increase toward a more hawkish sentiment during 2017.

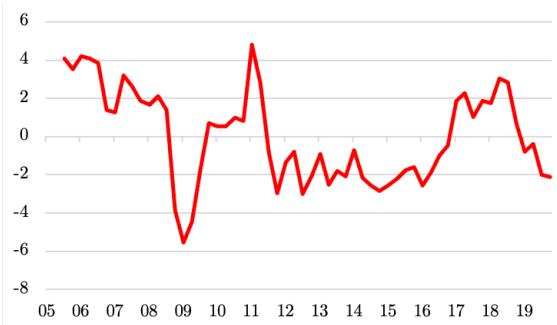
[21]The conclusions of this section are robust to using the sentiment scores that will be presented in the robustness section.

[22]The first principal component is a direction in a coordinate scalar projection of the data. It is the direction that covers the most variance of the scalar projections.

In the right panel of Figure 5, we run a two-year moving-window principal component analysis to obtain the percentage of the variance explained by the first principal component at different points in time. The results show an important percentage of the sentiment scores that can be explained by a common global factor. Although the percentage explained starts low at close to 40%, it rapidly increases to its peak at 80% during the Global Financial Crisis. It then decreases to move within a band between 50 and 60%. During 2019, the percentage explained began increasing again as the trade war between the US and China started to impact the real economy.

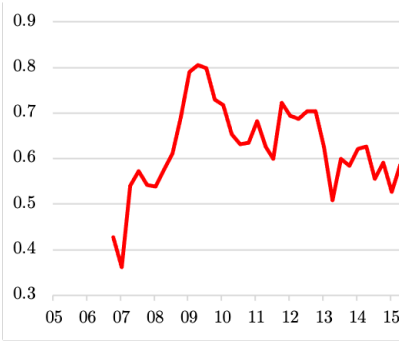
Figure 5: International Sentiment Score Comparison

Global Sentiment Score



Sent Score.png

Variance Explained



Explained.png

6 Robustness and Extensions

6.1 Altering the Modifier List by Country

In our current work, we build sentiment scores for the monetary policy press releases of a set of inflation-targeting countries. These indexes are built using new dictionaries designed for studying monetary policy documents. The dictionaries are divided between keywords and modifiers. The keywords' dictionaries are country-specific, while the modifiers' dictionary is general. To examine the robustness of our findings, we present the results we obtain when we replace the modifiers dictionary with a combination of the dictionaries presented in Loughran and McDonald (2011) and Hendry and Madeley (2010), which are dictionaries developed to analyze financial texts.

The comparison appears in Figures 6 and 7. The lines labeled as *GT dict* show the sentiment scores calculated using the Gonzalez-Tadle (GT) Dictionary while the *LMH dict* show the sentiment scores calculated using the combined dictionary from Loughran and McDonald (2011) and Hendry and Madeley (2010), which is referred to as LMH. In most cases, the two lines move close to each other, signaling that our results are robust to changes in the set of modifiers used.

Since these indexes are not directly observable, we do not take a stance on which one is better. We note, however, that for Brazil, the GT version of the sentiment score shows economic dynamics while the one calculated using LMH is much more volatile. We also calculated the cross-correlogram of the LMH version with their respective MPR rates.[23] These are, in general, similar to the ones calculated with the GT version. The main differences occur in Brazil, Israel, and New Zealand. For Brazil and Israel, the LMH version's correlograms show positive and significant correlations in the first few periods. This observation is interesting, especially when evaluating the GT version's correlations. Although they are positive, they are statistically insignificant. Furthermore, for New Zealand, the LMH version's correlogram has low and insignificant values in the first few periods, contrasting with the GT version that shows positive and significant values.

7 Conclusion

This paper examines the monetary policy decision communication strategy of a group of inflation-targeting central banks by studying the monetary policy press releases using linguistic analysis, LDA, term frequency, and Semi-automated Content Analysis. We follow the literature that brings linguistic analysis into economics. The use of linguistic analysis tools helps analyze a text document's qualitative content by transforming it into a more quantitative format. We incorporate such tools in our analysis to contribute to the literature that studies the central banks' communication by basing the analysis on the monetary policy's predictability and efficacy. Our novel approach utilizes these tools to evaluate the press releases of a group of inflation-targeting countries.

[23] These graphs are available upon request.

Figure 6: Sentiment Scores Robustness: Gonzalez Tadle Dictionary vs LMH Dictionary

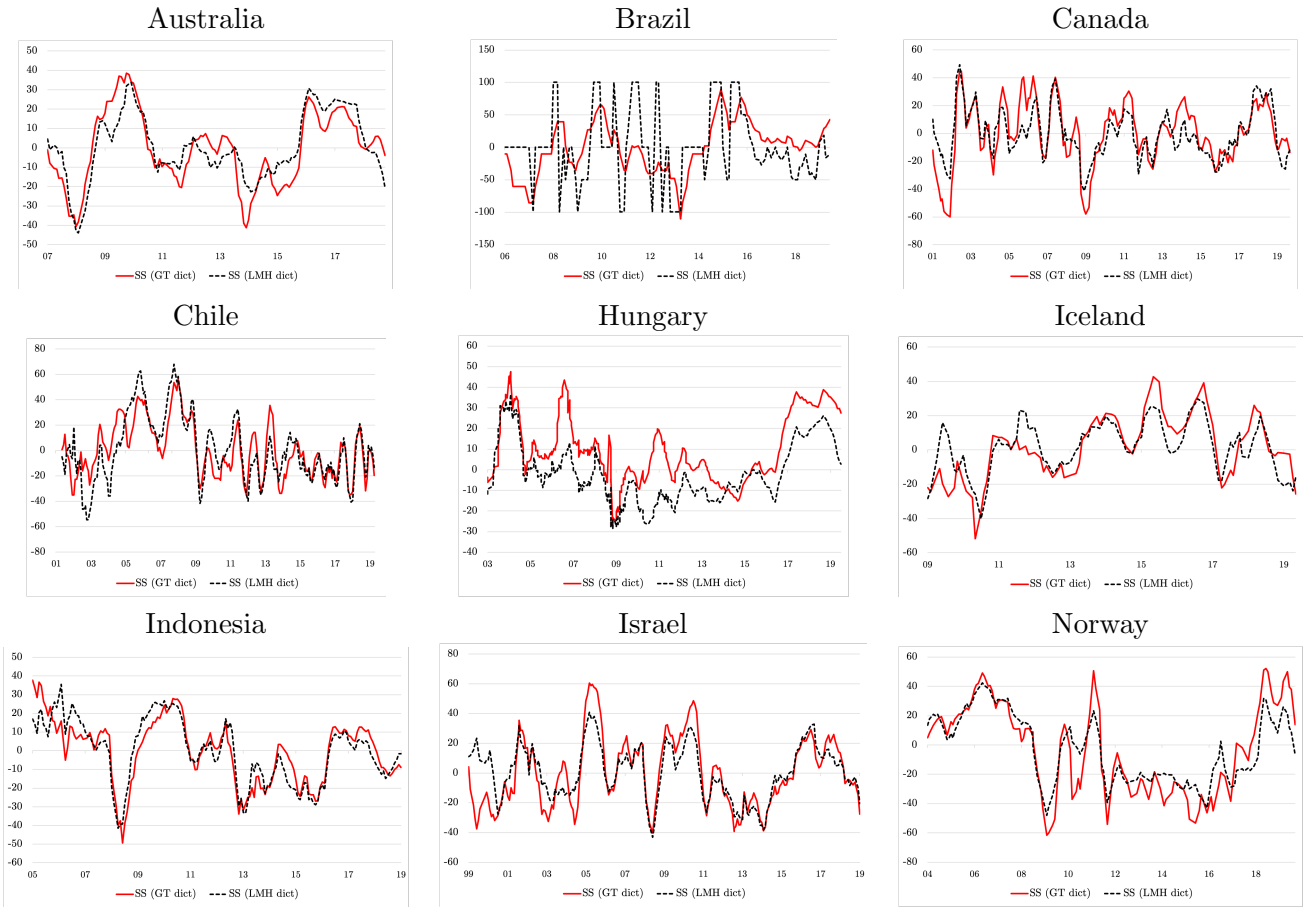
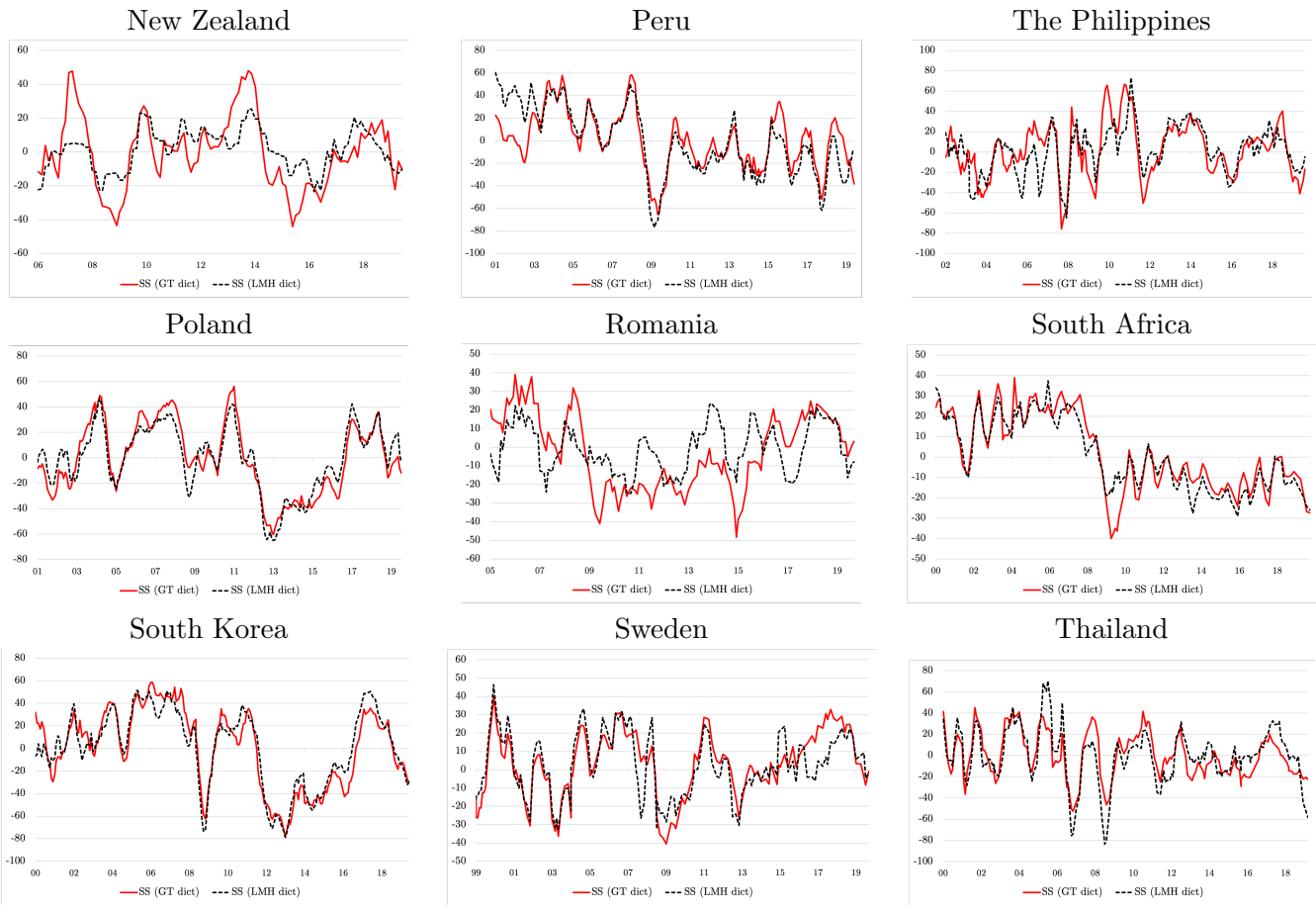


Figure 7: Sentiment Scores Robustness: Gonzalez Tadle Dictionary vs LMH Dictionary



We analyze the structure of the press releases in terms of length and reading difficulty, and we find that people from most of the countries we examine need at least some level of college education to understand the policy documents. Moreover, we find that there has been a convergence in the length of the press releases where the longest ones have been shortened, while the short ones have been lengthened. Using LDA and term frequency analysis, we build a new dictionary that we use combined with Semi-automated Content Analysis to measure each monetary policy statement's tone. We find that most central banks reveal information that can help anticipate the evolution of the MPR. Also, we find that during periods of international crisis, the press releases' tone tends to move closer together.

The tools and conclusions found in this paper can help guide communications used by central banks. Central banks can utilize the sentiment index to fine-tune their monetary policy press releases and convey more appropriate information about their monetary policy expectations. In addition, the linguistic analysis results can gauge the difficulty of central bank communication as a whole. Since the documents analyzed in this paper require a high level of education to understand them, they must be complemented with other tools that are easier to comprehend.

References

Ajina, A., Laouiti, M., and Msolli, B. (2016). Guiding through the fog: Does annual report readability reveal earnings management? *Research in International Business and Finance*, 38:509–516.

Armelius, H., Bertsch, C., Hull, I., and Zhang, X. (2020). Spread the word: International spillovers from central bank communication. *Journal of International Money and Finance*, 103:102–116.

Armstrong, J. S. (1982). Research on scientific journals: Implications for editors and authors. *Journal of Forecasting*, 1(1):83–104.

Blei, D. M., Ng, A. Y., and Jordan, M. I. (2003). Latent Dirichlet allocation. *Journal of Machine Learning Research*, 3(4-5):993–1022.

Blinder, A. S., Ehrmann, M., Fratzscher, M., De Haan, J., and Jansen, D.-J. (2008). Central bank communication and monetary policy: A survey of theory and evidence. *Journal of Economic Literature*, 46(4):910–45.

Carvalho, C., Cordeiro, F., and Vargas, J. (2013). Just words?: A quantitative analysis of the communication of the Central Bank of Brazil. *Revista Brasileira de Economia*, 67:443 – 455.

Fitzsimmons, P. R., Michael, B., Hulley, J. L., and Scott, G. O. (2010). A readability assessment of online parkinson's disease information. *The journal of the Royal College of Physicians of Edinburgh*, 40(4):292–296.

Flesch, R. F. (1979). *How to write plain English: A book for lawyers and consumers*. Harpercollins.

Gonzalez, M. and Tadle, R. (2020). Signaling and financial market impact of chile's central bank communication: a content analysis approach. *Economia, Forthcoming*.

Hansen, S. and McMahon, M. (2016). Shocking language: Understanding the macroeconomic effects of central bank communication. *Journal of International Economics*, 99:S114–S133.

Hansen, S., McMahon, M., and Prat, A. (2017). Transparency and Deliberation Within the FOMC: A Computational Linguistics Approach*. *The Quarterly Journal of Economics*, 133(2):801–870.

Hansen, S., McMahon, M., and Tong, M. (2019). The long-run information effect of central bank communication. *Journal of Monetary Economics*, 108:185–202.

Hendry, S. and Madeley, A. (2010). Text mining and the information content of bank of canada communications. Working Paper 2010-310, Central Bank of Canada.

Henry, E. (2008). Are investors influenced by how earnings press releases are written? *The Journal of Business Communication (1973)*, 45(4):363–407.

International Monetary Fund (2018). Regional economic outlook. western hemisphere: Seizing the momentum. Technical Report APR 18, IMF.

Kasabwala, K., Agarwal, N., Hansberry, D. R., Baredes, S., and Eloy, J. A. (2012). Readability assessment of patient education materials from the american academy of otolaryngology—head and neck surgery foundation. *Otolaryngology–Head and Neck Surgery*, 147(3):466–471.

Kawamura, K., Kobashi, Y., Shizume, M., and Ueda, K. (2019). Strategic central bank communication: Discourse analysis of the bank of japan's monthly report. *Journal of Economic Dynamics and Control*, 100:230 – 250.

Kayam, O. (2018). The readability and simplicity of donald trump's language. *Political Studies Review*, 16(1):73–88.

Kincaid, J. P., Fishburne Jr, R. P., Rogers, R. L., and Chissom, B. S. (1975). Derivation of new readability formulas (automated readability index, fog count and flesch reading ease formula) for navy enlisted personnel. Technical Report 8-75, Naval Technical Training Command Millington TN Research Branch.

Lee, Y., Kim, S., and Park, K. Y. (2018). Deciphering Monetary Policy Committee Minutes with Text Mining Approach: A Case of South Korea. Working papers 2018rwp-132, Yonsei University, Yonsei Economics Research Institute.

Loughran, T. and McDonald, B. (2011). When is a liability not a liability? textual analysis, dictionaries, and 10-ks. *The Journal of Finance*, 66(1):35–65.

Loughran, T. and McDonald, B. (2014). Measuring readability in financial disclosures. *The Journal of Finance*, 69(4):1643–1671.

Loughran, T. and McDonald, B. (2016). Textual analysis in accounting and finance: A survey. *Journal of Accounting Research*, 54(4):1187–1230.

Lucca, D. O. and Trebbi, F. (2009). Measuring central bank communication: An automated approach with application to fomc statements. Working Paper 15367, National Bureau of Economic Research.

Mc Laughlin, G. H. (1969). Smog grading-a new readability formula. *Journal of reading*, 12(8):639–646.

Nardelli, S., Martens, D., and Tobback, E. (2017). Between hawks and doves: measuring central bank communication. Working Paper 2085, BIS.

Pescatori, A. (2018). Central bank communication and monetary policy surprises in chile. Technical Report 156, IMF.

Rosa, C. (2011). The high-frequency response of exchange rates to monetary policy actions and statements. *Journal of Banking & Finance*, 35(2):478 – 489.

Tadle, R. (2021). FOMC Minutes Sentiments and their Impact on Financial Markets. *Manuscript in Preparation.*

Tetlock, P. C., Saar-Tsechansky, M., and Macskassy, S. (2008). More than words: Quantifying language to measure firms' fundamentals. *The Journal of Finance*, 63(3):1437–1467.

A Appendix

A.1 Coherence Score

The Coherence Scores, CS, is an alternative way to measure the understandability and interpretability of a given set of textual topics. To compute the CS, we compile the relevant documents into a corpus of texts. The corresponding text of words D are split into topic subsets.

We take the 20 most relevant tokens (unigrams and bigrams) from each topic as the top topic tokens. This selection creates a set of n top tokens. For each token t_i, we calculate the relationships with the other selected tokens. Using Boolean Sliding Window-based Detection, we count the co-occurrence of the tokens in the corpus of examined documents and assign probabilities based on the counts within five tokens (± 5 tokens) around t_i. We then note the probability for tokens t_i and t_j as $p(t_i, t_j)$. For each token, we create a vector of these co-occurrence probabilities using Normalized Pointwise Mutual Information (NPMI). The j-th element of this context vector $\vec{v}_i$ is given by

$$v_{i,j} = NPMI(t_i, t_j)^{\gamma} = \left(\frac{\log\left(\frac{P(t_i,t_j)+\epsilon}{P(t_i),P(t_j)}\right)}{\log\left(P\left(t_i, t_j\right) + \epsilon\right)} \right)^{\gamma}$$

Note that ϵ (equated as 10^{-12}) is added to avoid the logarithm of zero. The corresponding context vector for token t_i is given by

$$\vec{v}_i = \{NPMI(t_i, t_i)^{\gamma}, NPMI(t_i, t_{i+1})^{\gamma}, NPMI(t_i, t_{i+2})^{\gamma}, \ldots, NPMI(t_i, t_{n-1})^{\gamma}\}$$

Given our notation, higher γ values place more weight on higher NPMI values (default value of $\gamma = 1$ is used).

To calculate the coherence scores, we take the average of the cosine similarity confirmation measures among pairs of context vectors. These confirmation measures evaluate the context vector and accounts for their similarities. The coherence score based on the number of topics is

then given by

$$CS = \frac{1}{(n-1)!}\Big[\cos\left(\vec{v}_i, \vec{v}_{i+1}\right) + \cos\left(\vec{v}_i, \vec{v}_{i+1}\right)$$

$$\Big]$$

Table A1: Linguistic Analysis Results: Beginning Sample to Dec-2017

	Beginning of sample	Number of words (mean)	Number of Sentences (mean)	Words per Sentence (mean)	Word Length	Gunning Score	SMOG Score	Flesch-Kinkaid Score	Flecsch Score
Australia	Jan-90	468	25	19	5.2	15	14	11	10th-12th G
Brazil	Mar-03	160	8	19	5.4	15	14	12	College
Canada	Mar-99	416	18	23	5.1	17	15	13	College
Chile	Jan-01	238	12	20	5.4	18	16	13	College
Hungary	Jan-03	423	21	18	5.2	15	14	11	College
Iceland	Mar-09	386	19	20	5.2	16	14	12	College
Indonesia	Jul-05	889	42	21	5.5	18	16	13	College
Israel	Jun-99	1457	55	28	5.1	19	16	15	College
Korea	Jan-00	347	16	21	5.4	18	16	13	College
New Zealand	Dec-96	348	16	21	5.3	16	15	13	College
Norway	Oct-10	1445	81	18	5.1	14	13	10	10th-12th G
Peru	Feb-01	427	31	14	5.0	14	13	9	10th-12th G
The Philippines	Dec-01	327	13	25	5.5	19	17	15	College
Poland	Jan-01	873	40	22	5.0	17	15	12	College
Romania	Oct-03	695	21	34	5.4	23	20	19	College grad
South Africa	Jul-14	2187	102	21	5.1	15	14	12	College
Sweden	Jun-98	716	43	17	4.9	14	13	10	10th-12th G
Thailand	May-00	333	19	17	5.4	16	15	12	College
Average		674	32	21	5	17	15	12	
Max		2187	102	34	5	23	20	19	

Source: Authors' calculations

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