Monetary Policy Communication of the Bank of Japan: Computational Text Analysis

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Abstract

In this study, we empirically examine the effects of the Bank of Japan (BOJ)'s communications through its meeting minutes on the financial markets, especially during Mr. Kuroda's administration from April 2013 to September 2017. Using computational linguistic models and the Latent Dirichlet Allocation, we quantify the contents of the BOJ minutes and extract topics form these minutes, including the bank's historical monetary policy and policymakers' views on current economic conditions. The empirical results suggest that a relationship exists between the estimated topics and the market reactions on the days on which the minutes are released. Although the market paid attention to the monetary policy description in the minutes in the early period of the introduction of quantitative and qualitative monetary easing (QQE), the significance of monetary policy information under the October 2014 expansion of the QQE on financial markets faded. In contrast, information on fund-provisioning measures to support Japanese companies' activities, including a negative interest rate policy, induced a decline in the stock market. We found that the market pays attention to meeting members' opinions on current economic conditions.

1 Introduction

Today, central bank communication has become a key tool used by these banks to gain support for their monetary policies. Blinder et al. (2008) defined central bank communication as information that the central bank makes known to the public regarding its current and future monetary policy objectives, monetary policy strategy, economic outlook and outlook regarding the path of future policy decisions. Two main reasons exist for why an increasing number of central banks have activated such communication. First, central banks as independent institutions have a duty to explain both their actions and the thinking that underlines their monetary policies. Second, central banks communicate to manage market expectations and to influence asset prices. Moreover, Blinder et al. (2008) explained that the latter using the two aspects of 'creating news' and 'reducing noise'. 'Creating news' means that a central bank's announcement promotes expectations and moves asset prices. 'Reducing noise' means that a central bank's talk contributes to the predictability of its actions, which reduces financial market volatility.

Recently, the Bank of Japan (BOJ) regarded central bank communication also as an important toolkit to ensure the efficiency of its monetary policy. Shirai (2014), as a policy board member of the BOJ, presented three reasons why the BOJ accepted central bank communication. First, in January 2013, the BOJ adopted a 2% price stability target in terms of the year-over-year rate of change on the basis of the consumer price index (CPI). Second, also in January 2013, the BOJ and the Japanese government released a joint statement on their cooperation to overcome deflation and to achieve sustainable economic growth. Finally, the BOJ is actively using its communication strategy to achieve a 2% price stability target on monetary accommodations under quantitative and qualitative monetary easing (QQE) that started in February 2013. In particular, the BOJ declared that from April 2013, '*The Bank will continue with the quantitative and qualitative monetary easing, aiming to achieve the price stability target of 2%, as long as it is necessary for maintaining that target in a stable manner*'. The strategy was called the open-ended forward guidance and was an attempt to enhance the effect of the QQE.

However, some market participants pointed out that the monetary policy under Mr. Kuroda's BOJ administration, including the introduction of the QQE in April 2013, 'Expansion of the QQE' in October 2014 and the introduction of the 'QQE with a Negative Interest Rate' in January 2016, provided no signals before they were implemented. Although such a monetary policy, which cannot be expected by market participants, influences asset prices given the sudden change, the effect of monetary policy transparency through central bank communication is weakened. As a result, asset price volatility can be higher because of the uncertainty that monetary policy induces. In that case, we speculate that market participants seek to obtain additional clues on future monetary policy in the information that the BOJ publishes, such as statements, speeches and minutes, after every monetary policy meeting (MPM).

Typically, the BOJ minutes of a meeting are released three business days after the next MPM. Beforehand, the BOJ provides a lot of information on its monetary policy stance through statements and speeches immediately after the meeting and outlook reports. Thus, market participants may have already expected the BOJ's future actions before the publication of the minutes. However, market participants who are concerned about sudden

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changes in monetary policy focus on the contents of the deliberations over monetary policy in the minutes and volatility moves on release days. Then, we hypothesise that the changes in the substance of the minutes can influence the market's mind. To examine this hypothesis, we use tools from computational linguistics and measure topics in the BOJ minutes, allowing us to analyse whether each topic affects asset prices.

Our study proceeds as follows. Section 2 reviews previous studies on the impact of central bank communication on asset prices, and Section 3 describes our sample and data sources. Section 4 introduces our computational linguistic approach and reports the estimations. Section 5 verifies the asset price movements on the release day of the BOJ minutes and reports the results of our empirical tests on the relationship between volatility and the topics extracted in Section 4. Section 6 concludes.

2   Previous Studies

Numerous studies exist on central bank communication on both the theoretical and empirical fronts. Geraats (2006) and Eusepi and Preston (2010) showed a model-based evaluation of central bank communication strategies. In terms of the empirical literature, Kohn and Sack (2003) and Gürkaynak et al. (2005) measured the effect of FOMC monetary policy surprises in financial markets using multiple factors. The latter study uses a high-frequency event-study analysis and measures the movements of bond yields and stock prices after central bank announcements. They decomposed the effect of the announcements into two factors, as explained by a monetary policy action factor and a statements factor. They concluded that a statements factor has an important effect on longer-term Treasury yields, and the statements have a significant effect on investor expectations.

Previously, ample empirical studies demonstrated that monetary policy information released by the BOJ affects market expectations. For example, Honda and Kuroki (2006) showed that changes in the monetary policy target significantly impact both intermediate- and long-term interest rates. Nakajima and Hattori (2009) proposed also that the release of economic outlook reports or the MPM minutes decreases volatility, whereas changes in monetary policy and an increase in the MPM members who vote against the proposal increase volatility.

Simultaneously, certain empirical studies approached the content of central bank communications and focused on the wording. As an initial study, Romer and Romer (1989) read minutes of the FOMC and identified occasions when policymakers seemed to take a more anti-inflationary stance by picking up words in the minutes. Their approach attempted to find exogenous monetary policy shocks but had the problem of subjectivity because of the manual selection of target words. To remove this obstacle, alternative studies assessed the context of monetary policy using computational linguistics tools. Fligstein et al. (2014) applied Latent Dirichlet Allocation (LDA), which was developed by Blei et al. (2003), to FOMC transcripts in order to analyse policymakers' recognition of financial crises. Using LDA, Hansen et al. (2014) examined transparency in FOMC monetary policymakers' statements from FOMC minutes.

Hendry and Madeley (2010) and Hendry (2012) measured the impact of central bank communication in Canada on financial markets using other text-mining tools. Jegadeesh

and Wu (2015) extracted contents also from FOMC meeting minutes and applied the LDA. They reported topics on economic outlook and monetary policy stance, particularly as related to return volatility. Hansen and McMahon (2016) decomposed monetary policy information from the FOMC into multi-dimension aspects and measured the dimensions that most affected both market and real economic variables. To distinguish the state of the economic condition from the information in the FOMC transcript, they use the LDA and found that shocks from the current economic condition factor is less important than the forward guidance factor on financial markets in FOMC communications.

To the best of our knowledge, several studies exist on BOJ communication using textual analysis. Shibamoto (2016) applied a text-mining approach to words in press conferences after the MPMs and found that asset prices react through BOJ communication factors, which are especially the central bank's policy intentions and preferences. In terms of the LDA, which our study uses, Shirota et al. (2014) and Shirota et al. (2015) extracted topics from BOJ minutes and analysed the transitions. However, these studies do not point out the relationship between each topic and financial markets. In this study, we confirm the relationship.

3 Data

3.1 Introduction of BOJ minutes

In this subsection, we first provide how and when the BOJ releases decisions in the MPMs. Approximately three stages exist for informing monetary policy. First, monetary policy releases and outlook report outlines are announced rapidly after the MPMs. Second, entire outlook reports are published the following day. Finally, the minutes are released after approximately one month after the completion of the MPMs (the details of the timing of each piece of information are shown in Table 1). Therefore, the impact of the minutes on financial markets seems very restrictive. However, the minutes include a lot of information that indicates the likely future path of monetary policy. Thus, we consider that the minutes can influence market expectations about future monetary policy.

Before our analysis, we briefly reviewed the BOJ's monetary policy since Haruhiko Kuroda was inaugurated as the 31st governor because we believe that such information can be meaningful for the following sections. The BOJ implemented the QQE under Kuroda's BOJ administration. Table 2 summarises the deliberation results of monetary policies noted in the minutes. Table 2 shows that the BOJ monetary policy changed six times in the relevant terms, as follows: 1) introduction in April 2013 of the QQE; 2) expansion in October 2014 of the QQE; 3) introduction of supplementary measures in December 2015 for the QQE; 4) introduction of the QQE in January 2016 with a negative interest rate; 5) enhancement in July 2016 of monetary easing and 6) introduction of the QQE in September 2016 with yield curve control.

Given the introduction of the QQE, the BOJ shifts the monetary policy target from the uncollateralised overnight call rate to the monetary base. Accordingly, the BOJ decided to increase asset purchases of Japanese government bonds (JGBs), exchange traded funds (ETFs) and Japan real estate investment trusts (J-REITs). During the period of the

QQE expansion, the BOJ announced that it accelerated the pace of the increases in the monetary base and expanded asset purchases. However, these increases in asset purchases could lead to decreases in financial institutions' holdings of eligible collateral, increases in the average remaining maturity of the JGBs and shortages of the J-REITs eligible for the BOJ to purchases. Therefore, in December 2015, the BOJ introduced supplementary measures for the QQE. In the next MPM, the BOJ announced that it applied a negative interest rate of 0.1% to its current accounts of financial institutions. From this period, the BOJ adopted measures in terms of three dimensions: quantity, quality and interest rate. In 2016, the Japanese economy was exposed to uncertainties from the global financial market because of the United Kingdom's withdrawal from the European Union and a slowdown in emerging economies. To reduce the impact of these uncertainties on the domestic economy, in July 2016, the BOJ enhanced monetary policy by increasing purchases of ETFs and establishing measures to ensure smooth funding in foreign currencies by Japanese firms and financial institutions. In September 2016, the BOJ reviewed the outcome of the QQE that started in April 2016 and decided to introduce the QQE with yield curve control to enhance the monetary easing effect. This new framework consisted mainly of two components: 1) 'yield curve control' through which the BOJ controls short-term and long-term interest rates; 2) 'inflation-overshooting commitment' through which the BOJ promises to continue to expand the monetary base until the price stability target is achieved. From the minutes, we are able to understand not only these monetary policies decisions above our explanations but also the background and the path to them.

In our study, we focus on the minutes from April 2013 to September 2017 and downloaded them from the BOJ's web site.[1] Our sample consists of 52 meeting minutes. We adopted the minutes in Japanese because our main target in the following analysis is the domestic financial market, and we supposed that the original version in Japanese can convey more accurately the discussion contents. To apply Japanese minutes to our textural analysis method, we use morphological analysis with MeCab.[2] The BOJ minutes include technical terms on finance and economics. We employed mecab-ipdic-NEologd[3] as the morphological analysis dictionary in MeCab. Using SlothLib,[4] we picked up only nouns in the minutes after removing terms in the stop word list. After these processes, the size of the source text used is 94,235 words.

3.2   Market reaction data

In this study, we used daily business data from financial markets to measure market reactions on the days on which the BOJ minutes are released. For the bond market, we used two-year, five-year, ten-year and 40-year JGB yields. We downloaded these data from the Ministry of Economy, Trade and Industry in Japan. We employed also TOPIX,

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[1]Minutes downloaded in PDF from `https://www.boj.or.jp/mopo/mpmsche_minu/minu_all/index.htm/`

[2]MeCab is a morphological analyser for Japanese language developed by the Nara Institute of Science and Technology and is currently maintained by Taku Kudou.

[3]See `https://github.com/neologd/mecab-ipadic-neologd`

[4]See `http://svn.sourceforge.jp/svnroot/slothlib/CSharp/Version1/SlothLib/NLP/Filter/StopWord/word/Japanese.txt`

Nikkei225 and the yen/dollar exchange rate. To observe changes in the J-REITs, which are target assets for the BOJ's purchases, we used the TSEREIT also. Except for bond data, these data resources are all from Datastream. The observation term is from April 2013 through September 2017, which includes 1,175 business days. The BOJ meeting minutes are published at 8:50 a.m. on the release day. If the financial market reacts to the minutes' release, asset value changes are observed on that day or after the next day. Therefore, we constructed our event window as one day or two days.

Defining $\tau = 0$ as the event date, $\tau = T_1 + 1$ to $\tau = T_2 - l$ indicates the event window, where l is the event window length of one or two days. We calculate the event-window return volatility for each equity LB_i using the following equation. Specifically, for each minutes t in our sample:

$$V_t^{LB_i} = (Y_{t,T_2}^{LB_i} - Y_{t,T_1}^{LB_i}) \times 100 \tag{1}$$

For other assets OA_i, we computed the event-window return volatility using the following equation:

$$V_t^{OA_i} = (\log P_{t,T_2}^{OA_i} - \log P_{t,T_1}^{OA_i}) \times 100 \tag{2}$$

To simplify the following explanation, these event-window return volatilities in Eq. 1 and Eq. 2 are collectively referred to as V_t.

4   Measuring BOJ minutes

In this section, we explain the LDA developed by Blei et al. (2003), which we use for the topic extraction from the BOJ minutes and consider the output from the BOJ minutes using the model. The LDA assumes that each minute is a mix of a large range of 'topics'. These topics appear as a group of words, and each word has an internal latent meaning.

Two primary motivations exist to use the LDA for the extraction topics from the minutes. First, this topic model can estimate consistently topics that appear natural without a pre-assigned label (Hansen et al. 2014). Therefore, this approach can exclude a researcher's subjectivity and can classify using common intuition despite time-varying topics. Second, although standard topic models allocate the same words to just one topic, this model allows the same word to appear in multiple topics (Hansen et al. 2014). This flexibility enables more accurate descriptions of the content in the minutes.

The remainder of this section describes the frame of the LDA. Subsequently, we discuss the result of the estimated topics from each BOJ minute.

4.1   Latent Dirichlet Allocation (LDA)

The LDA is a very popular algorithm based on the multi-hierarchical Bayesian model. This model supposes that each topic has group words on the basis of repeated co-occurrence across paragraphs, and that one document (or one minute) has several topics. Each topic is characterised by different probability distribution over the words. The document is modelled as a distribution over the topics.

For a further description of LDA, the following symbols are used:

$w_t = (w_{t,1}, w_{t,2}, \cdots, w_{t,j}, \cdots, w_{t,I_t})$ are the words that appear in minutes t, which represent the minutes released on day t; I_t is the total number of words in each minute t

$z_t = (z_{t,1}, z_{t,2}, \cdots, z_{t,j}, \cdots, z_{t,I_t})$ are the topics for w_t

D is the total number of the sample minutes

K is the total number of topics

V is the total number of vocabulary words that appear in all minutes for the sample

$\theta_{k,t}$ is the probability that topic k appears in minutes t: the proportion of topic k in minutes t

$\theta_t = (\theta_{1,t}, \theta_{2,t}, \cdots, \theta_{K,t})$ is the topic distribution for minutes t

$\phi_{k,v}$ is the probability that word v appears in topic k

ϕ_k is the word distribution for topic k

$\alpha = (\alpha_1, \alpha_2, \cdots, \alpha_K)$ are the hyper-parameters of the Dirichlet prior on the per-minute topic distributions, which are K-dimensional vectors

$\beta = (\beta_1, \beta_2, \cdots, \beta_V)$ are the hyper-parameters of the Dirichlet prior on the per-minute topic distributions, which are V-dimensional vectors

We consider the statistical process of topic distribution θ_t. θ_t is the probability K-dimensional vector. For each minute t, we assume that these vectors follow an order-K Dirichlet distribution over the K topics:

$$\theta_t \sim Dir(\alpha) \qquad (t = 1, \cdots, M). \tag{3}$$

Given minutes t's topic mixture θ_t, each word $w_{t,i}$ is assigned to topics $z_{t,i}$. We assume that this allocation follows the multinomial distribution governed by topic vector θ_t:

$$z_{t,i} \sim Multi(\theta_t) \qquad (i = 1, \cdots, n_t). \tag{4}$$

The K topic distributions ϕ_k are collections of dimensional vectors that follow an order-V Dirichlet distribution over the V vocabularies, governed by hyper-parameter β:

$$\phi_k \sim Dir(\beta) \qquad (k = 1, \cdots, K). \tag{5}$$

The word $w_{t,i}$ in minute t is selected from V unique words from our BOJ minutes sample. We assume that the choice of word $w_{t,i}$ follows a multinomial distribution governed by the result of $\phi_{z_{t,i}}$:

$$w_{t,i} \sim Multi(\phi_{z_{t,i}}) \qquad (i = 1, \cdots, n_t). \tag{6}$$

Although w_t is the only observable variable, the other variables are latent. We describe this generating process as the joint distribution of latent variables, ϕ_k, θ_t and z_t and the observable variable w_t, as follows:

$$P(\phi_k, \theta_t, z_t, w_t) = \prod_{k=1}^{K} P(\phi_k) \prod_{t=1}^{D} P(\theta_t) \left[\prod_{i=1}^{I_t} P(z_{t,i}|\theta_t) P(w_{t,i}|\phi_k, z_{t,i}) \right] \tag{7}$$

If we observe w_t from our BOJ minutes sample, we can compute the posterior distribution of the document-topic structure given the observed minutes using Bayes' Rule:

$$P(\phi_k, \theta_t, z_t | w_t) = \frac{P(\phi_k, \theta_t, z_t, w_t)}{P(w_t)}. \tag{8}$$

Although we can compute the numerator in Eq. 8 with other Bayesian inference methods, the denominator is by construction a double integral, which cannot be computed. Then, we estimate the parameters in the LDA using a collapsed Gibbs sampling algorithm introduced by Griffiths and Steyvers (2004). Their approach directory estimates the posterior distribution over topic assignments $z_{t,i}$ by integrating out ϕ_k and θ_t. The algorithm first randomly assigns topics to words and updates topic assignments by repeatedly sampling from the appropriate posterior distribution. For algorithm implementation, we use models.ldamallet[5] in Gensim, which is in the Python package.

To estimate the parameters in the LDA, we must set the number of topics K. In terms of deciding on the number, we adopt an evaluation index for a topic model introduced by Newman et al. (2010), which is called 'coherence'. The score measures word-pair co-occurrence between the set of the N highest probability words of a topic. This evaluation defines that the LDA model with the highest score is the best model. We compare the models with a different number of topics K, and decide on the number of the topic whose model has the largest coherence score. As a result, we set the number of topics K to eight.

4.2 Estimated topics

In this subsection, we discuss the outputs from the LDA estimation. As mentioned in a previous subsection, LDA estimates latent variables: $\widehat{\phi_{k,v}}$, $\widehat{\theta_{k,t}}$ and $\widehat{z_{t,i}}$. Now, we mainly focus on $\widehat{\phi_{k,v}}$ and $\widehat{\theta_{k,t}}$, and use them to examine the contents of the BOJ minutes. The LDA is an unsupervised learning algorithm. Accordingly, it does not have a meaningful label before classification, making the implications of each topic depend on a researcher's subjective judgement (Hansen et al. 2014). To avoid the misinterpretation of each estimated topic, we revalidate these results by reading the raw text of the minutes.

The rank of topic probability $\widehat{\phi_{k,v}}$ of each word v can describe the meaning of topic k. Table 3 and Table 4 report the top 40 words for each topic. They should be noted that the same words can appear in multiple topics because of the property of the LDA. For example, '物価 (prices)' appears in almost all topics, as shown in the table. In the tables, 'weight' indicates the score of $\widehat{\phi_{k,v}}$, which the LDA estimates. A higher weight score for a word indicates that the word is more characteristic in the topic. For example, Topic 0 in Table 3 is characterised by the words that have a high weight score, such as '物価 (prices)', '経済 (economy)', '目標 (target)', '買入れ (purchases)' and others.

In contrast, the topic proportion $\theta_{k,t}$ over time can grasp the trend of the contents in the minutes. The fluctuations in the proportions of the entire estimated topic in the BOJ minutes for the MPMs between April 2013 and September 2017 are shown in Figure 1. At each point in time, the trend of the contents in the minutes can be explained by the

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[5]See `https://radimrehurek.com/gensim/models/ldamallet.html`

high score of the ratios of the topics: $\widehat{\theta_{k,t}}$. For instance, Topic 0 accounts for a large part of the minutes released on 2 May 2013, indicating that these minutes are devoted mainly to Topic 0. For further consideration, the MPM members discussed mainly Topic 0 at the MPM for these recoded minutes, and market participants can understand the BOJ's stance at that time by reading the minutes.

Based on the frequency appearance words in each topic, $\widehat{\theta_{k,t}}$, and each topic proportion over time, we interpret the topics as follows.

Topic 0: BOJ's Monetary Policy Decision under Introduction of the QQE

Topic 0 includes the words related to the BOJ's monetary policy decision on the top word distributions, as shown in Table 3, such as '買入れ (purchases)', '国債 (JGB)', '量的・質的金融緩和 (quantitative and qualitative easing)' and 'マネタリーベース (monetary base)', among others. Figure 2 shows time series changes of the topic proportion regarding Topic 0: $\widehat{\theta_{0,t}}$. The score reaches its peak after the introduction in April 2013 of the QQE, and decreases towards the October 2014 expansion of the QQE.

To validate our interpretation, we read the minutes for which Topic 0 accounts for a large part. In general, the BOJ's minutes were summarised in approximately 20 pages and consisted mainly of six components: 1) Summary of Staff Reports on Economic and Financial Development; 2) Summary of Discussions by the Policy Board on Economic and Financial Developments; 3) Summary of Discussions on Monetary Policy for the Immediate Future; 4) Remarks by Government Representatives; 5) Votes; and 6) Discussion on the Statement on Monetary Policy.

Our investigation objects are the minutes released on 2 May 2013, 14 June 2013 and 17 July 2013, and have high topic proportion regarding Topic 0. The common features of these minutes describe the explanation and effect of the QQE on the part of 'Summary of Discussions on Monetary Policy for the Immediate Future' and comprise a significant number of pages. Meanwhile, we confirmed the content of the minutes for which Topic 0 comprises a low proportion. We searched the minutes released on 6 November 2014, and found that the chapter on monetary policy accounts for fewer pages than the pages for the previously described minutes. For these reasons, we interpreted the implications of Topic 0 as the monetary policy decision during the early period of the introduction of the QQE. Then, we labelled this topic Monetary Policy 1.

Topic1: BOJ's Monetary Policy Decision under the QQE Expansion

Similar to Topic 0, Topic 1 as reported in Table 3 includes also words related to monetary policy, such as '量的・質的金融緩和 (quantitative and qualitative easing)', '金利 (interest rate)', '金融政策 (monetary policy)', 'マネタリーベース (monetary base)' and others. Compared with the word list for Topic 0, Topic 1 is described by words on asset purchases, such as '買入れ (purchases)', '資産 (asset)', 'ETF' and others. From Figure 2, the proportion changes of Topic 1, $\widehat{\theta_{1,t}}$, peaks from November 2014 to November 2015. This period corresponds to the term under the QQE expansion that begins from October 2014. We confirmed the minutes with a high proportion of Topic 1. In the minutes released on 25 December 2014, for which the proportion is elevated to the peak, we discovered that these minutes emphasised that the QQE expansion is beneficial to an

increase in inflation expectations. Furthermore, we found that the minutes released on 20 March 2015, whose proportion of Topic 1 has peaks, mentioned also the relationship between the QQE expansion and inflation expectations. From this discussion, we interpret that Topic 1 concerns monetary policy under the QQE expansion after October 2014. We labelled this topic Monetary Policy 2.

Topic 2: BOJ's Monetary Policy Decision after the Introduction of the QQE with Yield Curve Control

Topic 2 in Table 3 is also characterised by the words related to monetary policy. Compared with Topic 0 and Topic 1, certain characteristic words appear only in Topic 2, such as '操作 (control)', 'イールドカーブ (yield curve)', '長期金利 (long-term interest rates)' and others. In turn, the proportion of Topic 2, $\widehat{\theta_{2,t}}$, in Figure 2 peaks on 7 November 2016. Concerned minutes describe the introduction of the QQE with yield curve control from September 2016. After the proportion peaks, this topic maintains high levels until September 2017. Confirming the contents of the minutes in these terms, yield curve control through asset purchases is mentioned. From this discussion, Topic 2 seems to be about monetary policy after the introduction of the QQE with yield curve control after September 2016. Therefore, we defined Topic 2 as Monetary Policy 3.

Topic 3: Fund-provisioning Measures

Topic 3 in Table 3 includes also words that appear in the above topics, such as '買入れ (purchases)', '量的・質的金融緩和 (quantitative and qualitative easing)' and others. Meanwhile, this topic is characterised by specific words, such as '支援 (support)', '金融機関 (financial institutions)', '貸出 (lending)', '資金供給 (fund-provisioning)', 'マイナス金利 (negative interest rate)' and others. Figure 3 reports time series changes of the Topic 3 proportion, $\widehat{\theta_{3,t}}$. From this figure, the topic increases in certain minutes, including those released on 2 May 2013, 14 March 2014, 3 February 2016 and 18 March 2016. We checked these minutes using the words in Table 3 and found that they describe fund-provision measures to stimulate domestic corporate activities. In the minutes released on 14 March 2013, policymakers discussed the Stimulating Bank Lending Facility and other measures to strengthen the growth of Japan's economy. They concluded that these operations can enhance the effect of the QQE. Additionally, the minutes released on 3 February 2016, which had an extremely high Topic 3 ratio, described the introduction of supplementary measures for the QQE. Through this operation, policymakers decided to introduce measures to support companies that invest in physical and human capital to stimulate the domestic economy. The next set of minutes released on 18 March 2016 was also occupied by this topic, corresponding to the MPMs that discuss the introduction of the QQE with a negative interest rate. The purpose of this operation stimulates bank lending. Therefore, this measure intends also to enhance the supply of money to domestic firms, strengthening economic growth. From these reasons, we interpreted Topic 3 as a fund provisioning measure to stimulate Japanese companies' activities. Thus, we labelled this topic Fund-provisioning Measures.

Topic 4: Outlook for Economic Activity and Prices

The BOJ issues economic outlook reports four times a year after the MPMs[6], in January, April, July and October. The contents of the reports are discussed at the concerned MPMs. Figure 4 indicates the changes in the proportion of Topic 4: $\widehat{\theta_{4,t}}$. The ratio of the topic has regularity; that is, the minutes released at the end of May and November until 2015, and March, June, September and November after 2016, have a high ratio of Topic 4. We confirmed the content of these minutes using the words list for Topic 4 in Table 4, which includes words related to economic outlook, such as '物価 (prices)', '見通し (outlook)', '物価上昇率 (inflation rate)', '経済 (economy)', '情勢 (condition)' and others. Then, we found that these minutes correspond to the MPMs that discussed economic outlook reports. Hence, we viewed Topic 4 as concerning discussions on economic outlook reports and labelled this topic Outlook Report.

Topic 5: Economic and Financial Development

From Table 4, Topic 5 is characterised by words related to economic trends, such as '先行き (future)', '環境 (circumstance)', '個人消費 (consumer spending)', '設備投資 (capital investment)', '情勢 (condition)', '回復 (recovery)' and others. Figure 4 reports also the time series changes of Topic 5's proportion: $\widehat{\theta_{5,t}}$. As shown in the figure, Topic 5's ratio seems inversely correlated with Topic 4's ratio; that is, the ratio of Topic 5 increases when the ratio of Topic 4 decreases. We checked the contents of the minutes and found that these topics are allocated in same chapter: Summary of Staff Reports on Economic and Financial Development. In the MPMs without an economic outlook report, in this chapter, policymakers only shared their opinions on the economic and financial situations. In contrast, the MPMs that discussed economic outlook reports simultaneously addressed sharing opinions and summarising drafts of the reports. Thus, the ratio of Topic 5 decreased and the ratio of Topic 4 increased. From these considerations, we interpreted that Topic 5 refers to policymakers' opinions of economic and financial circumstances and labelled it Economic and Financial Development.

Topic 6: Emerging Economies

Topic 6 in Table 4 seems to consist of keywords related to emerging economies, such as '経済 (economy)', '新興国 (emerging country)', '輸出　(exports)', 'エネルギー (energy)' and others. Figure 5 plots the time series of the proportion of Topic 6: $\widehat{\theta_{6,t}}$. According to the transition, the proportion peaks in the minutes released on 13 October 2015, 24 December 2015 and 3 August 2016. In these minutes, we found that policymakers discussed the effect of the slowdown of emerging economies on the domestic economy in terms of imports and productions. In contrast, we observed that the minutes released on 22 March 2017, whose ratio of Topic 6 is relatively low, does not indicate as such. Hence, we defined this topic, which explains the impact of the emerging economy on Japan's economic activities and labelled it Emerging Economies.

For further discussion, Figure 1, which displays changes in entire topics' proportions over the time, indicates that the ratio of Topic 6 increases from mid-2015 to mid-2016

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[6]Until 2015, the outlook report was released twice a year: at end of April and end of October.

relative to other topics. This finding suggests that policymakers discussed this topic in greater detailed and, above all, worried about economic and financial developments in emerging countries.

Topic 7: Impact of Consumption Tax Hike

Topic 7 in Table 4 captures the words related to consumption tax hikes, such as '引き上げ (hike)', '消費税 (consumption tax)', '駆け込み需要 (rush demand)', '消費者 (consumer)' and others. In Figure 6, the time series proportion of the topic, $\widehat{\theta_{7,t}}$, increases from when the Japanese government passed the consumption tax hike bill in October 2013, and maintains its peak after the implementation of the tax hike in the subsequent half a year. We confirmed the contents of these minutes and found that policymakers pay attention to the effects of the tax hike on domestic economic activities, such as economic outlook, consumer spending, price development and others. Accordingly, we interpreted that this topic captures the content of meeting members' consideration of the impact of consumption tax hikes on the domestic economy, and we labelled this topic Consumption Tax Hike.

5   Empirical test and result

5.1   Measuring the informativeness of the BOJ minutes

In this subsection, we examine whether the BOJ minutes influence asset prices and yields. As mentioned in section 3.1, a long time passes between when the MPM minutes are recorded and released. Thus, the impact may very well be quite small or non-existent. To reject this possibility, we test the impact using the high-frequency event-study test introduced by Swanson (2011). This method uses changes in financial markets within narrow windows of times, especially one- or two-day changes in each asset price or yields in this study. We assume that changes around the BOJ's minutes' release days should reflect significant reactions from the releases relative to other days. To investigate this hypothesis, we develop hypothesis tests. The null hypothesis is that releases of the BOJ's minutes had no effects on market participants' expectations; thus, the change in the asset price or yield was the same: $H_0 : V_t = 0$. V_t is computed in Eq. 1 or Eq. 2. An alternative hypothesis is that the announcements lead to significant effects on the market's mind, and then the changes in asset prices or yields are statistically significant: $H_1 : V_t \neq 0$.

Table 5 and Table 6 report the results of the event-study analysis explained previously. The top panel in each table reports the change in each asset across every event window for each release day. The bottom panel reports the unconditional standard deviation of each change in assets for one- and two-day windows during our observation terms. The statistical significance of each asset response is assessed by dividing each change by the unconditional standard deviation for the same asset and window size in the bottom panel. Next to each change in asset, the statistical significance for a two-sided t-test is reported using asterisks: * 10 %, ** 5 % and *** 1 % level.

From Table 5, the changes within the one- and two-day windows in two-year and five-year Treaty yields were statistically significant on 3 February 2016 when the minutes

on the introduction of supplementary measures for the QQE were released. On 18 March 2016, the minutes indicated that the introduction of the QQE with a negative interest rate had a remarkable effect on the changes within a one-day window in all Treaty yields for all maturities. Subsequently, the release of minutes that recorded the MPMs on the enhancement of monetary easing in July 2016 (released on 27 September 2016) caused changes within one- and two-day windows in two- and five-year Treaty yields with statistical significance. These results show that the bond market changed around the release days of the minutes that described the BOJ's monetary policy changes, especially during the implementation period of the QQE with a negative interest rate.

In contrast, other asset prices did not seem to change on specific days, such as the bond market, as shown in Table 6. The change in the TOPIX and Nikkei225 stock markets are statistically significant on the release days between May 2013 and May 2014. The change in the J-REITs (TSEREIT) often seemed to occur on release days in 2013 and, subsequently, such changes are not statistically significant. The change in the yen/dollar exchange rate seems to have no trend relative to other asset prices or yields.

The reaction of the assets reported previously seems to have been caused by not only the release of the minutes but also by other factors. However, we show the possibility that this factor influences changes in asset values from the result of the aforementioned event-study analysis.

5.2 Relationship between individual BOJ's minutes' topics and changes in asset values

In this subsection, we analyse the informativeness of the individual topics estimated by the LDA, particularly using time series changes to each topic's proportion. To investigate this phenomenon, we are motivated by the approach in Jegadeesh and Wu (2015). They examined the relationship between unexpected volatility and the proportion of estimated topics' proportions. We calculate also the unexpected volatility on release day t as the raw volatility and the average event-window volatility as follows:

$$UV_{t,n} = V_t - \sum_{j=1}^{n} \frac{V_{t-j}}{n} \tag{9}$$

Because we follow Jegadeesh's approach, we use $n = 20$ days. Regarding event-window return volatility V_t as computed in Eq. 1 or Eq. 2, we set the event-window length as one day: $l = 1$ day. Then, we assess the relationship between the unexpected volatility and the proportion of each topic, as in the following equation:

$$UV_t = \alpha + \beta\widehat{\theta_{k,t}} + \sum_{m=1}^{M} \gamma_m X_{m,t} + \epsilon_t \tag{10}$$

where UV_t is the unexpected volatility of each asset around the event window on release date t computed per Eq. 9, $\widehat{\theta_{k,t}}$ is the proportion of topic k estimated by LDA and X_t represents the control variables, including:

SPX_t : Standard and Poor's 500 Index, which is calculated as 100 times the first log change over the time window under consideration on release day t (basis point);

$DJIA_t$: Dow Jones Industrial Average, which is calculated as 100 times the first log change over the time window under consideration on release day t (basis point);

WTI_t : West Texas Intermediate, which is calculated as 100 times the first log change over the time window under consideration on release day t (basis point);

$SHCOMP_t$: SSE Composite Index, which is calculated as 100 times the first log change over the time window under consideration on release day t (basis point); and

LUV_t : the unexpected volatility of each asset on the previous business day of release day t, calculated per Eq. 9.

Each regression uses 52 daily observations that capture all minutes' release days in our sample from April 2013 to September 2017.

Table 7 reports the coefficient estimates for each topic proportion $\widehat{\theta_{k,t}}$ from regression 10. First, the coefficient estimates for the Monetary Policy 1 topic proportion, which captures the content for the period of the introduction of the QQE, are statistically significant and negative and use the unexpected volatility of the five- and 10-year Treaty yields as explained variables. In addition, the coefficient estimate for this topic proportion is statistically significant and positive with the unexpected volatility in J-REITs. This result corresponds to the outcome in Table 6 and gives us a further topic for discussion. That is, information on the Monetary Policy 1 topic in the minutes affected the volatility of J-REITs. The slope coefficient for the yen/dollar exchange rate is also significantly positive for this topic. We interpret that information on monetary policy during the introduction of the QQE caused the yen to fall against the dollar.

In contrast, the coefficient estimate for the proportion of the Monetary Policy 2 topic, which describes monetary policy under the October 2014 expansion of the QQE, is only statistically significant and negative with the yen/dollar exchange rate. Furthermore, the coefficient estimates for the Monetary Policy 3 topic concerned monetary policy after the introduction in September 2016 of the QQE with yield curve control, and are not statistically significant with unexpected volatility in any assets. These findings suggest that information in the minutes on monetary policy, especially the expansion of the QQE and the QQE with yield curve control, did not influence market expectations.

The Fund-provisioning Measures topic significantly affects both bond and stock markets. Specifically, the slope coefficient for government bond yields, except for the 40-year Treaty yield, is significantly negative for this topic. Regarding the stock market, the proportion of the Fund-provisioning Measures topic is significantly related to negative changes in stock price indices. According to the interpretation of the extraction from the minutes in subsection 4.2, the Fund-provisioning Measures topic is strongly related to the description of monetary policies that introduced in December 2015 supplementary measures for the QQE, and that introduced in January 2016 the QQE with a negative interest rate because these policies stimulated the supply of money to domestic companies. The findings from these results identify that the market paid attention to this information in the minutes, and that the descriptions on the measures forced the stock market to decline.

The coefficient estimates for the other topics - 'Outlook Report', 'Economic and Financial Development' and 'Consumption Tax Hike' - are also statistically significant

with the unexpected volatility in some assets in Table 7. The findings from this result suggests that market participants pay attention to the monetary policy description and to information such as policymakers' views on current economic conditions.

6 Conclusion

In this study, we empirically examined the effect of BOJ communication through BOJ meeting minutes on financial markets, especially under Mr. Kuroda's BOJ administration from April 2013 to September 2017. Using a computational linguistic model, we quantify the contents of and extract eight topics from the minutes, including their historical monetary policy and policymakers' views on current economic conditions. The empirical results suggest that a relationship exists between the estimated topics and market reactions on the minutes' release days. During the early term of the introduction of the QQE, the market paid attention to the monetary policy description in the minutes, for which a long period had passed from being the subject of the MPMs. However, information in the minutes on monetary policy under the October 2014 expansion of the QQE and under the September 2016 QQE with yield curve control resulted in no changes to the bond and stock markets. From this point, the effect of communicating through the minutes during the four and a half years from April 2013 faded. Far from that, information on fund-provisioning measures to support Japanese companies' activities, including a negative interest rate policy, induces the stock market to decline. In contrast, we found that the market pays attention to meeting members' opinions about current economic conditions.

Significant improvements can be made to this study in future research. The first improvement is to exclude other factors that affect the changes in asset prices or yields. One approach is to use tick-by-tick trading data and to construct a narrower event window. The second approach is to develop a tool that measures market sentiment in financial markets from words appearing in the text, such as in Loughran and McDonald (2014). They used directional word lists to measure the tone of the financial text in English, but no Japanese word list exists that is specialised for the financial field. The third approach is to apply this method to other BOJ communications that were announced faster than the minutes were released, such as speeches and summaries of policymakers' opinions. We leave these extensions for future work.

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Table 1: The BOJ Releases Decisions in the MPMs

Event	The time of release	Notes
Statement on MPMs	Immediately after relevant MPM	
Outlook Report (The Bank's View)	Immediately after relevant MPM	Before 2015: End of April and October/ After 2016: January, April, July and October
Speeches	3:30 p.m. at the last day of relevant MPM	
Outlook Report (Full Text)	2:00 p.m. at the next day of relevant MPM	Before 2015: End of April and October/ After 2016: January, April, July and October
Summary of Opinions	Six business days after relevant MPM	It started from 2016
MPM Minutes	Three business days after the next MPM	
The Full Text of MPM Minutes	10 years after relevant MPM	

Table 2: The Deliberation Results of Monetary Policies Noted in the Minutes under Kuroda's BOJ Administration

Date of MPM	MPM Minutes	Votes
03, 04/04/2013	**02/05/2013**	**1. The Adoption of the 'Monetary Base Control'** **2. An Increase in JGB Purchases and Their Maturity Extension** **3. An Increase in ETF and J-REIT Purchases** 4. The Continuation of the QQE 5. The Extension of the Funds-Supplying Operation to Support Financial Institutions in Disaster Areas Affected by the Great East Japan Earthquake
26/04/2013	27/05/2013	1. Maintenance of the Current Guideline for Money Market Operation 2. Decision regarding the Outlook for Economic Activity and Prices
21, 22/05/2013	14/06/2013	Maintenance of the Current Guideline for Money Market Operation
10, 11/06/2013	17/07/2013	Maintenance of the Current Guideline for Money Market Operation
10, 11/07/2013	13/08/2013	Maintenance of the Current Guideline for Money Market Operation
07, 08/08/2013	10/09/2013	Maintenance of the Current Guideline for Money Market Operation
04, 05/09/2013	09/10/2013	Maintenance of the Current Guideline for Money Market Operation
03, 04/10/2013	06/11/2013	Maintenance of the Current Guideline for Money Market Operation
31/10/2013	26/11/2013	1. Maintenance of the Current Guideline for Money Market Operation 2. Decision regarding the Outlook for Economic Activity and Prices
20, 21/11/2013	26/12/2013	Maintenance of the Current Guideline for Money Market Operation
19, 20/12/2013	27/01/2014	Maintenance of the Current Guideline for Money Market Operation
21, 22/01/2014	21/02/2014	Maintenance of the Current Guideline for Money Market Operation
17, 18/02/2014	14/03/2014	1. Maintenance of the Current Guideline for Money Market Operation

Continue to the next page

Date of MPM	MPM Minutes	Votes
		2. Release of 'Outline of the Enhanced Framework for the Stimulating Bank Lending Facility and the Growth-Supporting Funding Facility'
		3. Amendment to 'Principal Terms and Conditions for the Funds-Supplying Operation to Support Financial Institutions in Disaster Areas' and 'Temporary Rules regarding the Eligibility Standards for Debt of Companies in Disaster Areas'
10, 11/03/2014	11/04/2014	Maintenance of the Current Guideline for Money Market Operation
07, 08/04/2014	07/05/2014	Maintenance of the Current Guideline for Money Market Operation
30/04/2014	26/05/2014	1. Maintenance of the Current Guideline for Money Market Operation 2. Decision regarding the Outlook for Economic Activity and Prices
20, 21/05/2014	18/06/2014	Maintenance of the Current Guideline for Money Market Operation
12, 13/06/2014	18/07/2014	Maintenance of the Current Guideline for Money Market Operation
14, 15/07/2014	13/08/2014	Maintenance of the Current Guideline for Money Market Operation
07, 08/08/2014	09/09/2014	Maintenance of the Current Guideline for Money Market Operation
03, 04/09/2014	10/10/2014	Maintenance of the Current Guideline for Money Market Operation
06, 07/10/2014	06/11/2014	Maintenance of the Current Guideline for Money Market Operation
31/10/2014	**25/11/2014**	**1. Accelerating the Pace of Increase in the Monetary Base** **2. Increasing Asset Purchases and Extending the Average Remaining Maturity of JGB Purchases** 3. Decision regarding the Outlook for Economic Activity and Prices
18, 19/11/2014	25/12/2014	1. Maintenance of the Current Guideline for Money Market Operation 2. Maintenance of the Current Guideline for Asset Purchases
18, 19/12/2014	16/01/2015	1. Maintenance of the Current Guideline for Money Market Operation

Date of MPM	MPM Minutes	Votes
		2. Maintenance of the Current Guideline for Asset Purchases
20, 21/01/2015	23/02/2015	1. Maintenance of the Current Guideline for Money Market Operation
		2. Maintenance of the Current Guideline for Asset Purchases
		3. Amendments to the Loan Support Program and other measures
17, 18/02/2015	20/03/2015	1. Maintenance of the Current Guideline for Money Market Operation
		2. Maintenance of the Current Guideline for Asset Purchases
16, 17/03/2015	13/04/2015	1. Maintenance of the Current Guideline for Money Market Operation
		2. Maintenance of the Current Guideline for Asset Purchases
07, 08/04/2015	08/05/2015	1. Maintenance of the Current Guideline for Money Market Operation
		2. Maintenance of the Current Guideline for Asset Purchases
30/04/2015	27/05/2015	1. Maintenance of the Current Guideline for Money Market Operation
		2. Maintenance of the Current Guideline for Asset Purchases
		3. Decision regarding the Outlook for Economic Activity and Prices
21, 22/05/2015	24/06/2015	1. Maintenance of the Current Guideline for Money Market Operation
		2. Maintenance of the Current Guideline for Asset Purchases
18, 19/06/2015	21/07/2015	**1. New Framework for MPM**
		2. Maintenance of the Current Guideline for Money Market Operation
		3. Maintenance of the Current Guideline for Asset Purchases
14, 15/07/2015	12/08/2015	1. Maintenance of the Current Guideline for Money Market Operation
		2. Maintenance of the Current Guideline for Asset Purchases
06, 07/08/2015	18/09/2015	1. Maintenance of the Current Guideline for Money Market Operation
		2. Maintenance of the Current Guideline for Asset Purchases

Date of MPM	MPM Minutes	Votes
14, 15/09/2015	13/10/2015	1. Maintenance of the Current Guideline for Money Market Operation 2. Maintenance of the Current Guideline for Asset Purchases
06, 07/10/2015	05/11/2015	1. Maintenance of the Current Guideline for Money Market Operation 2. Maintenance of the Current Guideline for Asset Purchases
30/10/2015	25/11/2015	1. Maintenance of the Current Guideline for Money Market Operation 2. Maintenance of the Current Guideline for Asset Purchases 3. Decision regarding the Outlook for Economic Activity and Prices
18, 19/11/2015	24/12/2015	1. Maintenance of the Current Guideline for Money Market Operation 2. Maintenance of the Current Guideline for Asset Purchases
17, 18/12/2015	**03/02/2016**	**1. The Introduction of Supplementary Measures for QQE** **- Extending the Application Periods for the Loan Support Program and Other Measures** **- Extending Eligible Collateral for the Bank's Provision of Credit** **- Extending the Average Remaining Maturity of JGB Purchases** **- Increasing the Maximum Amount of Each Issue of J-REIT to Be Purchasesd** **- Establishing a New Program for Purchases of ETFs** **- Enhancing the Fund-Provisioning Measure to Support Strengthening the Foundations for Economic Growth** 2. Maintenance of the Current Guideline for Money Market Operation 3. Maintenance of the Current Guideline for Asset Purchases
28, 29/01/2016	**18/03/2016**	**1. The Amendment to Principal Terms and Conditions of Complementary Deposit Facility as a Temporary Measure to Facilitate Supplying of Funds**

Date of MPM	MPM Minutes	Votes
		2. Maintenance of the Current Guideline for Money Market Operation 3. Maintenance of the Current Guideline for Asset Purchases 4. Decision regarding the Outlook for Economic Activity and Prices
14, 15/03/2016	09/05/2016	1. Maintenance of the Current Guideline for Money Market Operation 2. Maintenance of the Current Guideline for Asset Purchases 3. Applying a Negative Interest Rate of Minus 0.1 Percent to the Policy-Rate Balances in Current Accounts Held by Financial Institutions at the Bank
27, 28/04/2016	21/06/2016	1. Maintenance of the Current Guideline for Money Market Operation 2. Maintenance of the Current Guideline for Asset Purchases 3. Maintenance of the Current Policy Rate 4. Decision regarding the Outlook for Economic Activity and Prices
15, 16/06/2016	03/08/2016	1. Maintenance of the Current Guideline for Money Market Operation 2. Maintenance of the Current Guideline for Asset Purchases 3. Maintenance of the Current Policy Rate
28, 29/07/2016	**27/09/2016**	**1. An Increase in Purchases of ETFs** **2. Measures to Ensure Smooth Funding in Foreign Currencies by Japanese Firms and Financial Institutions** **- Increasing the Size of the Bank's Lending Program to Support Growth in U.S. Dollars** **- Establishing a New Facility for Lending Securities to Be Pledged as Collateral for the U.S. Dollar Funds-Supplying Operations** 3. Maintenance of the Current Guideline for Money Market Operation 4. Maintenance of the Current Guideline for Asset Purchases except for ETF Purchases 5. Maintenance of the Current Policy Rate

Date of MPM	MPM Minutes	Votes
		6. Decision regarding the Outlook for Economic Activity and Prices
20, 21/09/2016	**07/11/2016**	**1. 'Comprehensive Assessment: Developments in Economic Activity and Prices as well as Policy Effects since the Introduction of QQE**
		2. Current Situation of and Outlook for Economic Activity and Prices in Japan
		3. The Guideline for Market Operations - Applying a Negative Interest Rate of Minus 0.1 Percent to the Policy-Rate Balances in Current Accounts Held by Financial Institutions at the Bank - Purchases of JGBs so that 10-year JGB Yields Remain more or less at the Current Level of around 0 Percent
		4. The New Tools of Market Operations for Facilitating Yield Curve Control
		5. Maintenance of the Current Guideline for Asset Purchases
31/10/2016, 01/11/2016	26/12/2016	1. Maintenance of the Current Guideline for Money Market Operation
		2. Maintenance of the Current Guideline for Asset Purchases
		3. Decision regarding the Outlook for Economic Activity and Prices
19, 20/12/2016	03/02/2017	1. Maintenance of the Current Guideline for Money Market Operation
		2. Maintenance of the Current Guideline for Asset Purchases
30, 31/01/2017	22/03/2017	1. Maintenance of the Current Guideline for Money Market Operation
		2. Maintenance of the Current Guideline for Asset Purchases
		3. Decision regarding the Outlook for Economic Activity and Prices
15, 16/03/2017	02/05/2017	1. Maintenance of the Current Guideline for Money Market Operation
		2. Maintenance of the Current Guideline for Asset Purchases
26, 27/04/2017	21/06/2017	1. Maintenance of the Current Guideline for Money Market Operation

Date of MPM	MPM Minutes	Votes
		2. Maintenance of the Current Guideline for Asset Purchases
		3. Decision regarding the Outlook for Economic Activity and Prices
15, 16/06/2017	25/07/2017	1. Maintenance of the Current Guideline for Money Market Operation
		2. Maintenance of the Current Guideline for Asset Purchases
19, 20/07/2017	26/09/2017	1. Maintenance of the Current Guideline for Money Market Operation
		2. Maintenance of the Current Guideline for Asset Purchases

Sources: Bank of Japan; author's compilation

Table 3: Distribution of Top LDA Topic Keywords

	Topic 0		Topic 1		Topic 2		Topic 3
Weight	Word	Weight	Word	Weight	Word	Weight	Word
0.034	物価 (Prices)	0.038	買入れ (Purchases)	0.043	買入れ (Purchases)	0.034	支援 (Support)
0.022	経済 (Economy)	0.027	物価 (Prices)	0.037	経済 (Economy)	0.033	金融機関 (Financial Institutions)
0.017	目標 (Target)	0.025	回復 (Recovery)	0.026	金利 (Interest Rate)	0.025	量的・質的金融緩和 (QQE)
0.017	買入れ (Purchases)	0.019	調整 (Adjustment)	0.026	目標 (Target)	0.023	買入れ (Purchases)
0.016	市場 (Market)	0.019	量的・質的金融緩和 (QQE)	0.025	物価 (Prices)	0.02	貸出 (Lending)
0.015	国債 (JGB)	0.017	目標 (Target)	0.021	国債 (JGB)	0.019	資金供給 (Fund-Provisioning)
0.015	安定 (Stability)	0.016	資産 (Asset)	0.018	効果 (Effect)	0.018	導入 (Introduction)
0.014	予想 (Forecast)	0.016	効果 (Effect)	0.018	金融 (Finance)	0.018	日本銀行 (BOJ)
0.014	期待 (Expectation)	0.015	予想 (Forecast)	0.015	安定 (Stability)	0.017	金利 (Interest Rate)
0.012	財政 (Finance)	0.015	原油価格 (Oil Price)	0.015	物価上昇率 (Inflation Rate)	0.016	措置 (Measure)
0.012	政府 (Government)	0.014	価格 (Price)	0.015	実現 (Realization)	0.015	執行部 (Staff)
0.01	量的・質的金融緩和 (QQE)	0.014	金利 (Interest Rate)	0.014	政策 (Policy)	0.014	成長 (Growth)
0.01	マネタリーベース (Monetary Base)	0.013	継続 (Continuation)	0.013	期待 (Expectation)	0.014	マイナス金利 (Negative Interest Rate)
0.009	日本銀行 (BOJ)	0.013	先進国 (Developed Country)	0.013	予想 (Forecast)	0.014	国債 (JGB)
0.009	実現 (Realization)	0.012	金融政策 (Monetary Policy)	0.013	先行き (Future)	0.014	長期 (Long Term)
0.009	米国 (U.S.)	0.012	ペース (Pace)	0.012	操作 (Operation)	0.013	残高 (Stock)
0.009	金融政策 (Monetary Policy)	0.012	在庫 (Stock)	0.012	イールドカーブ (Yield Curve)	0.013	強化 (Strengthening)
0.008	効果 (Effect)	0.011	国際 (International)	0.012	長期金利 (Long-term Interest Rate)	0.012	金融市場 (Financial Market)
0.008	資産 (Asset)	0.011	長期 (Long Term)	0.011	資産 (Asset)	0.01	先行き (Future)
0.008	企業 (Company)	0.011	先行き (Future)	0.011	形成 (Formation)	0.01	基盤 (Base)
0.008	持ち直し (Recovery)	0.011	インフレ率 (Inflation Rate)	0.011	海外 (Overseas)	0.01	緩和 (Easing)
0.008	日本経済 (Japanese Economy)	0.011	マネタリーベース (Monetary Base)	0.011	残高 (Stock)	0.01	ETF
0.007	デフレ (Deflation)	0.01	物価上昇率 (Inflation Rate)	0.01	所得 (Income)	0.01	制度 (System)
0.007	欧州 (Europe)	0.01	金融市場 (Financial Market)	0.009	金融政策 (Monetary Policy)	0.01	担保 (Collateral)
0.007	圧力 (Pressure)	0.009	ユーロ (Euro)	0.009	政策金利 (Policy Interest Rate)	0.009	対応 (Correspondence)
0.007	金利 (Interest Rate)	0.009	期待 (Expectation)	0.009	緩和 (Easing)	0.009	市場 (Market)
0.007	リスク (Risk)	0.009	達成 (Accomplishment)	0.009	長期 (Long Term)	0.008	調節 (Adjustment)
0.007	継続 (Continuation)	0.009	残存 (Persistence)	0.009	ETF	0.008	情勢 (Condition)
0.006	輸出 (Export)	0.009	欧州 (Europe)	0.008	金融緩和 (Monetary Easing)	0.008	当座預金 (Current Deposit)
0.006	マインド (Mind)	0.008	情勢 (Condition)	0.008	ゼロ (Zero)	0.008	対象 (Target)
0.006	住宅 (House)	0.008	指標 (Index)	0.008	対策 (Measure)	0.008	追加 (Supplement)
0.006	達成 (Accomplishment)	0.008	個人消費 (Consumer Spending)	0.007	環境 (Circumstance)	0.008	延長 (Extension)
0.006	景気 (Business)	0.008	モメンタム (Momentum)	0.007	持続 (Continuation)	0.008	改正 (Amendment)
0.006	物価上昇率 (Inflation Rate)	0.008	国債 (JGB)	0.007	現状 (Current Situation)	0.007	要領 (Point)
0.006	状況 (Situation)	0.007	商品 (Product)	0.007	新興国 (Emerging Country)	0.007	観点 (Point)
0.006	社債 (Bond)	0.007	イールドカーブ (Yield Curve)	0.007	欧州 (Europe)	0.007	JREIT
0.005	見解 (Opinion)	0.006	日本銀行 (BOJ)	0.007	波及 (Spread)	0.007	マネタリーベース (Monetary Base)
0.005	注意 (Caution)	0.006	進捗 (Progress)	0.006	株価 (Stock Price)	0.007	被災地 (Disaster Stricken Area)
0.005	消費者 (Consumer)	0.006	ETF	0.006	社債 (Bond)	0.007	買入れ (Purchases)
0.005	金融緩和 (Monetary Easing)	0.006	景気 (Business)	0.006	枠組み (Framework)	0.007	基金 (Fund)

Table 4: Distribution of Top LDA Topic Keywords

Topic 4		Topic 5		Topic 6		Topic 7	
Weight	Word	Weight	Word	Weight	Word	Weight	Word
0.059	物価 (Prices)	0.039	先行き (Future)	0.065	経済 (Economy)	0.035	引き上げ (Hike)
0.047	見通し (Future)	0.025	環境 (Circumstance)	0.042	物価 (Prices)	0.032	消費税率 (Consumption Tax)
0.03	企業 (Company)	0.024	個人消費 (Consumer Spending)	0.039	企業 (Company)	0.031	物価 (Prices)
0.028	物価上昇率 (Inflation Rate)	0.023	設備投資 (Capital Investment)	0.039	新興国 (Emerging Country)	0.029	反動 (Reaction)
0.025	成長 (Growth)	0.023	調節 (Adjustment)	0.023	安定 (Stability)	0.029	経済 (Economy)
0.024	予想 (Forecast)	0.022	回復 (Recovery)	0.022	輸出 (Export)	0.026	駆け込み需要 (Rush Demand)
0.022	動向 (Trend)	0.022	情勢 (Condition)	0.022	ペース (Pace)	0.024	企業 (Company)
0.021	経済 (Economy)	0.018	金融市場 (Financial Market)	0.02	エネルギー (Energy)	0.023	所得 (Income)
0.021	情勢 (Condition)	0.018	投資 (Investment)	0.019	所得 (Income)	0.023	安定 (Stability)
0.018	金融市場 (Financial Market)	0.017	海外 (Overseas)	0.018	環境 (Circumstance)	0.021	雇用 (Employment)
0.018	賃金 (Wage)	0.017	金融 (Finance)	0.017	残高 (Balance)	0.019	環境 (Circumstance)
0.017	安定 (Stability)	0.017	生産 (Production)	0.016	動向 (Trend)	0.018	回復 (Recovery)
0.016	需給 (Supply and Demand)	0.015	残高 (Balance)	0.016	生産 (Production)	0.017	消費者 (Consumer)
0.016	海外 (Overseas)	0.015	市場 (Market)	0.015	雇用 (Employment)	0.014	輸出 (Export)
0.014	家計 (Household Budget)	0.014	需要 (Demand)	0.014	日本銀行 (BOJ)	0.014	ペース (Pace)
0.014	提出 (Submission)	0.014	金融政策 (Financial Market)	0.013	部門 (Department)	0.013	要因 (Factor)
0.014	実現 (Realization)	0.013	反映 (Reflection)	0.013	消費者 (Consumer)	0.011	リスク (Risk)
0.013	調節 (Adjustment)	0.012	景気 (Business)	0.013	支出 (Spending)	0.011	先行き (Future)
0.013	成長率 (Growth Rate)	0.011	持ち直し (Recovery)	0.013	政策 (Policy)	0.011	成長 (Growth)
0.013	需給ギャップ (Supply and Demand Gap)	0.011	金融経済 (Monetary Economy)	0.012	状況 (Situation)	0.01	動向 (Trend)
0.011	ペース (Pace)	0.011	ペース (Base)	0.011	リスク (Risk)	0.009	量的・質的金融緩和 (QQE)
0.011	労働 (Labor)	0.01	継続 (Continuation)	0.011	収益 (Revenue)	0.008	持続 (Continuation)
0.01	不確実性 (Uncertainty)	0.01	米国経済 (US Economy)	0.01	生鮮食品 (Fresh Food)	0.008	日本銀行 (BOJ)
0.009	黒田 (Kuroda)	0.01	内需 (Domestic Demand)	0.01	家計 (Household Budget)	0.008	先進国 (Developed Country)
0.008	展望レポート (Outlook Report)	0.01	成長 (Growth)	0.01	価格 (Price)	0.008	ASEAN
0.008	循環 (Circulation)	0.009	輸出 (Export)	0.01	保有 (Possession)	0.007	NIEs
0.008	リスク (Risk)	0.009	米国 (U.S.)	0.01	社債 (Bond)	0.007	構造 (Structure)
0.008	期待 (Expectation)	0.009	対外 (Foreign)	0.009	実現 (Realization)	0.007	緩和 (Easing)
0.008	変更 (Change)	0.009	所得 (Income)	0.009	要因 (Factor)	0.007	実現 (Realization)
0.008	見解 (View)	0.009	緩和 (Easing)	0.008	金融政策決定会合 (MPM)	0.007	点検 (Inspection)
0.008	説明 (Description)	0.009	CP	0.008	意見 (Opinion)	0.007	賃金 (Wage)
0.008	時期 (Period)	0.009	雇用 (Employment)	0.008	中国 (China)	0.007	ペース (Base)
0.008	設備投資 (Capital Investment)	0.009	調整 (Adjustment)	0.006	黒田 (Kuroda)	0.007	銀行 (Bank)
0.008	物価上昇 (Inflation)	0.008	前向き (Forward-looking)	0.006	消費 (Consumption)	0.006	貸出 (Lending)
0.008	輸出 (Export)	0.008	株価 (Stock Price)	0.006	先行き (Future)	0.006	マネタリーベース (Monetary Base)
0.007	マクロ (Macro)	0.008	貸出 (Lending)	0.006	点検 (Inspection)	0.006	住宅 (House)
0.007	環境 (Circumstance)	0.008	発言 (Speech)	0.006	住宅 (House)	0.005	コスト (Cost)
0.007	柱 (Pillar)	0.007	実質 (Real)	0.006	買入れ (Purchases)	0.005	考え方 (Approach)
0.007	為替相場 (Exchange Rate)	0.007	金融政策決定会合 (MPM)	0.006	資金調達 (Funding)	0.005	景気 (Business)
0.007	価格 (Price)	0.007	内外 (Inside and Outside)	0.006	委員会 (Committee)	0.005	需給 (Supply and Demand)

Table 5: Treaty Yields and Estimated Impacts on Yields around BOJ's Minutes' Release Days

Release date	1-day changes				2-day changes			
	2-year	5-year	10-year	40-year	2-year	5-year	10-year	40-year
02/05/2013	−0.4	−1.8	−2.8	0	−0.3	−0.2	0.7	2.9
27/05/2013	0	−1	−0.2	−2.5	0.6	3.7*	6.3**	−0.9
14/06/2013	0	−2.8**	−4.4**	−0.8	0	−3.1	−2.4	−0.5
17/07/2013	0	−1	−0.6	−1.6	0	−1.6	−1.9	−1.6
13/08/2013	0	−1.5	−1.4	−1.7	0	−0.4	0.7	0.4
10/09/2013	0	−1.3	−1.9	−1.6	0.1	−0.7	−1.4	−1
09/10/2013	0	0.6	0	−1.2	−0.5	0.6	0	−2
06/11/2013	0	0.5	0.5	−0.5	−0.5	0.1	−1.5	−1.6
26/11/2013	0	−0.8	−2	−2.5	0.1	−1.5	−3.5	−5
26/12/2013	0	1	1.8	0.8	0	1	1.9	1.6
27/01/2014	0	0	0.1	1.1	0	−0.4	−0.5	3.9
21/02/2014	0	0.4	1	1.6	0	0.4	0.5	1.2
14/03/2014	−0.1	−1.1	−1.8	−0.9	−0.1	−1	−1.8	−0.9
11/04/2014	0	0	−0.4	−0.1	0.9	0.6	−0.4	−0.4
07/05/2014	0	0	−0.8	−0.8	0	0.1	−0.3	−0.8
26/05/2014	0	0.2	0.2	0.1	0	0.1	0.6	−0.9
18/06/2014	0	0	0.5	−0.4	0	−0.6	0	4.3
18/07/2014	0	0	0.6	−0.4	0.5	0.1	0.7	0.4
13/08/2014	−0.1	0	0	−0.4	−0.1	−0.6	−0.4	0.3
09/09/2014	−0.1	0	0.1	1.2	−0.1	0.3	1.6	1.9
10/10/2014	0	1	1.2	2	−0.4	1	0.6	2.7
06/11/2014	1	0	0.1	1.6	1	0.6	0.7	1.7
25/11/2014	0	0.2	−1	−0.8	−0.1	−0.7	−2.4	−2
25/12/2014	1	0	−2	−3.2	0.8	0.6	−0.5	−1.6
16/01/2015	0	0	−0.9	−0.5	−0.1	−0.7	−4.4	−1.3
23/02/2015	−0.1	−0.5	−0.4	−1.2	−0.5	−1	−1.2	−3.7
20/03/2015	0.6	−0.6	0	4.1	1.5	0	−1.5	5.5
13/04/2015	−0.1	−0.4	0.1	1.7	−0.1	−2	−1.4	0
08/05/2015	−1	−1.8	−1.9	0	−1.5	−2.9	−3.8	−0.4
27/05/2015	0	−1.4	−3.1*	−1.2	−0.7	−1.9	−2	1.6
24/06/2015	−0.1	−1	−1	0.1	−0.2	−1	0.5	1.3
21/07/2015	0	−0.5	−0.3	−1.2	−0.1	−0.9	−1	−3.6
12/08/2015	0	−0.7	−4**	−2.7	0	−0.5	−1.9	−0.8
18/09/2015	−0.1	−2	−2.9	−3.5	−0.2	−2	−3.2	−4.6
13/10/2015	0	0	−0.4	−0.4	0	−1	−1.3	0
05/11/2015	−0.1	0	−0.1	0	−0.2	0	0.5	0.8
25/11/2015	−0.5	−0.7	−1.6	−0.8	−0.5	−0.7	−2	−1.9
24/12/2015	0.2	0	0.5	0	0.3	0.6	0.6	0
03/02/2016	−3***	−3.4**	−1.8	−0.4	−2.6*	−4.4**	−2.1	−0.4
18/03/2016	−2.1**	−3.6***	−4.7**	−13.7***	−1.6	−3.6*	−4.6*	−19.2***

Release date	1-day changes				2-day changes			
	2-year	5-year	10-year	40-year	2-year	5-year	10-year	40-year
09/05/2016	−0.1	0.1	1	0.5	−0.1	0.2	2.1	3.7
21/06/2016	0.4	0.6	0.5	0.6	0.9	0.6	0.1	−1.4
03/08/2016	−1.2	−2.7*	−2.5	4.2	−1.3	−2.1	−1.5	10***
27/09/2016	−3.9***	−4***	−1.6	0.8	−6.4***	−4.6**	−3.1	−2.9
07/11/2016	0.5	0.8	1.1	0.7	0.1	0.6	−0.4	0.7
26/12/2016	0.3	0.6	0.5	1.1	1.2	0.6	1	0.8
03/02/2017	−0.5	0	−0.8	0	0.5	1.7	−0.4	3.7
22/03/2017	−0.5	−1	−0.5	−1.5	−1	−2	−1	−1.5
02/05/2017	0.5	0.7	0.6	0.2	0.9	1.7	1.6	1.2
21/06/2017	1	0.6	0.4	−0.9	1	0.6	0	−1.6
25/07/2017	0.6	−0.1	0	−1.3	1.1	0.9	1.1	−0.5
26/09/2017	0	0.6	0.5	−0.2	0.9	2.6	2.6	2
Unconditional standard deviation of yield changes.								
	0.96	1.38	1.87	2.62	1.44	1.96	2.59	3.89

Note

Asterisks indicate statistical significance at the *10 percent, **5 percent, and ***1 percent level.

Table 6: Other Assets' Prices and Estimated Impacts on the
Prices around BOJ's Minutes' Release Days

Release date	1-day changes				2-day changes			
	TOPIX	Nikkei225	TSEREIT	Yen/Dollar	TOPIX	Nikkei225	TSEREIT	Yen/Dollar
02/05/2013	−0.191	−0.333	−0.541	0.300	−0.191	−0.333	−0.541	0.706*
27/05/2013	−1.480***	−1.419**	1.284***	−0.047	−0.949	−0.902	1.447**	0.497
14/06/2013	0.508	0.833	2.348***	0.166	1.655**	2.004**	1.810***	0.264
17/07/2013	0.097	0.047	−0.398	0.205	0.410	0.618	−0.247	0.582
13/08/2013	0.854	1.102*	0.112	0.727***	1.383*	1.672**	0.485	0.665*
10/09/2013	0.633	0.662	1.140**	0.369	0.598	0.667	1.815***	0.178
09/10/2013	0.629	0.445	0.964**	0.110	1.038	0.928	0.935	0.508
06/11/2013	0.350	0.340	−0.506	0.046	0.079	0.009	−1.051	0.220
26/11/2013	−0.228	−0.290	0.082	−0.128	−0.434	−0.474	0.260	0.173
26/12/2013	0.724	0.444	0.811*	0.172	1.087	0.456	1.043	0.286
27/01/2014	−1.232**	−1.103*	−0.379	0.034	−1.406*	−1.177	−0.247	0.184
21/02/2014	0.997*	1.234**	0.089	0.153	0.882	1.152	−0.029	0.057
14/03/2014	−1.422**	−1.456**	−0.420	−0.284	−1.788**	−1.607**	−0.367	−0.213
11/04/2014	−0.586	−1.045*	−0.293	0.051	−0.637	−1.201	0.063	0.141
07/05/2014	−1.134**	−1.293**	−0.009	0.068	−0.833	−0.891	−0.105	0.021
26/05/2014	0.521	0.419	−0.127	0.021	0.536	0.520	0.391	0.104
18/06/2014	0.382	0.404	0.303	−0.015	1.068	1.103	0.437	−0.153
18/07/2014	−0.345	−0.439	0.226	−0.066	−0.345	−0.439	0.226	−0.096
13/08/2014	0.153	0.150	0.031	0.079	0.440	0.437	0.506	0.106
09/09/2014	0.033	0.122	−0.231	0.345	0.272	0.231	0.342	0.530
10/10/2014	−0.614	−0.503	0.290	0.002	−0.614	−0.503	0.290	−0.224
06/11/2014	−0.491	−0.373	−1.050**	0.081	−0.257	−0.146	−0.656	0.178
25/11/2014	0.277	0.125	0.366	−0.199	0.192	0.065	0.298	−0.309
25/12/2014	−0.145	−0.111	−0.183	0.000	0.045	−0.086	0.131	−0.014
16/01/2015	−0.408	−0.625	0.017	0.283	−0.132	−0.240	−0.323	0.254

Release date	1-day change				2-day change			
	TOPIX	Nikkei225	TSEREIT	Yen/Dollar	TOPIX	Nikkei225	TSEREIT	Yen/Dollar
23/02/2015	0.072	0.318	0.252	0.049	0.230	0.638	0.565	0.166
20/03/2015	0.129	0.186	0.179	−0.243	0.451	0.615	0.240	−0.422
13/04/2015	−0.090	−0.005	−0.489	0.058	0.035	0.002	−0.347	−0.385
08/05/2015	0.360	0.196	0.208	0.102	0.649	0.734	0.764	0.163
27/05/2015	0.046	0.075	−0.241	0.246	0.344	0.242	−0.188	0.407
24/06/2015	0.090	0.122	−0.024	0.159	−0.142	−0.079	−0.117	−0.067
21/07/2015	0.285	0.400	−0.258	−0.149	−0.198	−0.121	0.221	−0.073
12/08/2015	−0.566	−0.693	−0.275	−0.339	−0.509	−0.263	−0.240	−0.139
18/09/2015	−0.868	−0.862	0.155	−0.343	−0.868	−0.862	0.155	−0.137
13/10/2015	−0.345	−0.483	−0.423	−0.018	−1.289	−1.309	−0.278	−0.240
05/11/2015	0.412	0.433	0.263	−0.005	0.648	0.770	0.217	0.564
25/11/2015	−0.306	−0.169	0.139	0.149	−0.098	0.043	0.296	0.035
24/12/2015	−0.284	−0.224	−0.074	−0.256	−0.496	−0.271	−0.047	−0.256
03/02/2016	−1.391**	−1.391**	0.453	−0.828***	−1.934**	−1.762**	0.323	−1.142***
18/03/2016	−0.447	−0.546	0.067	0.031	−0.447	−0.546	0.067	0.117
09/05/2016	0.278	0.294	0.649	0.687**	1.207	1.219	1.092*	0.960**
21/06/2016	0.497	0.551	0.269	0.052	0.184	0.272	−0.423	0.127
03/08/2016	−0.953*	−0.825	−0.267	0.137	−0.579	−0.363	0.086	0.052
27/09/2016	0.433	0.364	0.160	−0.037	−0.165	−0.208	0.086	0.130
07/11/2016	0.505	0.693	0.179	0.640**	0.527	0.678	0.108	0.740*
26/12/2016	−0.160	−0.069	0.340	0.000	−0.214	−0.055	0.474	0.135
03/02/2017	0.131	0.008	0.018	−0.015	0.287	0.142	0.042	−0.027
22/03/2017	−0.933*	−0.935	0.043	−0.308	−0.927	−0.835	−0.079	−0.288
02/05/2017	0.296	0.303	0.465	0.198	0.296	0.303	0.465	0.277
21/06/2017	−0.153	−0.197	−0.042	−0.045	−0.185	−0.258	−0.105	−0.132
25/07/2017	−0.121	−0.045	0.340	0.197	−0.018	0.162	0.191	0.345
26/09/2017	−0.002	−0.144	−0.042	0.184	−0.218	−0.279	−0.209	0.331

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Release date	1-day change			2-day change		
	TOPIX	Nikkei225	TSEREIT	Yen/Dollar	TOPIX	Nikkei225	TSEREIT	Yen/Dollar

Unconditional standard deviation of the prices' changes.

| | 0.561 | 0.597 | 0.449 | 0.279 | 0.786 | 0.809 | 0.665 | 0.394 |

Note

Asterisks indicate statistical significance at the *10 percent, **5 percent, and ***1 percent level.

Table 7: Topic Proportion and Market Reaction

	Treaty yields				TOPIX	Nikkei225	TSEREIT	Yen/Dollar
	2-year	5-year	10-year	40-year				
Policy 1	−0.3291 (−0.45)	−3.1108** (−2.15)	−3.5439* (−1.70)	−3.3077 (−1.09)	1.2689 (1.58)	1.3738 (1.60)	2.0668** (2.45)	1.2322*** (4.92)
Policy 2	0.0697 (0.08)	0.6589 (0.37)	0.4749 (0.19)	4.6150 (1.31)	−0.1569 (−0.16)	−0.2421 (−0.23)	−1.5085 (−1.50)	−0.8418** (−2.49)
Policy 3	0.2134 (0.31)	1.7594 (1.27)	2.0989 (1.05)	0.7641 (0.27)	−0.7572 (−0.99)	−0.7869 (−0.96)	−0.3105 (−0.37)	−0.0588 (−0.20)
Fund-provisioning Measures	−1.7781* (−1.74)	−4.9826** (−2.66)	−4.5836* (−1.77)	−5.3252 (−1.41)	−2.1263** (−2.16)	−2.4346** (−2.34)	−0.6572 (−0.58)	−0.2752 (−0.72)
Outlook Report	−0.3555 (−0.34)	−1.4105 (−0.66)	−3.9405 (−1.32)	−9.0113** (−2.19)	−0.9471 (−0.82)	−1.0495 (−0.85)	0.9594 (0.77)	−0.7109 (−1.69)
Economic and Financial Development	1.1832 (0.95)	2.6680 (1.08)	3.7337 (1.09)	6.3567 (1.31)	3.7317*** (3.11)	4.0481*** (3.17)	1.0596 (0.75)	1.1961** (2.59)
Emerging Economies	−0.7100 (−0.74)	−0.3945 (−0.20)	−1.1022 (−0.40)	−0.0474 (−0.01)	−0.2505 (−0.23)	−0.3161 (−0.28)	−0.3131 (−0.27)	−0.4361 (−1.11)
Tax Hike	0.8432 (1.32)	2.6552** (2.07)	3.8304** (2.12)	3.5865 (1.35)	0.1904 (0.26)	0.3163 (0.40)	−0.6458 (−0.84)	−0.1472 (−0.54)

Note

*Asterisks indicate statistical significance at the *10 percent, **5 percent, and ***1 percent level.*

Figure 1: BOJ Topic Proportions Over Time
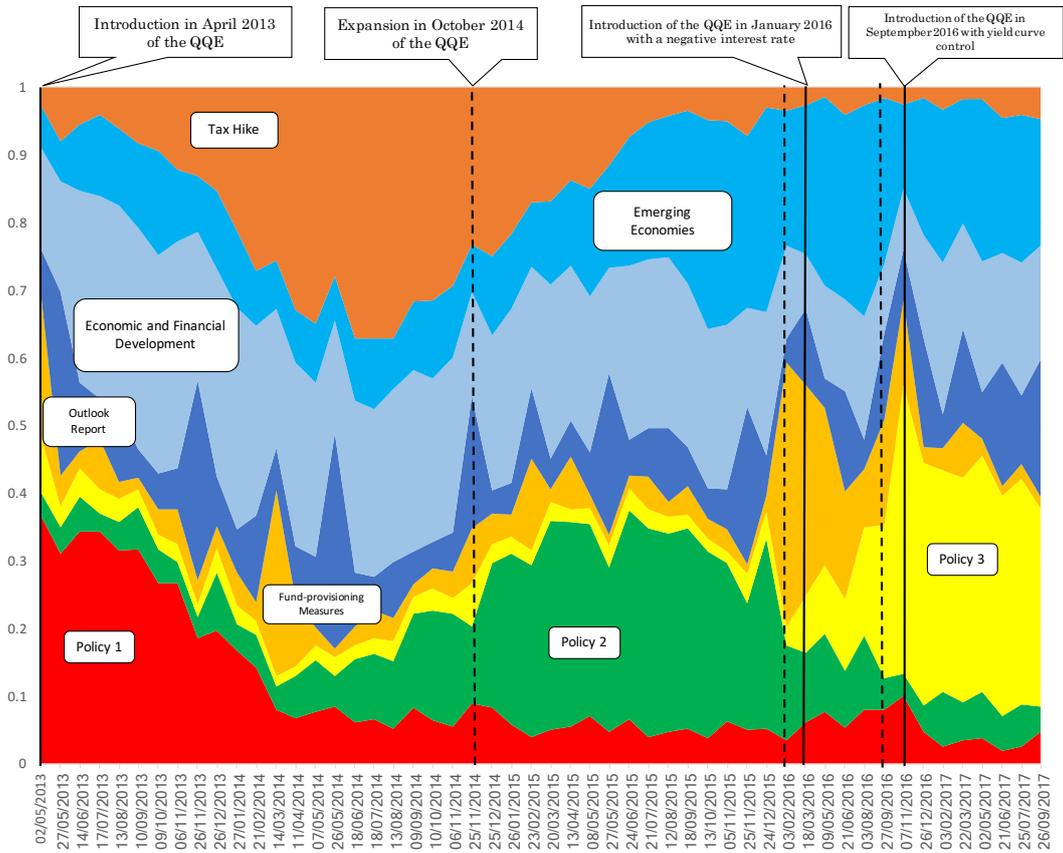
Figure 2: Topic 0, 1 and 2 Proportions Over Time
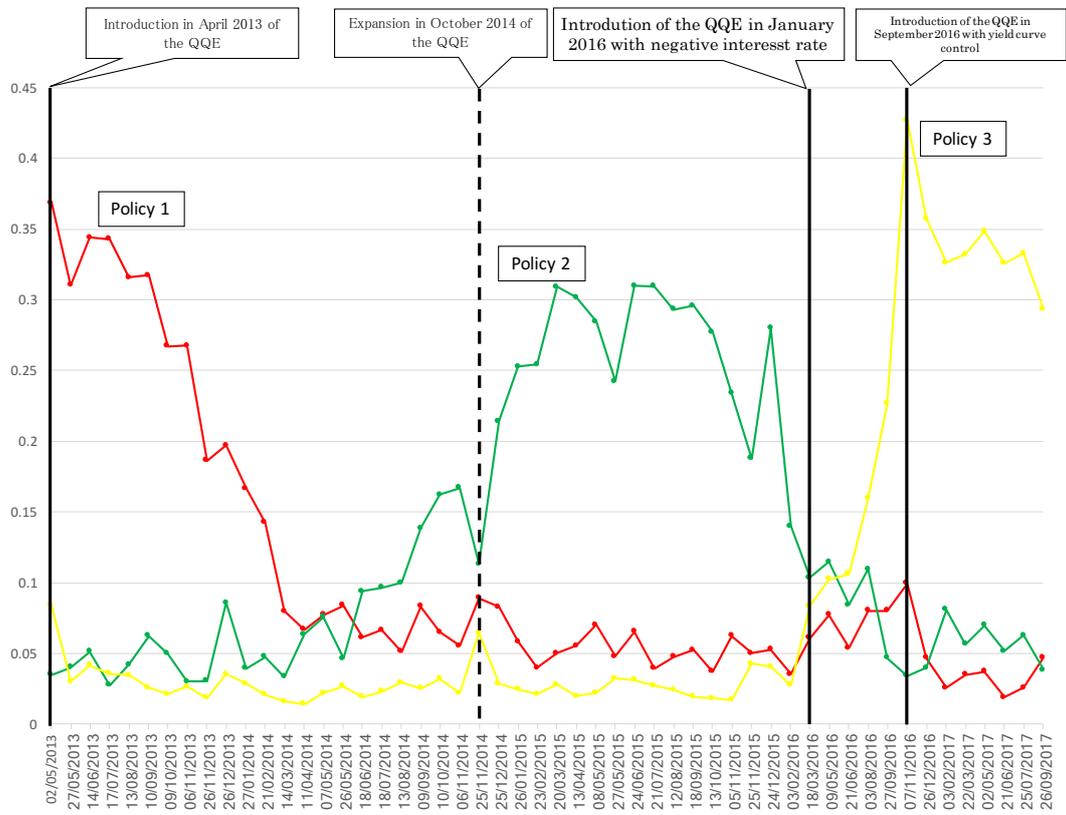
Figure 3: Topic 3 Proportions Over Time
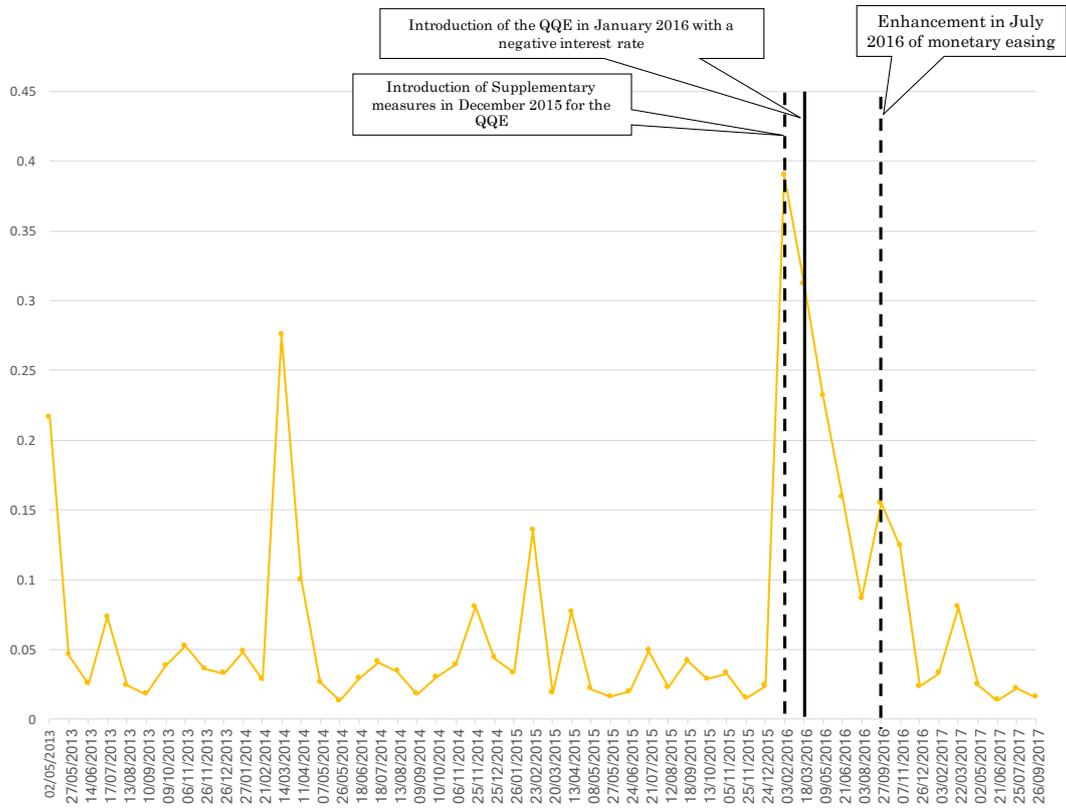
Figure 4: Topic 4 and 5 Proportions Over Time
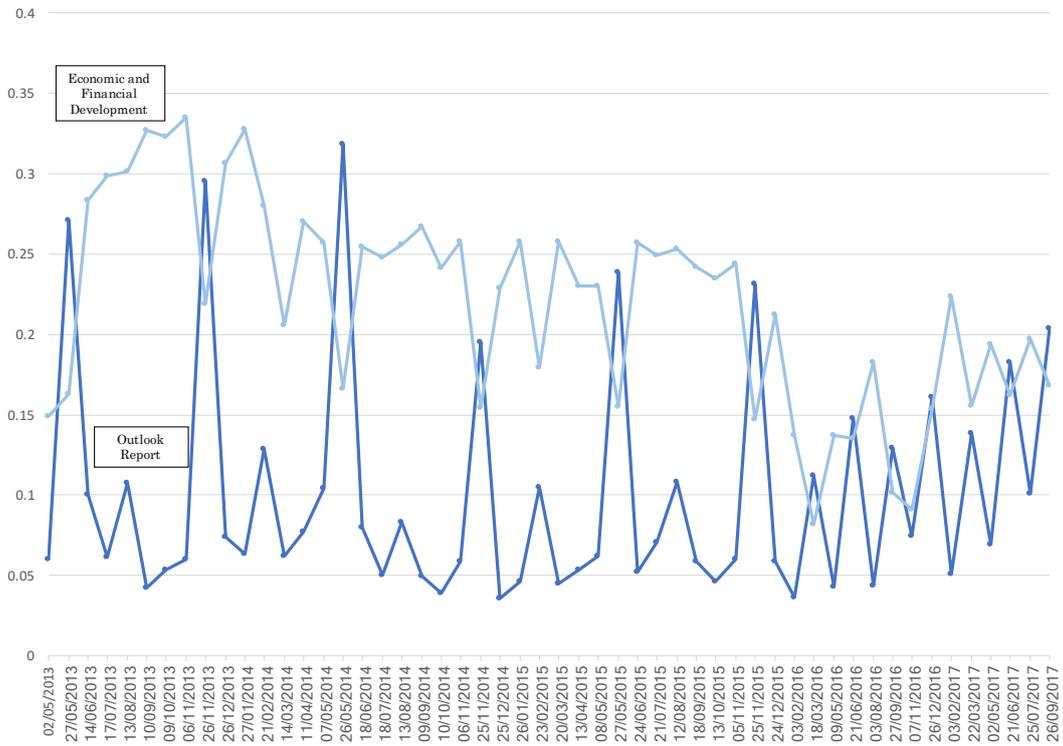
Figure 5: Topic 6 Proportions Over Time
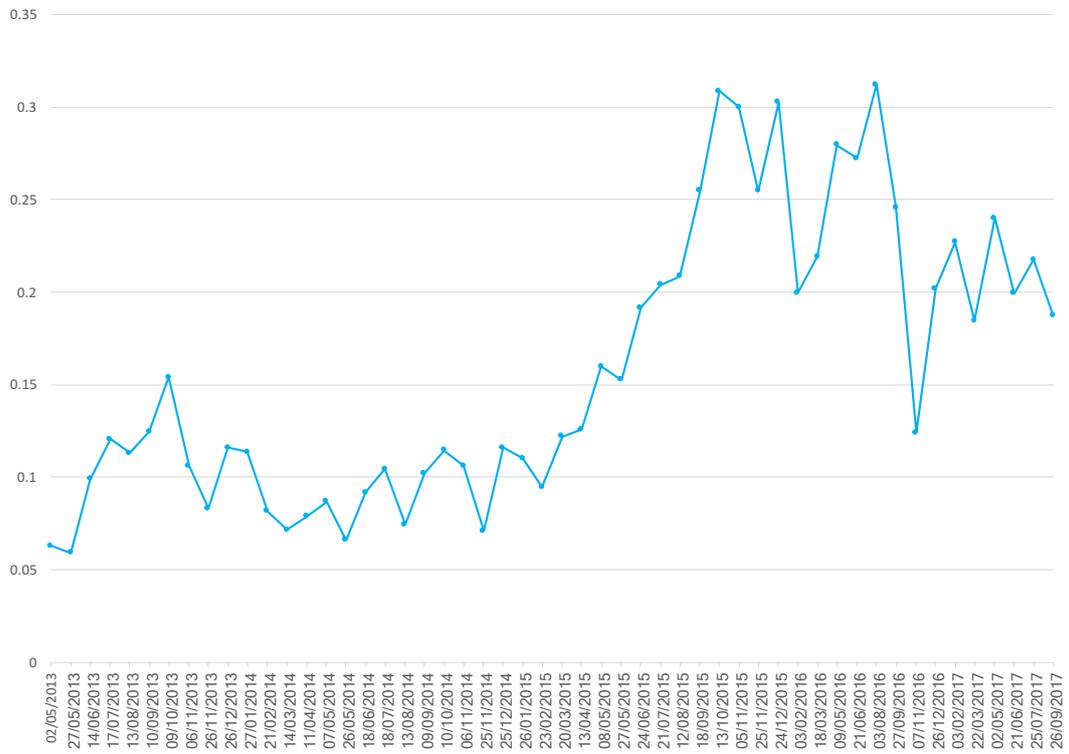
Figure 6: Topic 7 Proportions Over Time