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A Semantic Analysis of Monetary Shamanism:
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Abstract

This paper examines whether statistical natural language processing techniques have been useful in analyzing documents on monetary policy. A simple latent semantic analysis shows a relatively good performance in classifying the Bank of Japan (BOJ)'s documents on its governors' policy and the impact without human reading. Our results also show that Governor Haruhiko Kuroda's communication strategy changed slightly in 2016 when the BOJ introduced the negative interest rate policy. This change in 2016 is comparable to the one from the transition from Masaaki Shirakawa to Kuroda. In spite of the intention, the BOJ had a misjudgment in the communication strategy.

Keywords: Monetary policy, Communication, Latent semantic analysis

JEL classification: E52, E58

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1 Introduction

Communication with financial markets, its strategy in monetary policy-makings by central bankers in the advanced economies has ever gained momentum. In practice, it was the former Fed Chairman Alan Greenspan taking office after the era of ‘monetary mystique’ (Goodfriend, 1986), who pursued communication strategy in a collegial way that as the then-vice-Chairman Alan Blinder reflected (Blinder, 1998), financial markets do only respond to the Maestro’s voice of authority. The one-voice approach to communication is in contrast to a highly individualistic one, according to which individual policy board members are allowed and encouraged to manifest their personal views, as is often the case in the Bank of England (Ehrmann and Fratzscher, 2005). In theory, on the other hand, communication strategy is considered as crucial for the expectation channel of such unconventional monetary measures as quantitative easing. Persuasive announcements foster credibility for central bank’s policy commitment, stabilizing expectations of inflation (as shown by Barro and Gordon, 1983), long-term interest rates (Keynes, 1936), foreign exchange rates (Calvo, 1988), and so forth. In a word, communication strategy is now a policy instrument of the contemporary central banks for controlling expectations in a consistent way with the actual outcomes monetary policy would achieve.

However, in the exasperating course of unconventional monetary policy in Japan since 1998, some market analysts has begun to raise their voice against the communication strategy of the Bank of Japan (BOJ). They dubbed it as “monetary shamanism”. While the BOJ has adopted since 2013 inflation targeting framework with a target rate 2% measured with the core headline Consumer Price Index (core CPI), the unconventional measures succeeded in achieving higher rates of the core CPI than 2% with a peak rate 3.4% on May, 2014, consecutively from April, 2014 to March, 2015. But thereafter the core CPI

rate has been lower than 0.5%, again diving into deflation further away from the target. The BOJ Governor Haruhiko Kuroda confessed himself inspired by the story Peter Pan, quoting “The moment you doubt whether you can fly, you cease forever to be able to do it”. To make the BOJ’s commitment credible for the public, Governor Kuroda has taken every opportunity to reinforce his commitment to future inflation in defiance of the actual deflation.

This paper explores a question of how one measures communication strategy and the actions that each central banker has devised for enhancing credibility. We take a case of Governor Kuroda, the BOJ. Browsing his statements in the regular press conferences, we analyze the communication strategy with a latent semantic analysis (LSA) in statistical natural language processing. LSA which Deerwester et al. (1990) first proposed, can be applied to natural language in those documents which central banks have publicly released in a formal way of announcing decision-makings of monetary policy (for a case of the US FOMC statements, Boukus and Rosenberg, 2006; Mazis and Tsekrekos, 2015). In the case of the BOJ, all the documents in the regular press conference of the Governor are in Japanese, so that in our LSA procedure a morphological analysis is required specific to Japanese. Once we can obtain a quantitative measure of the communication strategy as a policy instrument, we will make use of it to estimate effects of the policy instrument on asset prices in financial markets, a research yet to remain in the literature of monetary policy.

Our results show that Governor Kuroda’s communication strategy has been changed slightly in 2016 when the BOJ introduced the negative interest rate policy. The change in 2016 has a difference comparable to the change from Governor Masaaki Shirakawa to Kuroda. In spite of the BOJ’s intention that the policy would not basically change, our analysis implies the BOJ had a misjudgment in the communication strategy.

The structure of this paper is organized as follows: Section 2 documents institutional background of the regular press conference in the BOJ's communication process, supplemented with evidence on the impacts of the announcements on financial markets. In Section 3, we explain the LSA applied to the BOJ's documents spoken and written in Japanese. The results of the analysis are presented in Section 4. Finally, we conclude this paper 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 Impacts on the Stock Market in 2013–2016

There were twice events during 2013-2016 when the BOJ's policy changes surprised the financial markets, the so-called Kuroda's bazooka. The first surprise was on April 4, 2013 at the onset of the first MPM in the chairmanship of Governor Kuroda. The BOJ introduced the quantitative and qualitative monetary easing (QQE). It committed to achieving the price stability target of 2 percent in terms of the year-on-year rate of change in the CPI at the earliest possible time, with a time horizon of about two years. In order to do so, it promised to double the monetary base and the amounts outstanding of Japanese government bonds as well as exchange-traded funds in two years, and more than double the average remaining maturity of JGB purchases.

The second bazooka occurred on October 31, 2014 when there was somewhat weak developments in demand following the consumption tax hike on April, and a substantial decline in crude oil prices have been exerting downward pressure on the price levels. The Bank judged it appropriate to expand the QQE. The Bank conducted money market operations so that the monetary base would

increase at an annual pace of about 80 trillion yen. The Bank promised to purchase JGBs so that their amount outstanding would increase at an annual pace of about 80 trillion yen.

The two-time surprises gave big impacts on the Tokyo Stock Exchange. The Nikkei 225 had surges in the vicinity of the days, shown in Figure 1 for a case of April 4, 2013 and the other of October 31, 2014. Looking at the intra-day price movement on a 5-minute basis indicated in Figure 2 and 3, we can confirm that after the price moved slightly on wait-and-see attitude, the price had surged at the end of the MPMs and on. The consequence of the QQE introduction and expansion was a part due to the communication strategy Governor Kuroda exemplifies.

3 Semantic Analysis for Documents in Japanese

3.1 Morphological Analysis

This section provides an overview on the method using in this paper. Unlike the European languages, Japanese does not have the space between words. Therefore, the first step of analysis in Japanese is to decompose the sentence into words. It means to decompose the sentence into morphological components in linguistics. This process is called the morphological analysis, and necessary for the statistical natural language processing in Japanese.

In the morphological analysis, it is necessary the knowledge on Japanese grammar. In this paper, we use the open source software for the morphological analysis in Japanese. MeCab is one of the standard software for these purposes. Natural language grammar is complicated system, so that, in some case, it does not coincide opinions of experts of linguistics. We avoid arbitrary decision in Japanese grammar to use the standard software. MeCab provides the relatively

easy way to these analysis for non-experts in linguistics.

3.2 Term Frequency and Inverse Document Frequency

In statistical natural languages processing literature, tf-idf, short for term frequency–inverse document frequency, is a statistic that represents how important a word is to a document in a collection or corpus. It is often used as a weighting factor in information retrieval. The tf-idf value increases proportionally to the number of times a word appears in the document, but is offset by the frequency of the word in the corpus, which helps to adjust for the fact that some words appear more frequently in general.

The tf-idf value is divided into “term frequency” term and “inverse document frequency” term. These are expressed as below¹.

$$tf_{i,j} = \frac{n_{i,j}}{\sum_k n_{k,j}}$$

$$idf_i = \log \left(\frac{|D|}{|\{d : t_i \in d\}|} + 1 \right)$$

$n_{i,j}$ is the word t_i 's frequency in the document d_j , $\sum_k n_{k,j}$ is the summation of frequency of all words in document d_j , $|D|$ is number of documents, $|\{d \in t_i\}|$ is number of documents including the word t_i . The tf-idf value of the word t_i

¹Usually, idf_i is defined as follows.

$$idf_i = \log \left(\frac{|D|}{|\{d : t_i \in d\}|} \right)$$

We modify the definition by adding to one, because it makes our result more clear. Obviously, this modification makes no changes idf_i order in the set of terms. And, even if the term i appeared in every documents, idf_i is not zero. Therefore, $tfidf_{i,j}$ also has a positive value as depending on a term frequency $tf_{i,j}$. Our all documents are about monetary policy, so that there are many necessary terminologies. These technical words appear in almost every documents, and it is possible that term frequencies of these words have important roll to our results.

in the document d_i is defined as below.

$$tfidf_{i,j} = tf_{i,j} \cdot idf_i$$

In case that there are $|T|$ words in $|D|$ documents, the tf-idf values are composed $|D| \times |T|$ matrix, called document matrix.

3.3 Latent Semantic Analysis

Latent semantic analysis (LSA) is a technique in statistical natural language processing using vector space model, in particular distributional semantics, of analyzing relationships between a set of documents and the terms they contain by producing a set of concepts related to the documents and terms. LSA assumes that words that are close in meaning will occur in similar pieces of text.

The terms and documents matrix is express as below.

$$TD = \begin{pmatrix} tfidf_{1,1} & tfidf_{1,2} & \cdots & tfidf_{1,|D|} \\ tfidf_{2,1} & tfidf_{2,2} & \cdots & tfidf_{2,|D|} \\ \vdots & \vdots & \ddots & \vdots \\ tfidf_{|T|,1} & tfidf_{|T|,2} & \cdots & tfidf_{|T|,|D|} \end{pmatrix}$$

A column in this matrix will be a vector corresponding to a document, giving its relation to each term:

$$d_i = (tfidf_{1,i}, \cdots, tfidf_{|T|,i})'$$

Now, from the theory of linear algebra, there exists a decomposition of TD such that U and V are orthogonal matrices and Σ is a diagonal matrix. This is

called a singular value decomposition (SVD).

$$TD = U\Sigma V'$$

In order to get a rank- n -approximation to TD with n largest singular values, we choose primary component analysis (PCA) where to pick up a value of n in term of a criteria of cumulative propotion. We construct a singular matrix Σ_n and their the corresponding left-singular vectors U_n and right-singular vectors V_n , We write this approximation TD_{LSA} as

$$TD_{LSA} = U_n \Sigma_n V_n'$$

We can interpret the approximated terms and documents matrix TD_{LSA} as a “semantic space”, where each “document” vector \hat{d}_j is a lower-dimensional approximation to the higher-dimensional space spanned by natural language.

3.4 Similarity Evaluation Using Vector Space Model

We can see how related documents h and i are in the low-dimensional space by comparing the vectors for documents estimated by LSA (typically by cosine similarity). The vectors for document i is written as follow,

$$\hat{d}_i = \Sigma_n^{-1} U_n' d_i$$

And the cosine similarity of documents h and i is written as follow.

$$sim(\hat{d}_h, \hat{d}_i) = \cos \theta = \frac{\hat{d}_h \cdot \hat{d}_i}{|\hat{d}_h| |\hat{d}_i|}$$

4 What Changes in the BOJ's Communication Strategy?

4.1 Data

In this paper, we investigate what changes the BOJ's communication strategy. For this purpose, we estimate the similarity between the BOJ's announcement by using LSA. There are many types of announcements from the BOJ; the regular press conference of the governor, the press conference of the governor, the speeches by the governor, the deputy governor, and the member of policy board, etc. The BOJ releases all announcements in Japanese, and a part of them in English on the web site. We focus on the regular press conference of the governor.

The BOJ usually releases the document for the regular press conference of the governor after one business day of the press conference. The documents consist of the part of the question by the press and the part of the answer by the governor. We use only the answer by the governor.

The data using in this paper are fifty two Japanese documents from the BOJ as the official reports of the regular press conference of the governor. The data period is from February 2012 to November 2016. The first seven documents are the reports released by Governor Shirakawa. The remained reports are released by Governor Kuroda.

After the morphological analysis using MeCab, we can get a set of words of a document. We focus only nouns excluding noun-aux and noun-suffix and verbs excluding verb-aux and verb-suffix. Both nouns and verbs are identified by MeCab. Using only nouns and verbs, our analysis focuses on the semantics of the documents to avoid the effects of personal wordings. Our fifty five documents has 4595 words. It means that our terms and documents matrix is 4595 x 55.

Our choice of cumulative propotion for selecting n largest singular values in the PCA is 90%. In our terms and documents matrix, the PCA shows that n is 13. Table 1, 2, and 3 shows top 30 words by largest absolute values in the primary, the secondary, and the tertiary axis, respectively.

4.2 Results

We apply the LSA method mentioned at section 3 to the documents of official reports on 55 regular press conferences in 2013–2016 from the BOJ². As a result, we can get the similarity matrix 55 x 55. The Table 4 shows the result of the LSA. In the Table 4, it has the similarity matrix 55 x 55 which is a diagonal matrix, because a correlation coefficient of same documents is one. It is also a symmetric matrix, because it is same correlation coefficient of documents \hat{d}_i and \hat{d}_j , and documents \hat{d}_j and \hat{d}_i . Non-diagonal elements show corresponding correlation coefficients.

Colored numbers show 0.8 or more of the correlation coefficient, and darker colors means that numbers are closer to one. A darker color block in matrix mean a bundle of similar documents. And these darker color blocks on the diagonal line show that serials of documents have a similarity.

The Table 4 shows the difference of Shirakawa era and Kuroda era. The 10 x 10 numbers of up-left corner of Shirakawa era and the 45 x 45 numbers of down-right corner of Kuroda era are relatively darker colored. On the other hand, the 10 x 45 numbers of up-right corner and 45 x 10 numbers of down-left corner are almost not colored. It means that the result shows the low similarity of documents of Shirakawa era and Kuroda era.

In Kuroda era, there are similar documents from 2013 to 2015, except of April and May 2013, February 19, 2014, May 1, 2014, and November 2014. The

²The codes used in this paper are available at https://github.com/masakeida/monetary_policy_lsa.

Document of April 5, 2013 is on Governor Kuroda's the first regular press conference. In the first conference, he releases the announcement that the BOJ completely changes the monetary policy and introduce the Quantitative-Qualitative Easing (QQE). And the document of November 4, 2014 is on the additional easing, so called the second Kuroda's Bazooka. Interestingly, the correlation coefficient of the documents of April 5, 2013 and November 4, 2014 is relatively high, 0.902. These two announcements have high impacts on the market and it is because of these similar semantic structures.

The documents of February 19, 2014 and May 1, 2014 are very unlike the documents from Governor Kuroda in these days. These announcements have almost no impact on the market.

In Kuroda era, there are three blocks of similar documents. It seems that the first change occurs at February 19, 2015 and the second change occurs at November 2014. It means that Kuroda's announcements have two minor changes from 2013 to 2015. Nevertheless, Table 4 shows that Governor Kuroda releases many similar announcements from 2013 to 2015.

After February 2016, Kuroda's documents are slightly different from before. In February 2016, the BOJ introduces the negative interest rate policy (NIRP), and it is the first time in Japan. Table 4 shows that the colored blocks from February 1, 2016 to May 17, 2016. It means that, after introducing the NRIP, Kuroda's announcements have a consistency. On the other hand, Table 4 shows low correlation coefficients between the documents of 2013–2015 and 2016. It means that Kuroda's announcements of 2016 do not have consistency to his announcements before.

Furthermore, the BOJ release the "Comprehensive Assessment" of monetary policy in September 21, 2016, and our results show that its document released September 23 change again from before. It implies that this event make changes

in the BOJ's communication strategy from NIRP era of the first half year of 2016. In 2016, the governor made continued unstable communications in the regular press conference.

4.3 Policy Implications

The results show that LSA of monetary policy will provide policy implications on the communication strategy for the central banks. Our findings in this paper have two aspects.

Governor Kuroda's communication strategy has huge impact on the Japanese markets and economy. His announcements were slightly different from Shirakawa's one, so that the market participants perceived Kuroda's making up his mind to change the monetary policy. And his QQE has an important role in Prime Minister Abe's economic policy package to recover from the long-run stagnation of the Japanese economy.

On the other hand, in 2016 Governor Kuroda's communication strategy has possibly a misjudgment. It is not a small misjudgment. The BOJ introduces the NIRP in February 2016 and the BOJ seems to state that the NIRP is an extension of their previous policies. Although the BOJ and Governor Kuroda repeatedly stated that the basic policy would not change, the fear of the monetary policy's failure spread widely in the markets. Our results show that Kuroda's messages changed in 2016. It implies that BOJ released a wrong message that the monetary policy from 2013 to 2015 had failed and the BOJ had started a new policy in 2016, though Governor Kuroda believed that his monetary policy would not change.

5 Concluding Remarks

This paper examines whether the statistical natural language processing techniques are useful for the analysis of documents on the monetary policy. Our simple LSA has relatively good performance of classifying the documents of the BOJ on governors' policy and its impact without human readings. The results show, especially, that this technique has a power to detect changes of governors. It implies that it is possible to evaluate impacts of monetary policy documents quantitatively.

Our results show that Governor Kuroda's communication strategy has been changed slightly in 2016 when the BOJ introduces the NIRP. In the human context, as Kuroda repeatedly emphasized, the BOJ seems to have sent the messages showing that the policy would not change. Our results imply that the BOJ has a huge mistake in the communication strategy.

It is difficult to devise a proper communication strategy. Proper monetary policy needs proper communication strategy, and some central bankers who have a good skill in communication to the financial market received reputation as a maestro. Statistical natural language processing will shed light on the secrets of the monetary maestros. The LSA technique is the first step of the literature of statistical natural language processing. Further steps will be more sophisticated method like the latent Dirichlet allocation. It will be our future work.

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Figure 1: Nikkei 225

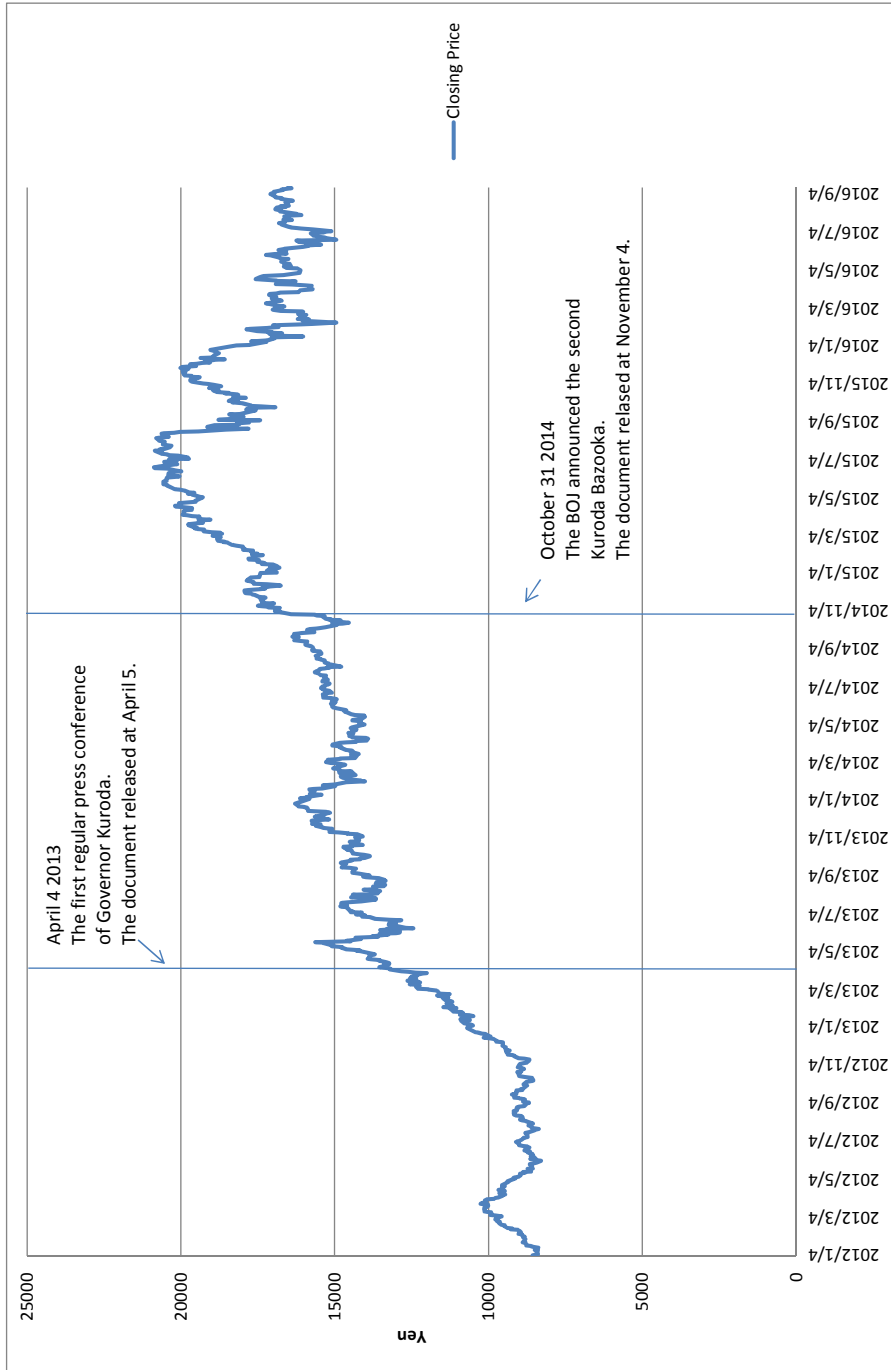


Figure 2: Nikkei 225 in April 4, 2013

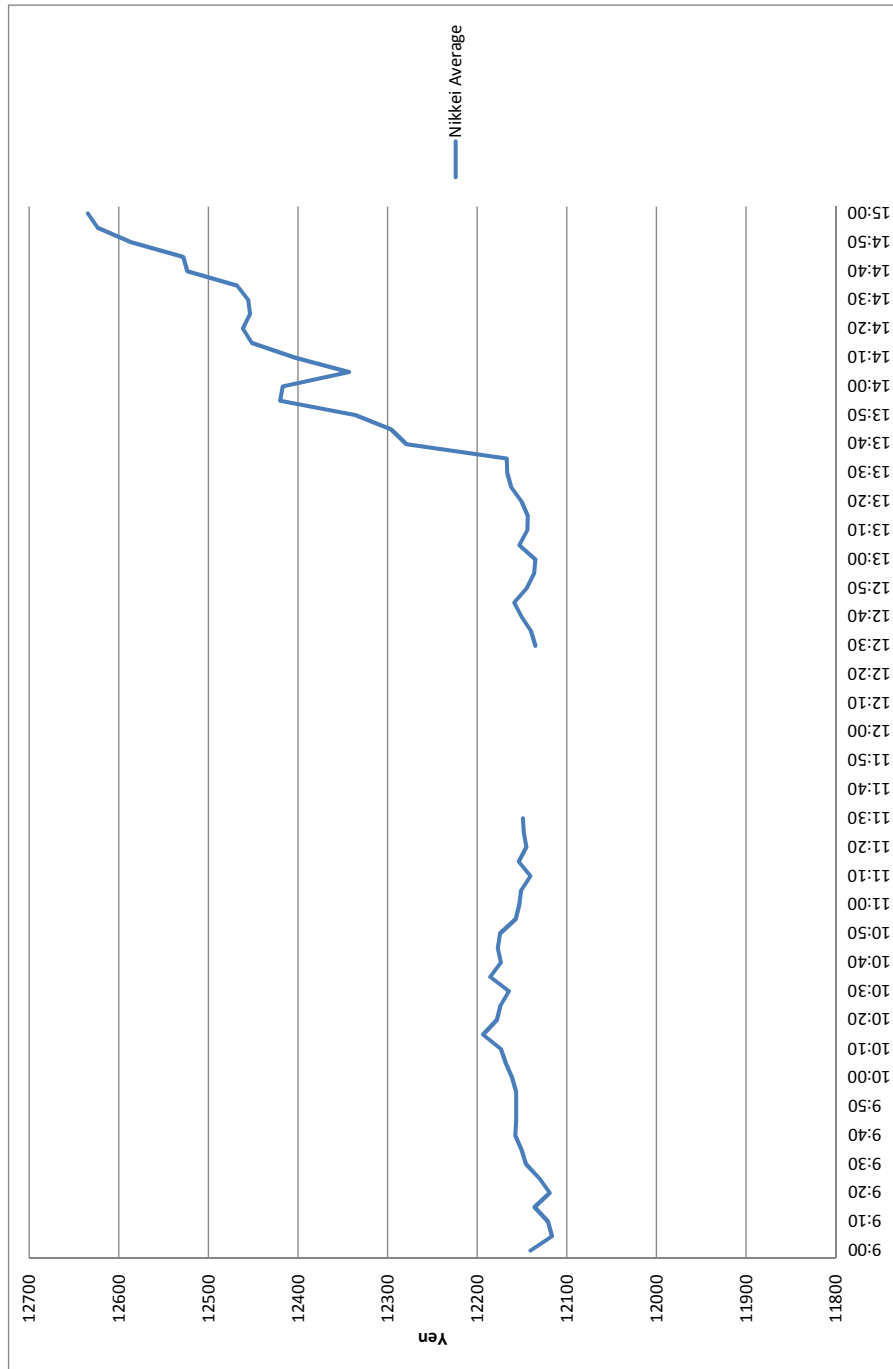


Figure 3: Nikkei 225 in October 31, 2014

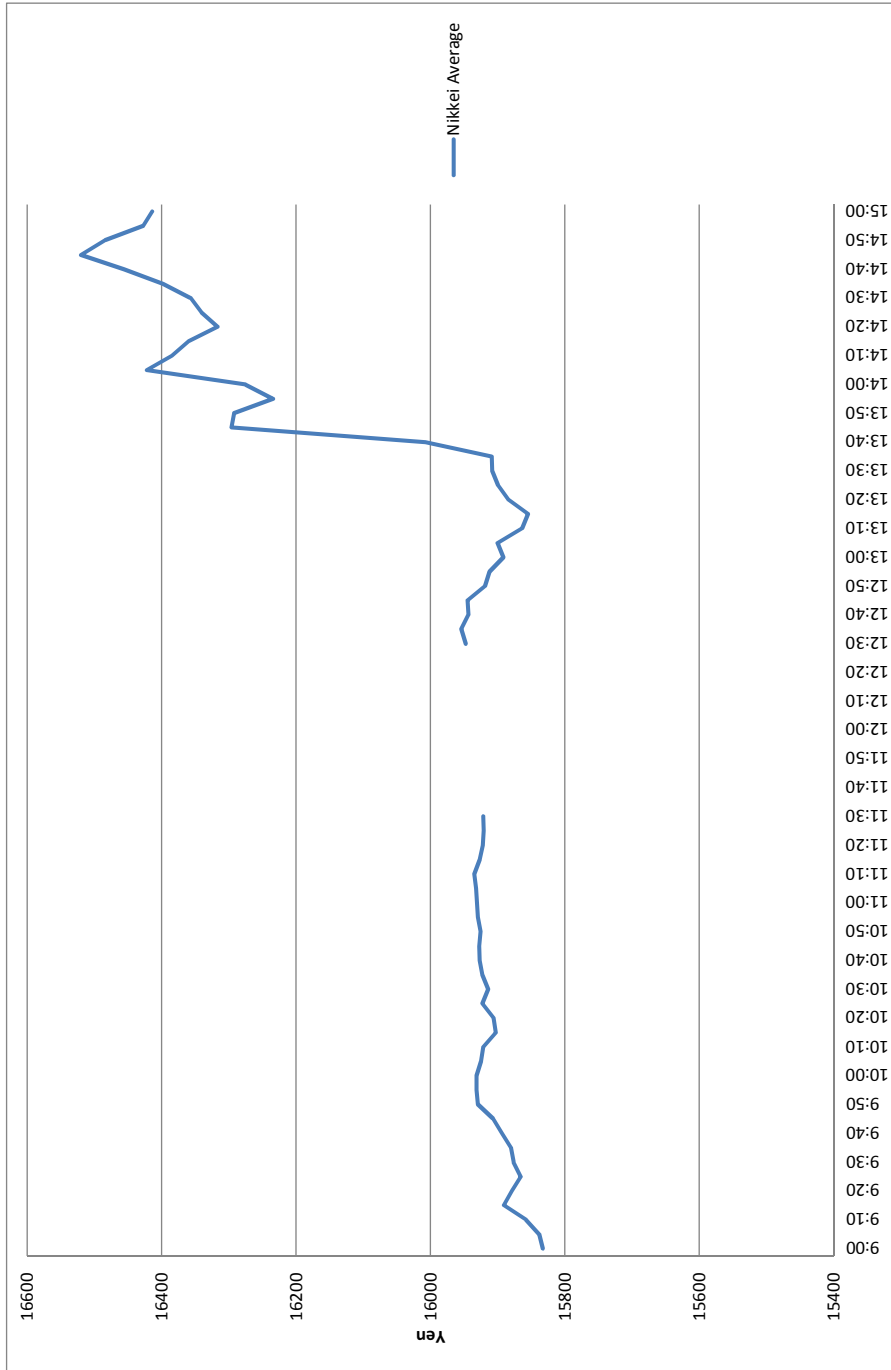


Table 1: The top 30 words of the first axis by value

value	term	phonetic	basic form	type 1 and 2	type 3	type 4
0.08019	し	shi	する	verb-main	suru	conjunctive form
0.03873	物価	bukka	物価	noun-common		
0.03449	金融	kinyuu	金融	noun-common		
0.03442	する	suru	する	verb-main	suru	basic form
0.02793	経済	keizai	経済	noun-common		
0.02708	思い	omoi	思う	verb-main	group-5 consonant- w consonant- onbin	conjunctive form
0.02001	2	2	2	noun-number		
0.01858	上昇	jousyou	上昇	noun-verbal		
0.01718	あり	ari	ある	verb-main	group-5 consonant-r	conjunctive form
0.01655	政策	seisaku	政策	noun-common		
0.01596	緩和	kanwa	緩和	noun-verbal		
0.01522	安定	antei	安定	noun-adjective- base		
0.01472	消費	syouhi	消費	noun-verbal		
0.01416	影響	eikyou	影響	noun-verbal		
0.01400	成長	seichou	成長	noun-verbal		
0.01392	さ	sa	する	verb-main	suru	imperfective reru- connection
0.01336	申し上げ	moushiage	申し上げる	verb-main	group-1	conjunctive form
0.01279	1	1	1	noun-number		
0.01208	ある	aru	ある	verb-main	group-5 consonant-r	basic form
0.01204	なっ	naxtu	なる	verb-main	group-5 consonant-r	conjunctive- ta- connection- form
0.01177	金利	kinri	金利	noun-common		
0.01166	思っ	omoxtu	思う	verb-main	group-5 consonant- w consonant- onbin	conjunctive- ta- connection- form
0.01129	目標	mokuhyou	目標	noun-common		
0.01067	量的	ryouteki	量的	noun-adjective- base		
0.01054	これ	kore	これ	noun-pronoun- misc		
0.01043	企業	kigyuu	企業	noun-common		
0.01031	質	shitsu	質	noun-common		
0.01012	市場	shijou	市場	noun-common		
0.00998	み	mi	みる	verb-main	group-1	conjunctive form
0.00985	必要	hitsuyou	必要	noun-adjective- base		

Table 2: The top 30 words of the second axis by value

value	term	phonetic	basic form	type 1 and 2	type 3	type 4
0.01093	金融	kinyuu	金融	noun-common		
0.00817	し	shi	する	verb-main	suru	conjunctive form
0.00803	物価	bukka	物価	noun-common		
0.00677	金利	kinri	金利	noun-common		
0.00645	上昇	jousyou	上昇	noun-verbal		
0.00586	日本銀行	nipponginkou	日本銀行	noun-proper-organization		
0.00568	経済	keizai	経済	noun-common		
0.00479	消費	syouhi	消費	noun-verbal		
0.00474	価格	kakaku	価格	noun-common		
0.00412	政策	seisaku	政策	noun-common		
0.00408	原油	genyu	原油	noun-common		
0.00405	強化	kyouka	強化	noun-verbal		
0.00343	2	2	2	noun-number		
0.00342	機関	kikan	機関	noun-common		
0.00339	緩和	kanwa	緩和	noun-verbal		
0.00337	銀行	ginkou	銀行	noun-common		
0.00328	強力	kyouryoku	強力	noun-adjective-base		
0.00312	み	mi	みる	verb-main	group-1	conjunctive form
0.00284	見通し	mitooshi	見通し	noun-common		
0.00284	思い	omoi	思う	verb-main	group-5 consonant-w consonant-onbin	conjunctive form
0.00284	賃金	chingin	賃金	noun-common		
0.00282	基金	kinin	基金	noun-common		
0.00281	認識	ninshiki	認識	noun-verbal		
0.00281	取組み	torikumi	取組む	verb-main	group-5 consonant-m	conjunctive form
0.00259	支援	shien	支援	noun-verbal		
0.00259	日本	nippon	日本	noun-proper-place-country		
0.00259	影響	eikyou	影響	noun-verbal		
0.00247	資金	shikin	資金	noun-common		
0.00243	質問	shitsumon	質問	noun-verbal		
0.00243	中央	chuuou	中央	noun-common		

Table 3: The top 30 words of the third axis by value

value	term	phonetic	basic form	type 1 and 2	type 3	type 4
0.00884	金利	kinri	金利	noun-common		
0.00595	物価	bukka	物価	noun-common		
0.00587	金融	kinyuu	金融	noun-common		
0.00583	緩和	kanwa	緩和	noun-verbal		
0.00578	質	shitsu	質	noun-common		
0.00566	量的	ryouteki	量的	noun-adjective-base		
0.00507	検証	kensyou	検証	noun-verbal		
0.00462	する	suru	する	verb-main	suru	basic form
0.00421	イールドカーブ	irudokabu	イールドカーブ	noun-common		
0.00416	目標	mokuhyou	目標	noun-common		
0.00411	マイナス	mainasu	マイナス	noun-common		
0.00408	2	2	2	noun-number		
0.00398	成長	seichou	成長	noun-verbal		
0.00393	イールドカーブ・コントロール	irudokabu・kontororu	イールドカーブ・コントロール	noun-proper-misc		
0.00361	原油	genyu	原油	noun-common		
0.00344	政策	seisaku	政策	noun-common		
0.00338	経済	keizai	経済	noun-common		
0.00309	駆け込み	kakekomi	駆け込み	noun-common		
0.00297	消費	syouhi	消費	noun-verbal		
0.00288	操作	sousa	操作	noun-verbal		
0.00287	シュート	syuto	シュート	noun-verbal		
0.00273	オーバー	oba	オーバー	noun-verbal		
0.00243	日本	nippon	日本	noun-proper-place-country		
0.00235	価格	kakaku	価格	noun-common		
0.00228	実現	jitsugen	実現	noun-verbal		
0.00224	支援	shien	支援	noun-verbal		
0.00224	増加	zouka	増加	noun-verbal		
0.00223	効果	kouka	効果	noun-common		
0.00222	回復	kaifuku	回復	noun-verbal		
0.00220	導入	dounyuu	導入	noun-verbal		

Table 4: The similarity matrix

	2012												2013												2014											
	13-Jul	10-Aug	20-Sep	6-Oct	31-Oct	21-Nov	21-Dec	23-Jan	15-Feb	8-Mar	1-Apr	27-Apr	23-May	12-Jun	12-Jul	9-Aug	6-Sep	7-Oct	1-Nov	22-Nov	24-Dec	23-Jan	19-Feb	12-Mar	9-Apr	1-May	22-May	16-Jun								
13-Jul	1.000	0.957	0.963	0.934	0.877	0.907	0.848	0.805	0.860	0.890	0.652	0.714	0.643	0.810	0.798	0.765	0.725	0.754	0.726	0.769	0.787	0.722	0.600	0.749	0.714	0.615	0.633	0.766								
10-Aug	0.957	1.000	0.893	0.840	0.767	0.823	0.752	0.732	0.785	0.825	0.618	0.700	0.647	0.768	0.757	0.747	0.708	0.705	0.665	0.698	0.704	0.661	0.507	0.678	0.650	0.593	0.751	0.737								
20-Sep	0.963	0.893	1.000	0.986	0.917	0.959	0.923	0.885	0.930	0.938	0.712	0.745	0.641	0.801	0.816	0.764	0.747	0.765	0.759	0.801	0.812	0.775	0.539	0.764	0.778	0.664	0.877	0.798								
6-Oct	0.934	0.840	0.986	1.000	0.928	0.974	0.944	0.909	0.960	0.961	0.691	0.741	0.624	0.790	0.852	0.808	0.791	0.817	0.787	0.854	0.859	0.815	0.562	0.799	0.810	0.663	0.893	0.812								
31-Oct	0.877	0.767	0.917	0.928	1.000	0.937	0.968	0.917	0.914	0.928	0.701	0.723	0.584	0.773	0.759	0.733	0.721	0.725	0.749	0.767	0.800	0.761	0.741	0.730	0.746	0.653	0.829	0.749								
21-Nov	0.907	0.823	0.959	0.974	0.937	1.000	0.975	0.956	0.982	0.968	0.680	0.740	0.696	0.820	0.833	0.783	0.780	0.805	0.771	0.836	0.832	0.804	0.570	0.751	0.779	0.656	0.879	0.791								
21-Dec	0.848	0.752	0.923	0.944	0.968	0.975	1.000	0.975	0.967	0.969	0.708	0.722	0.630	0.766	0.779	0.749	0.757	0.751	0.741	0.794	0.801	0.786	0.613	0.717	0.773	0.655	0.858	0.771								
23-Jan	0.805	0.732	0.885	0.909	0.917	0.956	0.975	1.000	0.969	0.959	0.692	0.785	0.657	0.742	0.798	0.770	0.799	0.776	0.795	0.814	0.777	0.839	0.531	0.703	0.787	0.733	0.846	0.788								
15-Feb	0.860	0.785	0.930	0.960	0.914	0.982	0.967	0.969	1.000	0.981	0.696	0.796	0.705	0.809	0.883	0.821	0.843	0.860	0.824	0.894	0.869	0.872	0.564	0.800	0.844	0.720	0.894	0.835								
8-Mar	0.890	0.825	0.938	0.961	0.928	0.988	0.969	0.959	0.981	1.000	0.702	0.765	0.717	0.828	0.866	0.843	0.836	0.844	0.795	0.865	0.852	0.828	0.580	0.764	0.793	0.664	0.878	0.809								
5-Apr	0.652	0.618	0.712	0.691	0.701	0.680	0.708	0.692	0.696	0.702	1.000	0.814	0.762	0.839	0.753	0.705	0.751	0.699	0.727	0.699	0.717	0.694	0.500	0.661	0.775	0.649	0.778	0.730								
27-Apr	0.714	0.700	0.745	0.741	0.723	0.740	0.722	0.785	0.796	0.765	0.814	1.000	0.769	0.824	0.899	0.837	0.901	0.872	0.966	0.861	0.804	0.926	0.543	0.795	0.865	0.919	0.812	0.854								
23-May	0.643	0.647	0.641	0.624	0.584	0.696	0.630	0.657	0.705	0.717	0.762	0.769	1.000	0.937	0.799	0.666	0.730	0.769	0.707	0.765	0.731	0.702	0.483	0.676	0.713	0.583	0.752	0.703								
12-Jun	0.810	0.768	0.801	0.790	0.773	0.820	0.766	0.742	0.809	0.828	0.839	0.824	0.937	1.000	0.860	0.719	0.801	0.846	0.797	0.842	0.860	0.773	0.669	0.797	0.800	0.646	0.855	0.793								
12-Jul	0.799	0.757	0.816	0.852	0.759	0.833	0.779	0.795	0.883	0.866	0.753	0.899	0.799	0.880	1.000	0.934	0.860	0.981	0.930	0.884	0.942	0.932	0.590	0.898	0.902	0.765	0.877	0.875								
9-Aug	0.765	0.747	0.764	0.808	0.733	0.783	0.749	0.770	0.821	0.843	0.705	0.837	0.666	0.779	0.934	1.000	0.976	0.944	0.884	0.913	0.905	0.891	0.588	0.855	0.856	0.752	0.845	0.879								
6-Sep	0.725	0.708	0.747	0.791	0.721	0.780	0.757	0.799	0.843	0.836	0.751	0.901	0.730	0.801	0.960	0.976	1.000	0.967	0.924	0.946	0.910	0.944	0.568	0.875	0.909	0.820	0.870	0.907								
7-Oct	0.754	0.705	0.765	0.817	0.725	0.805	0.751	0.776	0.860	0.844	0.699	0.872	0.769	0.846	0.991	0.944	0.967	1.000	0.924	0.983	0.939	0.932	0.592	0.893	0.889	0.752	0.860	0.864								
1-Nov	0.726	0.665	0.759	0.787	0.749	0.771	0.741	0.795	0.824	0.795	0.727	0.966	0.707	0.797	0.930	0.884	0.924	0.924	1.000	0.915	0.859	0.962	0.577	0.842	0.875	0.905	0.831	0.857								
22-Nov	0.769	0.698	0.801	0.854	0.767	0.836	0.794	0.814	0.894	0.865	0.699	0.861	0.765	0.842	0.984	0.913	0.946	0.983	0.915	1.000	0.961	0.951	0.618	0.928	0.926	0.763	0.897	0.887								
24-Dec	0.787	0.704	0.812	0.859	0.800	0.832	0.801	0.777	0.869	0.852	0.717	0.804	0.731	0.880	0.942	0.905	0.910	0.939	0.859	0.961	1.000	0.912	0.737	0.974	0.947	0.742	0.936	0.926								
23-Jan	0.722	0.681	0.775	0.815	0.761	0.804	0.786	0.839	0.872	0.828	0.694	0.926	0.702	0.773	0.932	0.891	0.944	0.932	0.962	0.951	0.912	1.000	0.597	0.915	0.951	0.919	0.903	0.936								
19-Feb	0.600	0.507	0.539	0.562	0.741	0.570	0.613	0.531	0.564	0.580	0.500	0.543	0.483	0.669	0.590	0.588	0.568	0.592	0.577	0.618	0.737	0.957	1.000	0.729	0.632	0.515	0.641	0.638								
12-Mar	0.749	0.678	0.764	0.799	0.730	0.751	0.717	0.703	0.800	0.764	0.661	0.795	0.676	0.797	0.888	0.855	0.875	0.893	0.842	0.928	0.974	0.915	0.729	1.000	0.961	0.793	0.927	0.950								
9-Apr	0.714	0.650	0.788	0.810	0.746	0.779	0.773	0.787	0.844	0.793	0.775	0.865	0.713	0.800	0.902	0.856	0.909	0.889	0.875	0.926	0.947	0.951	0.632	0.961	1.000	0.862	0.953	0.972								
1-May	0.615	0.593	0.664	0.663	0.653	0.656	0.655	0.733	0.720	0.664	0.649	0.919	0.583	0.646	0.765	0.752	0.820	0.752	0.905	0.763	0.742	0.919	0.515	0.793	0.862	1.000	0.798	0.885								
22-May	0.833	0.751	0.877	0.893	0.829	0.879	0.858	0.846	0.894	0.878	0.778	0.812	0.752	0.855	0.877	0.845	0.870	0.860	0.831	0.897	0.936	0.903	0.641	0.927	0.953	0.798	1.000	0.959								
16-Jun	0.766	0.737	0.798	0.812	0.749	0.791	0.771	0.788	0.835	0.809	0.730	0.854	0.703	0.793	0.875	0.879	0.907	0.864	0.857	0.887	0.926	0.935	0.638	0.950	0.972	0.885	0.959	1.000								
16-Jul	0.787	0.729	0.828	0.843	0.754	0.812	0.780	0.794	0.864	0.811	0.726	0.860	0.735	0.815	0.905	0.827	0.883	0.886	0.868	0.926	0.931	0.945	0.607	0.959	0.978	0.857	0.962	0.967								
11-Aug	0.672	0.641	0.684	0.718	0.645	0.702	0.670	0.682	0.776	0.714	0.577	0.760	0.681	0.738	0.853	0.784	0.844	0.859	0.779	0.890	0.909	0.893	0.656	0.955	0.933	0.785	0.883	0.929								
5-Sep	0.687	0.655	0.720	0.762	0.689	0.742	0.716	0.728	0.803	0.774	0.667	0.766	0.707	0.766	0.877	0.872	0.903	0.881	0.791	0.909	0.942	0.904	0.615	0.958	0.961	0.775	0.933	0.966								
2-Oct	0.720	0.655	0.780	0.815	0.753	0.798	0.793	0.811	0.860	0.814	0.769	0.866	0.718	0.799	0.902	0.869	0.926	0.900	0.880	0.923	0.933	0.955	0.613	0.940	0.988	0.867	0.961	0.971								
4-Nov	0.691	0.631	0.748	0.752	0.751	0.733	0.769	0.793	0.777	0.758	0.687	0.886	0.696	0.768	0.816	0.791	0.862	0.795	0.850	0.808	0.781	0.867	0.536	0.774	0.879	0.829	0.875	0.854								
20-Nov	0.686	0.691	0.699	0.737	0.693	0.729	0.742	0.752	0.761	0.803	0.690	0.704	0.596	0.678	0.797	0.923	0.904	0.810	0.719	0.795	0.816	0.793	0.541	0.775	0.810	0.668	0.832	0.859								
22-Dec	0.695	0.675	0.730	0.754	0.717	0.763	0.775	0.799	0.834	0.794	0.762	0.822	0.746	0.775	0.865	0.799	0.886	0.860	0.790	0.871	0.826	0.868	0.550	0.818	0.885	0.749	0.867	0.862								
22-Jan	0.695	0.684	0.697	0.712	0.712	0.710	0.730	0.769	0.782	0.745	0.719	0.858	0.670	0.720	0.840	0.797	0.880	0.838	0.828	0.836	0.774	0.871	0.582	0.784	0.840	0.800	0.807	0.833								
19-Feb	0.690	0.649	0.731	0.764	0.717	0.773	0.784	0.810	0.842	0.799	0.738	0.805	0.716	0.751	0.858	0.799	0.885	0.862	0.792	0.873	0.824	0.873	0.525	0.812	0.883	0.746	0.874	0.856								
18-Mar	0.702	0.667	0.726	0.756	0.712	0.754	0.754	0.783	0.832	0.777	0.711	0.841	0.714	0.758	0.866	0.795	0.886	0.866	0.831	0.893	0.827	0.868	0.555	0.825	0.873	0.764	0.839	0.838								
9-Apr	0.759	0.712	0.788	0.818	0.752	0.802	0.791	0.810	0.869	0.825	0.725	0.842	0.737	0.795	0.921	0.838	0.910	0.916	0.848	0.937	0.888	0.917	0.587	0.886	0.917	0.768	0.897	0.886								
1-May	0.662	0.646	0.695	0.717	0.696	0.708	0.732	0.780	0.789	0.742	0.764	0.889	0.645	0.704	0.850	0.824	0.908	0.850	0.859	0.839	0.780	0.893	0.517	0.782	0.868	0.843	0.818	0.851								
25-May	0.731	0.673	0.753	0.798	0.750	0.780	0.778	0.806	0.844	0.819	0.757	0.870	0.721	0.794	0.933	0.911	0.961	0.94																		

Table 4 continued: The similarity matrix

2014										2015										2016									
16-Jul	11-Aug	5-Sep	8-Oct	4-Nov	20-Nov	22-Dec	22-Jan	19-Feb	18-Mar	9-Apr	1-May	25-May	22-Jun	16-Jul	10-Aug	16-Sep	8-Oct	2-Nov	21-Dec	1-Feb	16-Mar	2-May	17-Jun	1-Aug	23-Sep	2-Nov			
0.787	0.672	0.687	0.720	0.691	0.686	0.695	0.695	0.690	0.702	0.759	0.662	0.731	0.798	0.729	0.746	0.722	0.712	0.798	0.787	0.752	0.806	0.810	0.819	0.662	0.608	0.687			
0.729	0.641	0.655	0.655	0.631	0.691	0.675	0.684	0.649	0.667	0.712	0.646	0.673	0.771	0.684	0.666	0.658	0.656	0.722	0.659	0.628	0.699	0.704	0.754	0.600	0.558	0.642			
0.828	0.684	0.720	0.780	0.748	0.699	0.730	0.697	0.731	0.726	0.786	0.695	0.753	0.799	0.741	0.781	0.762	0.755	0.812	0.829	0.752	0.777	0.799	0.820	0.699	0.597	0.704			
0.843	0.718	0.762	0.815	0.752	0.737	0.754	0.712	0.764	0.756	0.818	0.717	0.798	0.819	0.767	0.822	0.812	0.782	0.846	0.854	0.754	0.787	0.804	0.834	0.684	0.595	0.728			
0.754	0.645	0.669	0.753	0.751	0.693	0.717	0.712	0.717	0.712	0.752	0.696	0.750	0.754	0.698	0.685	0.716	0.735	0.764	0.819	0.716	0.740	0.763	0.765	0.671	0.589	0.692			
0.812	0.702	0.742	0.798	0.733	0.729	0.763	0.710	0.773	0.754	0.802	0.708	0.780	0.790	0.725	0.762	0.784	0.760	0.799	0.798	0.738	0.799	0.808	0.865	0.718	0.607	0.740			
0.780	0.670	0.716	0.793	0.769	0.742	0.775	0.730	0.784	0.754	0.791	0.732	0.778	0.761	0.710	0.709	0.760	0.767	0.774	0.807	0.721	0.753	0.774	0.820	0.706	0.620	0.739			
0.794	0.682	0.728	0.811	0.793	0.752	0.799	0.769	0.810	0.783	0.810	0.780	0.806	0.782	0.700	0.678	0.768	0.800	0.758	0.760	0.727	0.747	0.776	0.814	0.708	0.670	0.807			
0.864	0.776	0.803	0.860	0.777	0.761	0.834	0.782	0.842	0.832	0.869	0.789	0.844	0.854	0.794	0.818	0.858	0.832	0.848	0.804	0.714	0.769	0.781	0.849	0.715	0.623	0.792			
0.811	0.714	0.774	0.814	0.758	0.803	0.794	0.745	0.798	0.777	0.825	0.742	0.819	0.807	0.737	0.755	0.798	0.773	0.811	0.807	0.728	0.788	0.796	0.869	0.696	0.601	0.738			
0.726	0.577	0.667	0.769	0.887	0.690	0.762	0.719	0.738	0.711	0.725	0.764	0.757	0.707	0.684	0.651	0.682	0.761	0.762	0.854	0.705	0.652	0.691	0.730	0.715	0.708	0.707			
0.860	0.760	0.766	0.866	0.886	0.704	0.822	0.858	0.805	0.841	0.842	0.889	0.870	0.895	0.789	0.729	0.808	0.883	0.822	0.769	0.714	0.704	0.743	0.734	0.695	0.656	0.815			
0.735	0.681	0.707	0.718	0.696	0.596	0.746	0.670	0.716	0.714	0.737	0.645	0.721	0.694	0.638	0.633	0.664	0.662	0.705	0.641	0.642	0.716	0.692	0.784	0.581	0.613	0.631			
0.815	0.738	0.766	0.799	0.768	0.678	0.775	0.720	0.751	0.758	0.795	0.704	0.794	0.792	0.739	0.758	0.754	0.740	0.824	0.804	0.726	0.799	0.787	0.854	0.706	0.638	0.688			
0.905	0.853	0.877	0.902	0.816	0.797	0.865	0.840	0.858	0.886	0.921	0.850	0.933	0.940	0.876	0.897	0.922	0.880	0.935	0.840	0.713	0.768	0.765	0.828	0.685	0.619	0.791			
0.827	0.784	0.872	0.869	0.791	0.923	0.799	0.797	0.799	0.795	0.838	0.824	0.911	0.869	0.776	0.777	0.836	0.818	0.859	0.810	0.693	0.746	0.761	0.826	0.712	0.594	0.762			
0.883	0.844	0.903	0.926	0.862	0.904	0.886	0.880	0.885	0.886	0.910	0.908	0.961	0.922	0.846	0.817	0.900	0.900	0.900	0.821	0.716	0.757	0.772	0.834	0.723	0.635	0.814			
0.886	0.858	0.881	0.900	0.795	0.810	0.860	0.838	0.862	0.886	0.916	0.850	0.941	0.931	0.870	0.888	0.928	0.877	0.929	0.822	0.709	0.778	0.768	0.832	0.695	0.599	0.786			
0.868	0.779	0.791	0.880	0.850	0.719	0.790	0.828	0.792	0.831	0.848	0.859	0.895	0.901	0.794	0.774	0.841	0.879	0.849	0.801	0.747	0.751	0.781	0.754	0.687	0.606	0.798			
0.926	0.890	0.909	0.923	0.808	0.795	0.871	0.836	0.873	0.893	0.937	0.839	0.948	0.927	0.872	0.899	0.930	0.883	0.937	0.836	0.725	0.780	0.775	0.823	0.652	0.635	0.802			
0.931	0.909	0.942	0.933	0.781	0.816	0.826	0.774	0.824	0.827	0.888	0.780	0.912	0.883	0.836	0.888	0.886	0.831	0.920	0.805	0.699	0.776	0.778	0.835	0.685	0.600	0.746			
0.945	0.893	0.904	0.955	0.867	0.793	0.868	0.871	0.873	0.888	0.917	0.893	0.944	0.926	0.841	0.819	0.895	0.919	0.885	0.798	0.744	0.767	0.795	0.836	0.673	0.628	0.823			
0.607	0.656	0.615	0.613	0.536	0.541	0.550	0.582	0.525	0.555	0.587	0.517	0.623	0.608	0.573	0.524	0.536	0.534	0.620	0.603	0.480	0.566	0.558	0.540	0.479	0.427	0.477			
0.959	0.955	0.958	0.940	0.774	0.775	0.818	0.784	0.812	0.825	0.886	0.782	0.899	0.888	0.845	0.876	0.871	0.837	0.905	0.803	0.681	0.748	0.571	0.779	0.620	0.571	0.718			
0.978	0.933	0.961	0.988	0.879	0.810	0.885	0.840	0.883	0.873	0.917	0.868	0.934	0.899	0.855	0.861	0.895	0.907	0.911	0.840	0.726	0.751	0.781	0.808	0.695	0.663	0.806			
0.857	0.785	0.775	0.867	0.829	0.668	0.749	0.800	0.746	0.764	0.768	0.843	0.905	0.824	0.708	0.634	0.732	0.842	0.720	0.653	0.664	0.654	0.719	0.663	0.644	0.557	0.751			
0.962	0.883	0.933	0.961	0.875	0.832	0.867	0.808	0.874	0.839	0.897	0.818	0.908	0.862	0.820	0.837	0.860	0.873	0.902	0.884	0.837	0.878	0.900	0.922	0.756	0.690	0.787			
0.967	0.929	0.966	0.971	0.854	0.859	0.862	0.833	0.856	0.838	0.886	0.851	0.909	0.887	0.816	0.803	0.848	0.874	0.868	0.793	0.728	0.778	0.813	0.843	0.710	0.629	0.777			
1.000	0.952	0.947	0.974	0.861	0.769	0.897	0.859	0.895	0.898	0.941	0.864	0.924	0.929	0.888	0.890	0.911	0.917	0.927	0.826	0.763	0.802	0.821	0.836	0.681	0.658	0.802			
0.952	1.000	0.956	0.932	0.742	0.742	0.877	0.836	0.869	0.882	0.914	0.819	0.888	0.900	0.879	0.864	0.893	0.858	0.881	0.695	0.613	0.709	0.706	0.758	0.597	0.544	0.720			
0.947	0.956	1.000	0.958	0.792	0.870	0.869	0.804	0.866	0.841	0.897	0.812	0.916	0.859	0.819	0.830	0.867	0.841	0.875	0.764	0.671	0.745	0.756	0.827	0.642	0.601	0.739			
0.974	0.932	0.958	1.000	0.906	0.841	0.922	0.881	0.928	0.909	0.940	0.909	0.957	0.917	0.883	0.867	0.924	0.941	0.927	0.857	0.772	0.805	0.831	0.862	0.750	0.660	0.817			
0.861	0.742	0.792	0.906	1.000	0.801	0.904	0.909	0.905	0.890	0.887	0.934	0.918	0.853	0.830	0.731	0.830	0.936	0.870	0.906	0.862	0.804	0.844	0.816	0.730	0.734	0.805			
0.769	0.742	0.870	0.841	0.801	1.000	0.819	0.791	0.818	0.760	0.803	0.807	0.875	0.768	0.713	0.658	0.759	0.774	0.781	0.770	0.680	0.722	0.742	0.829	0.665	0.587	0.692			
0.897	0.877	0.869	0.922	0.904	0.819	1.000	0.968	0.984	0.984	0.978	0.957	0.949	0.928	0.938	0.842	0.937	0.958	0.924	0.815	0.738	0.771	0.769	0.834	0.694	0.672	0.805			
0.859	0.836	0.804	0.881	0.909	0.791	0.968	1.000	0.960	0.975	0.954	0.981	0.941	0.944	0.929	0.784	0.904	0.964	0.898	0.790	0.746	0.758	0.764	0.775	0.674	0.667	0.811			
0.895	0.869	0.866	0.928	0.905	0.818	0.994	0.960	1.000	0.983	0.977	0.957	0.955	0.922	0.935	0.850	0.948	0.967	0.929	0.830	0.772	0.803	0.801	0.855	0.725	0.685	0.823			
0.898	0.882	0.841	0.909	0.880	0.760	0.984	0.975	0.983	1.000	0.986	0.962	0.951	0.962	0.968	0.879	0.965	0.975	0.944	0.809	0.735	0.769	0.761	0.802	0.686	0.654	0.819			
0.941	0.914	0.897	0.940	0.887	0.803	0.978	0.954	0.977	0.986	1.000	0.938	0.972	0.966	0.961	0.904	0.969	0.965	0.967	0.849	0.769	0.804	0.798	0.836	0.668	0.672	0.819			
0.864	0.819	0.812	0.909	0.934	0.807	0.957	0.981	0.957	0.962	0.938	1.000	0.944	0.940	0.917	0.796	0.916	0.982	0.898	0.811	0.741	0.736	0.759	0.777	0.737	0.669	0.839			
0.924	0.888	0.916	0.957	0.918	0.875	0.949	0.941	0.955	0.951	0.972	0.944	1.000	0.944	0.912	0.857	0.942	0.958	0.955	0.882	0.811	0.832	0.838	0.859	0.720	0.711	0.846			
0.929	0.900	0.859	0.917	0.853	0.768	0.928	0.944	0.922	0.962	0.966	0.940	0.944	1.000	0.965	0.912	0.962	0.959	0.959	0.819	0.719	0.765	0.768	0.796	0.707	0.626	0.824			
0.888	0.879	0.819	0.883	0.830	0.713	0.938	0.929	0.935	0.968	0.961	0.917	0.912	0.965	1.000	0.943	0.975	0.949	0.966	0.828	0.690	0.734	0.721	0.762	0.661	0.554	0.737			
0.890	0.864	0.830	0.867	0.731	0.658	0.842	0.784	0.850	0.879	0.904	0.796	0.857	0.912	0.943	1.000	0.961	0.871	0.958	0.830	0									