The Arts of Central Bank Communication: A Topic Analysis on Words of the Bank of Japan's Governors*

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Abstract

This paper addresses the arts of central bank communication, in a semantic analysis of applying a topic model to the regular press conference documents of the Bank of Japan (BOJ)'s governor Masaaki Shirakawa and governor Haruhiko Kuroda. A standard method of latent Dirichlet allocation (LDA) in statistic natural language processing literature indicates some evidence on the communication strategy. Our results using 70 regular press conference documents show the difference of governorship of Shirakawa and Kuroda in their topics distribution. In the era of governorship of Kuroda, his topics dramatically changes in the early 2016 when the negative interest rate policy was introduced. It is notable that this change decreases a ratio of the "policy goal" topic which was the essential feature of governor Kuroda. Our results imply that statistical natural language processing techniques are useful for identifying changes monetary authorities' policy stance.

Keywords: Monetary policy; Communication; Private information; Delphic; Odyssean; Discretion; Commitment; Latent Dirichlet allocation

JEL classification: E52, E58

1 Introduction

Looking back to the centennial history of the US Federal Reserve System since the establishment in 1913, Romer and Romer (2013) presented narrative evidence on a link between pessimistic beliefs in efficacy of monetary policy and policy inaction among then monetary policy-makers in the 1930s after the Great Depression, the 1970s' stagflation and the Great Recession after 2008. The pessimistic views of the central bankers had been revealed in order to forestall an idea of monetary policy as a panacea for remedying the economic crises.

In past days before the inflation targeting framework of monetary policy was internationally accepted in the 1990s, central banks pursued monetary mystique obscuring their private information on policy targets (Goodfriend, 1986). The central bank secrecy in implementing monetary policy has been replaced with transparency and accountability in targeting policy objectives since institutionalizing the inflation targeting framework. Communication strategy is now a policy tool for central banks which transmit private information on their beliefs about monetary policy and economic fundamentals (Blinder et al, 2008).

The role of private information of central banks in monetary policy efficacy has been discussed in the Barro-Gordon type of policy-game literature. Discretion in monetary policy exerts a central banker to raise unanticipated inflation resulting in greater output than a potential one, so that inflation rate would be higher than the policy target. In order to reduce the inflation bias, some forms of policy commitment on targeted inflation are required for gaining credibility for central bankers. On the other hand, in the event of exogenous supply shocks in output, flexibility in policy targeting would be required for stabilization of output variations relative to the inflation bias. The tradeoff between credibility and flexibility is a rationale for ambiguity of central bank in revelation of its private information (Canzoneri, 1985; Cukierman and Meltzer, 1986; Stein, 1989; Garfinkel and Oh, 1995).

More recent attention is also paid to failures in forward guidance policy of unconventional monetary policy measures (Campbell, et al, 2012). The forward guidance aims to raise inflation expectations through a policy commitment of continuing expansionary monetary measures consistently until achieving the policy target and even after doing so. The time-consistent policy option could control the public's inflation expectations in theory, but still poses weak evidence for the efficacy. One of the causes of the policy failures is a central bank's communication. The announcement of commitment to ever-going quantitative easing can be transmitted to dual effects. One is 'Odyssean' an intended effect of anticipating an expansionary monetary policy. The other is 'Delphic' an unintended effect of anticipating bad economic fundamentals. The Delphic communication of forward guidance might be a reason for the policy failures in raising the inflation expectations.

This paper follows the aforementioned literature on the link between central bank communication of its private information and the policy efficacy. We address the arts of central bank communication in a case of the Bank of Japan (BOJ). The Bank of Japan experienced a drastic change in monetary policy

framework in 2013, when the governor Haruhiko Kuroda took office after the former Masaaki Shirakawa. The Gov. Kuroda launched facilities for large-scale purchases of financial assets to expand the monetary base. Though in the vicinity of his inauguration there were no formal changes in institutional arrangements for communication, we wonder what has qualitatively changed in communication strategy.

Keida and Takeda (2017) took a natural language analysis on the regular press conference held by the BOJ Governor after every monetary policy committee. The latent semantic analysis (LSA) of detecting similarities among documents confirmed large dissimilarities in informational contents at the press conferences between both governors.

This paper in turn applies a latent Dirichlet allocation (LDA) method of extracting relevant topics from the regular press conferences. The LDA analysis detects three types of topics meaning policy objectives, policy instruments or central bank's discretion. During the Gov. Shirakawa period, a topic category of the bank's discretion is most frequent, while for the Gov. Kuroda period a frequency of another category of the policy objectives or instruments increases. The evidence indicates that communication of the private information of the BOJ during the Gov. Shirakawa period was Delphic in that announcing the unconventional measures including forward guidance revealed bad news on macroeconomic fundamentals concerning the BOJ policy.

Shirota et al. (2015) and Kawamura et al. (2016) analyze on monetary policy using LDA. Shirota et al. (2015) focus on the specific topic in the MPM minutes. Kawamura et al. (2016) focus on frequency of positive, negative and ambiguous expression in the BOJ's monthly reports. They conclude that the BOJ adopted strategic information revelation using these expressions. On the other hand, we focus on the general communication in the press conferences of BOJ's governor. In this paper, we extract topics using all words of governors in the press conferences and investigate the change of ratio of topics. Our approach have an advantage in comparing the topic ratio variation and the BOJ's policy stance.

The remaining of this paper is organized as follows; Section 2 describes the BOJ's communication strategy especially a roll of regular press conferences held after every monetary policy meeting (MPM) in words of the BOJ governor; Section 3 explains the topic model and its standard method of inference called LDA. In Section 4, we present our corpus and the LDA results with some policy implication. Finally, some concluding remarks are made in Section 5.

2 Communication and its Impacts of the BOJ

We provide here a brief explanation of the institutional background on the BOJ's communication strategy. The Bank of Japan Law requires the Bank to clarify to the public the content of its decisions, as well as its decision making processes, regarding monetary policy. As a specific framework, the Law stipulates releasing the minutes and transcripts of MPMs, reporting to and attendance at the Diet

and public announcement of the Outline of Business Operations. In keeping with the principles of the Law described above, the Bank aims to establish a high degree of transparency with regard to its conduct of policies and operations in order to carry out external relations activities. Among the communication activities, releasing public statements on most of the Policy Board decisions and having the Governor hold regular press conferences play a crucial role in the BOJ's communication process.

2.1 Regular Press Conference of the Governor

There is eight times of MPMs in a year each for two days long. Immediately after relevant MPMs, "the Bank's View" in the Outlook for Economic Activity and Prices will be released, and the full text will be on the next day. However, it takes in principle a few weeks until the Summary of Opinions and the MPM Minutes will be released. In order to disclose information in a timely manner, the Governor holds the regular press conferences after the end of every MPM, ordinarily at 3:30 p.m. around for one hour. The abstract of the conference will be forthcoming on the next day.

The regular press conference is held in Japanese and the abstract released is written in Japanese. The regular press conferences have been covered live on internet, since Governor Kuroda in office. The Japanese media audits and reports live from the conference. In the presence of news on changes in monetary policy stance of the BOJ, there are often observed the financial market responses at the timing between the Bank's View released at the end of MPM and the governor's regular press conference from 3:30 p.m.

2.2 Natural Language Processing and Monetary Policy

The most important advantage of LDA method is the ability of extraction of topics from the corpus. Keida and Takeda (2017) investigate the similarity of abstract of the press conferences using a standard latent semantic analysis (LSA) method. They found that the 10 documents from the governorship of Shirakawa are very similar, and documents between Shirakawa and Kuroda are less similar. Also, they found documents from the governorship of Kuroda are comparatively similar as a whole. On the other hand, in the era of Gov. Kuroda, the documents gradually change from 2013 to 2015 and Gov. Kuroda's documents dramatically change in early 2016 when he introduced the negative interest rate policy.

The LSA method depicts clearly that the changing of the governor and the changing of the policy stance make changes in words of the press conferences of the BOJ's governor. However, this method could not answer the question what changes in words of governors are. Topic models and LDA methods are useful to show what changed and what did not change as the changing of ratio of topics. In this paper, we focus on the extraction of topics in these documents using LDA method and show the interpretation of these results.

4

3 Topic Model

3.1 Model notation

Latent Dirichlet Allocation (LDA) was first presented as a graphical model for topic discovery by Blei, Ng, and Jordan (2003). Essentially the same model was proposed independently by Pritchard, Stephens and Donnelly (2000) in the study of population genetics.

In LDA, each document is consisted as a mixture of several topics. The topic distribution is assumed to have a sparse Dirichlet prior. Using the sparse Dirichlet prior, the LDA method assumed that documents cover only a small set of topics and that topics use only a small set of words frequently. In practice, this results in a better disambiguation of words and a more precise assignment of documents to topics. Each document is assumed to be characterized by a particular set of topics. This is similar to the standard bag of words model assumption, and makes the individual words exchangeable.

Now we need to consider the model which describe how the documents are generated. The documents are bags of words, so we consider the process which choose the word following the topic distribution and put it into the specific bag. D denotes the number of documents, N_d the number of words in document d, V the number of vocabulary in this corpus. The variable notations are defined as follows; α is the parameter of the Dirichlet prior on the per-document topic distributions, β is the parameter of the Dirichlet prior on the per-topic word distribution, θ_d is the topic distribution for document d, ϕ_k is the word distribution for topic k, $z_{d,n}$ is the topic for the n-th word in document d, and $w_{d,n}$ is the specific word.

3.2 Generative process

LDA assumed the following generative process for a corpus consisting of D documents each of the length N_d:

- Choose $\boldsymbol{\theta}_i \sim \text{Dirichlet}(\alpha)$, where $i \in 1, \ldots, D$

- Choose $\boldsymbol{\phi}_k \sim \text{Dirichlet}(\alpha)$, where $i \in 1, \ldots, K$

- For each of the word position i, j, where $i \in 1, \ldots, D$, and $j \in 1, \ldots, N_i$

  - Choose a topic $z_{i,j} \sim \text{Multinomial}(\theta_i)$
  - Choose a word $w_{i,j} \sim \text{Multinomial}(\phi_{z_{i,j}})$

The length N_d are treated as independent of all the other data generating variables (w and z).

Figure 1 is the plate notation of the LDA model. The plate notation captures concisely the dependencies among the many variables in this model. The boxes are "plates" representing replicates, which are repeated entities. The outer plate represents documents, while the inner plate represents the repeated word

positions in a given document, each of which position is associated with a choice of topic and word.

The model summarizes following equations:

$$\boldsymbol{\theta}_k \sim \text{Dirichlet}(\alpha) \tag{1}$$

$$\boldsymbol{\phi}_k \sim \text{Dirichlet}(\beta) \tag{2}$$

$$z_{d,n} \sim \text{Multinomial}(\theta_k) \tag{3}$$

$$w_{d,n} \sim \text{Multinomial}(\phi_{z_{d,n}}) \tag{4}$$

3.3 Inference

According to the model, the total probability of the model is:

$$p(\boldsymbol{Z}, \boldsymbol{W}, \boldsymbol{\Theta}, \boldsymbol{\Phi}|\alpha, \beta) = p(\boldsymbol{\Theta}|\beta)p(\boldsymbol{\Phi}|\alpha)p(\boldsymbol{Z}|\boldsymbol{\Theta})p(\boldsymbol{W}|\boldsymbol{Z}, \boldsymbol{\Phi})$$

We have the simultaneous distribution which parameter $\boldsymbol{\Theta}$ and $\boldsymbol{\Phi}$ will be integrated out.

$$p(\boldsymbol{Z}, \boldsymbol{W}|\alpha, \beta) = p(\boldsymbol{Z}|\alpha)p(\boldsymbol{W}|\boldsymbol{Z}, \beta) \tag{5}$$

$$= \frac{\Gamma(\alpha K)^D}{\Gamma(\alpha)^{KD}} \prod_{d=1}^{D} \frac{\prod_{k=1}^{K} \Gamma(N_{d,k} + \alpha)}{\Gamma(N_d + \alpha K)} \times \tag{6}$$

$$\frac{\Gamma(\beta V)^K}{\Gamma(\beta)^{VK}} \prod_{k=1}^{K} \frac{\prod_{v=1}^{V} \Gamma(N_{k,v} + \beta)}{\Gamma(N_k + \beta V)}$$

N_{dk} is the number of words of topic k in document d and $N_d = \sum_{k=1}^{K} N_{d,k}$. And N_{kv} is the number of words of vocabulary v in topik k and $N_k = \sum_{v=1}^{V} N_{k,v}$ is the number of words in topic k.

3.3.1 Sampling equation

The conditional probability of sampling the topic of the n-th word of document d is, under that topic set without its topic is $\boldsymbol{Z}_{\backslash d,n}$ and the document set is $\boldsymbol{W}$, is given as follow:

$$p(z_{d,n} = k|\boldsymbol{W}, \boldsymbol{Z}_{\backslash d,n}, \alpha, \beta) \propto p(z_{d,n} = k|\boldsymbol{Z}_{\backslash d,n})p(w_{d,n}|\boldsymbol{W}_{\backslash d,n}, z_{d,n} = k, \boldsymbol{Z}_{\backslash d,n}, \beta) \tag{7}$$

$$p(z_{d,n} = k | \boldsymbol{Z}_{\backslash d,n}) \quad = \quad \frac{p(z_{d,n} = k, \boldsymbol{Z}_{\backslash d,n} | \alpha)}{p(\boldsymbol{Z}_{\backslash d,n} | \alpha)} \tag{8}$$

$$= \quad \frac{N_{d,k \backslash d,n} + \alpha}{N_d - 1 + \alpha K} \tag{9}$$

$$p(w_{d,n} | \boldsymbol{W}_{\backslash d,n}, z_{d,n} = k, \boldsymbol{Z}_{\backslash d,n}, \beta) \quad = \quad \frac{p(w_{d,n}, \boldsymbol{W}_{\backslash d,n} | z_{d,n} = k, \boldsymbol{Z}_{\backslash d,n}, \beta)}{p(\boldsymbol{W}_{\backslash d,n} | \boldsymbol{Z}_{\backslash d,n}, \beta))} \tag{10}$$

$$= \quad \frac{N_{k,w_{d,n} \backslash d,n} + \beta}{N_{k \backslash d,n} + \beta V} \tag{11}$$

Substituting the equation (9) and (11) in (7), we get followin equation.

$$p(z_{d,n} = k | \boldsymbol{W}, \boldsymbol{Z}_{\backslash d,n}, \alpha, \beta) \propto (N_{d,k \backslash d,n} + \alpha) \frac{N_{k,w_{d,n} \backslash d,n} + \beta}{N_{k \backslash d,n} + \beta V} \tag{12}$$

Note that $(N_d - 1 + \alpha K)$ is not depend k, we can eliminite it from the denominator. Hyperparameters α and β can be estimated by maxmizing the joint likelihood (5). We get the updating equation as follows.

$$\alpha^{new} \quad = \quad \alpha \frac{\sum_{d=1}^{D} \sum_{k=1}^{K} \Psi(N_{d,k} + \alpha) - DK\Psi(\alpha)}{K \sum_{d=1}^{D} \Psi(N_d + \alpha K) - DK\Psi(\alpha K)} \tag{13}$$

$$\beta^{new} \quad = \quad \beta \frac{\sum_{k=1}^{K} \sum_{v=1}^{V} \Psi(N_{k,v} + \beta) - KV\Psi(\beta)}{V \sum_{k=1}^{D} \Psi(N_k + \beta V) - KV\Psi(\beta V)} \tag{14}$$

Using these updating equations, we can estimate the hyperparameters α and β.

4   Results and Policy Implications

4.1   The Corpus

We analyze 70 abstracts of the regular press conference using Latent Dirichlet Allocation (LDA) to extract latent topics. The regular press conferences are held after the monetary policy meeting, so that it tend to be the first announcement of the changes of the policy stance of the BOJ. It is the reason that we focus on the regular press conferences. While the abstract of the regular press conferences

consist by the question parts of the press and the answer parts of the governor, we use only the answer parts for our analysis.

The analysis period is from July 2012 to July 2018. The analysis includes 10 documents from the governorship of Shirakawa and 60 documents from the governorship of Kuroda. We note that, in this period, the BOJ decrease number of the MPM for a year. It is held 14 times for a year before 2016 and 8 times after 2017. Therefore, the number of the regular press conferences also decreased in this period.

4.2 Results

The LDA extracts topics from the corpus. We assume that there are 3 topics in these documents. Our results show that the LDA extracts topics corresponding "policy goal", "policy instruments", and "discretion". Table 1 shows the top 20 high probability words for each topics.

Figure 2 shows the ratio of each topics in each documents. In this figure, there are two big change of the ratio in the period. The first one is occurred in 2013 when the governorship changes from Gov. Shirakawa to Gov. Kuroda. The second one is occurred in the era of Gov. Kuroda, and from the end of 2015 to early 2016. Hereafter, we state it happened in early 2016.

4.3 Policy Implication

The first change is consisted in the change the policy stance from Gov. Shirakawa to Gov. Kuroda. In the first press conference of Gov. Kuroda, he show his policy goal, achieving 2% inflation, doubling monetary base in 2 years, so that it is natural huge raise of the ratio of "policy goal" topic. And, under the Gov. Kuroda's policy stance which he express clear the policy goal, the topic of the discretion decrease to almost zero. It is interpreted that his rule based policy stance does not need the discretion topic. The LDA method detect fairly well the change of the governor of the Bank of Japan.

The second one is a big change as the words of the particular person, and this change has the persistent effect. It is natural interpretation that the policy stance of Gov. Kuroda change greatly. In fact, he introduced the negative interest policy in early 2016. Furthermore, in this period, Gov. Kuroda is criticized on nonachievement of 2% inflation in two years from 2013. It is possible that his explanation in his press conferences is not enough only to talk about his policy goal. And it is consistent that the ratio of the topic of policy instruments increase in this period.

5 Concluding Remarks

Communication strategies have become a policy instrument used by central banks to control expectations, especially to enhance financial markets' credibility for the time-consistent policy. This paper explores a statistical natural

language processing of policy narratives with a focus on the Bank of Japan since 2012. The period covers when both Governors, Masaaki Shirakawa and Haruhiko Kuroda held office. The LDA analysis also detects three topics on policy goal, policy instruments and discretion. During a transitional period from Shirakawa to Kuroda, the topics of policy goal increased. In 2016 within the Kuroda period, the topics of policy instruments increased. Our result in this paper is consistent with the result of Keida and Takeda (2017). Since the ambiguity in words of the governors is reflected in "discretionary" topics, the communication strategy in the Shirakawa governorship was considered as "Delphic" in that the semantic ambiguity might reveal bad fundamental conditions concerning the Japanese economy. As our empirical analyses show, statistical natural language processing methods, including the LDA method, are useful to analyze monetary policy documents. The further researches could uncover more the arts of central bank communication.

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Table 1: Top 20 high probability words in each topics

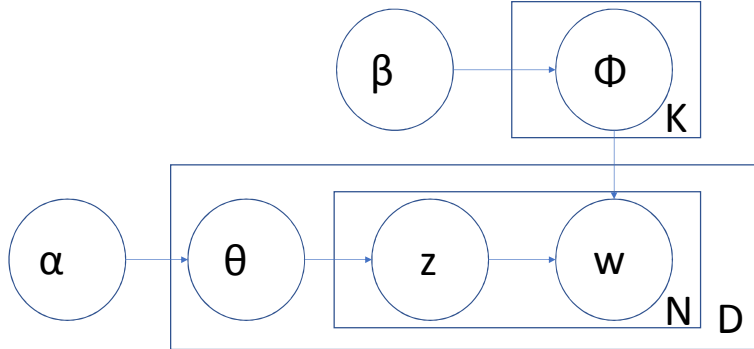| topic 1: discretion	topic 2: policy instruments	topic 3: policy goal
強化	金融	する
資金	経済	物価
支援	政策	思う
取組む	緩和	ある
欧州	金利	なる
供給	市場	上昇
認識	日本銀行	みる
状態	行う	安定
質問	量的	申し上げる
巡る	質	影響
基金	状況	成長
図る	決定	2
意識	実現	消費
課題	効果	1
制度	銀行	目標
国民	国債	考える
主体	長期	必要
使う	マイナス	見通し
基盤	3	通り
担保	中央	価格

Figure 1: Plate notation representing the LDA model

Figure 2: Topic ratio in the regular press conference