Monetary Policy Communication during the 2016 Economic Recession in Nigeria: Insights from a Text Mining Analysis

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Abstract

This paper analyses the monetary policy communication of the Central Bank of Nigeria (CBN) during the 2016 economic recession. Particularly, we apply text mining techniques to derive useful insights from the monetary policy communiques published between 2015 and 2017. First, we find evidence of greater monetary policy transparency during the recession as evidenced by increased communication about the CBN's objectives and prevailing economic conditions. Second, the computed readability scores of the published communiques declined at the outset of the recession, implying increased complexity of the documents. Third, our results show that the communiques expressed negative policy sentiments over the sample period, reflecting the economic uncertainties that trailed the oil price slump of 2014. Interestingly, the negative sentiments reached its trough in July 2016 and recorded an inflexion, reflecting the optimism of the Monetary Policy Committee (MPC) about future economic conditions. Fourth, results from our estimated topic model show that issues relating to oil price shocks, external reserves, and inflation were of concern to the MPC in 2015 while exchange rate management was prioritised in 2016. The topic proportion for prices and macroeconomic policies is found to be consistently sizeable across the sample period, reflecting the MPC's commitment to the CBN's primary mandate of price stability.

Keywords: Monetary policy, central bank communication, economic recession, text mining

JEL Classification: E52, E58, E32, E61

I. Introduction

Monetary policy has been recognised as a useful tool for macroeconomic management (Bernanke, Gertler, Watson, Sims & Friedman, 1997). Consequently, a recent and growing body of research has focused on the importance of transparency, as well as effective central bank communication in the conduct of a successful monetary policy. This evolving strand of literature argues that effective central bank communication represents a useful strategy for managing private sector expectations, influencing asset prices, securing support for monetary policy, achieving better forecasts of policy decisions, and stabilising the macroeconomy (Blinder, 1999; Bernanke & Reinhart, 2004; Blinder, Ehrmann, Fratzscher, De Haan, & Jansen, 2008; Eusepi & Preston, 2010; Berger, Ehrmann & Fratzscher, 2011; Sturm & De Haan, 2011; Oshima & Matsubayashi,

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2018).Monetary policy transparency, a central pillar of central bank communication, refers to a situation in which the different facets of monetary policy are conducted under an atmosphere devoid of information asymmetry[1] (Geraats, 2002). Most often, such transparency is anchored on an effective central bank communication strategy that helps to reduce macroeconomic volatility and policy uncertainties. A number of studies have noted that the effectiveness of monetary policy communication could be gauged by its ability to correctly shape market expectations through the "creation of news" and "reduction of noise"[2] (Blinder, 1999; Woodford, 2002; Blinder et al., 2008; Hoeberichts, Tesfaselassie & Eijffinger, 2008).

Central bank communication includes the quantity and quality of information made available by the central bank to the public with regards to its current and future monetary policy objectives, monetary policy strategy, economic outlook and outlook regarding the path of future policy decisions (Blinder et al., 2008). Studies, such as Blinder et al. (2008) and Coenen et al. (2017) have argued that the increasing level of independence accorded to central banks requires that they regularly communicate their decisions, as well as the logic behind their policies to the public, especially during unconventional times[3]. Consequently, published monetary policy reports have become popular among central banks in recent years, especially, as a tool for achieving economic, procedural, and policy transparency.

The issues relating to the nature, strategy, effectiveness and implications of central bank communication have been studied from both theoretical and empirical perspectives (Bernanke et al., 1997; Blinder, 1999; Clarida, Gali & Gertler, 2000; Woodford, 2002; Geraats, 2002; Bernanke & Reinhart, 2004; Ehrmann & Fratzscher, 2007; Hoeberichts et al., 2008; Blinder et al., 2008; Eusepi, 2010; Eusepi & Preston, 2010; Sturm & De Haan, 2011; Berger et al., 2011; Demiralp, Kara & Ozlu, 2012; Bergholt, 2014; Apel & Grimaldi, 2014; Luangaram & Sethapramote, 2016; Bruno, 2016; Coenen et al., 2017). In line with increased level of central bank communication, coupled with advancements in the algorithms for handling textual information, a budding body of research has focused on extracting useful insights from monetary policy documents,

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[1]The five facets of monetary policy transparency identified by Geraats (2002) include political, economic, procedural, policy and operational transparency.

[2]According to them, the central bank creates news when its announcement promotes expectations and moves asset prices; and reduces noise when its communication enhances the predictability of its actions, thereby reducing financial market volatility.

[3]Further discussions on the roles of central bank communication can be found in Huang (2007), Hoeberichts et al. (2008).

especially for the analysis and prediction of macroeconomic out-turns (for instance, see Shirota, Yashimoto & Sakura, 2015; Bruno, 2016; Kahveci & Odabas, 2016; Luangaram & Wongwachara, 2017; Oshima & Matsubayashi, 2018; Park, Lee & Kim, 2019; Shapiro & Wilson, 2019). Our paper belongs to this strand of the literature, as discussions regarding the communication strategy of the CBN during the economic turbulence of 2016 is still scanty.

The conduct of monetary policy and the development of an appropriate communication strategy in small open resource-rich economies is particularly challenging – such economies are often hit by terms of trade, as well as other related shocks. In Nigeria, oil contributes an average of about 11.2 per cent to the Gross Domestic Product (GDP) during 2010-2018, while its share in government revenue and total exports stand at about 64.8 and 93.1 per cent, respectively (Omotosho, 2019). Consequently, the net exports as a component of GDP represent an important source of business cycles in the country. Indeed, a number of studies have noted that the economic recession recorded in 2016 was induced by negative oil price shocks that began in 2014 (see, Omotosho, 2019). While monetary policy communication is generally important for overall macroeconomic stability, the communication strategy adopted by central banks during periods of economic uncertainties, caused by oil price shocks, is particularly crucial for stabilising expectations and output (Coenen et al., 2017). Therefore, an understanding of the CBN's reaction to the 2016 economic recession, from the perspective of its monetary policy communication strategy, is of crucial importance to monetary policy execution and the evolution of well-anchored market expectations.

This paper analyses the communication strategy of the CBN's Monetary Policy Committee (MPC) during the 2016 economic recession. To achieve this, we apply text mining techniques to a corpus consisting of eighteen CBN's monetary policy communiques, released between 2015 and 2017. This approach is useful for generating meaningful quantitative insights from textual data (Blei, Ng & Jordan, 2003; Hubert & Fabien, 2017). An advantage of this method is that it is fully automated, thus removing the subjectivity and cumbersomeness that is associated with coded indices that are based on human reading (Hubert & Fabien, 2017). While the major focus of the paper is on the CBN's communication strategy during the periods of negative economic growth (2016Q1-2017Q1), we considered an extended sample in order to also derive additional insights regarding the events leading to the recession as well as the policy dynamics in the immediate period after the

recession. In particular, we analyse how understandable the policy documents are, by computing their respective readability scores (Coleman & Liau, 1975). In addition, we estimate a topic model in order to identify the major themes driving monetary policy communication during the sample period. Finally, we compute the monetary policy sentiment scores in order to gauge the tone of CBN communication over the sample period. To our knowledge, this effort represents the first attempt at understanding monetary policy communication during Nigeria's 2016 economic recession, using natural language processing approach.

The paper is organised into five sections. The next section reviews related literature, with particular emphasis on the application of text mining to monetary policy reports issued by central banks around the world. In the third section, we describe the data, the data pre-processing procedures, as well as the methods of analysis. The results are presented in section four, while section five concludes.

II. Literature Review

The adoption of inflation-targeting frameworks by countries around the world, coupled with the drive for more independent central banks have led to greater transparency in the conduct of monetary policy, as well as substantial improvements in the communication strategies of most central banks (Amato, Morris & Shin, 2002; Blinder et al., 2008; Kahveci & Odabas, 2016). Thus, central bank communication is increasingly being recognised as an indispensable aspect of monetary policy. According to Blinder et al. (2008), central bank communication plays two roles in the management of expectations. First, it "creates news", by shaping agents' expectations and thereby influencing asset prices. Second, it "reduces noise", thus helping to predict monetary policy actions and thereby reducing financial market volatility. In this section, we present a non-exhaustive but relevant review of studies relating to the use of text mining techniques in the analyses of central bank communication[4].

The Executive Board of the Sveriges Riksbank (the Central Bank of Sweden) holds six monetary policy meetings annually. A monetary policy report is issued by the Governor, almost immediately after each meeting, while the minutes of the meetings are published about two weeks later. The published minutes is a

[4]See Gentzkow, Kelly and Taddy (2019) for a survey of the application of text mining to other areas of economic research.

more detailed document that contains the current decision of the Riksbank, as well as the arguments advanced by the different executive board members. In a study aimed at predicting future Riksbank's decisions, Apel and Grimaldi (2012) analysed the published minutes of the monetary policy meetings based on text mining techniques. The authors derived the tone and stance of monetary policy and used same to predict future actions of the Riksbank. They composed a dictionary of dovish and hawkish words used in the documents and generated a net index of hawkishness from each minute. The outcome showed that interest rate hikes in Sweden are associated with high degree of net hawkishness in Riksbank's communication. It was also found that the minutes of the Executive Board are more useful for predicting future Riksbank's decisions than the monetary policy report.

The Bank of Canada (BoC) adopted a system of fixed announcement dates for its interest rate decisions in November 2000, as a way of enhancing transparency, accountability and dialogue with economic agents. Thus, the current practice by the BoC involves making interest rate decisions on eight pre-announced dates throughout the year, with an interval of six to seven weeks between each one. At four of those eight times, the Bank of Canada further explains its monetary policy decisions by issuing the Monetary Policy Report. Thus, the report constitutes an important tool of monetary policy communication for the BoC. In a study of the BoC's monetary policy report using text mining approach, Binette and Tchebotarev (2019) showed that, while the BoC generally focuses on macroeconomic stability, the language used in the monetary policy report varied from one governor's tenure to another. Their analyses also revealed that the monetary policy reports were slightly more complicated for an average Canadian to understand, and that increased levels of lexical innovation were associated with important macroeconomic events. However, Hayo and Neuenkirch (2011) noted that prior to the introduction of fixed announcement dates, BoC communications were more useful in predicting future policy moves and showed that the communications by the U.S. Fed outperformed BOC's communication indicators in explaining interest rate decisions in Canada.

The Governing Council of the European Central Bank (ECB) is responsible for formulating monetary policy in the Eurozone. It comprises the members of the Executive Board of the European Central Bank and the governors of the national central banks of the Eurozone's 19 member states. The Governing Council's monetary policy meeting is held every six weeks, with the ECB

President conducting a press conference after each meeting to explain the Council's monetary policy decisions. Sturm and De Haan (2011) examined whether ECB communication provides additional information in the prediction of future policy actions beyond the usual information contained in a standard Taylor rule model. They derived five indicators of ECB communication, based on the statements issued by the ECB President at the end of each ECB policy meeting. It was found that the ECB communication-based indicators were quite useful in predicting the next policy decision. In a related study, Coenen et al. (2017) studied the readability and effectiveness of ECB's monetary policy statements during unconventional times, especially with regards to announcements of asset purchase programmes and the use of forward guidance. Based on the results of the Flesch- Kincaid reading grade level statistic, they showed that the ECB's monetary policy statements have become easier to understand over time. It was also found that detailed announcements regarding the asset purchase programmes of the ECB were useful in reducing market uncertainty.

Luangaram and Sethapramote (2016) investigated the usefulness of central bank's communication in the prediction of Thailand's short-term policy interest rate. The policy stance of the Bank of Thailand was identified, by analysing the monetary policy committee (MPC) statements of the Bank of Thailand (BOT) using textual analysis technique. The MPC of the BOT meets eight times a year but issues monetary policy reports quarterly. By augmenting various Taylor-rule type specifications, with the computed communication measure from the policy reports, Luangaram and Sethapramote (2016) showed that the published monetary policy statements enhanced the predictability of the policy interest rate. In addition, the results from their estimated structural vector autoregression revealed that the response of output to interest rate shock is amplified under a model that allows for a measure of central bank communication.

The Monetary Policy Board (MPB) of the Bank of Korea (BOK) is responsible for determining the monetary policy stance of BOK. The MPB meets eight times a year based on a pre-announced schedule to review economic developments and make policy decisions. The minutes of the meeting are produced after each meeting, while the parts that relate to monetary policy are published on the Bank's website. In order to study the relevance of the MPB minutes for the prediction of current and future interest rate decisions, Park et al. (2019) analysed the published minutes for the period May 2005 to December 2017,

using text mining techniques. They derived text-based indicators of monetary policy stance and included same in an augmented Taylor rule. It was found that the text-based indicators derived from the minutes provided additional information for explaining and predicting the interest rate setting behaviour of the BOK.

The Federal Open Market Committee (FOMC) of the Federal Reserve System (Fed) holds eight regular meetings each year based on pre-scheduled calendar of meeting. Amongst others, the FOMC meets to review economic and financial conditions in the US, decide the appropriate monetary policy stance, and assess the risks to the goals of price stability and sustainable economic growth. After each meeting, the policy statement is released, while the minutes of the meetings are released to the public three weeks afterwards. In order to derive useful insights regarding the communication strategy of the FOMC, Shapiro and Wilson (2019) analysed the transcripts of the FOMC meetings, the minutes of their meetings, as well as speeches of FOMC members for the period 1986 to 2013, using text mining techniques. The authors generated a measure of monetary policy sentiment contained in the documents and showed that the FOMC's negative sentiments are inversely related to economic growth in the United States. In other words, the negativity score of the FOMC meeting rises during recessions and falls during expansions. In a similar but cross-country study, Luangaram and Wongwachara (2017) analysed monetary policy statements across 22 central banks, including the Fed, in order to derive insights regarding their readability, topics and tones. They showed that while there are general improvements in the readability of monetary policy statements across the selected central banks, the complexity of the documents has increased, due to the increasing use of technical and unfamiliar words. With regards to the Fed, the study analysed the FOMC statements for the period 2000 to 2015 and showed that the share of growth topics in the statements is negatively related to GDP growth and positively related to the unemployment rate.

The Policy Board of the Bank of Japan (BOJ) meets eight times a year to determine the Bank's policy stance. Following each monetary policy meeting of the Board, three different reports are produced, including the minutes of the meeting and the policy statement. The minutes provide detailed information and the logic behind the policy decisions of the Policy Board, and they are published on the BOJ's website. Using textual data collected from the published minutes, covering the period April 2013 to September 2017, Oshima

and Matsubayashi (2018) studied the effects of BOJ's communication on the Japanese financial market. They estimated a Latent Dirichlet Allocation (LDA) model and showed that a significant relationship exists between their estimated topics and market reactions, especially on the days the minutes were published. In a similar study, Shirota et al. (2015) analysed the minutes of the BOJ's Monetary Policy Meeting during the sales tax increase of 2014 and the economic recession that followed. The main themes in the minutes were extracted, based on an estimated LDA model. The authors found evidence for the prominence of the topic relating to the sales tax increase and showed that the topic relating to output growth declined after the tax hike, while the proportion of the topic relating to monetary easing increased after the tax hike.

In a comparative study of three central banks—the Fed, the Bank of England (BOE) and ECB, Ehrmann and Fratzscher (2007) assessed their communication strategies and found that the effectiveness of monetary policy communication is dependent on the decision-making process adopted by the policy committee. For instance, their results showed that the Fed is characterised by an individualistic communication strategy with a collegial decision-making process, while the BOE is characterised by a collegial communication strategy with an individualistic decision-making process. The results from the evaluation of the two approaches indicate that both strategies are equally effective in enhancing the predictability of future policy decisions and the responsiveness of financial markets to central bank communication. Consequently, the authors concluded that a single best strategy for the design of central bank communication and decision-making process does not exist. In a similar study, Farina, Galloppo & Previati (2018) examined the communication strategies of the Fed and the ECB, with regards to tone, growth and ambiguity. Using computational linguistics tools, they could not find any significant difference between the communication strategy of the Fed and the ECB, regardless of the state of the economic variables being considered.

Hubert and Fabien (2017) also investigated the relationship between monetary policy sentiment and the term structure of private short-term interest rate expectations, taking the case of the ECB and the Fed. Based on a computational linguistics approach, they derived monetary policy sentiment scores from the estimated tone of the policy statements. It was found that positive shocks to sentiment, which is defined as optimism shocks, generated

an increase in private interest rate expectations both in the euro area and in the US, albeit at varied time horizons. The finding also showed that the response of private agents to monetary policy sentiment is dependent on the nature of the signal, as well as the state of the economy. They concluded that a successful management of interest rate expectations requires consistency between the communication strategy of the central bank and its policy decisions.

Studies have also focused on investigating whether the tone and linguistic content of central bank communication have changed since the 2008 global financial crisis (GFC). For instance, Kahveci and Odabas (2016) analysed monetary policy statements from the Fed, ECB and the Central Bank of the Republic of Turkey (CBRT) from 2001 to 2015. By comparing the linguistic contents of the statements before and after the GFC, their results showed that the Fed's policy statement have recorded less optimistic tone and more certainty tone. On the other hand, the policy statements from the ECB and CBRT have not experienced any significant difference in tone with regards to certainty and optimism. Similarly, Siklos (2013) investigated whether the linguistic content of central bank communication has changed since the GFC, by analysing textual data from five central banks—the Reserve Bank of Australia, the Bank of Canada, the Reserve Bank of New Zealand, the Bank of England and the U.S. Federal Reserve. Based on a sample period from 2003 to 2012, their results showed that policy makers' concern about financial stability was at the highest during the GFC while uncertainties regarding economic outlook was also high. It was also found that the evolution of macroeconomic and financial variables is important for the nature of central bank communication, especially with regards to the issues concerning financial stability and uncertainty.

A strand of the literature has also employed the human reading approach in analysing the information content of monetary policy documents. For instance, Demiralp et al. (2012) adopted the human-reading approach to construct a dummy variable that captures the sentiments expressed in the monetary policy statements of the Central Bank of Turkey (CBRT). The monetary policy meetings of the CBRT are held monthly, based on a pre-announced annual timetable, and the policy statements are published on the Bank's website the next morning after each meeting. These published statements were analysed by Demiralp et al. (2012), in order to investigate the extent to which the communication strategy of the CBRT contains useful signals

for the prediction of future interest rate in Turkey. Based on their text-based coded sentiments, they showed that the published policy statements have strong signalling effects, with respect to the direction of future interest rate decisions, especially since the adoption of the pre-announced fixed decision dates by the CBRT in 2005.

Beyond monetary policy, text mining techniques have also been applied to financial stability issues. For instance, Born, Ehrmann and Fratzscher (2014) analysed over 1,000 releases of Financial Stability Reports (FSRs) as well as speeches and interviews by central bank governors, from 37 central banks, for the period 1996-2009. Based on computerised textual analysis, the authors showed that FSRs with net optimistic tones impacts the stock market returns positively, while those with net pessimistic tones do not have such effects. Computational text analysis has also become popular in other areas of communication research. For instance, it has been used to analyse twitter sentiments and tourism development (Barbagallo, Bruni, Francalanci & Giacomazzi, 2012); the complexity of communication during banking reforms (Amadxarif, Brookes, Garbarino, Patel & Walcak, 2019); social media sentiment and consumer confidence (Daas & Puts, 2014); sentiment indicators and exchange rate prediction (Hopper, 1997; Crone & Koeppel, 2014; Janetzko, 2014; Ozturk & Ciftci, 2014; Plakandaras, Papadimitriou, Gogas & Diamantaras, 2015; Iwantoro & Koesrindartoto, 2017); twitter sentiment and stock price returns (Mittal & Goel, 2012; Sumbureru, 2013; Khatri, Singhal & Johri, 2014; Kumar, Masakara, Chandak & Goswami, 2015; Ranco, Aleksovski, Caldarelli, Grcar & Mozetic, 2015); twitter sentiment and government perception (Amusa, Yahaya & Balogun, 2016); and sentiment in central banks' Financial Stability Reports (Correa, Garud, Londono & Mislang, 2017).

In Nigeria, studies on central bank communication is still at its infancy, with the existing ones employing the human reading approach. For instance, Ekor, Adeniyi and Saka (2013) studied the relationship between central bank communication and the effectiveness of monetary policy during the period 1985Q1-2013Q2. They manually read through the monetary policy documents and classified them into three categories, namely: monetary policy related, economy related, and others. They showed that improvements in central bank communication are associated with lower inflation volatility. In a related study, Sanusi (2011) examined the implications of monetary policy signals on the Nigeria Inter-bank Offered Rates (NIBOR), using data for the period 2005-2011. The author obtained a measure of central bank communication, by manually

extracting information with regards to the stance of monetary policy from the published minutes and communiques of the CBN's monetary policy committee. It showed that NIBOR for different maturities recorded higher volatilities whenever the rate-setting meetings of the CBN were held. To our knowledge, our study represents one of the pioneering efforts at studying monetary policy communication in Nigeria, using an automated text mining approach.

III. Data and Methodology

In this section, we describe the numeric and textual data used for our empirical analysis, as well as their sources. Also, the automated text mining procedure employed is discussed.

III.1 Data

The data set used for our analyses comprises textual content sourced from the CBN communiques issued six times a year following each meeting of the monetary policy committee (MPC). The MPC sits at its bi-monthly meetings to determine the Monetary Policy rate (MPR) based on its considerations regarding the current state of the economy, as well as its expected future path (Mordi, Adeniyi & Omotosho, 2019). Information regarding the interest rate decisions of the MPC, as well as the arguments behind those decisions are communicated through the policy communique. Thus, the CBN communique represents an important tool of CBN communication by which its objectives, monetary policy decisions, sentiments, and economic outlook are made known to the public.

For the purpose of this study, we downloaded eighteen CBN communiques issued by the CBN during the period 2015 to 2017 and published on the Bank's website. Although the focus of this paper relates to central bank communication during the 2016 economic recession, we included 6 communiques released in 2015 to capture the policy uncertainties leading to the recession. Nigeria exited the recession in 2017Q2, implying that eight communiques were issued during the economic recession. Thus, our corpus consists of eighteen documents with combined word count of 40, 835 words.

In line with standard text mining procedure, we subjected our corpus to a number of pre-processing steps in order to make it suitable for analysis. First, we

remove numbers, punctuations, white spaces, and special characters (such as "/" and "-"). Second, all the letters are converted to lower case so as to allow for uniformity in the appearances of the same word across the documents. Third, we remove English stop words such as "the", "about", "this", "therefore" as they add no value to our analysis. In the same vein, certain redundant words in the communique are also removed, including terms such as "billion", "trillion", "vote", "period", "annualised", etc. In the fourth step, we stem the corpus by dropping letters or combination of letters such as "e", "c", "ing", "ed" from the end of words so as to generate uniqueness. We apply these steps to all the documents in the same order and based on the same rules so as to ensure that we focus on the most relevant words driving the topics in the corpus (Gefen, Endicott, Fresneda, Miller & Larsen, 2017). Lastly, we translate our corpus of text documents into a term by document matrix, such that each cell, $c_{i,j}$, in the matrix represents a weighted frequency of the word *i* in the document *j*.

In order to relate the insights derived from our textual analyses to macroeconomic developments in Nigeria, we also use time series data on the MPR, inflation rate, 91-day treasury bill rate, and the growth rate of Gross Domestic Product (GDP) for the period 2015 to 2017. Data on these variables were sourced from the Central Bank of Nigeria and the National Bureau of Statistics.

III.2 Methodology

Automated text mining procedures involve using a suite of computational tools and statistical techniques to derive useful insights from unstructured textual data contained in a collection of documents, often called a corpus. The advantage of this sort of analysis, which is also called natural language processing, lies in the use of computer-enabled algorithms to process large textual documents in a more effective and efficient manner than can be achieved by human reading (Bholat, Hansen & Santos, 2015). In this section, we present a brief discussion of the text mining techniques employed in the paper.

III.2.1 Readability Analysis

According to Bruno (2017), the readability level of a document is an important factor in the evaluation of its public acceptance. A suite of methods is available for measuring the readability of a text; most of which rely on

analysing the word and sentence structure of the document being examined. In this paper, we employ the readability index developed by Coleman and Liau (1975) to gauge the level of understandability of the CBN communiques contained in our corpus. The Coleman-Liau Index (CLI) represents the percentage of deletions in a document that can be filled in by a college undergraduate. Consequently, a higher value of the CLI indicates an increased readability level of our documents and vice versa.

The index determines the ease of reading a document by considering the number of characters per word (word difficulty) as well as the number of words per sentence (sentence difficulty) as follows:

$$CLI = 141.8401 - 0.214590 \times \frac{100 \times N_{ch}}{N_w} + 1.079812 \times \frac{N_{st} \times 100}{N_w} \quad (1)$$

Where N_{ch} denotes the number of characters, N_{st} represents the number of sentences while N_w denotes the number of words in the document.

III.2.2 Sentiment Analysis

Sentiment analysis refers to the determination of the general sentiments, opinions, and affective states of people reflected in a corpus of textual data (Miner, Delen, Elder, Fast, Hill & Nisbet, 2012). It involves the process of classifying an opinion expressed in a document as positive, neutral, or negative. This technique is applied to our corpus in order to understand the tone and mood of the CBN's monetary policy committee, especially during the 2016 economic recession. However, since our corpus consists of communiques released during the 2015-2017 period, our approach allows us to study the evolution of monetary policy sentiment over the sample period. In an approach similar to Binette and Tchebotarev (2019), we derive the monetary policy sentiment score (*MPSS*) for each document in our corpus as follows:

$$MPSS = \frac{N_{postive} - N_{negative}}{N_{total}} \times 100 \quad (2)$$

Where $N_{positive}$ denotes the number of positive sentiment words, $N_{negative}$ is the number of negative sentiment words, and N_{total} is the total number of words in the document. Thus, a value of *MPSS* > 0 indicates positive sentiment about economic out-turns while *MPSS* < 0 signifies the expression of negative sentiments. As noted by Binette and Tchebotarev (2019), studying the monetary policy sentiment helps to determine the direction of the change in economic conditions as perceived by the central bank.

III.2.3 Topic Extraction

Topic extraction involves making inferences about a statistical model that generates a text process such that the model can then be used to obtain a cluster of words that are likely to appear under a particular topic (Blei & Lafferty, 2009; Miner et al., 2012). Arguably, the popular method of topic extraction is the Latent Dirichlet Allocation (LDA) developed by Blei et al. (2003). As succinctly explained by Blei et al. (2003), the LDA assumes that each document is a distribution over the topics in a corpus while every topic is in turn a distribution over the words in the corpus. Thus, the LDA is a probabilistic model that is built upon the assumption that the documents being analysed were generated through a probabilistic generative process that is latent. This sort of generative process is explored to obtain the probability of words appearing under different topics within the document[5].

In this paper, we apply the LDA modelling approach to classify the texts contained in our corpus into meaningful categories that characterise the topics, *k,* discussed in the CBN communiques. Thus, following the procedure outlined in Calvo-Gonzalez, Eizmendi and Reyes (2018) and Shirota et al. (2015), the LDA generative process for our corpus is described in the following steps:

Step 1: For each topic *k*, we draw a distribution over words φ_k according to a Dirichlet distribution ~ *Dir* (β), where β is the parameter of the Dirichlet prior on the per-topic word distribution. A high value of β means that each topic comprises most of the words in the corpus, whereas a low beta means that each topic features fewer words.

Step 2: For each document *D*: we draw a vector of topic proportions θ_d according to a Dirichlet distribution ~ *Dir* (α), where α is the parameter of the Dirichlet prior on the per-document topic distribution. A high value of α means that each document comprises a mixture of most of the identified topics whereas a low α means that each document features fewer topics.

Step *3:* For each of the *N* words w_n: we choose a topic assignment z_n based on a multinomial distribution ~Multinomial (θ) according to the topic proportion θ_d. Next, we choose a word w_n from $p(w_n \mid z_n, \varphi)$ based on a multinomial probability conditioned on the topic z_n; where z represents the per-word topic

[5]For a detailed tutorial on topic modelling using LDA, see Debortoli et al. (2016)

assignments.

Based on the above routine, we infer the distribution of the parameters φ, θ, and z, that are most likely to have governed the generation of the documents in our corpus. Thus, given our documents and the Dirichlet priors (α and β), the LDA approach we adopted seeks to compute the posterior distribution of the latent variables as follows:

$$P(\theta, z, \varphi|w, \alpha, \beta) = \frac{P(\theta, z, \varphi|\alpha, \beta)}{P(w|\alpha, \beta)} \quad (3)$$

Calculating the maximum likelihood for equation (3) is computationally costly. This is because the size of the estimation space is the number of topics, k, to the power of the dimension of the vocabulary, v, in the corpus. To circumvent this problem and in line with the practice in extant literature, we use the collapsed Gibbs sampling algorithm to approximate the posterior distributions of the hidden variables given in equation (3) by running 2,000 iterations[6]. Once the posterior estimates for φ and θ are derived, the algorithm then returns the topic representation of each document in the corpus. Heuristically, the number of topics in our corpus is taken to be (k=6).

IV. Results

IV.1 Exploratory Data Analysis

Table 1 presents a list of the communiques issued by the CBN during our sample period. Since the MPC meeting holds bi-monthly, a total of 18 communiques with a combined word count of 40, 835 words were analysed. In addition, the table shows Monetary Policy Rate (MPR) decisions of the CBN during the period. Of the eighteen meetings analysed, there were 15 instances in which the MPR was retained at its previous period's level, one instance of an interest rate cut (November 2015), and two instances of an interest rate hike (March 2016 and July 2016). A preliminary observation of the data shows that the word count for the communique issued in November 2015 (when the interest rate was reduced) was 2, 070; which is lower than the word count of 2, 201 in the previous meeting communique and an average word count of 2, 269 over the sample period.

[6]As noted by Shirota et al. (2015), the collapsed Gibbs sampling algorithm is a useful procedure for approximating posterior distributions that are difficult to compute directly.

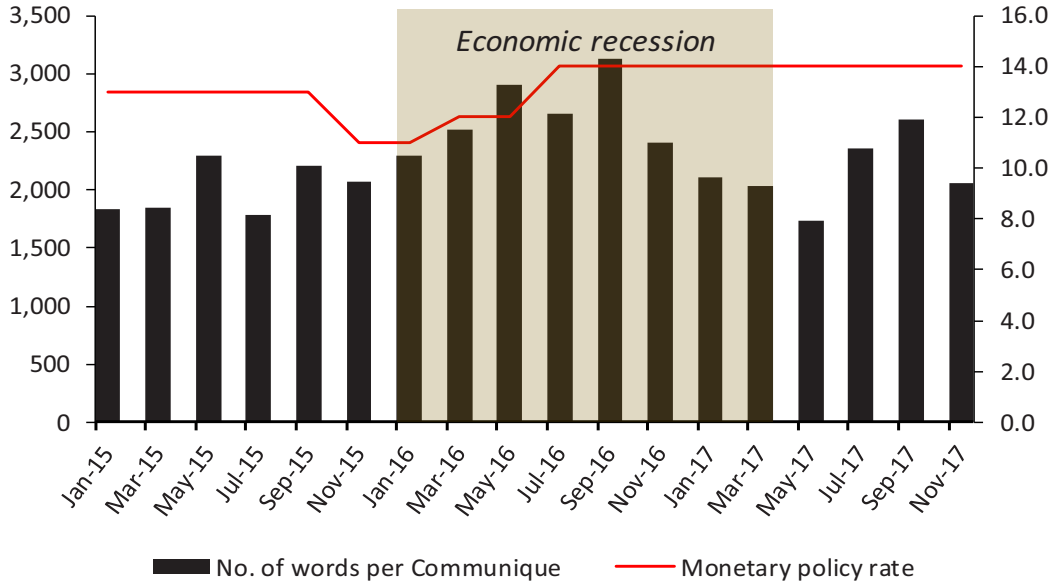
Table 1: MPC Communiques and Selected Macroeconomic Indicators, 2015 -2017

Communique No.	Meeting Date	No. of words	Monetary policy rate	91 Day T-Bill Rate (%)	Inflation rate (%)	GDP growth (%)
No. 99	Jan. 19-20, 2015	1,838	13.0	11.2	8.34	3.96
No. 100	Mar. 23-24, 2015	1,852	13.0	10.8	8.34	3.96
No. 101	May. 18-19, 2015	2,297	13.0	10.0	8.96	2.35
No. 102	Jul. 23-24, 2015	1,784	13.0	10.0	9.32	2.84
No. 103	Sep. 21-22, 2015	2,201	13.0	10.4	9.32	2.84
No. 104	Nov. 23-24, 2015	2,070	11.0	5.6	9.41	2.11
No. 105	Jan. 25-26, 2016	2,296	11.0	4.1	11.26	-0.67
No. 106	Mar. 21-22, 2016	2,521	12.0	5.5	11.26	-0.67
No. 107	May 23-24, 2016	2,905	12.0	8.0	15.26	-1.49
No. 108	Jul. 25-26, 2016	2,655	14.0	12.3	17.53	-2.34
No. 109	Sep. 19-20, 2016	3,124	14.0	14.0	17.53	-2.34
No. 110	Nov. 21-22, 2016	2,402	14.0	14.0	18.45	-1.73
No. 111	Jan. 23-24, 2017	2,110	14.0	14.0	17.92	-0.91
No. 112	Mar. 20-21, 2017	2,036	14.0	13.6	17.92	-0.91
No. 113	May 22-23, 2017	1,736	14.0	13.5	16.53	0.72
No. 114	Jul. 24-25, 2017	2,352	14.0	13.5	16.01	1.17
No. 115	Sep. 25-26, 2017	2,601	14.0	13.2	16.01	1.17
No. 116	Nov. 20-21, 2017	2,055	14.0	13.0	15.72	2.11

Source: Central Bank of Nigeria and and National Bureau of Statistics

On the other hand, the average word count for the two communiques released when the MPC hiked the MPR was 2, 588, which is higher than the average word count for the sample period. This seems to suggest that there was increased communication whenever the policy rate was increased. It is important to also note that the interest rate cut of November 2015 occurred in the face of a declining output growth and a slightly increasing rate of inflation. The interest rate hike of March 2016 was communicated in a communique with a word count of 2, 521 (higher than the word count of 2, 296 in the previous communique) amidst a significant increase in inflation and negative GDP growth. This seems to suggest that the CBN was conscious of the need to provide more explanations to economic agents for increasing the policy rate in the face of a declining output growth.

Figure 1: Word Count of MPC Communiques and Monetary Policy Rate, 2015 -2017



Source: Central Bank of Nigeria

Furthermore, Figure 1 presents the word counts of the MPC communiques issued during the period 2015 – 2017 as well as the monetary policy rate. It shows that there was a systematic upward adjustments in the monetary policy rate in the first half of 2016. During the same period, the CBN appeared to communicate more as there was a steady increase in the word count of the issued communiques at the outset of the crisis.

IV.2 Frequency Distribution of Words in the Term Document Matrix

Having pre-processed our corpus in line with the procedures enumerated under section 3.2, we generated the frequency distribution of unique words in the final corpus as shown in Figure 2. There are 85 cases in which a unique word appeared between 1-20 times within the corpus. There are 6 cases in which unique words appear between 20-40 times. There are 3 cases in which a set of unique words appear 40-60 times. There is a single case in which a unique word appears between 60-80 times. In terms of distribution of words, our document has a concentration of unique words with appearances ranging between 1-20. By implication, words within this frequency category are likely to have significant influence in the determination of the key topics in our corpus as well as the concerns and policy focus of the CBN over the sample period.

Figure 2: Distribution of Words in the Corpus

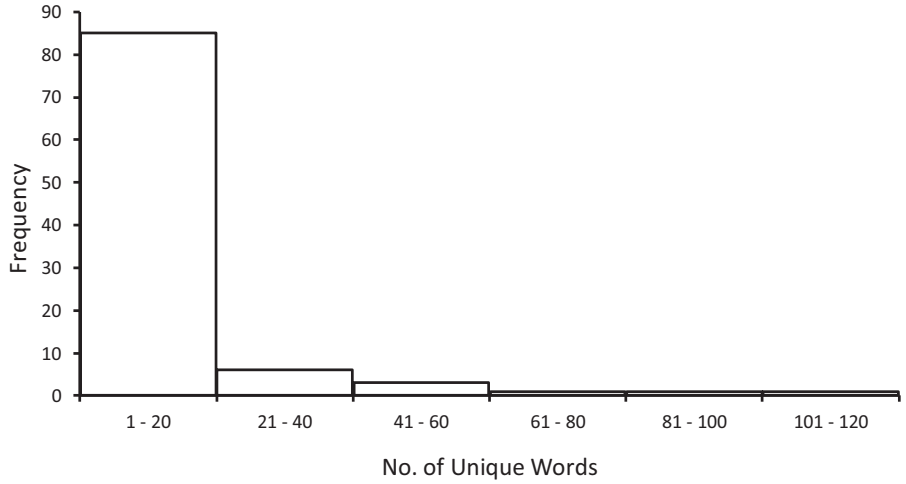


Table 2 presents the cumulative frequency regarding the character length of the 903 unique words contained in our corpus. As can be seen, the most frequent are six-character words with a frequency rate of 26.7 per cent; followed by five-character words with a frequency rate of 17.8 per cent. In other words, about two thirds of the words contained in our corpus are between three to six-character words. This tends to suggest that the CBN communiques issued during the period 2015 – 2017 were written in words that are not quite complicated in terms of their character lengths.

Table 2: Cumulative Frequency by Word Length in the Corpus

Word length	freq	cum.freq	percent	cum.percent
3	52	52	5.8	5.8
4	155	207	17.2	22.9
5	161	368	17.8	40.8
6	241	609	26.7	67.4
7	132	741	14.6	82.1
8	93	834	10.3	92.4
9	40	874	4.4	96.8
10	19	893	2.1	98.9
11	3	896	0.3	99.2
12	4	900	0.4	99.7
13	3	903	0.3	100.0

IV.3 Assessing the Readability of the Published Communiques

In Table 3, we show the Coleman and Liau (1975) readability index of the documents in our corpus. The average readability index of the CBN communiques

released during 2015 – 2017 is 16.7 per cent. This level of understandability corresponds to that expected of a college student and other higher qualifications, similar to the findings of Bruno (2017) with regards to the Financial Stability Reports (FSR) in Italy.

Table 3: Coleman & Liau (1975) readability index of CBN communiques

Communique No.	Meeting month	Coleman & Liau Readability Index
No. 99	Jan-15	19.8
No. 100	Mar-15	17.2
No. 101	May-15	18.0
No. 102	Jul-15	18.1
No. 103	Sep-15	16.5
No. 104	Nov-15	17.0
No. 105	Jan-16	16.8
No. 106	Mar-16	15.6
No. 107	May-16	15.9
No. 108	Jul-16	17.2
No. 109	Sep-16	17.6
No. 110	Nov-16	15.8
No. 111	Jan-17	15.7
No. 112	Mar-17	15.8
No. 113	May-17	15.3
No. 114	Jul-17	14.5
No. 115	Sep-17	15.8
No. 116	Nov-17	18.1
Average readability index		*16.7*

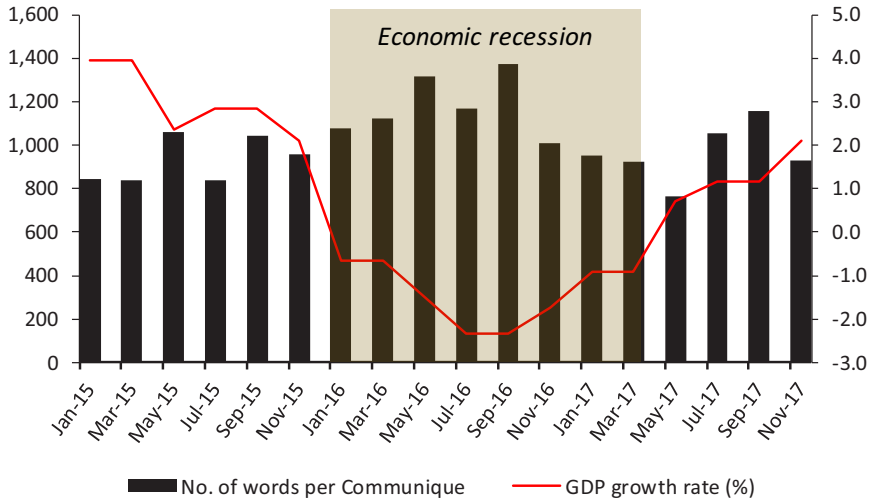
January 2015 to 14.5 for the communique of July 2017, indicating increased complexity in the word and sentence structures of the documents overtime. Also, the average readability score during the period of the economic recession was 16.4, which is lower than the average of 16.7 for the entire sample period; indicating that the CBN communiques issued during the period of the economic recession were written in a relatively more complicated style. However, the readability index for the November 2017 communique improved substantially to 18.1 per cent from the level of 15.8 per cent recorded in the previous release.

IV.4 Did the CBN Communicate more during the 2016 Economic Recession?

The CBN appears to communicate more through its policy communiques during the 2016 economic recession as demonstrated by the number of words contained in policy documents. As shown in Figure 3, the communique with the highest number of word count during the sample period was issued after

the MPC meeting of September 2016. It is clear from the chart that this period coincided with the business cycle trough, beyond which the economy transited to a state of recovery. In other words, the word count for the issued communiques increased systematically as Nigeria's economic performance worsened, starting from the MPC meeting of November 2015 to the meeting of September 2016 when the growth in GDP experienced a turning point.

Figure 3: Word Count of MPC Communique in Corpus and GDP Growth Gate, 2015 -2017



Source: Central Bank of Nigeria

This observed behaviour is often borne out of the need for the central bank to effectively communicate their outlook about the economy, shape the expectations of economic agents, reinstate policy objectives, and explain the rationale behind its policy choices (see Woodford, 2002; Eusepi & Preston, 2010; Berger et al., 2011; Siklos, 2013; Apel & Grimaldi, 2014; Luangaram & Sethapramote, 2016; Coenen et al., 2017). Thus, we find evidence that the CBN demonstrated greater transparency and communication during the 2016 economic recession. This behaviour is consistent with the findings in the literature that central banks communicate more during difficult periods (Luangaram & Wongwachara, 2017).

IV.5 What Issues were of Concern to the MPC during the 2015 – 2017 Period?

In this section, we employ term frequency and word clouds to gain insights into the main issues that were of concern to the MPC during our sample period. For ease of analysis and presentation, we first analysed our full sample corpus

(comprising the 18 MPC communiques issued during 2015 - 2017) and show the results in section 4.5.1. We then generated three corpuses (one for each year) and analysed them individually in order to gain insights into the evolution of the frequent terms contained in the communiques over the sample period. The results for the individual years are presented in section 4.5.2.

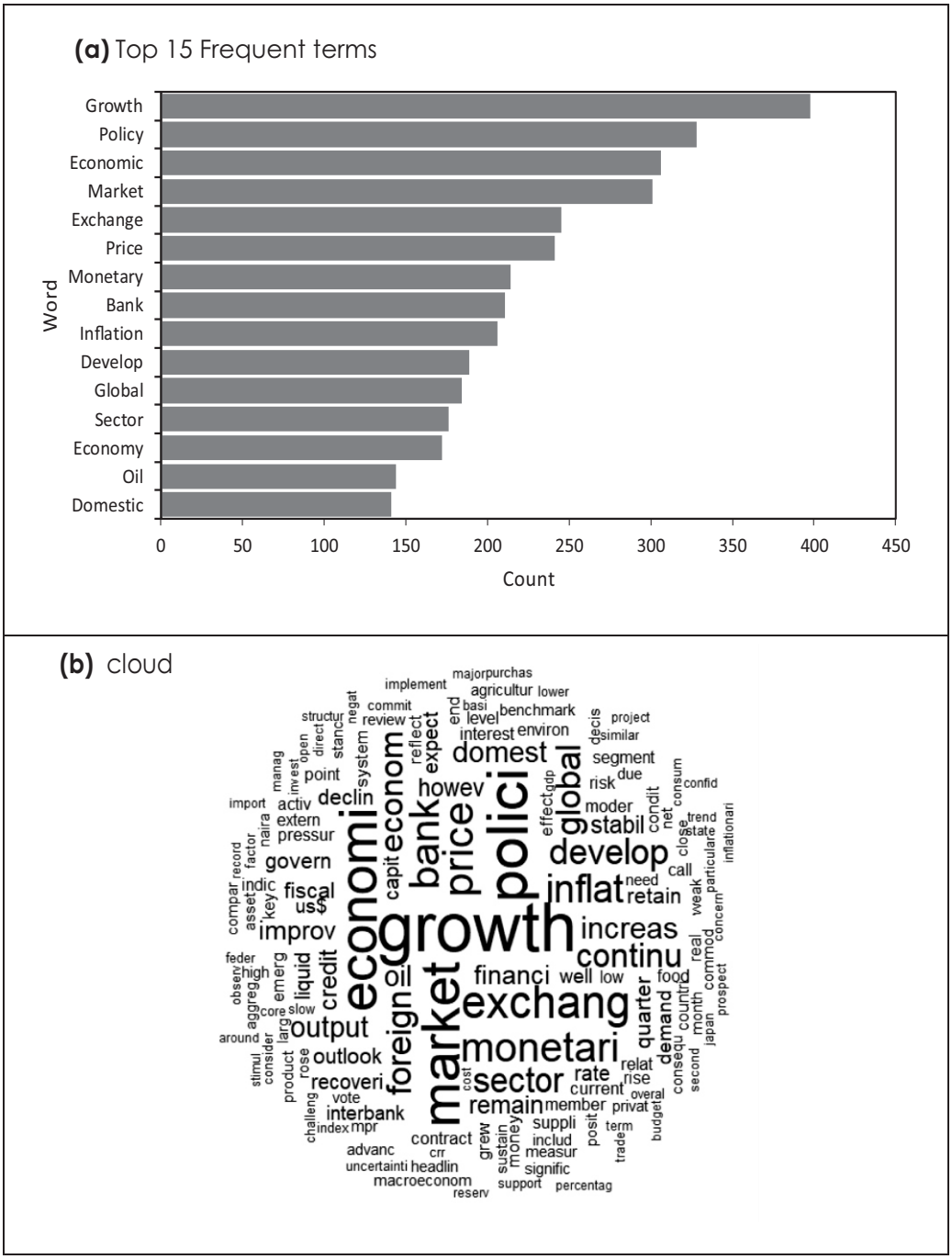
IV.5.1 Analysis for the Full Sample

Figure 4 presents a pictorial representation of the predominant words in the corpus for the full sample, 2015 - 2017. Figure 4a is a bar chart showing the most frequent words and their counts while the word cloud is shown in Figure 4b. The word cloud presents the most frequent words in our corpus in the form of a synthetic picture by resizing their fonts proportionally to their relative frequency (Bruno, 2017). Our analyses show that the fifteen most common words used in the MPC communiques were growth, policy, economic, market, exchange, price, monetary, bank, inflation, develop, global, sector, economy, oil and domestic (Figure 4a).

It is important to note that these words reflect the mandates of the CBN as well as the concerns of the MPC during the sample period. A careful examination of the word cloud as well as the bar chart shows that issues around economic growth and policies were of crucial importance to the MPC during the 2015 – 2017 period. Next are the issues relating to the foreign exchange market as the country was confronted with a decline in the price of its dominant foreign exchange earner (crude oil) during the period. The oil price slump which began in early 2014 resulted to a decline in the country's foreign exchange reserves and a resultant scarcity in the supply of foreign exchange.

The next set of frequent words in the MPC communique issued during the full sample relates to price and monetary stability, indicating the commitment of the MPC to price stability in line with the mandate of the CBN as well as the MPC's concerns regarding the likely inflationary implications of the instability in the foreign exchange market. It is also clear that developments in the global economy, including the issues around the international crude oil market were of concern to the MPC. Particularly, oil shows up as the fourteenth most frequent term under the full sample corpus. This observed behaviour of the CBN is consistent with the configuration of a Taylor rule for a small open economy in which the central bank responds to developments in prices, output, and the exchange rate.

Figure 4: Most Frequent Terms and Word Cloud, 2015 –2017



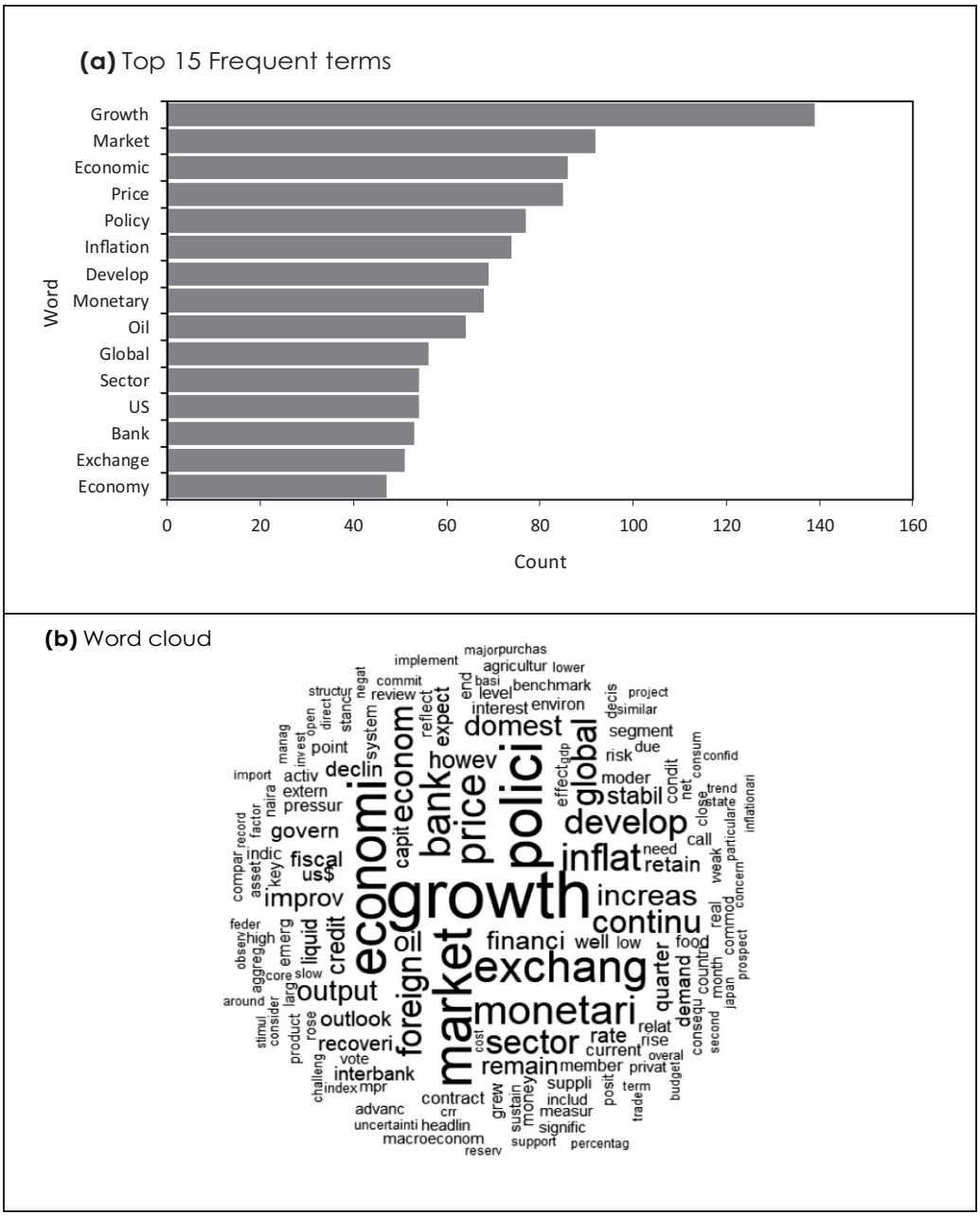
IV.5.2 Analysis for the Sub-Samples

In this section, the word clouds for the corpuses generated based on the communiques issued in 2015, 2016 and 2017 are presented. Figures 5a and 5b indicate that issues around economic growth and market stability were pre-eminent during the year 2015. These were followed by concerns about price and monetary instabilities as well as developments in the global economy, including oil. It is noteworthy that while concerns regarding the foreign exchange market featured as about the fifth most frequent term during the full sample, it was not much of a concern during 2015.

However, oil moved up about five places to represent the ninth most frequent term in 2015; reflecting the MPC's concern regarding the possible deleterious effects of declining oil prices on the Nigerian economy. For instance, a sentence in the January 2015 communique reads as follows: "Furthermore, the divergence between the US and Euro Area monetary policy stance, non-inclusive growth and the regional impact of falling oil prices with acute revenue shortages in countries like Nigeria, Venezuela and Russia add to the risk factors". In another sentence, the communique reads thus: "The Committee was, however, concerned about the weakening contribution of the oil sector to overall growth, which is now being exacerbated by the rapid drop in oil prices since June 2014".

In 2016, the issues of economic growth and the foreign exchange market were of concern to the MPC as the declining crude oil price continues to take its toll on the Nigerian economy (Figure 6). For instance, a sentence in the March 2016 communique reads: "The Bank had adopted accommodative monetary policy since July 2015 in the hope of addressing growth concerns in the economy, effectively freeing up more funds for DMBs by lowering both CRR and MPR, with excess liquidity arising from the lower CRR warehoused at the CBN". The term "policy" is the second most frequent, which tends to indicate the MPC's recognition of the need for economic policies towards ameliorating the growth challenges of the economy. This point was clearly made in one of the MPC communiques issued in 2016, which reads that "The MPC believes that complementary fiscal and structural policies are essential for reinvigorating growth". The term "exchange" also showed up prominently, reflecting the scarcity of foreign exchange experienced during the year as well as the CBN's concerns regarding the pass-through effects of exchange rate to domestic inflation in the country.

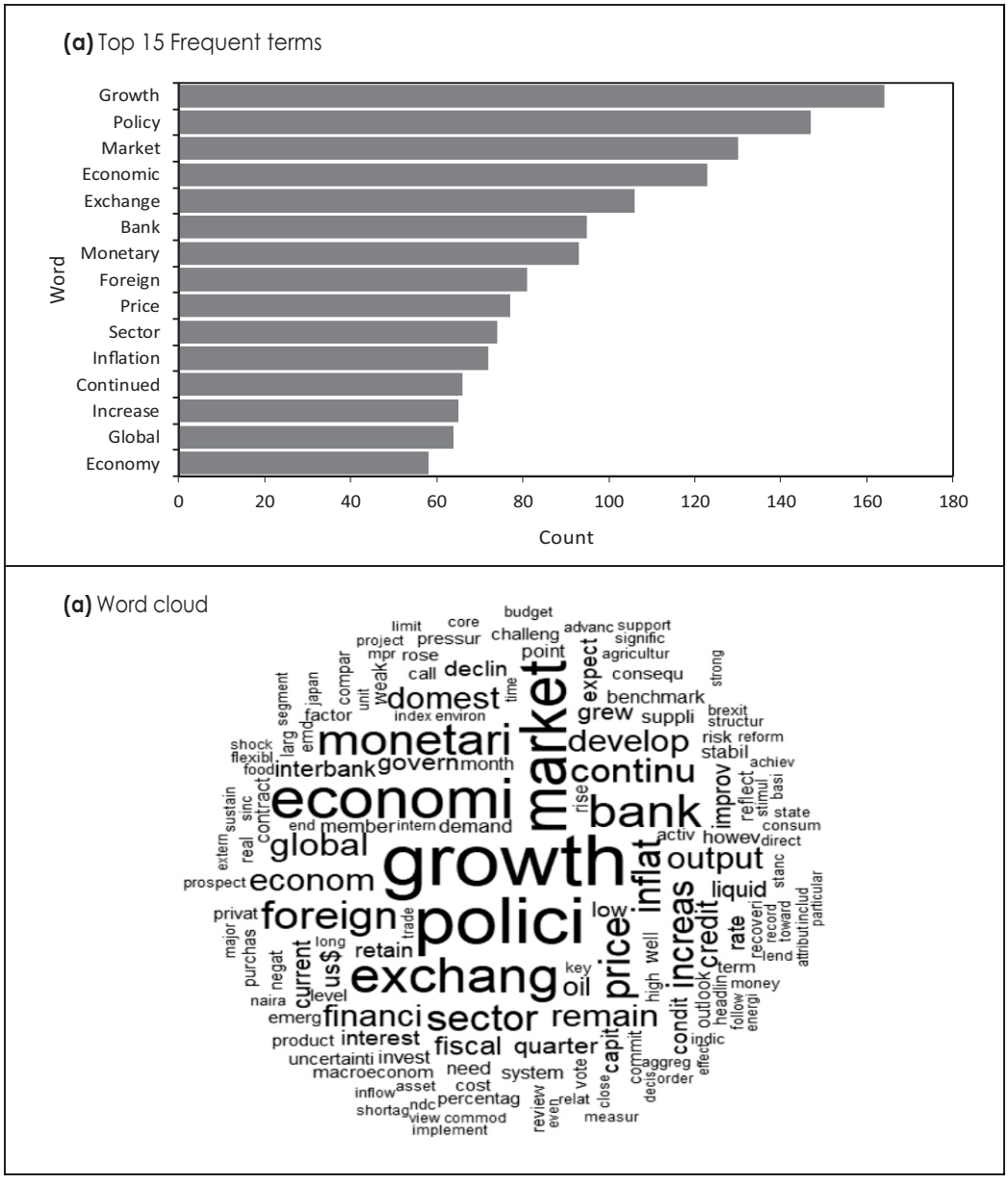
Figure 5: Most Frequent Terms and Word Cloud, 2015



In the 2017 corpus, the fifteen most frequently used terms were: "policy", "economic", "growth", "exchange", "market", "price", "economy", "foreign", "global", "bank", "develop", "inflation", "improvement", "monetary" and "outlook" (Figure 7a). The word cloud (Figure 7b) tend to suggest that a major focus of the MPC in 2017, as reflected by the frequency of terms used in the communiques relates to the limitations of monetary policy in

propelling growth and the need for other complementary economic policies. As stated in the communique of January 2017, "The Committee is of the view that the key undercurrents, that is, scarcity of foreign exchange, low fiscal activity, high energy prices and the accumulation of salary arrears - cannot be directly ameliorated by monetary policy actions". The communique further states that "Consequently, members acknowledged the imperative of sectoral policies and greater coordination of monetary and fiscal policy".

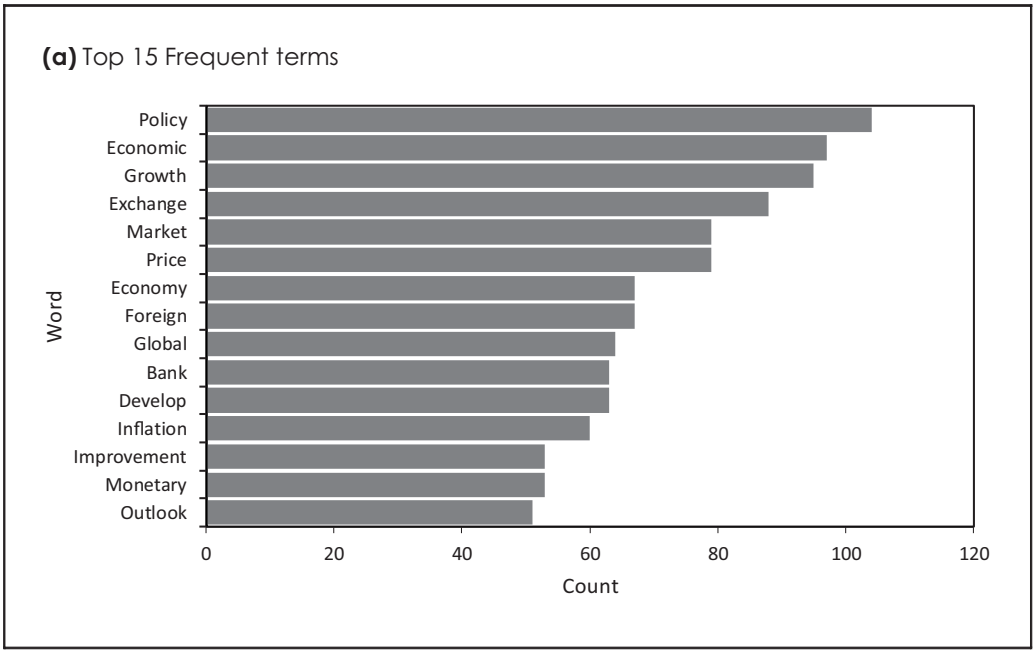
Figure 6: Most Frequent Terms and Word Cloud, 2016



A careful examination of the word cloud also indicates that the MPC was quite optimistic about the economy's recovery as terms such as "improvements", "recovery", "outlook", "fiscal" also featured prominently. For instance, it was stated in the July 2017 communique that "On the domestic front, the economy is on a path to moderate recovery with a positive short- to medium-term outlook, premised largely on fiscal stimulus and a stable naira exchange rate. Inflation expectations also appear sufficiently anchored with the current stance of monetary policy".

The analysis conducted in this section tend to suggest that the need to achieve output, exchange rate, and price stability in the face of global and domestic shocks represent the key concerns of the MPC, as reflected by the most frequently used terms in the MPC communiques. This finding is consistent with the observed Taylor rule configuration for most small open resource-rich emerging economies facing negative terms of trade shocks. As explained under the section 3, another technique for deriving useful insights from our corpus is to model the topics in the documents. The results for the estimated topic model are discussed next.

Figure 7: Most Frequent Terms and Word Cloud, 2017



(b) Word cloud

IV.6 Results of the Topic Model

We model our corpus by assuming that the MPC communiques for the period 2015 – 2017 and the terms used in the corpus can be analysed under six topics. Table 4 presents the six topics as well as the terms with high probabilities of featuring under each of the topics.

As hinted by Debortoli, Muller, Junglas and Vom Brocke (2016), the meaning of a topic can be discerned by inspecting its most probable terms in combination with the associated most probable documents. For instance, the term with the highest probability of featuring under topic one is "exchange", followed by "foreign" and "market". On the other hand, the most likely term under topic 6 is growth, followed by "market" and "sector". Therefore, we assign descriptions to the six topics based on the words classified under each of them as shown in Table 4.

Topic 1 is substantially defined by terms such as "exchange", "foreign", "market" (Table 4). Other related terms, though with lower probabilities to this topic are "weak", "flexible", "reform", "adjust", and "pressure". Therefore, we assign a description relating to "exchange rate and its management" to this topic. These terms were frequently used during the foreign exchange market instabilities experienced in 2016, which necessitated the reform of the market

in June 2016. For instance, a sentence in the communique issued in July 2016 states as follows: "Against this backdrop, the Committee reiterated its commitment to sustain and deepen flexibility in the foreign exchange market to further enhance foreign exchange flow in the economy". Thus, the issues around the management of exchange rate constituted one of the topics of central bank communication during the period 2015 – 2017.

Table 4: Top Terms Per Topic

s/n	Topic 1	Topic 2	Topic 3	Topic 4	Topic 5	Topic 6
1	exchange	outlook	policy	oil	economic	growth
2	foreign	policy	remain	develop	price	market
3	market	recovery	bank	financing	continued	sector
4	retain	stability	domest	increase	economy	inflation
5	economic	improve	monetary	countries	bank	output
6	growth	contract	supply	global	fiscal	quarter
7	financing	global	low	moderate	govern	liquid
8	large	risk	credit	decline	monetary	rate
9	high	however	interest	measure	expect	interbank
10	negative	real	increas	food	well	demand
11	active	capital	however	asset	develop	reflect
12	cost	position	invest	external	environ	point
13	rise	member	challenging	system	segment	key
14	arising	economy	grew	crr	current	monetary
15	continue	implement	condition	end	level	us$
16	weak	money	need	due	pressure	month
17	aggregate	naira	percentage	inflation	product	compare
18	increase	domestic	capital	lower	commodity	private
19	benchmark	macroeconom	since	trend	overal	commit
20	concern	credit	global	vote	global	improve
21	achieve	retain	structural	reserves	federal	consumption
22	flexible	boost	lend	exports	inflation	purchases
23	reform	inflow	consumption	stability	headline	employment
24	adjust	prospect	coordination	deprectaion	mpr	brexit
25	pressure	stimulus	industry	tension	headwind	slowdown
Assigned topic	Exchange rate and its management	Exit from recession and economic recovery	Policy response to domestic constraints	Oil shocks, external reserves and inflation	Prices, monetary and fiscal policies	Output growth and market stability

Topic 2 features terms such as "outlook", "policy", "recovery", "stability", "improve" with high probabilities. Therefore, we describe this topic as relating to the country's exit from recession and the subsequent recovery. The terms featuring under topic 3 with high probabilities include: "policy", "remain", "domestic", "monetary", "supply". Others include terms such as "structural", "consumption", "coordination", "challenging". Consequently, we assign topic 3 to issues bordering on domestic constraints confronting the economy as well as the policy responses for addressing them. Terms with high probabilities of featuring under topic 4 include "oil", "develop", "financing", "countries", "global", "moderate", "decline", "inflation", "reserves", "depreciation", "tension". A careful consideration of these words tends to suggest that the fourth topic covers MPC discussions regarding oil and other global disturbances as well as their implications for exchange rate and inflation in Nigeria. Topic 5 seems to encapsulate the issues around inflation, fiscal policy and monetary policy. Lastly, the 6th topic is described as covering MPC

discussions on output growth, sectoral policies, and stability in the foreign exchange as well as money markets.

In Table 5, we present the probabilities of each of the documents in our corpus belonging to any of the six identified topics. As can be seen, the CBN communique of January 2015 has the highest probability of being categorised under topic 4 (0.31) and the least probability of being categorised under topic 1 (0.08). This is consistent with our earlier analysis under section 4.2 regarding the MPC's concerns about the declining oil prices and its possible consequences for exchange rate and inflation in Nigeria. As is the case for the communique of January 2015, the communiques issued in March 2015 and May 2015 are also classified under topic 4 with high probabilities of 0.33 and 0.35, respectively. The communique of July 2015 is classified under topic 5 with a probability of 0.24, reflecting the need for monetary and fiscal policy coordination towards addressing the inflationary pressure that was building up in the first half of the year.

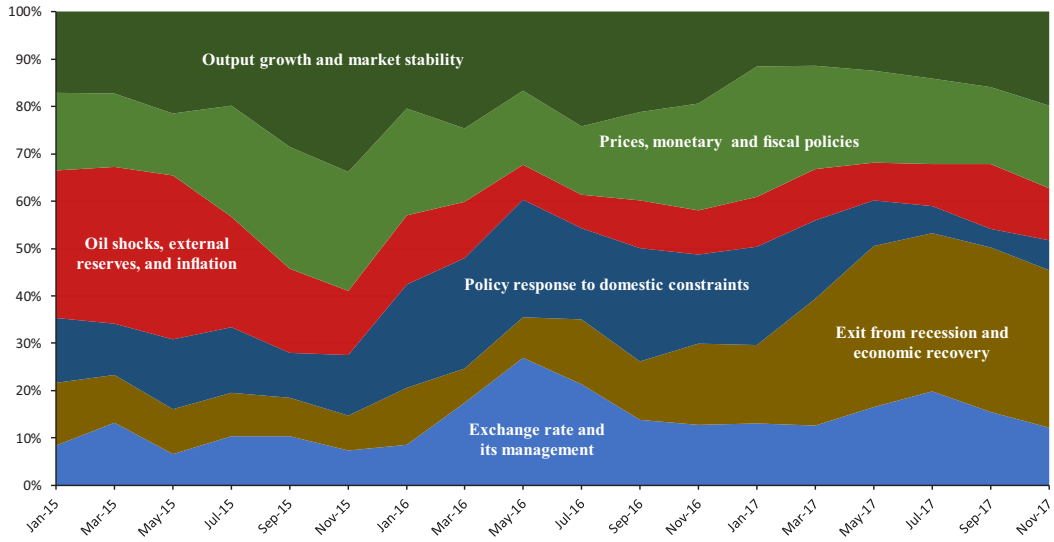
Table 5: Documents to Topic Probabilities

Communique No.	Meeting Date	Topic 1	Topic 2	Topic 3	Topic 4	Topic 5	Topic 6	Topic classification	Assigned topic based on common terms
No. 99	Jan. 19-20, 2015	0.0832	0.1325	0.1381	0.3106	0.1650	0.1706	Topic 4	Oil shocks, external reserves and inflation
No. 100	Mar. 23-24, 2015	0.1320	0.1005	0.1095	0.3311	0.1545	0.1725	Topic 4	Oil shocks, external reserves and inflation
No. 101	May. 18-19, 2015	0.0662	0.0951	0.1474	0.3460	0.1312	0.2142	Topic 4	Oil shocks, external reserves and inflation
No. 102	Jul. 23-24, 2015	0.1029	0.0927	0.1378	0.2335	0.2357	0.1974	Topic 5	Prices, monetary and fiscal policies
No. 103	Sep. 21-22, 2015	0.1036	0.0807	0.0945	0.1785	0.2572	0.2855	Topic 6	Output growth and market stability
No. 104	Nov. 23-24, 2015	0.0740	0.0730	0.1287	0.1347	0.2511	0.3386	Topic 6	Output growth and market stability
No. 105	Jan. 25-26, 2016	0.0856	0.1203	0.2181	0.1461	0.2252	0.2047	Topic 5	Prices, monetary and fiscal policies
No. 106	Mar. 21-22, 2016	0.1736	0.0729	0.2326	0.1190	0.1557	0.2462	Topic 6	Output growth and market stability
No. 107	May 23-24, 2016	0.2695	0.0854	0.2482	0.0743	0.1565	0.1661	Topic 1	Exchange rate and its management
No. 108	Jul. 25-26, 2016	0.2127	0.1373	0.1931	0.0708	0.1447	0.2415	Topic 6	Output growth and market stability
No. 109	Sep. 19-20, 2016	0.1380	0.1232	0.2392	0.1007	0.1879	0.2111	Topic 3	Policy response to domestic constraints
No. 110	Nov. 21-22, 2016	0.1270	0.1714	0.1894	0.0929	0.2253	0.1941	Topic 5	Prices, monetary and fiscal policies
No. 111	Jan. 23-24, 2017	0.1309	0.1658	0.2077	0.1040	0.2765	0.1150	Topic 5	Prices, monetary and fiscal policies
No. 112	Mar. 20-21, 2017	0.1257	0.2686	0.1658	0.1072	0.2193	0.1134	Topic 2	Exit from recession and economic recovery
No. 113	May 22-23, 2017	0.1656	0.3395	0.0959	0.0800	0.1950	0.1240	Topic 2	Exit from recession and economic recovery
No. 114	Jul. 24-25, 2017	0.1985	0.3333	0.0582	0.0890	0.1795	0.1415	Topic 2	Exit from recession and economic recovery
No. 115	Sep. 25-26, 2017	0.1546	0.3472	0.0393	0.1372	0.1621	0.1596	Topic 2	Exit from recession and economic recovery
No. 116	Nov. 20-21, 2017	0.1218	0.3320	0.0636	0.1105	0.1738	0.1983	Topic 2	Exit from recession and economic recovery

The CBN communiques of September 2015 and November 2015 are each categorised under topic 6 with probabilities of 0.29 and 0.34, respectively. As earlier described, this topic relates to MPC's discussions on output growth and market stability. Expectedly, the monetary policy rate was reduced from 13.0 per cent to 11.0 per cent at the MPC meeting of November 2015. It can also be seen that the May 2016 communique is classified under topic 1, focusing on exchange rate and its management. This is in line with the foreign exchange reforms implemented in June 2016. The probabilities associated with communique numbers 110 and 111 being classified under topic 5 are computed as 0.23 and 0.28, respectively. Thus, the need for effective coordination between monetary and fiscal policies aimed at stabilising prices and addressing domestic constraints were the major concerns in the meetings of November 2016 and January 2017. The communiques issued after the MPC meetings held during March 2017 to November 2017 are classified under topic 2 based on their computed probabilities. As earlier described, topic 2 is associated with the economy's recovery from recession.

In Figure 8, we show the evolution of the topic proportion for the communiques issued during the period 2015 – 2017. As can be seen, the contents of the CBN communiques for the period January – December 2015 were largely driven by topics relating to "output growth and market stability", "prices, monetary and fiscal policies" and "oil price shocks, external reserves and inflation". This combination of topics appears to be in tandem with the concerns of the CBN's monetary policy committee regarding the impacts of the negative oil price shocks recorded in 2014 on Nigeria's output, external reserves, exchange rate, and inflation. In 2016, the contents of the policy communiques focused mainly on "exchange rate and its management", "policy response to domestic constraints", and to some extent on "output growth and market stability". However, the issues around monetary and fiscal policy response to inflation became more relevant in third quarter of 2016, culminating into the hike in MPR in the July 2016 meeting of the MPC.

Figure 8: Evolution of Topical Issues in CBN Communique



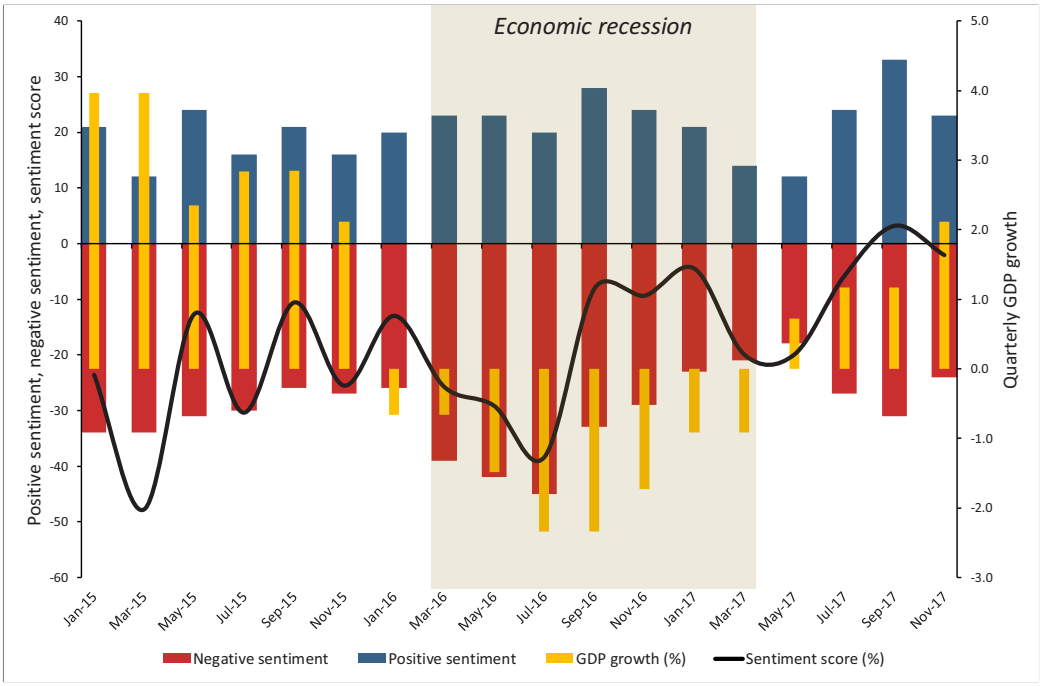
There is a major shift in the contents of the monetary policy documents released in 2017 as they focused on topics relating to economic recovery; prices, monetary and fiscal policies; and exchange rate management. It is noteworthy that the issues concerning prices as well as monetary and fiscal policies were consistently of relevance to the MPC as the proportion of its contributions to the topics remained fairly stable and substantial across the sample period.

IV.7 Sentiment Analysis

Figure 9 shows that the monetary policy committee expressed negative sentiments across the meetings held during the 2015 – 2017 period, with the exception of the September 2017 meeting. In 2015, the central bank's net sentiment score averaged 25.1 per cent, reflecting the MPC's concerns regarding the potential negative impacts of declining oil prices and other global shocks on the performance of the economy. The negative sentiments of the MPC during the year were expressed in words such as: "risk", "concern", "shock", "weak", "slow", "fall", "limit", "tension", "weak", "bearish", etc. (Table 6). At 13.3, the standard deviation of the score for 2015 is higher than the values of 12.3 and 9.6 recorded in the years 2016 and 2017 (Table 6). This is reflective of the MPC's perception regarding the economic uncertainties facing the country in 2015 as well as the impending economic recession. While the negative sentiment improved, albeit in an unsteady manner up till January

2016, it increased steadily in the first half of 2016, reaching a trough of about -40.0 per cent as at the meeting of July 2016. Though the sentiment score remained in the negative territory in the second half of 2016, it improved significantly from about -40.0 per cent in July 2016 to about -5.0 per cent in January 2017, signalling the country's improved economic performance and the eventual exit from recession in the first half of 2017.

Figure 9: Monetary Policy Sentiment Score, 2015 -2017



The sentiment again dipped in the meeting of March 2017, reflecting the views of the MPC regarding the economy as well as the challenges confronting the policy makers. For instance, a portion of the March 2017 communique reads as follows: "On the domestic front, while the Q4 2016 GDP figure was better than the last two consecutive quarters, the economy remained in recession with inflationary pressures continuing unabated. These adverse external and domestic conditions continued to complicate the policy environment…".

In the meetings of May 2017 and July 2017, the sentiment score trended upwards, moving to a positive territory in September 2017. The positive net sentiment expressed in September 2017 reflects the MPC's mood regarding the country's favourable economic outlook as well as the effectiveness of the policies implemented.

Table 6: Summary Statistics of Monetary Policy Sentiment, 2015 -2017

Sentiment*	2015		2016		2017	
	Frequency	Common words	Frequency	Common words	Frequency	Common words
Positive	110	well, modest, support, success, gain, benefit, progress, strong, reaffirm, proper	138	well, reform, strong, boost, proper, robust, support, rapid, protect, solid	127	well, strong, support, boost, gain, favourable, modest, successful, prompt, rapid
Negative	-182	risk, concern, shock, weak, slow, fall, limit, tension, weaken, bearish	-214	risk, weak, concern, slow, shock, critical, delay, fall, severe, sluggish	-144	weak, risk, concern, confront, threaten, worsen, stress, slow, tepid, glut
Average sentiment score (%)	-25.1		-20.7		-8.2	
Standard deviaition of sentiment score	13.3		12.3		9.6	

*Each positive word has a score +1, each negative word has a score of -1.

For instance, it was stated in the September 2017 communique that "On the domestic front, the economy exited recession (which began in the first quarter of 2016) in the second half of 2017, with a modest positive short to medium-term outlook, resulting largely from deliberate macroeconomic stimulus and a stable naira exchange rate. Inflation expectations also appeared anchored on the strength of prevailing tight monetary policy stance". The computed net sentiment score for the years 2015, 2016, and 2017 averaged -25.1, -20.7, and -8.2 per cent, respectively (Table 6). It is important to note that, of the three years considered in this study, the MPC expressed the lowest negative net sentiment (both average and standard deviation) in 2017 following the country's exit from economic recession.

Figure 10: Coleman & Liau (1975) Readability Index and Monetary Policy Net Sentiment Score

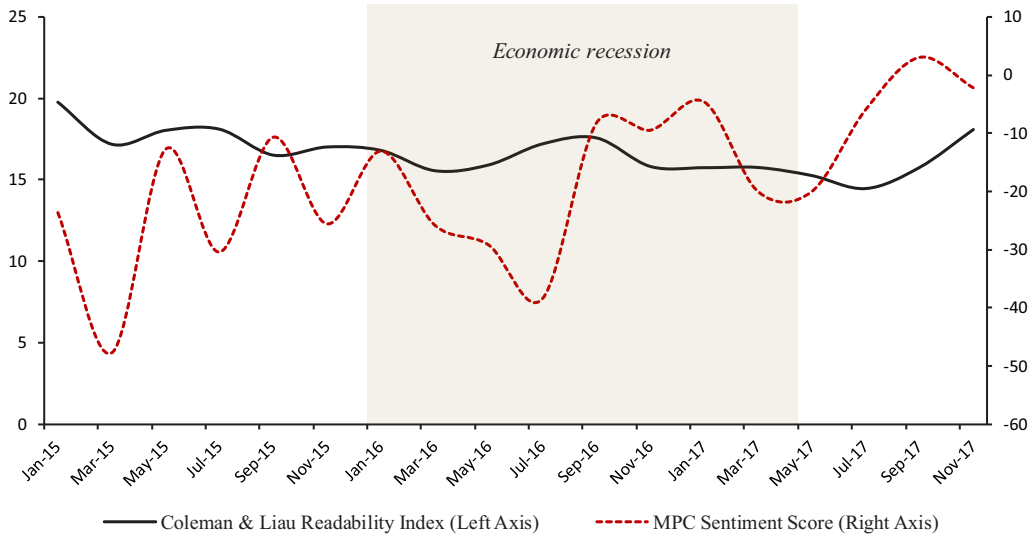


Figure 10 displays the readability index of the communiques issued between January 2015 and November 2017 as well as the computed monetary policy net sentiment score. As noted earlier, the readability index declined systematically during the sample period, indicating an increase in the complexity of the communique. This is especially so during the early periods of the 2016 recession. It can be seen that the sharp decline in monetary policy sentiment of the first half of 2016 was associated with reduced readability of the published CBN communiques during the period.

V. Conclusion

Over the years, central bank communication has evolved as an important component of monetary policy design and execution, especially during periods of economic turbulence and uncertainties. This is predicated on the belief that an effective monetary policy communication strategy helps in shaping market expectations, thereby reducing macroeconomic volatility. In this paper, automated text mining techniques are applied to analyse central bank communication during the 2016 economic recession in Nigeria. We derive useful insights from the bi-monthly monetary policy communiques, published by the CBN on its website during 2015 – 2017. Thus, our corpus consists of eighteen CBN communiques, which were evaluated with respect to their readability, tone and topics, in order to characterise CBN's communication strategy during the sample period.

We document a number of results. First, we find that the CBN communicated more during the period of the economic recession. This seems to suggest that the MPC of the CBN recognised the need for greater monetary policy transparency during the crisis period. Second, our results indicate that the level of readability of the published communiques declined over the sample period, especially at the outset of the economic recession. Third, the period of the recession was associated with negative sentiments in CBN communication, as the number of negative sentiments words outweighed the number of positive sentiments words in corpus. The negativity of the policy sentiments peaked in July 2016, after which the sentiment score recorded a turning point, reflecting the MPC's optimism regarding the gradual recovery of the economy. It was also found that the readability level of the communiques declined during periods of high negativity in CBN's policy sentiments.

Fourth, results from our estimated topic model showed that in 2015 concerns about oil shocks and its impact on external reserves and inflation dominated, while the proportions of topics for exchange rate and domestic policies for

addressing domestic constraints were sizable in 2016. Starting from January 2017, the proportion of topics for issues around the country's exit from recession and the drive towards economic recovery increased substantially. Thus, in 2017, there was a shift in the content of MPC's communication in favour of issues pertaining to pulling the economy out of recession and strengthening the recovery process. As the CBN continues to aim for increased monetary policy transparency, it is important that efforts are made towards improving the readability of the policy communiques.

References

Amadxarif, Z., Brookes, J., Garbarino, N., Patel, R., & Walczak, E. (2019). The language of rules: Textual complexity in banking reforms. *Bank of England Staff Working Paper,* No. 834.

Amato, J. D., Morris, S., & Shin, H. S. (2002). Communication and monetary policy. *Oxford Review of Economic Policy, 18*(4), 495–503.

Amusa, L., Yahya, W., & Balogun, A. (2016). Data mining of Nigerian's sentiments on the administration of federal government of Nigeria. *Annals. Computer Science Series, 14*(2), 69 – 75.

Apel, M., & Grimaldi, M. (2012). The information content of central bank minutes. *Riksbank Research Paper Series,* (92).

Apel, M., & Grimaldi, M. B. (2014). How informative are central bank minutes? *Review of Economics, 65*(1), 53–76.

Barbagallo, D., Bruni, L., Francalanci, C., & Giacomazzi, P. (2012). An empirical study on the relationship between twitter sentiment and influence in the tourism domain. In: Fuchs, M., Ricci, F., & Cantoni, L. (eds), Information and Communication Technologies in Tourism, *Springer*, 506– 516.

Berger, H., Ehrmann, M., & Fratzscher, M. (2011). Monetary policy in the media. *Journal of Money, Credit and Banking, 43*(4), 689–709.

Bergholt, D. (2014). Monetary policy in oil exporting economies. Working paper 0023, Centre for Applied Macro-and Petroleum economics (CAMP), BI Norwegian Business School.

Bernanke, B. S., Gertler, M., Watson, M., Sims, C. A., & Friedman, B. M. (1997). Systematic monetary policy and the effects of oil price shocks. *Brookings papers on economic activity,* (1), 91–157.

Bernanke, B. S., & Reinhart, V. R. (2004). Conducting monetary policy at very low short-term interest rates. *American Economic Review, 94*(2), 85–90.

Bholat, D., S. Hansen, P. Santos., & Schonhardt-Bailey, C. (2015). Text mining for central banks. *Centre for Central Banking Studies Handbook, (33)*, 1-19.

Binette, A., & Tchebotarev, D. (2019). Canada's monetary policy report: If text could speak, what would it say? *Bank of Canada Staff Analytical Note*, No. 2019-5.

Blei, D. M., & Lafferty, J. D. (2009). Topic models. *Text Mining: Classification, Clustering, and Applications*, *10*(71), 34.

Blei, D. M., Ng, A. Y., & Jordan, M. I. (2003). Latent dirichlet allocation. *The Journal of Machine Learning research, 3*, 993–1022.

Blinder, A. S. (1999). *Central Banking in Theory and Practice*. MIT press.

Blinder, A. S., Ehrmann, M., Fratzscher, M., De Haan, J., & Jansen, D.J. (2008). Central bank communication and monetary policy: A survey of theory and evidence. *Journal of Economic Literature, 46*(4), 910–45.

Born, B., Ehrmann, M., & Fratzscher, M. (2014). Central bank communication on financial stability. *The Economic Journal, 124*(577), 701–734.

Bruno, G. (2016). Text mining and sentiment extraction in central bank documents. International Conference on Big Data (Big Data). IEEE, 1700–1708.

Bruno, G. (2017). Central bank communications: Information extraction and semantic analysis. *IFC Bulletins chapters* 44.

Calvo-Gonzalez, O., Eizmendi, A., & Reyes, G. J. (2018). Winners never quit, quitters never grow: Using text mining to measure policy volatility and its link with long-term growth in Latin America. *World Bank Policy Research Working Paper,* No. 8310.

Clarida, R., Gali, J., & Gertler, M. (2000). Monetary policy rules and macroeconomic stability: Evidence and some theory. *The Quarterly Journal of Economics, 115*(1), 147– 180.

Coenen, G., Ehrmann, M., Gaballo, G., Hoffmann, P., Nakov, A., Nardelli, S.,... Strasser, G. (2017). Communication of monetary policy in unconventional times. *ECB Working Paper. No. 2080*.

Coleman, M., & Liau, T. L. (1975). A computer readability formula designed for machine scoring. *Journal of Applied Psychology, 60*(2), 283 - 284.

Correa, R., Garud, K., Londono, J. M., & Mislang, N. (2017). Sentiment in central banks' financial stability reports. *International Finance Discussion Papers 1203*.

Crone, S. F., & Koeppel, C. (2014). Predicting exchange rates with sentiment indicators: An empirical evaluation using text mining and multilayer perceptrons. In: 2014 IEEE Conference on Computational Intelligence for Financial Engineering & Economics (CIFEr), IEEE. 114–121.

Daas, P. J., & Puts, M. J. (2014). Social media sentiment and consumer confidence. *ECB Statistics Paper*, No. 5.

Debortoli, S., Muller, O., Junglas, I., & Vom Brocke, J. (2016). Text mining for information systems researchers: An annotated topic modelling tutorial. *Communications of the Association for Information Systems, 39*(1).

Demiralp, S., Kara, H., & Ozlu, P. (2012). Monetary policy communication in Turkey. *European Journal of Political Economy, 28*(4), 540–556.

Ehrmann, M., & Fratzscher, M. (2007). Communication by central bank committee members: Different strategies, same effectiveness?. *Journal of Money, Credit and Banking*, *39*(2-3), 509-541.

Ekor, M., Adeniyi, O., & Saka, J. (2013). Central bank communication and monetary policy effectiveness: Empirical evidence from Nigeria. *West African Journal of Monetary and Economic Integration*, *13*(1), 118-152.

Eusepi, S. (2010). Central bank communication and the liquidity trap. *Journal of*

Money, Credit and Banking, 42(2-3), 373–397.

Eusepi, S., & Preston, B. (2010). Central Bank communication and expectations stabilisation. *American Economic Journal: Macroeconomics, 2*(3), 235–71.

Farina V., Galloppo G., & Previati D. A. (2018). Central banks' communication strategies: Just words?. In: Garcia-Olalla M., & Clifton J. (eds), Contemporary issues in banking. Palgrave Macmillan Studies in Banking and Financial Institutions. Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-319-90294-4_5.

Gefen, D., Endicott, J. E., Fresneda, J. E., Miller, J. L., & Larsen, K. R. (2017). A Guide to text analysis with latent semantic analysis in R with annotated code: Studying online reviews and the stack exchange community. *CAIS*. 41(1).

Gentzkow, M., Kelly, B., & Taddy, M. (2019). Text as data. *Journal of Economic Literature, 57*(3), 535–74.

Geraats, P. M. (2002). Central bank transparency. *The Economic Journal, 112*(483), F532– F565.

Hayo, B., & Neuenkirch, M. (2011). Canadian interest rate setting: The information content of Canadian and US central bank communication. *Southern Economic Journal, 78*(1), 131–148.

Hoeberichts, M., Tesfaselassie, M. F., & Eijffinger, S. (2008). Central bank communication and output stabilisation. *Oxford Economic Papers, 61*(2), 395–411.

Hopper, G. P. (1997). What determines the exchange rate: Economic factors or market sentiment. *Business Review,* 5, 17–29.

Huang, K. X. (2007). Effective central bank communication under uncertainty. *Journal of Economic Issues, 41*(3), 661–680.

Hubert, P., & Fabien, L. (2017). Central bank sentiment and policy expectations. *Bank of England Staff Working Paper 648.*

Iwantoro, T., & Koesrindartoto, D. P. (2017). Exchange rate directional forecasting using sentiment analysis on social media in Indonesia 2015. *Australian Academy of Accounting and Finance Review,* 1(2), 132–147.

Janetzko, D. (2014). Predictive modelling in turbulent times–what twitter reveals about the EUR/USD exchange rate. *NETNOMICS: Economic Research and Electronic Networking.* 15(2), 69–106.

Kahveci, E., & Odabas, A. (2016). Central bank's communication strategy and content analysis of monetary policy statements: The case of Fed, ECB and CBRT. *Procedia-Social and Behavioural Sciences.* 235, 618–629.

Khatri, S. K., Singhal, H., & Johri, P. (2014). Sentiment analysis to predict bombay stock exchange using artificial neural network, in *Proceedings of 3rd International Conference on Reliability, Infocom Technologies and*

Optimisation. IEEE. pp. 1–5.

Kumar, S., Maskara, S., Chandak, N., & Goswami, S. (2015). Empirical study of relationship between twitter mood and stock market from an Indian context. *International Journal of Applied Information Systems.* 8(7), 33–37.

Luangaram, P., & Sethapramote, Y. (2016). Central bank communication and monetary policy effectiveness: Evidence from Thailand. Puey Ungphakorn Institute for Economic Research.

Luangaram, P., &Wongwachara, W. (2017). More than words: A textual analysis of monetary policy communication. *PIER Discussion Papers.* 54.

Miner, G., Delen, D., Elder, J., Fast, A., Hill, T., & Nisbet, B. (2012). Practical text mining and statistical analysis for non-structured text data applications. Amsterdam, The Netherlands: Academic Press.

Mittal, A., & Goel, A. (2012). Stock prediction using twitter sentiment analysis. *Stanford University Working Paper* 15.

Mordi, C. N., Adebiyi, M. A., & Omotosho, B. S. (2019). Modelling interest rates passthrough in Nigeria: An error correction approach with asymmetric adjustments and structural breaks. In *Contemporary Issues in the Nigerian Economy: A Book of Readings.* Central Bank of Nigeria. 3 – 20.

Omotosho, B. S. (2019). Oil price shocks, fuel subsidies and macroeconomic instability in Nigeria. *CBN Journal of Applied Statistics*, *10*(2), 1-38.

Oshima, Y., & Matsubayashi, Y. (2018). Monetary policy communication of the bank of Japan: Computational Text Analysis. *Graduate School of Economics Working paper*, Kobe University.

Ozturk, S. S., & Ciftci, K. (2014). A sentiment analysis of twitter content as a predictor of exchange rate movements. *Review of Economic Analysis,* 6(2), 132–140.

Park, K. Y., Lee, Y., & Kim, S. (2019). Deciphering monetary policy board minutes through text mining approach: The case of Korea. *Bank of Korea Working Paper*, No.1.

Plakandaras, V., Papadimitriou, T., Gogas, P., & Diamantaras, K. (2015). Market sentiment and exchange rate directional forecasting. *Algorithmic Finance, 4*(1-2), 69–79.

Ranco, G., Aleksovski, D., Caldarelli, G., Grcar, M., & Mozetic, I. (2015). The effects of twitter sentiment on stock price returns. *PloS One*. 10(9), e0138441.

Sanusi, A. R. (2011). Signaling effects of monetary policy in Nigeria: Evidence from the new central bank's communication regime: 2005-2011. In *52nd Annual Conference of the Nigerian Economics Society*. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1893705.

Shapiro, A. H., & Wilson, D. (2019). Taking the Fed at its word: Direct estimation of central bank objectives using text analytics. Federal Reserve Bank

of San Francisco. *Working Paper, 2019-02*.

Shirota, Y., Hashimoto, T., & Sakura, T. (2015). Topic extraction analysis for monetary policy minutes of Japan in 2014. In: Perner, P. (ed) *Advances in Data Mining: Applications and Theoretical Aspects*, Lecture Notes in Computer Science, 141-152: Springer International Publishing.

Siklos, P. L. (2013). The global financial crisis and the language of central banking: Central bank guidance in good times and in bad. *CAMA Working Paper Series Paper 58/2013*.

Sturm, J. E., & De Haan, J. (2011). Does central bank communication really lead to better forecasts of policy decisions? New evidence based on a taylor rule model for the ECB. *Review of World Economics, 147*(1), 41–58.

Sumbureru, P. T. (2013). Analysis of tweets for prediction of Indian stock markets. *International Journal of Science and Research*, *4*(8), 1168–1172.

Woodford, M. (2002). Monetary policy in the information economy. In Bai, C & Yuen, C (Eds.). 2002. Technology and the new economy. MIT Press, Cambridge, MA, USA.