Strategic Central Bank Communication:
Discourse Analysis of the Bank of Japan's Monthly Report*

Kohei Kawamura†, Yohei Kobashi‡, Masato Shizume§ and Kozo Ueda¶

November 6, 2018

Abstract

We conduct a discourse analysis of the Bank of Japan's Monthly Report and examine its characteristics in relation to business cycles. We find that ambiguous expressions tend to appear more frequently with negative expressions, and this tendency is more pronounced in recessions. This suggests that the central bank communicates strategically by obfuscating the reports when their private information is unfavorable.

Keywords: monetary policy; transparency; natural language processing; modality; latent Dirichlet allocation (LDA); verifiable disclosure model

JEL classification: D78, D82, E58, E61

1 Introduction

Central banks not only implement monetary policy but also provide a substantial amount of information for the market, and their communication policy has attracted significant attention of both academic researchers and practitioners (Goodfriend [1986], Blinder [2004], Eijffinger and Geraats [2006]). Indeed, most publications of central banks are not solely about monetary policy but provide data and analyses on the state of the economy. It has been widely recognized that central banks use various communication channels to influence market expectations so as to enhance the effectiveness of their monetary policy. Meanwhile, it is not readily obvious whether central banks reveal all information they have exactly as it stands. For example, the Federal Reserve under Alan Greenspan is said to have used "constructive ambiguity" to influence the liquidity of financial markets (Woodward [2000], Greenspan [2007], Bloomberg Businessweek [2012]). Although central banks cannot make untruthful statements owing to accountability and fiduciary requirements, they may communicate strategically and can be selective about the types of information they disclose. This concern takes on special importance when central banks' objectives (e.g., keeping inflation/deflation under control and achieving maximum employment) may not be aligned completely with those of market participants, and possibly, governments.

In this paper, we study a central bank's communication strategy by analyzing how expressions used in published reports are related to the state of the economy. Among many kinds of expressions, our particular focus is on ambiguous expressions. We conduct a discourse analysis using the Bank of Japan's *Monthly Report of Recent Economic and Financial Developments* (the Monthly Report, hereafter) from January 1998 to March 2015. The reports in this period are of special interest in terms of central bank communication, because Japan had not only been in economic stagnation but also had persistently seen inflation much lower than the target level. We postulate that the Bank of Japan had incentives to attenuate the impact of negative information on the economy, albeit within the fiduciary duties. Thus for our sample period, we hypothesize that i) the Bank of Japan tends to use ambiguous expressions more frequently with negative expressions; and that ii) this tendency is more pronounced when the economy is in recessions.

We employ natural language processing to analyze the Monthly Report. Natural language processing is the computational approach to analyzing naturally occurring human languages. We classify expressions in the Monthly Report according to polarity (whether an expression is positive, negative, or neutral) and modality (whether an expression is clear-cut, ambiguous, or subjective). We find that the difference between the number of positive and negative expressions in the Monthly Report leads the leading index of the economy by approximately three

months, which suggests that the central bank has forecasting power for the state of the economy. More importantly, ambiguous expressions are more likely to be used when the economy is in a recession. For example, when the leading index of the economy is low, the Monthly Report tends to contain a larger number of expressions with negative tones (e.g., "fall") and modal expressions that indicate likelihood (e.g., "seem" and "should") rather than certitude. In addition, we find that ambiguous expressions do not exclusively reflect underlying exogenous uncertainty in the economy. Using a latent Dirichlet allocation (LDA) model, we also confirm that ambiguous expressions are indeed more likely to be used in the sentences that contain negative expressions. This suggests the possibility that the central bank deliberately introduces ambiguity into sentences conveying negative information about the economy.

Our study contributes to the existing literature by illustrating and explaining the strategic aspect of central banks' communications. The first strand of relevant papers in the literature reveal a rapidly increasing number of studies on central banks' communications using discourse analyses. Bholat et al. (2015) offer a survey of discourse analyses on central banks' communications.[1] Born, Ehrmann, and Fratzscher (2014) find that financial stability reports released by central banks have positive effects on financial markets when their views are optimistic but no effect when they are pessimistic. As an illustrative example in which central banks' communications play an important role, Hansen and McMahon (2016) and Coenen et al. (2018) investigate communications under forward guidance policy. Our study complements these previous studies by emphasizing the usage of ambiguity.

Ambiguity in central banks' communications is analyzed by Jansen (2011), Bruno (2016), Kahveci and Odabas (2016), and Montes and Nicolay (2017). For example, Jansen (2011) and Montes and Nicolay (2017) measure clarity using the "Flesch reading easy score" by counting the number of words per sentences and the number of syllables per word. Our contribution to the literature is to introduce a new, arguably clearer notion of ambiguity in a central bank's communication with the financial market. In particular, we make an extensive use of modality that aligns with a standard grammatical concept in linguistics. More importantly, unlike those studies, we investigate the relationship among ambiguous expressions, polarity expressions, and macroeconomic indicators, which allows us to examine the use of ambiguous expressions in a systematic manner in light of the central bank's potential incentive to influence market expectations.

Ambiguity in communication also has been studied in various other fields. For example, Brown, Hossain and Morgan (2010) find that delivery charges are often hidden at first on

---

[1]For example, Boukus and Rosenberg (2006), Hendry and Madeley (2010), Apel and Grimaldi (2012), Hendry (2012), Acosta (2015), Bennani and Neuenkirch (2017) analyze central banks' communications, and their relevance to the real economy and/or effects on financial markets.

online auction sites, which boosts revenues especially when the charges are high. Using a survey, Tomz and Van Houweling (2009) show that ambiguity in an electoral platform may attract (rather than put off) voters. Li (2008, 2010) reveals that the annual reports of firms with low earnings tend to have longer words (with more syllables) and longer sentences, which points to intentional obfuscation. Loughran and McDonald (2011) construct an uncertainty word list for financial text. Jin, Luca, and Martin (2015) find in a laboratory experiment that senders of information who are required to communicate truthfully may nonetheless make the messages complex and difficult to comprehend, when there is a conflict of interest between the senders and receivers.

In terms of natural language processing, our analysis contributes to the field of semantic analyses by pointing out the importance of modality in inferring a sender's assessments and intentions in the actual policy. A hegemony view is often taken as granted, that is, communications by the authority are regarded as perfectly credible (Gramsci [1971]), although there exist critical discourse analyses by Fairclough (1989) and van Dijk (2008). Our study challenges the hegemony view by considering the possibility that a receiver does not necessarily believe what a sender says.[2]

Our analysis employs both human coding and automated computational methods, or following the terminology of Bholat et al. (2015), both deductive and abductive approaches. We adopt human coding to classify polarity and modality expressions, as we need to capture the sentiment an expression is associated with (deductive approach). Meanwhile, we employ the LDA model, an automated computational method in order to group expressions that tend to be used together (abductive approach). The combination of the different approaches helps us obtain robust and balanced findings (see Ehrmann and Talmi [2017]).

Our hypotheses on the central bank's strategic communication, along with the empirical results that are consistent with them, can be understood in the framework of persuasion games (e.g., Milgrom [1981], Dye [1985]), where the sender of information can choose to disclose or withhold his private information to the receiver but cannot fabricate it. In the model of Dye (1985), the sender is not only biased but also may not be informed. In addition, whether the sender is informed or uninformed is also private information to the sender. In equilibrium, even when the sender is informed, he may choose not to disclose unfavorable information by pretending to be uninformed, while he always discloses favorable information if he has it. The intuition is applicable to our empirical results. We can think of ambiguous expressions in the Monthly Report as a way for the Bank of Japan to strategically withhold precise information it

---

[2]The advent of big data has opened up the field of machine learning. However, its primary interest lies not in economic structure such as the relationships among ambiguity, polarity, and macroeconomy, but in prediction (Varian [2014]).

4

may have observed. Then given the inflation rates in the Japanese economy during the sample period, we can readily hypothesize that ambiguous expressions tend to be used for unfavorable (i.e. negative) information.[3]

This paper proceeds as follows. Section 2 describes the data, and Section 3 presents the results from our discourse analysis. Section 4 concludes.

2   Data

In this section we describe the construction of our dataset and how we classify expressions in the Bank of Japan's Monthly Report.

2.1   Monthly Report

Our dataset of central bank communication is based upon the Monthly Reports published from January 1998 to March 2015 (207 issues in total). The Bank of Japan started to publish the Monthly Report in January 1998 when it became legally independent from the government. Each Monthly Report is released on the next day of the monthly Monetary Policy Committee meeting.[4] It begins with a "Summary" section, which is a few pages long and approved by the Committee before publication. The Summary is deemed to represent the Committee's, and hence, the Bank's, official view on the current and future state of the Japanese economy. The full body of the Report is written by the staff of the Bank of Japan, not by the Committee members.

For our study, the Monthly Report has three main advantages over other types of communication methods. First, it is published more frequently than comparable reports from central banks in other advanced economies. This high frequency helps us explore the relationship between central bank communication and the current and future states of the economy.

Second, the Monthly Report provides us with rich data: we have access to 207 issues since January 1998, and typically, each Monthly Report and the Summary section have around 150 and 32 sentences on average, respectively. The Summary alone is longer than the statements from other central banks such as the Federal Reserve and the Bank of England.[5] Therefore, we can evaluate the contents of the Monthly Report in more detail than is possible for other countries.

Third, the format of the Monthly Report has remained clear and consistent over time. It consists of four sections, in the order of Summary, Economic Developments, Prices, and

---

[3]We develop a modified version of Dye's (1985) model in Appendix E to illuminate a game theoretic interpretation of our empirical results.

[4]Before August 2008, it was released two days after the meeting.

[5]The Bank of England enriched their communication in August 2015.

Financial Developments. Furthermore, the paragraphs in the Summary can be easily and clearly classified into two categories, namely those that refer to the current state and those that refer to the future state of the economy. In particular, the Summary has a highly stable structure that follows the same order in every issue: it begins with a short sentence that gives an overview on the current state of the economy, followed by detailed assessments on overseas economies, exports, business investment, and other items. In this paper we focus only on the Summary, since its consistent format enhances the accuracy of natural language processing.[6]

We use the Monthly Report in Japanese, although the officially translated English version is also available at the Bank of Japan's website. This is because the Monetary Policy Committee of the Bank of Japan uses Japanese for their discussions and decision making, and also because the original Monthly Report in Japanese is translated into English and released a few days after the publication of the original version in Japanese. Therefore, the market reacts to the Japanese version. We provide the translation tables in Appendix A.

Table 1 presents some basic statistics of the Monthly Report. The four sections, Summary, Economic Developments, Prices, and Financial Developments contain on average 32, 79, 20, and 24 sentences, respectively. The section on Economic Developments is the longest, reflecting detailed evaluations of all the components of the gross domestic product (GDP) such as business investment and consumption. The number of morphemes (the smallest grammatical unit of meaning that a word can be divided into) per sentence is about 30 across the four sections.[7]

The time series developments in the number of sentences and morphemes in the Summary are displayed in Figure 1. It shows a clear level shift in October 2003, when the Bank of Japan enhanced monetary policy transparency, although the number of morphemes per sentence (mor/sen) stayed almost constant. In order to control for the effect of the change in the size of the Summary, we normalize the number of expressions by the total number of morphemes in the Summary section.

---

[6]In June 2015 the Bank of Japan decided to discontinue the publication of the Monthly Report from January 2016. The number of monetary policy meetings now stands reduced from 14 times a year to 8, and the frequency of publication of the Outlook for Economic Activity and Prices has increased from semi-annually to quarterly. Nevertheless, we believe that our study will still contribute to the understanding of the characteristics of central bank communication.

[7]An example of a morpheme is "juyou (demand)," which can be used as both a noun and a verb, and "ryouko (good)," which can be used as both a noun and an adjective. See Appendix A for details. In Japanese, the number of morphemes is a better measure of the size of a document than the number of words, not least because there are multiple ways to count words. For example, when "juyou (demand)" is used in a sentence, it is typically followed by other morphemes such as "juyou-shi," "juyou-shite," "juyou-wa," "juyou-ga" etc. One may count "juyou" (root word) and the following morpheme that determines the grammatical function of "juyou" as separate words, or a single word.

2.2 Classification of Expressions

We classify the expressions in the Monthly Report according to polarity and modality (ambiguity). The unit of analysis is "expression," which represents the smallest set of morphemes that can be translated into an English word.

2.2.1 Sentiment Polarity (Positive vs. Negative)

Sentiment polarity concerns positive, negative, or neutral tones in expressions, where both positive and negative tones are further divided into two types: objective experiences and subjective evaluations. Linguists have constructed lexicons that contain terms expressing polarity for opinion mining and sentiment analysis (Pang and Lee [2008]). We adopt the Japanese Sentiment Polarity Dictionary, which is based on two dictionaries that include around 5,000 verbs and adjectives (Kobayashi et al. [2004]) and 8,500 nouns (Higashiyama et al. [2008]). The advantage of using the Japanese Sentiment Polarity Dictionary is that, while the extraction of expressions is computerized, the classification for each expression has been human coded by the authors of Kobayashi et al. (2004) and Higashiyama et al. (2008).

For each category, Table 2 lists the five expressions that appeared most frequently, where each number to the right of the expression indicates the number of appearances. As the table indicates, the classification is mostly intuitive but not always. For example, "increase" is categorized as neutral, which is indeed intuitive as it is positive when it refers to an increase in demand but negative when it denotes an increase in debt. Meanwhile, "demand," "fund," and "economy" are all categorized as positive, although they should be neutral from the economists' viewpoint. In Japanese, *tame* can indicate two ideas: "is good for" or "is because of (reason)." Only the former contains a positive tone. Despite these caveats, we use the polarity dictionary to maintain objectivity. Moreover, as we will see later, the results drawn from this criterion turn out to be indicative about business cycles.

Table 3 presents the basic statistics of polarity expressions. Evaluation expressions, both positive and negative, are less frequently used than experiential expressions. Comparing the expressions used to describe the current state and the future state (forecasts), we find that the latter tend to have more positive (less negative) expressions. Indeed, the difference between positive and negative expressions, which is shown in the last column, is significantly larger for forecasts than that for the current state at the 1 percent level.

2.2.2 Modality (Ambiguity)

We also classify expressions in the Monthly Report according to their modality. Modality is a grammatical concept in linguistics and is typically conveyed through auxiliary verbs such as

"must," "would," and "may" in English (e.g., see Johnson-Laird [1978]). These expressions are often defined as "subjective," "unreal," or "unassertive" (Palmer [2001]). Specifically, we focus on the modality of truth judgment and divide it into three types: high probability, low probability, and unreal (as opposed to certitude). Such modality is particularly indicative of ambiguity, conveying a writer's subjective view.[8]

In Japanese, modality is drawn from a predicate, which is located almost always at the very end of each sentence. We use this definition, because it is widely accepted in linguistics that while every language has some layered semantic structure (Fillmore [1968], Sweetser [1991]), the hierarchical semantic structure of modal expressions in Japanese is much more strongly associated with its syntactic structure than in other languages (Narrog [2009]). This suggests that modality, and hence, ambiguity, in Japanese can be more effectively identified from its structure compared to other languages such as English.[9] In this paper, we choose all end-of-sentence expressions that appear at least five times across all 207 issues of the Monthly Report published in the period of study. Then, referring to previous studies such as Nitta (2011), we classify them into high probability, low probability, unreal, and certitude according to our human coding. Appendix B explains our detailed procedure.

Table 4 shows the expressions in each category and their basic statistics. High probability expressions such as "seem" and "appear" suggest that the possibility that an event referred to in the sentence occurs is high, but not 100%. An example of a low probability expression is "may." Unreal expressions include "should" (showing what is right, appropriate, etc.) and "it is important to." When they are used, the possibility of an event actually occurring is very low.

Table 4 suggests that modality is more frequently used in sentences referring to the future state of the economy than its current state. Naturally, the future state is inherently uncertain, which calls for the frequent use of "seem" or "appear." Modal expressions for low probability events never appeared in the sentences about the current state.

---

[8]Throughout the paper, we focus on ambiguity, rather than other text characteristics such as (un)assertiveness, vagueness, opaqueness, and obscurity, not least because the ambiguity in central bank communication has been discussed at several Federal Open Market Committee (FOMC) meetings. In particular, "constructive ambiguity" has often been associated with the communication style of the Federal Reserve under Alan Greenspan (see, for example, Greenspan [2007]), while his successors Ben Bernanke and Janet Yellen openly rejected such intentional obfuscation. According to Oxford Learner's Dictionary, the definition of ambiguity is "the state of having more than one possible meaning."

[9]Moreover, the Japanese linguistics is known for its rich expressions, which lend subjectivity as well as ambiguity. This may help us identify the association between economic conditions and the ambiguity/clarity of the central bank communication.

2.3 Macroeconomic Data

In order to explore the relationship between the contents of the Monthly Report and the economic environment, we use macroeconomic monthly data that indicate Japan's business cycles and/or are related to monetary policy. First, we use three composite indexes compiled and published by the Cabinet Office: the leading, coincident, and lagging indexes of the economy. The leading index, on which we focus the most, is compiled by combining 11 variables, such as machinery orders, housing starts, the commodity price index, and the Tokyo Stock Price Index (TOPIX). It leads the coincident index by a quarter. The second data series is the year-on-year inflation rate based on the consumer price index (CPI). The direct effects of the consumption tax increases in 1997 and 2014 are excluded.

For these variables, we use real-time data. The composite indexes and CPI are published about 40 and 30 days, respectively, after the month in question ends (e.g. around March 10 for the index for January for the composite indexes). Thus, to align the timing of the publication of the data with the Monthly Report, we use two-month lagged series. Moreover, we use originally published values of CPI before revisions, which take place every five years.

Third, we construct a monetary policy change dummy from the actual monetary policy changes. The variable takes one when policy is tightened and minus one when it is eased. Otherwise, it is zero. As some policy changes may have been anticipated before monetary policy meetings, the dummy does not necessarily reflect a monetary policy shock. Since there have been a number of small monetary easings in our sample period, we additionally construct an alternative dummy variable, which we call the big change dummy, by choosing significant policy changes.[10]

3 Results

3.1 Correlations with Macroeconomic Indicators

In order to explore the relationship between the expressions in the Monthly Report and the macroeconomic indicators, we adopt the simple approach of looking at their correlations. Although correlations per se do not imply causality, in our data causality is highly likely to go from business cycles to the Bank of Japan's communications at least in the monthly time horizon. In other words, business cycles should be considered exogenous, although monetary policy is sure to influence the macroeconomy with a lag of several months to a couple of years. Spurious correlations tend to arise in non-stationary data, but our data are stationary. Given our sample size of 207, a correlation is significantly different from zero at the 1 and 5% levels, if

---

[10]See Appendix C for the construction of the dummy variables.

its absolute value exceeds 0.179 and 0.137, respectively. The following two subsections present results regarding sentences and expressions on the current and future states of the economy.

3.1.1 Current State

Table 5 presents the correlations between the expressions in sentences referring to the current state of the economy and the macroeconomic data. We highlight several findings. First, polarity expressions with positive (negative) tones are positively (negatively) correlated with the leading index, that is, the future state of the economy. This indicates the informativeness of the polarity criterion in linguistics, as seen in Kobayashi et al. (2004), although it is not designed to be applied to economics. In particular, the difference between the number of positive and negative polarity expressions (denoted by "pos neg" in the table) is highly informative of the future state of the economy. Moreover we find that the words "increase" and "decrease" are correlated positively and negatively with the future economy, respectively.

Second, factors associated with ambiguity are negatively correlated with the leading index. This is illustrated by a number of observations. First, the frequency of modal expressions is negatively correlated with the leading index. When the Monthly Report uses more modal expressions associated with ambiguity while referring to the current state of the economy, the future prospect of the economy tends to deteriorate. Second, the ratio of morphemes to sentences is negatively correlated with the leading index. That is, the future prospect of the economy worsens; the sentences become longer. While longer sentences may contain more detailed revelations about the economy, they also tend to involve more modal expressions and adverbs, which typically make the meaning of the sentences less clear and/or more difficult to grasp.[11] Third, we construct an index for mixed messages by calculating the ratio of a difference between positive and negative expressions to the sum of positive and negative expressions in the absolute term. The index takes a value between zero and one, and a lower value implies more mixed messages, because positive expressions are used as frequently as negative expressions. This index is positively correlated with the leading index, suggesting that the Monthly Report has more mixed tones, when the the future prospect of the economy is worsened. Fourth, the use of "etc." is negatively correlated with the leading index. This expression, which corresponds to "etc." and "and so on" in English, is considered to represent ambiguity in what the sentence is referring to.

Third, of the three composite indexes, the leading index is the most highly correlated with polarity and modality. The coincident index is less correlated with such expressions and the

---

[11]Moreover, we find that conjunctions with negative tones such as "although" and "but" are negatively correlated with the leading index. Sentences such as "Although A, B" prevent readers from judging which of the statements (A or B) the writer is emphasizing.

lagging index is the least correlated. In other words, the Monthly Report is indicative of the future state of the economy, about a quarter ahead, even in the sentences referring to the current state.

Fourth, the correlations between the documented characteristics and the inflation rate are lower in their absolute size than those with the leading index. In particular, polarity expressions are hardly informative about inflation. However, the words "increase" and "decrease" are significantly positively and negatively correlated with the inflation rate, respectively.

Finally, the differences in the positive and negative expressions are positively correlated with the monetary policy change dummy. That is, when positive expressions are used more frequently than negative expressions, the Bank of Japan tends to tighten its monetary policy.

3.1.2 Future State

Next, we examine sentences referring to the future state (and hence forecast) of the economy. Table 6 presents correlations between the expressions and the macroeconomic data. The table indicates that the findings are largely consistent with the previous results for the current state except for a few differences. The first difference is the role of modality. For sentences on the future state, modal expressions associated with high probability events are not negatively but positively correlated with the leading index. This is not surprising because the future state of the economy is intrinsically uncertain, and hence, sentences with high probability modal expressions such as "seem" and "forecast" will correspond to sentences that do not have modal expressions if referring to the current state. In other words, rather than construing high probability modal expressions as representing ambiguity, they should be viewed as a relatively clear statement about the future state of the economy.

When the economy is performing well, the number of morphemes tends to decrease, which increases the ratio of high probability expressions in sentences. On the other hand, less probable expressions, that is, modal expressions for low probability and unreal events, are negatively correlated with the leading index. Ambiguous expressions using "may" or "should" are counter-cyclical.

Second, while the frequency of polarity (positive and negative) expressions is informative about the future state of the economy, the size of correlations is lower in sentences referring to the future state than those referring to the current state. This is somewhat counterintuitive, because sentences on the future state should be more indicative of that state than those on the current state.

3.1.3 Polarity and Lead–Lag Relationships

To investigate the lead–lag relationship with the frequency of polarity expressions and the leading index, we show the correlations using the leading index that differs in timing from minus six months to plus six months in Figure 2. The horizontal axis represents the month. For example, plus one indicates a correlation between the frequency of polarity expressions and the leading index with a one-month lead. This figure shows that correlations peak at $x = 3$ for both sentences, those referring to the current and future states. In other words, polarity expressions in the Monthly Report lead the leading index by three months. This indicates that the Bank of Japan has significant forecasting power, which leads the government's leading index by three months. This is consistent with the superiority of central banks' information, as pointed out by Romer and Romer (2000) for the Federal Reserve, and Fujiwara (2005) for the Bank of Japan. Even if we exclude the effect of the two-month delay in the publication of the leading index, the Bank of Japan's forecasting power leads the leading index by one month. Another finding is that the timing of the peak is the same for the sentences referring to the current state and those referring to the future state, which implies that as far as predictive power is concerned, there is no difference in the time horizon.

The leading index published by the Japanese government systematically incorporates 11 economic indicators including two financial market variables, namely the TOPIX (Tokyo Stock Price Index) and the commodity price index. These indices can be fast-moving and may respond to changes in monetary policy as suggested by or extrapolated from the Monthly Report, for which endogeneity may be a concern. However, endogeneity if anything would go against the positive correlation between polarity expressions and the leading index, since a central bank's open recognition of economic expansions typically leads the financial market to expect a tightening of monetary policy, thereby decreasing stock and commodity prices. Thus we see the correlations in Tables 5 and 6 as conservative estimates.[12]

3.1.4 Time Series Developments

To explore the relationship between the contents of the Monthly Report and the macroeconomic indicators in more detail, Figure 3 presents the time series developments in the frequency of polarity expressions and the leading index. For polarity, we plot the differences between the frequencies of the positive and negative expressions for both the current and the future states. Clearly, the overall trends are consistent with the correlations seen earlier in Tables 5 and 6.

---

[12]The TOPIX enters the leading index as the monthly average, while the Monthly Report during the sample period was published mostly in the middle of each month. Together with the fact that the indices are only two of the 11 economic indicators, the direct effects of the Monthly Report on the leading index are likely to be small.

Figure 4 illustrates the time series developments in the frequency of modal expressions and the leading index. We focus on modal expressions for high probability for both the current and the future states, since we have much fewer per-issue observations of modal expressions for low probability and unreal events. The figure suggests that the Monthly Report has more modal expressions for high probability events in sentences on the current state when the leading index falls, which is confirmed by the negative correlation observed between them in Table 5.

3.2 Discussions on Ambiguity

3.2.1 Ambiguous Expressions and Recessions

In order to see how the correlations appear in practice, let us illustrate three examples of negative correlations between the economic activity and ambiguity in the Monthly Report. First, during the financial crisis of 1998, the Monthly Report often used such expressions as "may be attributed to" and "appear to." According to its English version, the Monthly Report of July 1998 stated "stock prices and yields on long-term government bonds have rebounded since mid-June 1998. This *may be attributed to* a slight recovery in market sentiment, although still weak..." (italics added). The same issue also stated "growth in M2+CDs has been slowing... These developments *appear to* strongly reflect the further decline in credit demand of private firms...." Second, the Monthly Report of May 2009 used the word "seem" in the aftermath of the Lehman shock: "It *seems* that firms' funding costs ... have remained more or less unchanged at low levels." The third example is "appear to," which was used from May 2013 to the end of our sample period: "Inflation expectations *appear to* be rising on the whole." During this period, the economy was in a relatively better shape owing to the large-scale monetary easing introduced in April 2013. However, the inflation rate and its expectations were well below the Bank of Japan's inflation target of 2%, although the Bank of Japan promised to achieve this level within two years. This seems to have induced the Bank to use the word "appear" in its Monthly Report, in order to avoid a definitive judgment.[13]

3.2.2 Sources of Ambiguity

It should be noted that our empirical analysis so far does not explicitly identify reasons for ambiguity. Ambiguous expressions do not necessarily reflect a writer's subjective judgment. In particular, ambiguity in the Monthly Report may well be inevitable when the economic environment itself is very unclear. For example, Bloom (2009) argues that exogenous uncertainty

---

[13]We are aware that the nuances in the English version of the Monthly Report differ from the Japanese version at times. For example, the Japanese version in May 2009 used two more modal expressions, "considered" and "seem." However, such expressions disappear in the English version. This may reflect the importance of modality in Japanese, compared to the English language, in judging the writer's perspective.

shocks can account for short, sharp recessions and recoveries. Baker, Bloom, and Davis (2016) measure economic policy uncertainty by analyzing major newspapers.

In order to disentangle the association between negative and ambiguous expressions from the association between underlying uncertainty and ambiguous expressions, we introduce two indices of economic uncertainty into our analysis. One is VIX, the volatility index published by the Chicago Board Options Exchange (CBOE), which can be considered to capture uncertainty in the global, and especially US economy. The other is the Nikkei Stock Average Volatility Index, which would capture domestic uncertainty, although the index has been available only since January 2001. We adopt these measures of uncertainty partly because the Bank of Japan has not given confidence intervals around its projections, unlike the Bank of England that reports fan charts in the Inflation Report. In addition, the very absence of confidence intervals in the Monthly Report suggests that any ambiguity should be reflected in the text, and thus text analysis is the only systematic way to quantify the ambiguity. Table 7 suggests that both uncertainty indices are indeed negatively and significantly correlated with polarity expressions.[14] That is, when the economic outlook is more uncertain, negative expressions are used more frequently than positive ones.

On the other hand, ambiguous expressions in the Monthly Report also tend to be positively correlated with the uncertainty indexes. The ratio of morphemes to sentences also exhibits significantly positive correlations with the uncertainty indices. For the current state, modal expressions are positively correlated, and also with respect to the future state, the modal expressions for the low and unreal probabilities tend to be positively correlated, although some are insignificant. The ratio of a difference between positive and negative expressions to the sum of positive and negative expressions in the absolute term is negatively correlated with the uncertainty indexes. These results suggest that ambiguous expressions in the Monthly Report reflect uncertain/ambiguous economic conditions.

However, ambiguous expressions in recessions cannot be entirely attributed to the underlying uncertainty in the economy for the following two reasons. First, regressions indicate that ambiguous expressions in the Monthly Report are explained not only by the VIX but also by the leading index.[15] Table 8 reports the estimation results when modal expressions in the Monthly Report are regressed with the leading index and VIX. The dependent variables are the ones associated with modal expressions, whereas the explanatory variables are the leading index and the VIX, and we report heteroskedastic and autocorrelation consistent standard er-

---

[14]As Table 4 indicates, there were no low probability expressions for the current state, and thus the correlation coefficient cannot be calculated.

[15]We have omitted the Nikkei Stock Average Volatility Index from the regressions due to the lack of observations. However, where available it is highly correlated with VIX.

rors. The table demonstrates that, even when the VIX is included in the explanatory variables, coefficients on the leading index continue to be significant. The bottom two rows show that adjusted R squared improves considerably when the leading index is included in the explanatory variables. These results suggest that ambiguous expressions in the Monthly Report tend to be used more frequently when the leading index is low, even when the VIX does not increase.

3.2.3 Intentional Ambiguity in Action

The transcripts of the monetary policy meetings provide two further illustrative examples of intentional ambiguity. The Summary in the Monthly Report is edited and approved in each meeting by the Committee members, while a draft of the Summary is prepared by the staff at the Bank of Japan prior to the meeting. We can see how the draft was discussed and edited through the transcript published ten years after each meeting. Edits by the Committee are largely minor and infrequent. However, in June 1998 - in the midst of the financial crisis - the Committee members discussed intensively whether to ease the monetary policy further, and after all, decided not to. Near the end of the meeting they looked at the Summary of the Monthly Report. The staff presented the draft (p.134 in the transcript), adding that "it explains the facts flatly." However, the Committee members expressed their concerns about such flat sentences. Deputy Governor Yamaguchi said that the expression "by the ongoing rapid deterioration in employment and income conditions" pointed to the risk in the future, which was correct, but it would be perceived that such a risk should be considerably high. He also raised a similar concern regarding the expression about the future price risk, namely "there may also be additional downward pressures if domestic demand weakens further." He maintained that such a deflationary spiral risk was actually emerging but it would be better not to mention it. The Committee members spent a lot of time discussing the wording of the expressions (p.134 to 156 in the transcript). A few members agreed that the expressions were too "strong." One member proposed to add "etc." to "the ongoing rapid deterioration in employment and income conditions."[16]

The meeting in October 2000 is another example of intentional ambiguity. Within several months after lifting zero interest rate policy in August 2000, a number of indicators suggested a slow-down on the economy, but the committee decided not to ease the monetary policy. Against such a backdrop, the staff proposed the following sentence in the Monthly Report regarding the future state: "Overall, the economy is likely to recover gradually ..., unless there are major adverse external shocks including developments in crude oil prices and their effects." A committee member pointed out that adverse external shocks such as the drop in stock prices

---

[16]This proposal was finally agreed, but "etc." was used only in the Japanese version.

had already occurred, so the use of "unless" was not appropriate. However, highlighting such adverse shocks was deemed to lead to a downward revision in their assessment and potentially contradict with their recent monetary policy decision. Eventually, the members agreed on using the unreal modal expression of "need careful monitoring" stating, "Overall, the economy is likely to recover gradually ..., while the developments in crude oil prices as well as foreign and domestic capital markets, along with their effects on the economy, need careful monitoring."[17]

3.3 Other Robustness Checks

We checked the robustness of our results in various ways.

3.3.1 Further Time Series Analyses

Although our variables are stationary, some of them exhibit a substantial degree of persistence. For example, the exact same sentence, "Inflation expectations appear to be rising on the whole," appeared in several consecutive issues. Thus, an alternative is to take monthly differences for all the variables and compute correlations with the macroeconomic indicators. We confirm that monthly changes in polarity expressions remain significantly correlated with monthly changes in the leading index. The correlation between the difference between the number of positive and negative expressions for the current state and the leading index is 0.22. However, many of our results regarding ambiguity disappear. In particular, neither the frequency of modal expressions nor the average length of the sentences is correlated with the leading index when their monthly changes are taken.

The Granger causality test for the leading index and the polarity expressions, as defined by the difference between the number of positive and negative expressions for the current state, reveals that i) the Akaike information criterion (AIC) chooses the lag of six months, and that ii) the polarity expressions Granger-cause the leading index with one percent significance and the leading index Granger-causes polarity expressions only with 10 percent significance.

3.3.2 GDP Gap and Sample Split

The Bank calculates the quarterly GDP gap on its own and assigns more weight to it than the composite indexes while making policy decisions. The correlations between the GDP gap

---

[17]In addition to the anecdotal evidence discussed here, it is also worth noting that recessions tend to be more clearly recognized and evidenced than recoveries, as exemplified in the Great Recession in the sample period. During the Great Recession, the current state of the economy was clearly weak while the future prospect of the economy was highly uncertain. This suggests the possibility that the Bank of Japan uses ambiguity more intentionally in the Monthly Report when discussing the current state of the economy, while needless to say, the current state also entails exogenous uncertainty, as is often called "nowcasting" and studied recently by Jurado, Ludvigson, and Ng (2015) and Rossi and Sekhposyan (2015).

and polarity expressions and those between the GDP gap and modal expressions remain significant.[18]

Our results are robust to splitting the sample at October 2003, when the Bank decided to enhance monetary policy transparency and reduced the size of the Monthly Report considerably.

3.3.3 Monthly Report in English

Let us examine whether our results hold for the Monthly Report translated into English. The results from both the original and translated versions are largely consistent. Here we focus on results associated with modality, for which differences between Japanese and English may be pronounced, as already discussed in Section 2.2.2. The details of our method and results are explained in Appendix D. In the English version, modal expressions appeared less frequently than those in the Japanese version, both in terms of the number of expressions and the relative frequency. The correlations between modal expressions and the leading index are lower in their absolute size, and in particular, the correlation between the high probability expressions and the leading index for the current state, and that between unreal expressions and the leading index for the future state become insignificant at the 5% level. However, all the other correlation coefficients are statistically significant and have the same signs as in the Japanese version. This suggests that ambiguity is more effectively identified from the original version due to the grammatical structure of Japanese, than from the translated version.

3.3.4 Relationship among Multiple Variables

Last but not least, although we focus on correlations between two variables, more than two variables are likely to interact among each other. In particular, certain expressions in the Monthly Report are more likely to be used together depending on economic circumstances. For example, both negative polarity expressions and modal expressions tend to be used in the Monthly Report when the economy is in a recession. We could address this by regressing various modal expressions on polarity expressions and macroeconomic variables. However, because polarity expressions are endogenous, such regressions would yield biased estimates. Moreover, the causal link between modal expressions and polarity expressions is not a priori clear. Thus we employ the LDA method in the next subsection, so as to focus on the link between the *combinations* of certain expressions in the Monthly Report and the macroeconomic indicators.

---

[18]We thank a member of staff at the Bank of Japan for suggesting this robustness check and the GDP gap data.

3.4 Document Analysis

3.4.1 Latent Dirichlet Allocation (LDA)

We apply the LDA for exploratory analysis to the Monthly Report, in order to study the relationship between the combination of expressions used and macroeconomic conditions.[19] The LDA extracts fewer latent discrete variables ("topics") from a large number of discrete random variables ("expressions"). Such dimension reduction has attracted much attention in text analysis in recent years because the number of words is often much larger than that of the documents (a mixture of various topics). Moreover, the extracted latent variables, which we call "the topics of documents," or simply "topics," can often be easily interpreted, which helps us understand the semantic structure of the documents. The LDA is Bayesian unsupervised learning and does not rely on the supervised classification that is based on subjective judgments by humans.

The LDA has mainly two advantages over other methods of dimension reduction such as principal component analysis, factor analysis, and traditional clustering algorithms. First, the LDA has a better generalization ability in analyzing high-order structure than traditional methods. Factor analysis is not suitable to estimate a high-order semantic structure including synonymy and polysemy. The LDA inherits the merit of a Latent Semantic Indexing (LSI) analysis that is proposed to resolve such a difficulty (Deerwester et al. [1990]). More specifically, the LDA resolves high-order and sparse data which include many variables (= expressions) and topics using Gibbs sampling. Second, the LDA allows documents and expressions to belong to more than one topic (Blei, Ng, and Jordan [2003]). Expressions can be given different interpretations corresponding to the topics, which is plausible in that the same expression, such as "increase" or "seem," can be used in different contexts depending on economic circumstances and objectives. By contrast, the LSI sorts documents into one topic, and thus, expressions cannot be interpreted in multiple ways.

The LDA makes use of a generative probabilistic model for text corpora. The model consists of a finite mixture over an underlying set of topics of documents, where the topics are extracted from latent discrete variables and represent properties common to a number of expressions. More precisely, in the LDA, the distribution of expressions in documents is described by the model that consists of the index of expressions $\{1, 2, \cdots, V\}$, a document (=a sequence of N expressions) $\vec{w} = (w_1, w_2, \cdots, w_N)$, and a corpus (=a collection of M documents) $D = (\vec{w_1}, \vec{w_2}, \cdots, \vec{w_M})$. It assumes the following generative process for each document $\vec{w}$ in a corpus D: (1) Choose $N \sim \text{Poisson}(\xi)$, (2) Choose $\theta \sim \text{Dir}(\alpha)$, (3) For each of the N expressions w_i,

---

[19]Moniz and de Jong (2014), Hansen and McMahon (2016) and Hansen, McMahon, and Prat (2018) apply the LDA to central banks' communications.

choose a topic $z_i \sim \text{Multi}(\theta)$ and a word w_i from $\text{Multi}(w_i|z_i, \beta)$, where $\text{Poisson}(\xi)$, $\text{Dir}(\alpha)$ and $\text{Multi}(\theta)$ represent the Poisson, Dirichlet, and multinomial distribution, respectively. β is also the Dirichlet distribution with parameter η. $\text{Multi}(w_i|z_i, \beta)$ indicates a multinomial probability conditioned on the topic z_i. The assumption of the Poisson distribution is not crucial because N is an independent variable and we can estimate the appropriate distribution of N from the data. Loosely speaking, the model posits that the distribution of expressions is generated by the two Dirichlet distributions characterized by given vector parameters α and η, where α and η are defined as scalar values when the symmetric Dirichlet prior is assumed. We adopt a symmetric Dirichlet distribution like most researchers working on natural language processing, although there is some controversy over the symmetry assumption (Wallach et al. [2009]).

We apply the LDA to our data in the following manner. The expressions are sorted in the order of those associated with modality, polarity, and adjective and adverb; we add the adjective and adverb in order to cover subjective, uncertainty, or unassertive expressions spilling over from modality and polarity. No double counting is allowed. For example, once "clear" is selected as a polarity expression, it cannot be included as an expression of adjective. The parameter values α and η and the number of topics are chosen according to the Bayesian information criterion (BIC). We adopt a parsimonious model, which consists of expressions associated with modality and polarity, sorted in this order. For an expression to be selected, we require it to appear a minimum of five times during the sample period.

3.4.2 Results

Table 9 reports the results for the sentences referring to the current state of the economy. The BIC chooses four topics. Each column represents a topic. The second row lists the label of each of the four topics, namely, the type(s) of modal and polarity expressions whose frequency exceeds (at the 5 percent significance level) the expected frequency calculated from the marginal distribution. The table also presents correlations between the appearances of each topic and the macroeconomic data.

This table illustrates that Topic 2 is pro-cyclical, while Topics 3 and 4 are counter-cyclical. Topic 2 is positively correlated with both the leading index and the inflation rate. Meanwhile, Topic 2 consists of expressions with positive tones such as "increase" and "ease," although they are categorized as neutral according to the polarity criterion. In this topic, no modal expression is selected. On the other hand, Topics 3 and 4 are negatively correlated with both the leading index and the inflation rate. Although Topic 3 includes positive expressions, they do not entail any positive tones if we view the expressions closely (e.g., "demand," "fund," and "credit"). Rather, Topics 3 and 4 consist of negative expressions such as "fall" and "worsen." Moreover,

Topic 3 embeds modal expressions related to high probability and unreal. Modal expressions such as "seem" and "should" indicate ambiguity and/or a lack of objectivity.

Next, we report the results for the sentences on the future state in Table 10. We obtain fairly similar results. Four topics are selected by the BIC, of which Topics 1 and 2 are counter-cyclical and Topics 3 and 4 are pro-cyclical. Topics 1 and 2 consist of not only negative expressions but also modal ones. In particular, modal expressions for low probability and unreal events are associated with these topics. Its examples include "attention should be paid to the possibility," "may," and "should." Again these expressions have ambiguous tones. When these expressions are used, the economy is likely to be weak with respect to the leading index and the inflation rate. By contrast, Topics 3 and 4 are positively correlated with the macroeconomic data. These topics consist of neutral polarity expressions, but they actually have positive tones (e.g., "increase"). Modal expressions associated with high probability events appear together with positive expressions.

We can construct other models by selecting various combinations of expressions. For example, the richest model would comprise all the expressions used in the all issues of the Monthly Report during the sample period. However, less parsimonious models of this type tend to yield a larger number of topics, sometimes more than 15, which prevents us from drawing economic insights. Meanwhile, we confirm that the above findings hold for many other parsimonious models with topics that can be interpreted intuitively. One interesting note is that "etc." appeared more often in issues that had more negative expressions.

3.5   Interpretation of Results

Throughout this paper, as discussed in the Introduction, ambiguous expressions in the Monthly Report are interpreted as a way for the Bank of Japan to strategically withhold precise information it may have observed. Specifically, we consider ambiguity as a manifestation of the central bank's attempt to shift market expectations upwards by withholding precise information when it is unfavorable.[20]

An alternative interpretation of our empirical results is that no information is effectively withheld in ambiguous expressions as the market participants can perfectly "decode" them to infer the information the central bank has. This interpretation seems implausible in our context. In particular, if the information were fully revealed to the market regardless of the expressions, the central bank would have no reason to be ambiguous except when there is genuine underlying uncertainty, which is at odds with our finding discussed in Section 3.2.2 that ambiguous expressions are more frequently used when both the leading and volatility

---

[20]See Appendix E for a simple formalization of this idea using a persuasion game (Dye [1985]).

indexes are low.

Stein (1989) theoretically studied central bank announcements by using a cheap talk model, where the sender is allowed to send any kind of message at no cost irrespective of the nature of the private information. The assumption on the sender's report is in contrast to that in persuasion games where the sender is restricted to reveal truthfully once he has decided to disclose his private information. Furthermore, we posit that the Bank of Japan had a consistent upward bias for the period of this study, while in Stein's (1989) model the central bank can be either upward or downward biased depending on private information. In fact, if we apply cheap talk to our setup (Crawford and Sobel [1982]), positive information is *less* precisely communicated than negative information since the central bank would have incentive to inflate their reports regardless of private information. This is not consistent with our findings which indicate the contrary.

Yet another approach to central bank disclosure is that by Morris and Shin (2002, 2005, 2018). Their main concern is welfare implications of disclosure with respect to the market participants' coordination problem through the provision of public information. In their models, whether the central bank should disclose clear or ambiguous information depends on the nature of private information and/or the action to be taken by the central bank. While their insights may well lead to interesting hypotheses on central bank communication, we have taken a different approach to examine the central bank's upward bias in communication relative to business cycles.

4 Concluding Remarks

We have studied a central bank's communication strategy by analyzing how expressions used in published reports are related to the state of the economy. The findings from our discourse analysis are two-fold. First, the Bank of Japan has forecasting power for the economy, since the positive–negative indicator compiled from the Monthly Report leads the government's leading index by three months. The second finding concerns the characteristics of the Bank of Japan's communications. We find that ambiguity tends to increase (decrease) when the economy is bad (good). More specifically, when the leading index is low, word length tends to be longer; positive and negative words are more likely to be used together; and modality and "etc." expressions tend to appear more frequently. Our parsimonious LDA model suggests that modality is used in tandem with negative expressions when the leading index is low.

Future research is to test our analysis using other forms of publications. We are particularly interested in whether our results hold for publications from the Federal Reserve or other central banks. Also, since the Japanese economy in the sample period is characterized either by

stagnation or the inflation rate *below* the target level even in a recovery phase, the Bank of Japan should have had a consistent upward bias, if any, in its communication strategy. It would thus be particularly interesting to study reports from central banks facing high inflation or over-heated macroeconomies, in which case the central bank should have a downward bias in communication.

References

[1] Acosta, Miguel. (2015) "FOMC Responses to Calls for Transparency." Finance and Economics Discussion Series 2015-060. Board of Governors of the Federal Reserve System.

[2] Apel, M. and M. Blix Grimaldi. (2012) "The Information Content of Central Bank Minutes." Sveriges Riksbank Working Paper Series 261.

[3] Baker, Scott R., , Nicholas Bloom, and Steven J. Davis. (2016) "Measuring Economic Policy Uncertainty." *Quarterly Journal of Economics*, 131(4), pp. 1593–1636.

[4] Bennani, Hamza and Matthias Neuenkirch. (2017) "The (Home) Bias of European Central Bankers: New Evidence Based on Speeches." *Applied Economics*, 49(11), 1114—1131.

[5] Bernardo, J. M. (2003) "Bayesian Statistics 7." In *Proceedings of the Seventh Valencia International Meeting*. New York: Oxford University Press.

[6] Bholat, David, Stephen Hansen, Pedro Santos, and Cheryl Schonhardt-Bailey. (2015) "Text Mining for Central Banks." Centre for Central Banking Studies, Bank of England.

[7] Blei, David M., Andrew Y. Ng and Michael I. Jordan. (2003) "Latent Dirichlet Allocation." *Journal of Machine Learning Research*, 3, pp. 993–1022.

[8] Blinder, Alan S. (2004) *The Quiet Revolution: Central Banking Goes Modern.* New Haven: Yale University Press.

[9] Bloom, Nicholas. (2009) "The Impact of Uncertainty Shocks." *Econometrica*, 77(3), pp. 623–685.

[10] Bloomberg Businessweek. (2012) "Alan Greenspan on His Fed Legacy and the Economy" August 10, 2012.

[11] Born, Benjamin, Michael Ehrmann, and Marcel Fratzscher. (2014) "Central Bank Communication on Financial Stability." *Economic Journal*, 124, pp. 701–734.

[12] Boukus, E. and J. V. Rosenberg. (2006) "The Information Content of FOMC Minutes." mimeo, Federal Reserve Bank of New York.

[13] Brown, Jennifer, T. Hossain and J. Morgan. (2010) "Shrouded Attributes and Information Suppression: Evidence from the Field." *Quarterly Journal of Economics*, 125(2), pp. 859–876.

[14] Bruno, Giuseppe. (2016) "Text Mining and Sentiment Extraction in Central Bank Documents." *2016 IEEE International Conference on Big Data (Big Data)*, pp. 1700—1708.

[15] Coenen, Günter, Michael Ehrmann, Gaetano Gaballo, Peter Hoffmann, Anton Nakov, Stefano Nardelli, Eric Persson and Georg Strasser. (2018) "More, and More Forward-looking: Central Bank Communication After the Crisis" Sylvester C. W. Eijffinger and Donato Masciandaro (eds), *Hawks and Doves: Deeds and Words – Economics and Politics of Monetary Policymaking*, CEPR Press, London, Chapter 13, pp. 125–133.

[16] Crawford, Vincent P. and Joel Sobel. (1982) "Strategic Information Transmission." *Econometrica*, 60(6), pp. 1431-1451.

[17] Deerwester, Scott, Susan T Dumais, George W Furnas, Thomas K Laundauer. (1990) "Indexing by Latent Semantic Analysis." *Journal of American Society for Information Science*, 41(6), pp. 391–407.

[18] Dye, Donald A. (1985) "Disclosure of Nonproprietary Information." *Journal of Accounting Research*, 23(1), pp. 123-145.

[19] Ehrmann, Michael and Jonathan Talmi. (2017) "Starting from a Blank Page? Semantic Similarity in Central Bank Communication and Market Volatility." European Central Bank Working Paper 2023.

[20] Eijffinger, Sylvester and Petra Geraats. (2006) "How Transparent are Central Banks?" *European Journal of Political Economy*, 22, pp. 1–21.

[21] Fairclough, Norman. (1989) *Language and Power*. London: Longman.

[22] Fillmore, Charles J. (1968) "The Case for Case." in *Universals in Linguistic Theory*, Holt (ed.) Rinehart & Winston of Canada Ltd., pp.1–88.

[23] Fujiwara, Ippei. (2005) "Is the Central Bank's Publication of Economic Forecasts Influential?" *Economics Letters*, 89, pp. 255–261.

[24] Goodfriend, Marvin. (1986) "Monetary Mystique: Secrecy and Central Banking," *Journal of Monetary Economics*, 17(1), pp.63-92.

[25] Gramsci, Antonio. (1971) *Selections from the Prison Notebooks of Antonio Gramsci*. New York: International Publisher.

[26] Greenspan, Alan. (2007) *The Age of Turbulence: Adventures in a New World*. New York: Penguin Press.

[27] Hansen, Stephen and Michael McMahon. (2016) "Shocking Language: Understanding the Macroeconomic Effects of Central Bank Communication." *Journal of International Economics*, 99(1), pp. S114–133.

[28] Hansen, Stephen, Michael McMahon, and Andrea Prat (2018) "Transparency and Deliberation within the FOMC: A Computational Linguistics Approach." *Quarterly Journal of Economics*, 133(2), pp. 801–870.

[29] Hendry, S. (2012) "Central Bank Communication or the Media's Interpretation: What Moves Markets?" Bank of Canada Working Papers 12-9.

[30] Hendry, S., and A. Madeley. (2010) "Text Mining and the Information Content of Bank of Canada Communications." Bank of Canada Working Papers 10-31.

[31] Higashiyama, Masahiko, Kentaro Inui and Yuji Matsumoto. (2008) "Jutugo no Sentakushikousei NiChakumoku Shita Meishi Hyouka Kyokusei No Kakutoku [Acquiring Noun Polarity Knowledge Using Selectional Preferences] (in Japanese)." In *Proceedings of the 14th Annual Conference of the Natural Language Processing*, 2G3-01, pp.584–587.

[32] Jansen, David-Jan. (2011) "Does the Clarity of Central Bank Communication Affect Volatility in Financial Markets? Evidence from Humphrey-Hawkins Testimonies." *Contemporary Economic Policy*, 29(4), 494–509.

[33] Jin, Ginger Zhe, Michael Luca, and Daniel Martin. (2015) "Complex Disclosure." mimeo.

[34] Johnson-Laird, Philip N. (1978) "The Meaning of Modality." *Cognitive Science*, 2, pp. 17–26.

[35] Jurado, Kyle, Sydney C. Ludvigson, and Serena Ng (2015) "Measuring Uncertainty." *American Economic Review*, 105(3), pp. 1177–1216.

[36] Kahveci, Eyup, and Aysun Odabas. (2016) "Central Banks' Communication Strategy and Content Analysis of Monetary Policy Statements: The Case of Fed, ECB and CBRT." *Procedia - Social and Behavioral Sciences*, 235, pp. 618–629.

[37] Kaji, Nobuhiro and Masaru Kitsuregawa. (2007) "Building Lexicon for Sentiment Analysis from Massive Collection of HTML Documents." In *Proceedings of the 2007 Joint Conference on Empirical Methods in Natural Language Processing and Computational Natural Language Learning* (EMNLP-CoNLL), pp.1075–1083.

[38] Kobayashi, Nozomi, Kentaro Inui, Yuji Matsumoto, Kenji Tateishi and Toshikazu Fukushima. (2004) "Collecting Evaluative Expressions for Opinion Extraction." In *Proceedings of the First International Joint Conference on Natural Language Processing* (IJCNLP-04), pp. 584–589.

[39] Li, Feng. (2008) "Annual Report Readability, Current Earnings, and Earnings Persistence." *Journal of Accounting and Economics*, 45, pp. 221–247.

[40] Li, Feng. (2010) "Textual Analysis of Corporate Disclosures: A Survey of the Literature." *Journal of Accounting Literature*, 29, pp. 143–165.

[41] Loughran, Tim, and Bill McDonald. (2011) "When is a Liability not a Liability? Textual Analysis, Dictionaries, and 10-Ks." *Journal of Finance*, 66(1), pp. 35–65.

[42] Milgrom, Paul. (1981) "Good News, Bad News: Representation Theorems and Applications." *Bell Journal of Economics*, 12, pp. 380–391.

[43] Moniz, Andy, and Franciska de Jong. (2014) "Predicting the Impact of Central Bank Communications on Financial Market Investors' Interest Rate Expectations." In Valentina Presutti, Eva Blomqvist, Raphaël Troncy, Harald Sack, Ioannis Papadakis, and Anna Tordai (Eds.) *The Semantic Web: ESWC 2014 Satellite Events*, pp. 144—155.

[44] Montes, G. C. and R. T. F. Nicolay. (2017) "Does Clarity of Central Bank Communication Affect Credibility? Evidences Considering Governor-Specific Effects." *Applied Economics*, 49(32), pp. 3163—3180.

[45] Morris, Stepehn and Hyun Song Shin. (2002) "The Social Value of Public Informa-tion." *American Economic Review* 92(5), 1521- 1534.

[46] Morris, Stephen and Hyun Song Shin. (2005) "Central Bank Transparency and the Signal Value of Prices." *Brookings Papers on Economic Activity* 2, 1-66.

[47] Morris, Stephen and Hyun Song Shin. (2018) "Central Bank Forward Guidance and the Signal Value of Market Prices." *American Economic Review Papers and Proceedings* 108, 572-577.

[48] Narrog, Heiko. (2009) *Modality in Japanese: The Layered Structure of the Clause and Hierarchies of Functional Categories.* Amsterdam: John Benjamins Publishing.

[49] Nitta, Yoshio. (2011) *Nihongo no modariti to sono shuhen [Modality in Japanese and Related Topics]* (in Japanese). Tokyo: Hitsuji Shobo.

[50] Palmer, F. R. (2001) *Mood and Modality.* Second Edition. Cambridge: Cambridge University Press.

[51] Pang, Bo and Lillian Lee. (2008) "Opinion Mining and Sentiment Analysis." *Foundations and Trends in Information Retrieval*, 2(1-2), pp.1–135.

[52] Romer, Christina and David Romer. (2000) "Federal Reserve Information and the Behavior of Interest Rates." *American Economic Review*, 90, pp. 429–457.

[53] Rossi, Barbara and Tatevik Sekhposyan. (2015) "Macroeconomic Uncertainty Indices Based on Nowcast and Forecast Error Distributions." *American Economic Review: Papers and Proceedings*, 105(5), pp. 650–655.

[54] Stein, Jeremy C. (1989) "Cheap Talk and the Fed: A Theory of Imprecise Policy Announcements." *American Economic Review*, 79(1), pp. 32–42.

[55] Steyvers, Mark. and Tom Griffiths. (2007) "Probabilistic Topic Models." *Handbook of Latent Semantic Analysis*, 427(7), pp. 424–440.

[56] Sweetser, Eve. (1991) *From Etymology to Pragmatics: Metaphorical and Cultural Aspects of Semantic Structure.* Cambridge: Cambridge University Press.

[57] Takamura, Hiroya, Takashi Inui and Manabu Okumura. (2005) "Extracting Semantic Orientations of Words using Spin Model." In *Proceedings of the 43rd Annual Meeting on Association for Computational Linguistics*, pp. 133–140.

[58] Tomz, Michael and Robert P. Van Houweling. (2009) "The Electoral Implications of Candidate Ambiguity." *American Political Science Reveiw*, 103(1), pp. 83–98.

[59] van Dijk, Teun A. (2008) *Discourse and Power.* Houndmills: Palgrave.

[60] Varian, Hal R. (2014) "Big Data: New Tricks for Econometrics." *Journal of Economic Perspectives*, 28(2), pp. 3–27.

[61] Wallach, Hanna. M., Mimno, David. M., and McCallum, Andrew. (2009) "Rethinking LDA: Why Priors Matter." *Advances in Neural Information Processing Systems*, pp. 1973–1981.

[62] Walsh, Carl E. (2010) *Monetary Theory and Policy.* Cambridge: MIT Press.

[63] Wilson, Theresa, Janyce Wiebe, and Paul Hoffmann. (2005) "Recognizing Contextual Polarity in Phrase-Level Sentiment Analysis." In *Proceedings of HLT-EMNLP-2005.*

[64] Woodford, Michael. (2003) *Interest and Prices.* Princeton: Princeton University Press.

[65] Woodward, Bob. (2000) *Maestro: Greenspan's Fed and the American Boom.* New York: Simon and Schuster.

Table 1: Basic Statistics

	Sentences mean	(s.d.)	Morphemes mean	(s.d.)	Mor/sen mean	(s.d.)
Summary	31.69	(8.24)	940.14	(338.82)	29.25	(4.47)
- present	22.61	(5.92)	629.11	(224.66)	27.44	(4.07)
- forecast	9.08	(2.84)	311.03	(129.84)	33.89	(6.79)
Economics	79.12	(27.88)	2848.83	(1110.44)	36.12	(4.19)
Prices	19.55	(8.07)	704.60	(300.63)	36.80	(6.24)
Financial	24.35	(3.58)	753.33	(211.22)	30.52	(4.46)

Table 2: Top Five Polarity Expressions

Positive experience	#	evaluation	#	Negative experience	#	evaluation	#	Neutral	#
demand	1062	good	205	fall	522	excess	147	invest	1166
improve	733	good/reason	92	decline	397	weak	131	increase	1121
fund	626	ease	85	price	335	minus	108	environment	891
recovery	501	ample	62	worsen	181	sluggish	88	modest	802
economy	478	grow	60	cost	150	weak	45	produce	541

Table 3: Basic Statistics of Polarity Expressions

	Positive experience	evaluation	Negative experience	evaluation	Neutral	Positive–negative
Summary	0.0390	0.0040	0.0154	0.0030	0.0964	0.0246
	(0.0065)	(0.0019)	(0.0079)	(0.0018)	(0.0109)	(0.0101)
- present	0.0347	0.0043	0.0148	0.0022	0.0954	0.0219
	(0.0076)	(0.0019)	(0.0084)	(0.0014)	(0.0116)	(0.0120)
- forecast	0.0469	0.0036	0.0156	0.0045	0.0985	0.0307
	(0.0110)	(0.0040)	(0.0094)	(0.0041)	(0.0139)	(0.0138)

Note: The numbers indicate the ratio to total morphemes. Figures in parentheses represent standard deviations.

Table 4: Modal Expressions

Examples	High probability (seems, appear, expected, considered, forecasted, likely)	Low probability (may, warrant careful monitoring)	Unreal (should, it is important to)
Summary	0.0090	0.0001	0.0007
	(0.0028)	(0.0003)	(0.0010)
- present	0.0006	0.0000	0.0004
	(0.0010)	(0.0000)	(0.0007)
- forecast	0.0261	0.0003	0.0014
	(0.0090)	(0.0009)	(0.0020)

Note: The numbers indicate the ratio to total morphemes. Figures in parentheses represent standard deviations.

Table 5: Correlations (Current State)

	leading	coincident	lagging	inflation	mdummy	mbigdummy
mor/sen	-0.73**	-0.61**	-0.46**	-0.14*	-0.05	-0.06
high prob	-0.37**	-0.33**	-0.15*	0.14*	0.04	-0.03
low prob	N/A	N/A	N/A	N/A	N/A	N/A
unreal	-0.61**	-0.44**	-0.31**	-0.08	-0.09	-0.09
pos−neg	0.57**	0.38**	-0.03	-0.14*	0.20**	0.15*
pos exp	-0.11	-0.27**	-0.54**	-0.28**	0.03	-0.05
pos eval	0.45**	0.48**	0.35**	0.18**	0.18**	0.20**
neg exp	-0.82**	-0.67**	-0.35**	0.02	-0.18**	-0.17*
neg eval	-0.18**	-0.02	-0.06	0.01	-0.05	-0.12
increase	0.65**	0.67**	0.69**	0.21**	0.28**	0.24**
decrease	-0.41**	-0.40**	-0.10	-0.29**	-0.06	-0.01
|(pos−neg)/(pos+neg)|	0.73**	0.56**	0.26**	0.00	0.24**	0.19**
etc	-0.55**	-0.39**	-0.24**	-0.10	-0.08	-0.04

The column items represent expressions in the Monthly Report, where mor/sen is the ratio of morphemes to sentences; pos−neg is the difference between the number of positive and negative polarity expressions; pos is positive; neg is negative; exp is experience; eval is evaluation; and etc is "etc." or "and so on." The row items represent macroeconomic data, where mdummy is a dummy from the actual monetary policy changes and mbigdummy is a dummy from the actual big monetary policy changes. ** and * represent significance at the 5 and 10 percent levels, respectively.

Table 6: Correlations (Forecasts)

	leading	coincident	lagging	inflation	mdummy	mbigdummy
mor/sen	-0.54**	-0.40**	-0.35**	-0.06	-0.09	-0.06
high prob	0.60**	0.42**	0.33**	0.10	0.09	0.08
low prob	-0.39**	-0.28**	-0.19	-0.22**	-0.05	-0.03
unreal	-0.31**	-0.17*	-0.09	0.08	0.01	-0.01
pos−neg	0.14*	0.16*	0.05	0.19**	0.21**	0.06
pos exp	-0.21**	-0.13	0.06	0.01	0.19**	0.07
pos eval	-0.33**	-0.25**	-0.26**	0.15*	-0.07	-0.13
neg exp	-0.60**	-0.45**	-0.09	0.01	-0.06	-0.04
neg eval	0.02	-0.05	-0.01	-0.28**	0.01	-0.01
increase	0.79**	0.67**	0.54**	0.12	0.24**	0.20**
decrease	-0.01	0.11	0.31**	0.04	-0.08	0.01
|(pos−neg)/(pos+neg)|	0.44**	0.37**	0.12	0.21**	0.16*	0.07
etc	-0.01	-0.01	-0.12	0.02	0.15*	0.07

The column items represent expressions in the Monthly Report, where mor/sen is the ratio of morphemes to sentences; pos−neg is the difference between the number of positive and negative polarity expressions; pos is positive; neg is negative; exp is experience; eval is evaluation; and etc is "etc." or "and so on." The row items represent macroeconomic data, where mdummy is a dummy from the actual monetary policy changes and mbigdummy is a dummy from the actual big monetary policy changes. ** and * represent significance at the 5 and 10 percent levels, respectively.

Table 7: Correlations with Uncertainty Indices

	Current State		Forecasts	
	VIX	Nikkei vol	VIX	Nikkei vol
mor/sen	0.48**	0.28**	0.33**	0.06
high prob	0.09	0.17*	-0.28**	-0.04
low prob	N/A	N/A	0.20**	0.19**
unreal	0.36**	0.26**	0.14*	-0.09
|(pos−neg)/(pos+neg)|	-0.68**	-0.55**	-0.35**	-0.24**
pos−neg	-0.56**	-0.47**	-0.18**	-0.23**

The column items represent expressions in the Monthly Report, where mor/sen is the ratio of morphemes to sentences and pos−neg is the difference between the number of positive and negative polarity expressions. In the row items, commodity and Nikkei vol represent the commodity price index and the Nikkei-average volatility index, respectively. ** and * represent significance at the 5 and 10 percent levels, respectively.

Table 8: Regression of Modal Expressions

Dep vars	Current State			Forecasts			
	mor/sen	high prob	unreal	mor/sen	high prob	low prob	unreal
Indep vars							
leading	-0.372***	-7.13e-05***	-6.18e-05**	-0.497***	8.395e-04***	-5.37e-05**	-9.77e-05**
	(0.091)	(1.96e-05)	(2.43e-05)	(0.177)	(2.56e-04)	(2.20e-05)	(4.67e-05)
VIX	-0.003	-8.86e-06***	-2.19e-06	-0.016	6.16e-05**	-3.25e-06	-7.68e-06
	(0.013)	(3.15e-06)	(2.22e-06)	(0.028)	(2.67e-05)	(3.03e-06)	(6.16e-06)
c	65.635***	1.041e-02***	7.275e-03**	88.225***	-7.637e-02**	6.675e-03**	1.343e-02**
	(11.668)	(0.003)	(0.003)	(23.362)	(0.030)	(0.003)	(0.006)
Adj R^2	0.527	0.185	0.376	0.291	0.386	0.150	0.098
Adj R^2							
w/o leading	0.227	0.002	0.126	0.101	0.073	0.034	0.014

** and * represent significance at the 5 and 10 percent levels, respectively. Figures in parentheses indicate the heteroskedastic and autocorrelation consistent (HAC, Newey–West) standard errors. Adj R^2 w/o leading indicates the adjusted R squared when explanatory variables are just VIX and constant.

Table 9: LDA Results (Current State)

Topic	1	2	3	4
Label	positive, neutral	neutral	high prob, unreal, positive, negative	negative
high prob			seem, appear	
low prob				
unreal			should	
positive	fund, demand, improve, credit demand, good, effect, money, profit, economy, income		demand, fund, credit demand, interest, credit, activity, service, income, good/reason, resolve	
negative			fall, weak, decline, attention, cost, excess, worsen, expenditure	price, fall, decline, worsen, subdue, sluggish, financial positions, severe, recession, risk
neutral	environment, ease, level, issue, invest, increase, finance, modest, thing/maturity, under/middle	increase, environment, invest, level, modest, issue, state, thing/maturity, ease, finance		
others (top three)	adv: previous year, adv: meanwhile, adv: generally, and so on	adv: previous year, adv: meanwhile, adv: generally, and so on	adv: recently, adv: still, adv: slight, and so on	adv: previous year, adv: still, adv: severe, and so on
Correlations with				
leading	0.07	0.51**	-0.55**	-0.54**
coincident	-0.09	0.46**	-0.42**	-0.44**
lagging	-0.23**	0.39**	-0.42**	-0.34**
inflation	-0.09	0.20**	-0.25**	-0.20**
mdummy	-0.04	0.04	-0.06	-0.06
mbigdummy	-0.04	0.01	-0.038	-0.02

** and * represent significance at the 5 and 10 percent levels, respectively.

Table 10: LDA Results (Future State)

Topic	1	2	3	4
Label	low prob, positive, negative	low prob, unreal, negative	high prob, neutral	high prob, neutral
high prob.			seem, appear, considered, forecasted, likely	seem, appear, forecasted, considered, likely
low prob.	attention should be paid to the possibility of, may	may		
unreal		should, is important to		
positive	economy, demand, improve, supply and demand conditions, information, profit, technology, income, progress, capital			
negative	fall, price, worsen, weak, risk, adverse effect, uncertain, sluggish, uncertain	decline, excess, price, fall, subdue, expenditure, restructuring, attention, pass through, minus		
neutral			modest, increase, invest, trend, consume, effect, produce, consumer, invest, employment	increase, trend, invest, modest, produce, effect, employment, consumer, expand, under/middle
others (top three)	adv: for the time being, adv: whole, adv: still, and so on	adv: future, adv: for the time being, adv: still, and so on	adv: for the time being, adv: previous year, adv: gradual, and so on	adv: for the time being, adv: meanwhile, adv: previous year, and so on
Correlations with				
leading	-0.50**	-0.48**	0.26**	0.47**
coincident	-0.43**	-0.39**	0.19**	0.46**
lagging	-0.36**	-0.41**	-0.06	0.55**
inflation	-0.35**	-0.22**	0.18*	0.06
mdummy	-0.14	-0.01	-0.18*	0.22**
mbigdummy	-0.04	-0.03	-0.12	0.16

** and * represent significance at the 5 and 10 percent levels, respectively.
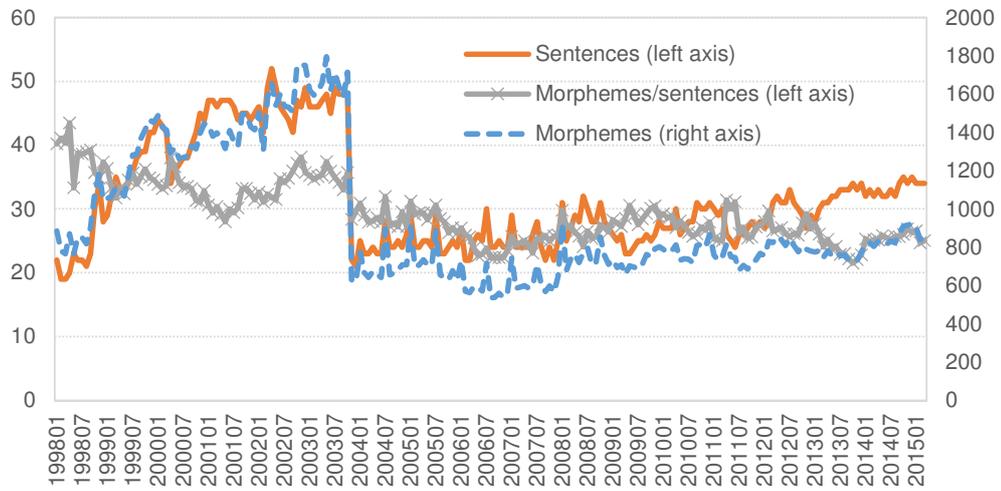
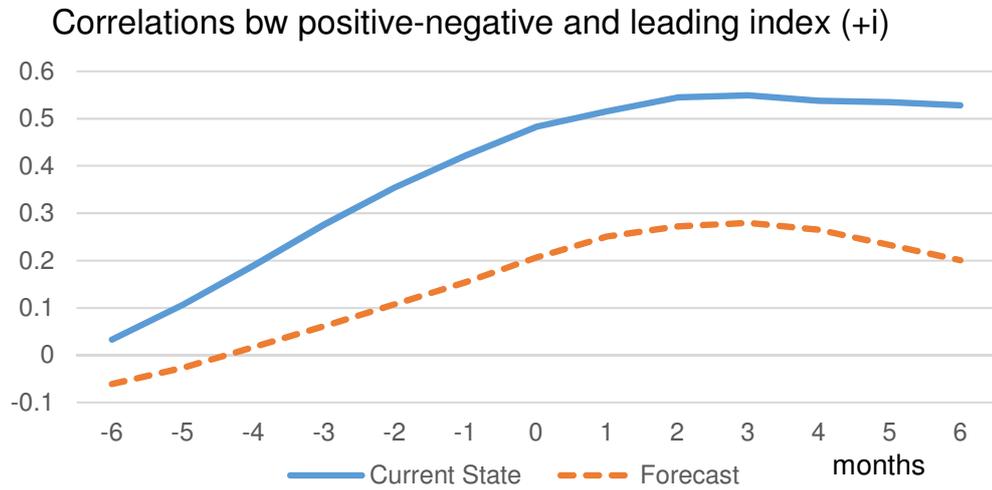Figure 1: Number of Sentences and Morphemes in the Summary Section

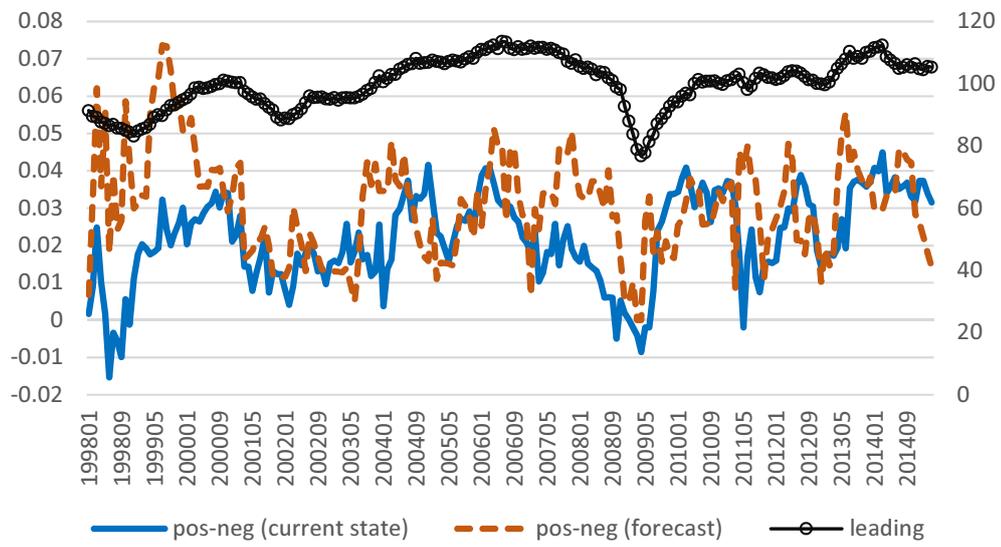Figure 2: Correlations with Polarity Expressions and the Leading Index

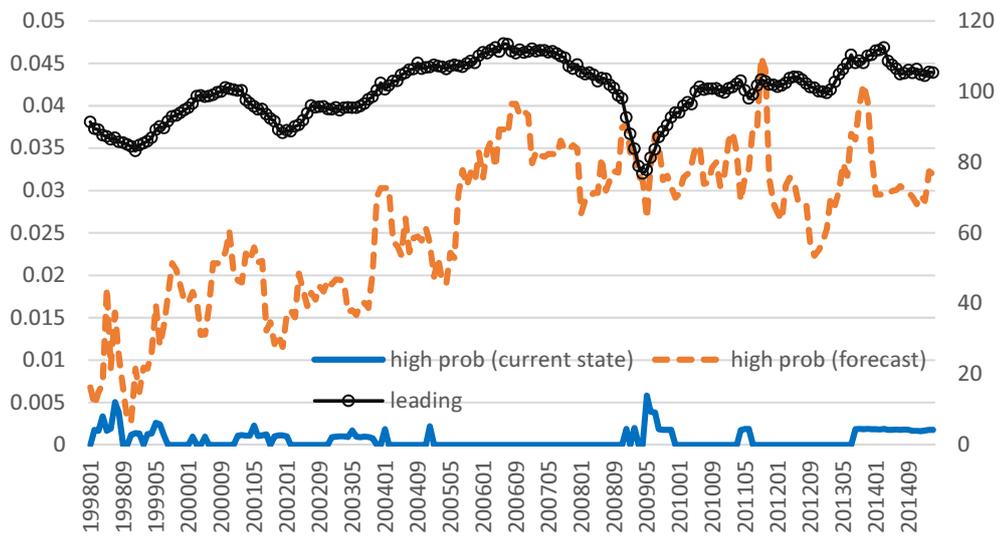Figure 3: Polarity Expressions (Left) and Leading Index (Right)

Figure 4: Modal Expressions (Left) and the Leading Index (Right)

Appendix A. Japanese–English Correspondence Tables

In each cell, the expression on the left indicates the original Japanese morpheme corresponding to the expression in English on the right, which we translate for this paper.

Table A.1: Top Ten Polarity Expressions

Positive Experience		Evaluation	
juyou	demand	ryouko	good
kaizen	improve	tame	good/reason
shikin	fund	yawaragu	ease
kaifuku	recovery	juntaku	ample
keiki	economy	takamaru	grow
shotoku	income	kousuijyun	high level
shuueki	profit	meikaku	clear
shikin juyou	credit demand	medatsu	conspicuous
kanousei	possibility	kenchou	firm
jyukyuu	supply and demand conditions	sekkyoku	active

Negative Experience		Evaluation		Neutral	
geraku	fall	kajou	excess	toshi	invest
teika	decline	yowai	weak	zoka	increase
kakaku	price	mainasu	minus	kankyou	environment
akka	worsen	teichou	sluggish	yuruyaka	modest
kosuto	cost	toboshii	weak	seisan	produce
shikin guri	financial positions	fukakujitsu	uncertain	kanwa	ease
donka	subdue	kanman	lacklustre	naka	under/middle
kibishii	severe	futoumei	uncertain	suijun	level
teimei	weak	zeijaku	fragile	kichou	trend
risuku	risk	-	-	koyou	employment

Appendix B. Linguistic Testing

Table A.2: Modal Expressions

high risk	u	seem, appear
	ga ukagawareru	seem, appear
	koto ga mikomareru	expected
	koto wa tenbou shinikui	unlikely
	te iku koto ga kitai sareru	expected
	te iku to mirareru	seem, appear
	te iku to yoso sareru	forecasted
	te iku to kangae rareru	considered
	te iku mono to kitai sareru	expected
	te iku mono to kangae rareru	considered
	te iku kanousei ga takai	likely
	te iru to mirareru	seem, appear
	te iru mono to mirareru	seem, appear
	te iru yo ni ukagawareru	seem, appear
	de iku to mirareru	seem, appear
	de iku to kitai sareru	expected
	to mirareru	seem, appear
	to yosou sareru	forecasted
	to kangae rareru	considered
	to mikomareru	seem, appear
	wa izen toshite kitai shinikui jokyo ni aru	still difficult to expect
	mo ukagawareteiru	seem, appear
	reteiru to kangae rareru	considered
	wo tadoru tono mikata ga ippanteki de aru	generally thought
	kousan ga ookii	likely
	kanousei ga ookii	likely
	hajimeru to kangae rareru	considered
	tsudukete iku to mirareru	seem, appear
low risk	risuku niwa hikitsuzuki ryuui ga hitsuyou de aru	attention should still be paid to the possibility of
	kanousei ga aru	may
	kanousei nimo ryuui ga hitsuyou de aru	warrant careful monitoring
unreal	ga hitsuyou de aru	should
	te iku koto ga hitsuyou de aru	should
	te iku koto ga jyuuyou to kangae rareru	is important to
	te iku koto mo jyuuyou to kangae rareru	is important to
	te iku hitsuyou ga aru	should
	te mite iku hitsuyou ga aru	should be observed
	hitsuyou ga aru	should

In this Appendix, we explain how modality is extracted using linguistic testing. Consider the following statement: "Sakiyuki ni tsuite wa, keiki wa kaifuku wo tsudukeru ga, sono tenpo wa yuruyaka na mono ni todomaru to kangaerareru" (As for the outlook, Japan's economy is anticipated to continue recovering, albeit at a moderate pace). We call them "candidates of the predicate" and take the following steps.

(1) Identify the noun, adjective, and verb that can be a predicate in Japanese.

- Sakiyuki (outlook), keiki (economy), kaifuku (recovering), tsudukeru (continue), tenpo (pace), yuruyaka (moderate), todomaru (albeit at), kangaerareru (be anticipated)

(2) Separate the sentence into A) candidates of proposition (terms preposing the predicate), and B) candidates of modality (terms postposing the candidates of the predicate).

A) Candidates of proposition	B) Candidates of modality
Sakiyuki	ni tsuite wa, keiki wa kaifuku wo tsudukeru ga, sono tenpo wa yuruyaka na mono ni todomaru to kangaerareru
Sakiyuki ni tsuite wa, keiki	wa, keiki wa kaifuku wo tsudukeru ga, sono tenpo wa yuruyaka na mono ni todomaru to kangaerareru
Sakiyuki ni tsuite wa, keiki wa kaifuku	wo tsudukeru ga, sono tenpo wa yuruyaka na mono ni todomaru to kangaerareru
Sakiyuki ni tsuite wa, keiki wa kaifuku wo tsudukeru	ga, sono tenpo wa yuruyaka na mono ni todomaru to kangaerareru
Sakiyuki ni tsuite wa, keiki wa kaifuku wo tsudukeru ga, sono tenpo	wa yuruyaka na mono ni todomaru to kangaerareru
Sakiyuki ni tsuite wa, keiki wa kaifuku wo tsudukeru ga, sono tenpo wa yuruyaka	na mono ni todomaru to kangaerareru
Sakiyuki ni tsuite wa, keiki wa kaifuku wo tsudukeru ga, sono tenpo wa yuruyaka na mono ni todomaru	to kangaerareru

(3) Separate all the sentences that appear in the 207 issues of the Monthly Report and count the appearance frequencies of all candidates of modality.

B) Candidates of modality	Frequency
ni tsuite wa, keiki wa kaifuku wo tsudukeru ga, sono tenpo wa yuruyaka na mono ni todomaru to kangaerareru	less than 5
wa, keiki wa kaifuku wo tsudukeru ga, sono tenpo wa yuruyaka na mono ni todomaru to kangaerareru	less than 5
wo tsudukeru ga, sono tenpo wa yuruyaka na mono ni todomaru to kangaerareru	less than 5
ga, sono tenpo wa yuruyaka na mono ni todomaru to kangaerareru	less than 5
wa yuruyaka na mono ni todomaru to kangaerareru	9
na mono ni todomaru to kangaerareru	9
to kangaerareru	161

(4) Categorize candidates of modality that appear five times or more according to the following four conditions. This step was completed by one of the authors, Kobashi, who is a native Japanese speaker.

1. It connotes assertion of a corresponding proposition. If yes, it does not belong to modality.

2. It conflicts with "the corresponding proposition would not be true." If yes, it belongs to high probability.

3. It conflicts with "the corresponding proposition is not true beyond all doubt." If yes, it belongs to low probability.

4. Other candidates belong to unreal.

In this example, *wa yuruyaka na mono ni todomaru to kangaerareru* satisfies the first condition, and both *na mono ni todomaru to kangaerareru* and *to kangaerareru* satisfy the second condition.

Appendix C. Monetary Policy Change Dummy

Table A.3: Monetary Policy Change Dummy: Otherwise dummies are zero.

	Monetary policy change dummy	Big change dummy	Notes
1998.09	-1	-1	call rate from 0.5% to 0.25%
1999.02	-1	-1	call rate to 0.15%
2000.08	1	1	call rate to 0.25%
2001.02	-1	-1	call rate to 0.15%
2001.03	-1	-1	quantitative easing (5 tril yen)
2001.08	-1	0	6 tril yen
2001.09	-1	0	over 6 tril yen
2001.12	-1	0	10 to 15 tril yen
2002.02	-1	0	increase the purchase of long-term bonds (0.8 to 1 tril yen/month)
2002.10	-1	0	increase the purchase of long-term bonds (1 to 1.2 tril yen/month)
2003.03	-1	0	17 to 22 tril yen
2003.04	-1	0	22 to 27 tril yen
2003.05	-1	0	27 to 30 tril yen
2003.10	-1	-1	27 to 32 tril yen, enhance monetary policy transparency
2004.01	-1	0	30 to 35 tril yen
2006.03	1	1	terminate quantitative easing, understanding of price stability
2006.07	1	1	call rate from 0% to 0.25%
2007.02	1	1	call rate to 0.5%
2008.09	-1	0	U.S. dollar funds-supplying operation
2008.10	-1	-1	call rate to 0.3%
2008.12	-1	-1	call rate to 0.1%, purchase or long-term bonds (1.2 to 1.4 tril yen/month)
2009.03	-1	0	purchase or long-term bonds (1.4 to 1.8 tril yen/month)
2009.12	-1	-1	enhance easy monetary conditions, clarify price stability
2010.04	-1	0	strengthen the foundations for economic growth
2010.10	-1	-1	comprehensive monetary easing, call rate 0 to 0.1%, asset purchase program
2011.03	-1	0	asset purchase program to 40 tril yen
2011.08	-1	0	asset purchase program to 50 tril yen
2011.10	-1	0	asset purchase program to 55 tril yen
2012.02	-1	0	asset purchase program to 65 tril yen
2012.04	-1	0	asset purchase program to 70 tril yen
2012.09	-1	0	asset purchase program to 80 tril yen
2012.10	-1	0	asset purchase program to 91 tril yen
2012.12	-1	0	asset purchase program to 101 tril yen
2013.01	-1	-1	2% inflation target, accord with the government
2013.04	-1	-1	Quantitative Qualitative Monetary Easing (QQE)
2014.10	-1	-1	expand QQE

Appendix D. Monthly Report in English

We use the Multi-Perspective Question Answering (MPQA) developed by Wilson, Wiebe, and Hoffmann (2005) for sentiment polarity expressions. For modality, we take the same linguistic testing approach as the one described in Appendix 4, except that we extract modal expressions from expressions *before* predicates, in order to adjust to the grammatical structure of English.[21] Our classification of modal expressions as a result is almost the same as that in Appendix 4. That is, high probability expressions include "seem," "appear," and "expected," and unreal expressions include "should" and "is important to."

Table A.4: Comparison of the Monthly Report in Japanese and English

The number of expressions

		Current state		Future state	
		Japanese	English	Japanese	English
Polarity	Positive	5265	3211	3320	1294
	Negative	2487	2606	1436	854
Modality	High prob	88	56	1530	973
	Low prob	0	0	30	6
	Unreal	78	10	99	30
Total morphemes		130520	105296	64090	52858

Correlations with the Leading Index

	Current state		Future state	
	Japanese	English	Japanese	English
Pos neg	0.57**	0.72**	0.14*	0.50**
High prob	-0.37**	0.13	0.60**	0.73**
Low prob			-0.39**	-0.22**
Unreal	-0.61**	-0.24**	-0.31**	-0.14*

** and * represent significance at the 5 and 10 percent levels, respectively.

Appendix E. Central Bank Communication as a Disclosure Game

In this Appendix we develop a simple game-theoretic model to explain the empirical findings we have presented in the main text. Specifically, we model communication by a central bank as a persuasion game where the sender can choose to disclose or withhold private information to the receiver but cannot fabricate it. The assumption that the sender (central bank) cannot lie but can withhold information is relevant to the context of the central bank's periodic reports, because the data they contain may be verified later, and because repeated interaction with the receiver/market (which is not modeled explicitly here) means that there may be significant

---

[21] For example, in the sentence "Furthermore, it is important to promote structural reform in order to facilitate a recovery in private demand" (February 2000), we identify "is important to" as a modal expression and "promote structural reform" as a predicate.

reputational and political costs if the central bank is found to have fabricated information. Meanwhile, it would be much more difficult for the market to discern whether the central bank did or did not have a certain piece of information, as assumed in our model below.

We make two further assumptions in light of the particular environment the Bank of Japan had been in during the period of our study. First, the central bank has information superior to that of private market participants. This is supported by our finding in Section 3.1 that the Bank of Japan has forecasting power for the economy. Second, we assume that the central bank has an upward bias to induce inflation, as discussed in the main text.[22]

Needless to say, the validity of these assumptions does not readily generalize. The purpose of developing a simple model with these assumptions is to highlight the importance of strategic motives in understanding central bank communications, by focusing on a particular economic environment.

E.1 Setup

The economy consists of a central bank (CB) and a representative market participant (P). The CB is the sender of information, and the P is the receiver. There are three states of the macroeconomy $y \in \{-1, 0, 1\}$. Each state arises with strictly positive probability and is either partially or completely known to the CB but unknown to the P, as we will describe in detail shortly. The feature that the CB has private information is consistent with our finding that the Bank of Japan has forecasting power for the economy.

P's payoff is given by a quadratic loss function $-(y - V)^2$, where V denotes P's action. We can think of V as price level. The CB's report is denoted by m. The P Bayesian-updates the belief about the economy based on m and best responds, so that his reaction is given by $V^* = E[y \mid m]$.

We assume that the CB's and P's interests are not completely aligned in the sense that, conditional on the state y, the CB wants the P to take an action higher than y. In this paper, we assume that the CB has an upward bias. For simplicity the CB's payoff function is given by V, in order to capture situations where the CB wishes to induce higher inflation, as in our empirical analysis. [23] This implies that the CB is better off when the market reaction is higher.

Before publishing the report m, the CB receives two types of private signals about the state of the economy, namely $S \in \{S_L, S_H\}$ and $s \in \{-1, 0, 1\}$. The CB receives an *ambiguous* signal S with probability 1. If $S = S_L$ then $y \in \{-1, 0\}$, that is, *y may be* low. If $S = S_H$, then

---

[22]Although the inflation target was one percent or not clearly stated before January 2013, the Bank of Japan had always attempted to raise the inflation rate to escape from the deflationary stagnation. Chapter 7 of Walsh (2010) discusses an inflation bias.

[23]This particular form of the payoff function is not essential. Our results hold, for example, if the CB's payoff function is $-(y + b - V)^2$ and b is large enough, where $b > 0$ is the CB's upward bias.

$y \in \{0, 1\}$, that is, y *may be* high. In addition, the CB receives a precise, *clear* signal s with probability $\theta \in (0, 1)$. The clear signal is perfectly informative about the state: if $s = x$ then $y = x$. The parameter θ is common knowledge and represents how well the CB is informed. The CB's choice in this game is which signal to disclose or withhold.

E.2 Equilibrium

Let us consider how information is revealed in a perfect Bayesian equilibrium of this game. The first step is to note that in equilibrium, the CB cannot completely withhold private information. Suppose that the CB does not publish any information. Then, P's reaction will be $V = E[y]$, where $E[y]$ is the unconditional expectation of y. However, when $S = S_H$, the CB reveals the signal since it induces a higher reaction $E[y \mid S_H] > E[y]$. In turn, if the CB does not reveal $S = S_H$ or s, then the P can infer that $S = S_L$ (recall the assumption that the CB always receives S). The P is indifferent between publishing $S = S_L$ and not publishing any information, and in any case S is perfectly revealed in equilibrium. Naturally, when s is not observed, the CB only publishes $S \in \{S_L, S_H\}$.

When the CB observes a clear signal s, four cases arise.

First, if $s = -1$, the CB withholds $s = -1$ and publishes only $S = S_L$. This is because we have $V = E[y \mid m = S_L] > -1$, which holds since the P cannot tell whether the CB has received $s = -1$ and withheld it, or the CB has not received s and state y can be either -1 or 0.

Second, if $s = 0$ and $S = S_L$, the CB reveals $s = 0$, since it induces higher reaction $V = 0 > E[y \mid m = S_L]$.

Third, if $s = 0$ and $S = S_H$, the CB withholds $s = 0$, since $V = E[y \mid m = S_H] > 0$.

Finally, if $s = 1$, the CB reveals $s = 1$, since $V = 1 > E[y \mid m = S_H]$.

The above arguments can be summarized in the following proposition.

Proposition 1 *In the unique perfect Bayesian equilibrium,*

i) if clear signal s is not observed, then the CB's report is ambiguous;

ii) if s is observed, then the CB sends the report $m = s$ only when $s = 1$ or when $s = 0$ and $S = S_L$.

The proposition has the simple intuition that, because of the upward bias, the CB hides a clear signal whenever the corresponding ambiguous signal induces a more optimistic belief (and reaction). The results can be related readily to our empirical findings.

Remark 2 *The negative reports are always ambiguous.*

The CB never reports $s = -1$. If $s = -1$, then the CB hides it and sends an ambiguous report $m = S_L$ instead. In the context of our empirical analysis, $m = S_L$ can be thought of as reporting negative sentences with modality, which makes them ambiguous and less categorical about the state of the economy. The market cannot know for certain whether modality is used because the CB does not have clear information, or because the CB has clear information but withholds it to influence the beliefs in the market. Positive reports can also be ambiguous ($m = S_H$) but if a clear signal has been obtained, it is revealed, which suggests that positive expressions are less likely to contain modality. The CB's equilibrium reporting strategy here is consistent with our findings in the main text.