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# Strategic Central Bank Communication: Discourse and Game-Theoretic Analyses of the Bank of Japan's Monthly Report\*

Kohei Kawamura<sup>†</sup>, Yohei Kobashi<sup>‡</sup>, Masato Shizume<sup>§</sup>, and Kozo Ueda<sup>¶</sup>

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## 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 the difference between the number of positive and negative expressions in the reports leads the leading index of the economy by approximately three months, which suggests that the central bank's reports have some superior information about the state of the economy. Moreover, ambiguous expressions tend to appear more frequently with negative expressions. Using a simple persuasion game, we argue that the use of ambiguity in communication by the central bank can be seen as strategic information revelation when the central bank has an incentive to bias the reports (and hence beliefs in the market) upwards.

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

JEL classification: D78, D82, E58, E61

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# 1 Introduction

Central banks not only implement monetary policy but also provide a significant amount of information for the market (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. In particular, 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. Specifically, we conduct discourse analyses using the Bank of Japan's *Monthly Report of Recent Economic and Financial Developments* (the Monthly Report, hereafter) from January 1998 to March 2015.

Employing a natural language processing method, we first 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 some superior information about the state of the economy. Moreover, 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. Using a latent Dirichlet allocation (LDA) model, we further 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.

Second, we develop a simple game-theoretic model to understand the empirical observations as a consequence of strategic communication. In the model, the central bank always obtains coarse information about the state of the economy but may or may not find precise information. Moreover, the central bank has an upward bias: it wants the market to hold optimistic beliefs

when the ongoing inflation rate is lower than the target, which is actually the case for the period included in our empirical analysis. We demonstrate that when the state of the economy is bad, the central bank only discloses coarse information. In other words, negative reports become ambiguous in order to avoid the market from becoming very pessimistic. On the other hand, if the central bank receives a precise signal about the economy being good, that signal is disclosed as it makes the market belief more optimistic than when it is withheld. We argue that the central bank's equilibrium reporting strategy is consistent with our observations in the Monthly Report.

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. For example, Boukus and Rosenberg (2006), Hendry and Madeley (2010), Apel and Grimaldi (2012), Hendry (2012), and Hansen and McMahon (forthcoming) analyze the communications of the Federal Reserve, Bank of Canada, and Riksbank, and their relevance to the real economy and/or effects on financial markets. 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. Our study complements these previous studies by emphasizing the usage of ambiguity and explaining its rationale using a game theory. In particular, the above finding by Born, Ehrmann, and Fratzscher (2014) as well as our empirical results are consistent with the predictions from our game-theoretic model. To the best of our knowledge, there is no academic study regarding the Bank of Japan's communication in the given context. Furthermore, the findings of our study may be valuable to financial market participants interested in the intent of central banks' forecasts of the future course of monetary policy.

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 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. 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 deciphering the actual policy front from a sender’s assessments and intentions. 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.<sup>1</sup>

This paper is structured as follows. Section 2 describes the data, and Section 3 presents the results from our discourse analyses. Section 4 proposes a game-theoretic model to explain the Bank of Japan’s communication strategy. Section 5 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. 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 mainly three 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 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.<sup>2</sup>

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<sup>1</sup>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]).

<sup>2</sup>The Bank of England enriched their communication in August 2015.

Therefore, we can evaluate the contents of the Monthly Report in more detail than we would otherwise be able to.

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 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.<sup>3</sup>

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 on 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.<sup>4</sup>

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.

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<sup>3</sup>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.

<sup>4</sup>In Japanese, the number of morphemes is a better measure of the size of a document than the number of words, since there are multiple ways to count words.

Table 1: Basic Statistics

	Sentences		Morphemes		Mor/sen	
	mean	(s.d.)	mean	(s.d.)	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)

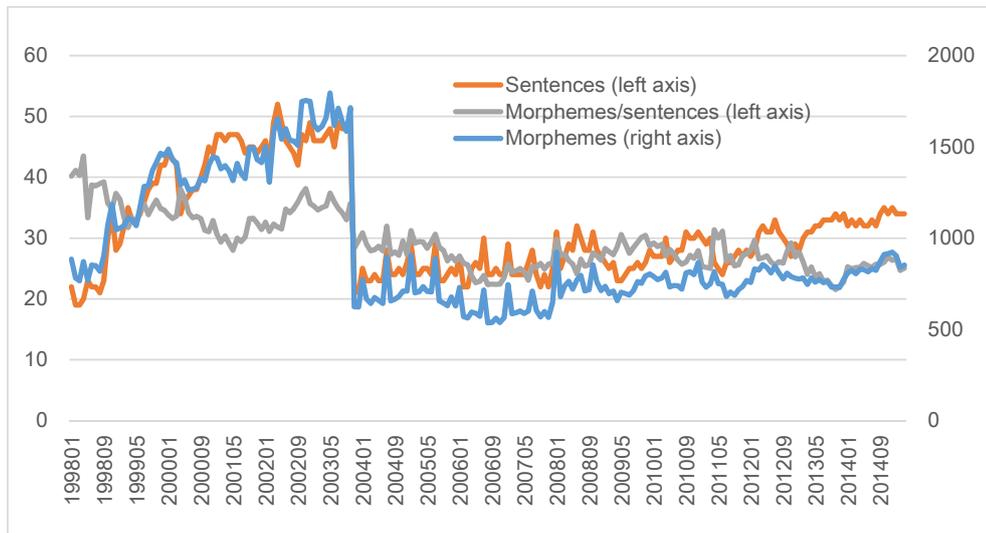


Figure 1: Time Series Developments in the Number of Sentences and Morphemes in the Summary Section

## 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. 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 inflectional expressions (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 checked by native speakers.

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. Many of the expressions are classified according to their usual meaning. 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 this criterion 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)

The second classification is modality (e.g., see Johnson-Laird [1978]). Modality is a grammatical concept in linguistics and is typically conveyed through auxiliary verbs such as “must,” “would,” and “may” in English. These expressions are often defined as “subjective,” “unreal,”

Table 2: Top Five Polarity Expressions

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

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

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 certainty). Such modality is particularly indicative of ambiguity, conveying a writer’s subjective view.<sup>5</sup>

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.<sup>6</sup> In this study, we choose all end-of-

<sup>5</sup>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, 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.”

<sup>6</sup>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.

sentence expressions that appear at least five times in the Monthly Report. 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 were never used in sentences about the current state.

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 (0.0028)	0.0001 (0.0003)	0.0007 (0.0010)
- present	0.0006 (0.0010)	0.0000 (0.0000)	0.0004 (0.0007)
- forecast	0.0261 (0.0090)	0.0003 (0.0009)	0.0014 (0.0020)

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

### 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. It leads the composite 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.<sup>7</sup>

## 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 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

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<sup>7</sup>See Appendix C for the construction of the dummy variables.

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.<sup>8</sup> Third, 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 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

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<sup>8</sup>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.

Table 5: Correlations (Current Situations)

	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						
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
etc	-0.55**	-0.39**	-0.24**	-0.10	-0.08	-0.04

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

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 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 Relationship

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

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
etc	-0.01	-0.01	-0.12	0.02	0.15*	0.07

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

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.

### 3.2 Time Series Developments and Illustrative Examples

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.

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

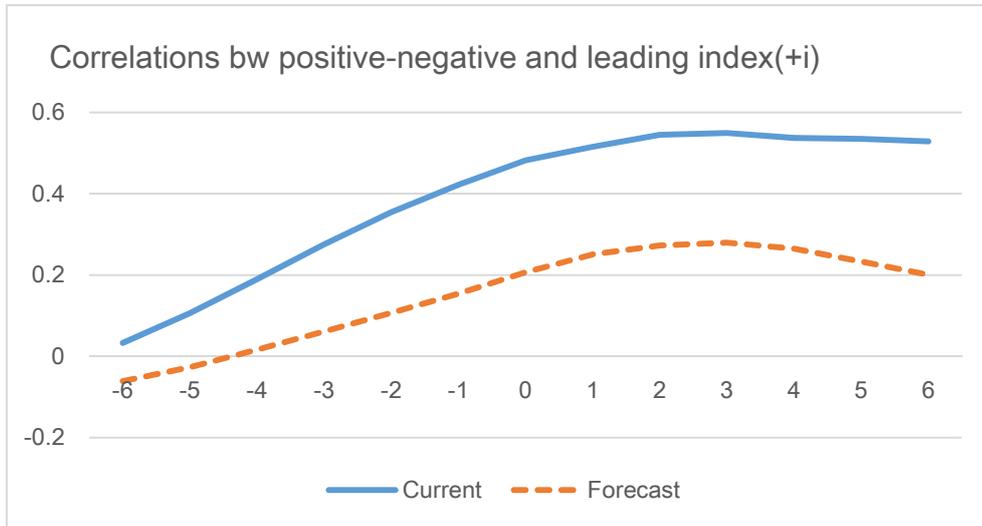


Figure 2: Correlations with Polarity Expressions and the Leading Index

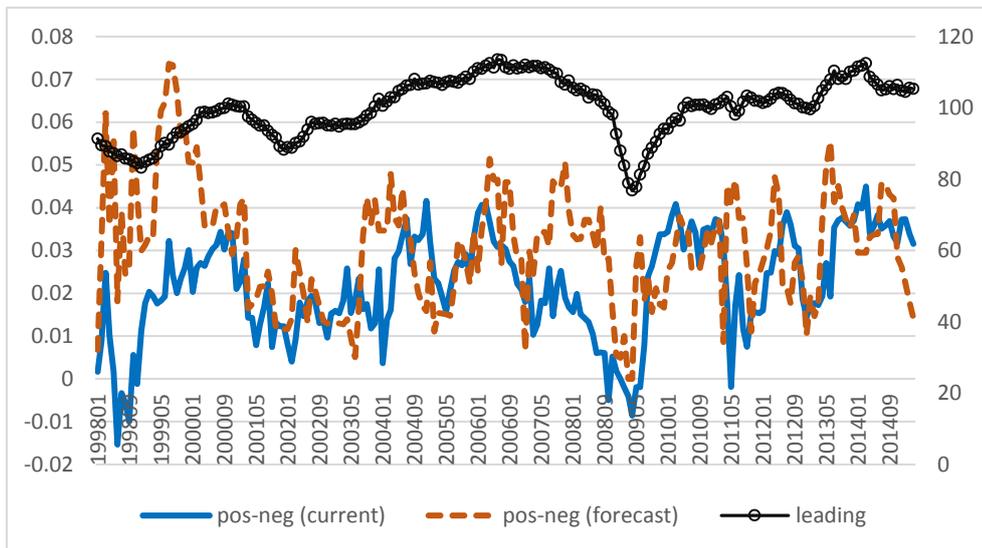


Figure 3: Time Series Developments in Polarity Expressions (Left) and Leading Index (Right)

falls, which is confirmed by the negative correlation observed between them in Table 5.

Let us provide three illustrations. 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.<sup>9</sup>

### 3.3 Robustness

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 tend to obey a slow moving process and show some 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

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<sup>9</sup>We are aware that the nuances in the English version differ 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.

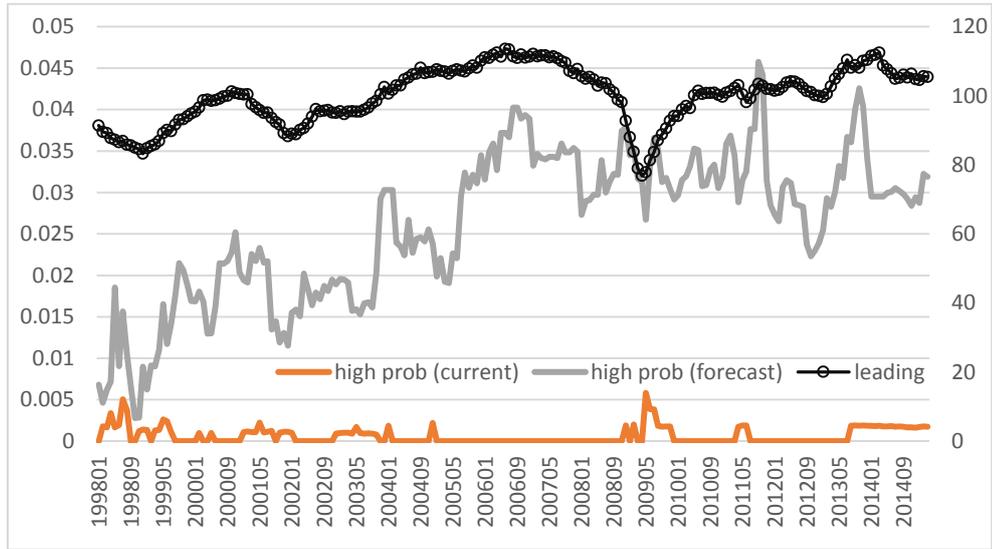


Figure 4: Time Series Developments in Modal Expressions (Left) and the Leading Index (Right)

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 Sample Split and GDP Gap

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.

The Bank calculates the quarterly GDP gap of its own and assigns more weight to it than the composite indexes while making policy decisions. The correlations between the GDP gap and polarity expressions and those between the GDP gap and modal expressions remain significant.<sup>10</sup>

### 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

<sup>10</sup>We thank a member of staff at the Bank of Japan for suggesting this robustness check and the GDP gap data.

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.

## 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.<sup>11</sup> 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. Moreover, the extracted latent variables, which we call “topics of documents,” or simply “topics,” can often be easily interpreted, which helps us understand the semantic

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<sup>11</sup>Hansen, McMahon, and Prat (2014) and Hansen and McMahon (forthcoming) previously apply the LDA to economics. The former investigates how discussions and decision making proceed using the Federal Reserve’s transcripts.

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. The 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  $\{1, 2, \dots, V\}$ , a document (=a sequence of  $N$  expressions)  $\vec{w} = (w_1, w_2, \dots, w_N)$ , and a corpus (=a collection of  $M$  documents)  $D = (\vec{w}_1, \vec{w}_2, \dots, \vec{w}_M)$ . 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  $w_i$ , 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.  $\beta$  is also the Dirichlet distribution with parameter  $\eta$ .  $\text{Multi}(w_i|z_i, \beta)$  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  $\alpha$  and  $\eta$ , where  $\alpha$  and  $\eta$  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  $\alpha$  and  $\eta$  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 7 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 8. 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

Table 7: LDA Results (Current State)

Topic Label	1 positive, neutral	2 neutral	3 high prob, unreal, positive, negative	4 negative
high prob			seem, appear	
low prob				
unreal			should	
positive	fund, demand, improve, credit demand, good, ef- fect, money, profit, economy, income		demand, fund, credit demand, interest, credit, activity, service, income, good/reason, resolve	
negative			fall, weak, decline, attention, cost, ex- cess, worsen, expen- diture	price, fall, decline, worsen, subdue, slug- gish, financial posi- tions, severe, reces- sion, risk
neutral	environment, ease, level, issue, in- vest, increase, finance, modest, thing/maturity, under/middle	increase, environ- ment, 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: se- vere, 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.

positive expressions.

Table 8: LDA Results (Future State)

Topic Label	1 low prob, positive, negative	2 low prob, unreal, negative	3 high prob, neutral	4 high prob, neutral
high prob.			seem, appear, con- sidered, forecasted, likely	seem, appear, fore- casted, considered, likely
low prob.	attention should be paid to the possibil- ity 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, restruc- turing, attention, pass through, minus		
neutral			modest, increase, in- vest, trend, consume, effect, produce, con- sumer, invest, em- ployment	increase, trend, in- vest, modest, pro- duce, effect, employ- ment, consumer, ex- pand, under/middle
others (top three)	adv: for the time be- ing, adv: whole, adv: still, and so on	adv: future, adv: for the time being, adv: still, and so on	adv: for the time be- ing, adv: previous year, adv: gradual, and so on	adv: for the time be- ing, 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.

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 Findings So Far

Our empirical findings 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. This implies that the Bank of Japan has some information superior to that of private market participants, which serves as one of our modeling assumptions in the next section.

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, word length tends to be longer and modality and “etc.” expressions tend to appear more frequently when the leading index is low. Our parsimonious LDA model suggests that modality is used in tandem with negative expressions when the leading index is low.

It should be noted that our empirical analysis 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 shocks can account for short, sharp recessions and recoveries. However, 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 may well have been highly uncertain. This suggests that one of our main findings—that ambiguous expressions appeared more frequently in sentences referring to the current state when the economy was weak—cannot be entirely attributed to the underlying lack of clarity in the economic conditions. A natural interpretation then is that the Bank of Japan used ambiguity intentionally when the economy was weak, at least when discussing the current state of the economy. In the next section we formalize this insight and obtain the intuition using a simple game-theoretic model.

## 4 Central Bank Communication as a Disclosure Game

In this section we develop a simple game-theoretic model to explain the empirical findings we have presented so far. We model communication by a central bank as a persuasion game (e.g., Milgrom [1981], Shin [2003], sometimes called a verifiable disclosure model), where the sender can choose to disclose or withhold private information to the receiver but cannot fabricate it. The assumption is in contrast to that in “cheap talk” models (e.g., Stein [1989]), where the sender is allowed to send any kind of message at no cost irrespective of the nature of the private information. 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 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.

#### 4.1 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  $-(y - V)^2$ . 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  $V^* = E[y | m]$ .

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  $y$ .<sup>12</sup> In this paper, we assume that the CB has an upward bias, since during the period under study, Japan has seen deflation or inflation lower than the current target level of two percent. For simplicity the CB's payoff function is given by  $V$ .<sup>13</sup> 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  $y \in \{0, 1\}$ , 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  $\theta$  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.

<sup>12</sup>See, for example, Chapter 7 of Walsh (2010) for discussions on such inflation bias.

<sup>13</sup>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.

## 4.2 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  $E[y | S_H] > E[y]$ . 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  $V = E[y | m = S_L] > -1$ , 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  $V = 0 > E[y | m = S_L]$ .

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

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

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.

In addition, the model generates implications beyond our empirical findings.

**Remark 3** *If taken literally, the CB's reports are upward biased.*

If  $s = -1$ , then  $m = S_L$ . If  $s = 0$  and  $S_H$  is observed, then  $m = S_H$ . Although the P rationally Bayesian-updates and thus is never deceived, the expressions should include more positive and less negative expressions than the state of the economy indicates.

**Remark 4** *Let  $m \in \{S_L, -1\}$  be an pessimistic report and  $m \in \{S_H, 1\}$  be an optimistic report. Then on average, optimistic reports have more impact on the market reaction than pessimistic reports.*

The apparent asymmetric reaction of the market is only due to the fact that  $m = -1$  is never revealed, and thus, the overall reaction is dampened when the report is negative. This can explain the findings of Born, Ehrmann, and Fratzscher (2014) that financial stability reports from central banks around the world lead to significant positive stock market returns when they are optimistic, but no such effect is found when they are pessimistic.

## 5 Concluding Remarks

We studied a central bank's communication strategy by analyzing how expressions used in published reports are related to the state of the economy. We conducted a discourse analysis of the Bank of Japan's Monthly Report and found that the difference between the number of positive and negative expressions leads the leading index of the economy by approximately three months. Moreover, ambiguous expressions tend to appear more frequently with negative expressions, which suggests the possibility that the Bank of Japan attenuated the negative tones in the Monthly Report intentionally. Using a simple persuasion game, we argued that the use of ambiguity in communication by the central bank can be seen as strategic information revelation when the central bank has an incentive to bias the reports (and hence beliefs in the market) upwards.

Future research is to test our analysis using other forms of publications. We are particularly interested in whether our results hold for other publications, namely those by 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 a central bank's reports under an overheated macroeconomy or high inflation, in which case the central bank should have a downward bias in communication.

## References

- [1] Apel, M. and M. Blix Grimaldi (2012) "The Information Content of Central Bank Minutes." Sveriges Riksbank Working Paper Series 261.
- [2] Bernardo, J. M. (2003) "Bayesian Statistics 7." In Proceedings of the Seventh Valencia International Meeting. New York: Oxford University Press.
- [3] Blei, David M., Andrew Y. Ng and Michael I. Jordan. (2003) "Latent Dirichlet Allocation." *Journal of Machine Learning Research*, 3, pp. 993-1022.
- [4] Blinder, Alan S. (2004) "The Quiet Revolution: Central Banking Goes Modern." New Haven: Yale University Press.
- [5] Bloom, Nicholas (2009) "The Impact of Uncertainty Shocks." *Econometrica*, 77(3), pp. 623–685.
- [6] Born, Benjamin, Michael Ehrmann, and Marcel Fratzscher (2014) "Central Bank Communication on Financial Stability." *Economic Journal*, 124, pp. 701–734.
- [7] Boukus, E. and J. V. Rosenberg (2006) "The Information Content of FOMC Minutes." mimeo, Federal Reserve Bank of New York.
- [8] 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.
- [9] 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.
- [10] Eijffinger, Sylvester and Petra Geraats (2006) "How Transparent are Central Banks?" *European Journal of Political Economy*, 22, pp. 1–21.
- [11] Fairclough, Norman (1989) "Language and Power." London: Longman.

- [12] Fillmore, Charles J. (1968) “The Case for Case.” in *Universals in Linguistic Theory*, Holt (ed.) Rinehart & Winston of Canada Ltd., pp.1–88.
- [13] Fujiwara, Ippei (2005) “Is the Central Bank’s Publication of Economic Forecasts Influential?” *Economics Letters*, 89, pp. 255–261.
- [14] Gramsci, Antonio (1971) “Selections from the Prison Notebooks of Antonio Gramsci.” New York: International Publisher.
- [15] Hansen, Stephen and Michael McMahon (forthcoming) “Shocking Language: Understanding the Macroeconomic Effects of Central Bank Communication.” *Journal of International Economics*.
- [16] Hansen, Stephen, Michael McMahon, and Andrea Prat (2014) “Transparency and Deliberation within the FOMC: A Computational Linguistics Approach.” mimeo.
- [17] Hendry, S. (2012) “Central Bank Communication or the Media’s Interpretation: What Moves Markets?” *Bank of Canada Working Papers* 12-9.
- [18] Hendry, S., and A. Madeley (2010) “Text Mining and the Information Content of Bank of Canada Communications.” *Bank of Canada Working Papers* 10-31.
- [19] 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.
- [20] Jin, Ginger Zhe, Michael Luca, and Daniel Martin (2015) “Complex Disclosure.” mimeo.
- [21] Johnson-Laird, Philip N. (1978) “The Meaning of Modality.” *Cognitive Science*, 2, pp.17–26.
- [22] 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.
- [23] 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.

- [24] Li, Feng (2008) “Annual Report Readability, Current Earnings, and Earnings Persistence.” *Journal of Accounting and Economics*, 45, pp. 221–247.
- [25] Li, Feng (2010) “Textual Analysis of Corporate Disclosures: A Survey of the Literature.” *Journal of Accounting Literature*, 29, pp. 143–165.
- [26] Milgrom, Paul (1981) “Good News, Bad News: Representation Theorems and Applications.” *Bell Journal of Economics*, 12, pp. 380–391.
- [27] Narrog, Heiko (2009) “Modality in Japanese: The Layered Structure of the Clause and Hierarchies of Functional Categories.” Amsterdam: John Benjamins Publishing.
- [28] Nitta, Yoshio (2011) “Nihongo no modariti to sono shuhen [Modality in Japanese and Around] (in Japanese).” Tokyo: Hitsuji Shobo.
- [29] Palmer, F. R. (2001) “Mood and Modality.” Second Edition. Cambridge: Cambridge University Press.
- [30] Pang, Bo and Lillian Lee. (2008) “Opinion Mining and Sentiment Analysis.” *Foundations and Trends in Information Retrieval* 2(1-2), pp.1–135.
- [31] Romer, C. and Romer, C. (2000) “Federal Reserve Information and the Behavior of Interest Rates.” *American Economic Review*, 90, pp. 429–457.
- [32] Shin, Hyun Song (2003) “Disclosures and Asset Returns.” *Econometrica* , 71(1), pp. 105–133.
- [33] Stein, Jeremy C. (1989) “Cheap Talk and the Fed: A Theory of Imprecise Policy Announcements.” *American Economic Review*, 79(1), pp. 32–42.
- [34] Steyvers, Mark. and Tom Griffiths. (2007) “Probabilistic Topic Models.” *Handbook of Latent Semantic Analysis*, 427(7), pp.424–440.
- [35] Sweetser, Eve. (1991) “From Etymology to Pragmatics: Metaphorical and Cultural Aspects of Semantic Structure.” Cambridge University Press.
- [36] 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.
- [37] Tomz, Michael and Robert P. Van Houweling (2009) “The Electoral Implications of Candidate Ambiguity.” *American Political Science Review*, 103(1), pp 83–98.

- [38] van Dijk, Teun A. (2008) “Discourse and Power.” Houndmills: Palgrave.
- [39] Varian, Hal R. (2014) “Big Data: New Tricks for Econometrics.” *Journal of Economic Perspectives*, 28(2), pp. 3–27.
- [40] Wallach, Hanna. M., Mimno, David. M., and McCallum, Andrew. (2009) “Rethinking LDA: Why Priors Matter.” *Advances in Neural Information Processing Systems*, pp. 1973–1981.
- [41] Walsh, Carl E. (2010) “Monetary Theory and Policy.” Cambridge: MIT Press.
- [42] Wilson, Theresa, Janyce Wiebe, and Paul Hoffmann (2005) “Recognizing Contextual Polarity in Phrase-Level Sentiment Analysis.” In *Proceedings of HLT-EMNLP-2005*.
- [43] Woodford, Michael (2003) “Interest and Prices.” Princeton: Princeton University Press.

## 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 9: Top Ten Polarity Expressions

Positive experience		evaluation		Neutral	
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	kankyau	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

Table 10: 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 tonon 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

## B Linguistic Testing

In this section of the 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 monthly reports 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.

## C Monetary Policy Change Dummy

Table 11: 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

## 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 B, except that we extract modal expressions from expressions *before* predicates, in order to adjust to the grammatical structure of English.<sup>14</sup> Our classification of modal expressions as a result is almost the same as that in Appendix A. That is, high probability expressions include “seem,” “appear,” and “expected,” and unreal expressions include “should” and “is important to.”

Table 12: 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.

<sup>14</sup>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.