Central Bank Communication during Economic Recessions: Evidence from Nigeria

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Abstract

This paper analyses the communication strategy of the Central Bank of Nigeria (CBN) during the 2016 economic recession. Applying text mining techniques, useful insights are derived regarding the linguistic intensity, readability, tone, and topics of published monetary policy communiques. Our results provide evidence of increased central bank communication during the recession. However, the ease of reading the published policy communiques declined, especially at the outset of the recession. In terms of tone, we find that negative policy sentiments were expressed during the 2015-2017 period; reflecting the economic uncertainties that trailed the oil price slump of 2014 and its implications for the domestic economy. The negativity of the policy sentiment score reached its trough in July 2016 and recorded an inflexion; signalling the economy's turning point towards recovery. Based on the results of the estimated topic model, issues relating to "oil price shocks", "external reserves", and "inflation" were of concern to the Monetary Policy Committee (MPC) a few quarters preceding the recession while the topics relating to "exchange rate management" as well as "output growth and market stability" were dominant during the recession. Expectedly, the topic proportion for "prices and macroeconomic policies" remain relatively sizeable across the sample period, reflecting the MPC's commitment to the CBN's primary mandate of maintaining price stability.

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

JEL classification: E52, E58, E32, E61, E65

1.0 Introduction

Monetary policy has been recognised as a useful tool of macroeconomic management (Bernanke, Gertler, Watson, Sims and 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 (Berger, Ehrmann and Fratzscher, 2011; Bernanke and Reinhart, 2004;

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Blinder, 1999; Blinder, Ehrmann, Fratzscher, De Haan and Jansen, 2008; Eusepi and Preston, 2010; Oshima and Matsubayashi, 2018; Sturm and De Haan, 2011).

According to Geraats (2002), monetary policy transparency refers to a situation in which the different facets of monetary policy are conducted under an atmosphere devoid of information asymmetry[1]. 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; Blinder et al., 2008; Hoeberichts, Tesfaselassie and Eijffinger, 2008).

What is central bank communication? According to Blinder et al. (2008), central bank communication encapsulates 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. Studies such as Blinder et al. (2008) and Coenen, Ehrmann, Gaballo, Hoffmann, Nakov, Nardelli, Persson and Strasser (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 (Apel and Grimaldi, 2014; Berger et al., 2011; Bergholt, 2014; Bernanke et al., 1997; Bernanke and Reinhart, 2004; Blinder, 1999; Blinder et al., 2008; Bruno, 2016; Clarida, Gali and Gertler, 2000; Coenen et al., 2017; Demiralp, Kara and Ozlu, 2012; Ehrmann and Fratzscher, 2005; Eusepi, 2010; Eusepi and Preston, 2010; Geraats, 2002; Hoeberichts et al., 2008; Luangaram and Sethapramote, 2016; Sturm and De Haan, 2011; Omotosho, 2020). 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, especially for the analysis and prediction of macroeconomic out-turns (for instance, see Bruno, 2016; Kahveci and Odabas, 2016; Luangaram and Wongwachara, 2017; Oshima and Matsubayashi, 2018; Park, Lee and Kim, 2019; Shapiro and Wilson, 2019; Shirota, Hashimoto and Sakura, 2015). 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 like Nigeria is particularly challenging – such economies are often hit by terms of trade as well as other related shocks. Oil contributes an average of about 11.2 per cent to Nigeria's Gross Domestic Product (GDP) in the current decade while its share in government revenue and total exports stands at about 64.8 and 93.1 per cent, respectively. Consequently, net exports as a component of GDP represent an important source of business cycles in the country. For instance, the Nigerian economy slipped into an oil-induced recession in 2016 following the international oil price

[1] The five facets of monetary policy 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).

declines that began in 2014. While monetary policy communication is generally important for overall macroeconomic stability, the communication strategy adopted by central banks during periods of economic uncertainties is particularly crucial for stabilising expectations and output (Coenen et al., 2017). Therefore, an understanding of the policy behaviour and preferences of the CBN during the 2016 economic recession is of significant imperatives to monetary policy execution and the formation of market expectations in the country.

This paper analyses the communication strategy of Nigeria'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 during 2015 - 2017. Our approach allows us to analyse textual data with a view to generating meaningful quantitative insights (Blei, Ng and Jordan, 2003; Hubert and 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 and 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 the understandability of the policy documents by computing their respective Coleman and Liau (1975) readability scores. 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. In an earlier work, Tumala and Omotosho (2019) studied central bank monetary policy communication during the period 2004-2019 but did not pay particular attention to the period of the domestic economic crisis.

The paper is organized 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.

2.0 Related literature

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 and Shin, 2002; Blinder et al., 2008; Kahveci and 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" helping to predict monetary policy actions, thereby reducing financial market volatility. In this section, we present a non-exhaustive review of studies relating to the use of text mining techniques in the analyses of central bank communication[4].

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

The Executive Board of the Sveriges Riskbank (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 more detailed document that contains the current decision of the Riskbank as well as the arguments advanced by the different Executive Board members. In a study aimed at predicting future Riskbank'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 Riskbank. They composed a dictionary of dovish and hawkish words used in the documents; generated a net index of hawkishness from each minutes; and showed that interest rate hikes in Sweden are associated with high degree of net hawkishness in Riskbank's communication. It was also found that the minutes of the executive board are more useful for predicting future Riskbank'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 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-type rule 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 in 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. (20190 analysed the published minutes for the period May 2005-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 1986-2013 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 2000-2015 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 for the Japanese economy, Shirota et al. (2015) analyzed 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, Ehrmann and Fratzscher (2005) assessed the communication strategies of the Fed, the Bank of England (BOE) and the ECB. It was 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 of their 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 and Previati (2018) examined the communication strategies of the Fed and the ECB with regards to tone, growth and ambiguity. Using computational linguistics tools, they failed to find any significant difference between the communication strategy of the Fed and the ECB, regardless of the state of the economic variables being considered. In a related study, Hubert and Fabien (2017), 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. It was 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.

A couple of 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 2001/2002 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 of 2003-2012, 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/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 and Giacomazzi, 2012); the complexity of communication during banking reforms (Amadxarif, Brookes, Garbarino, Patel and Walczak, 2019); social media sentiment and consumer confidence (Daas and Puts, 2014); sentiment indicators and exchange rate prediction (Crone and Koeppel, 2014; Hopper, 1997; Iwantoro and Koesrindartoto, 2017; Janetzko, 2014; Ozturk and Ciftci, 2014; Plakandaras, Papadimitriou, Gogas and Diamantaras, 2015); twitter sentiment and stock price returns (Khatri, Singhal and Johri, 2014; Kumar, Maskara, Chandak and Goswami, 2015; Mittal and Goel, 2012; Ranco, Aleksovski, Caldarelli, Grčar and Mozetič, 2015; Sumbureru, 2013); twitter sentiment and government perception (Amusa, Yahya and Balogun, 2016); and sentiment in central banks' Financial Stability Reports (Correa, Garud, Londono and Mislang, 2017).

In Nigeria, studies on central bank communication is still at its infancy, with most of 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 employed the human reading approach by manually reading through the monetary policy documents and classifying 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 Interbank Offer 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 was shown that the NIBOR for different maturities recorded higher volatilities whenever the rate-setting meetings of the CBN were held. A pioneering attempt was made by Tumala and Omotosho (2019) to study CBN's monetary policy communication using automated text mining approach. The results of their estimated topic model indicated that the Bank's stated policy objectives and the types of shocks confronting the economy were the major drivers of the linguistic contents of the published communiques. This paper follows the approach in Tumala and Omotosho (2019) but focused on the communication strategy of the CBN during the 2016 economic recession.

3.0 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.

3.1 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, Adebiyi and Omotosho, 2019). Information regarding the interest rate decisions of the MPC as well as the arguments behind the decisions are communicated through the CBN 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 - 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 2016 in order 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 and 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 2015-2017. Data on these variables were sourced from the Central Bank of Nigeria and the National Bureau of Statistics.

3.2 Methodology

Text mining refers to using a suite of computational tools and statistical techniques for quantifying and deriving useful insights from unstructured textual data contained 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 and Schonhardt-Bailey, 2015). In this section, we present a brief discussion of the text mining techniques employed in the paper.

3.2.1 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:

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

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.

3.2.2 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, Elder IV, Fast, Hill, Nisbet and Delen, 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:

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

where $N_{postive}$ 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.

3.2.3 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 and 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].

[5] For a detailed tutorial on topic modelling using LDA, see Debortoli, Müller, Junglas and vom Brocke (2016)

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-González, 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 $p(w_n|z_n,\varphi)$ based on a multinomial probability conditioned on the topic z_n; where z represents the per-word topic 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:

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

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 ($k=6$).

4.0 Results

4.1 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 the interest rate decisions of the CBN during the period, represented by the Monetary Policy Rate (MPR). 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

[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.

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.

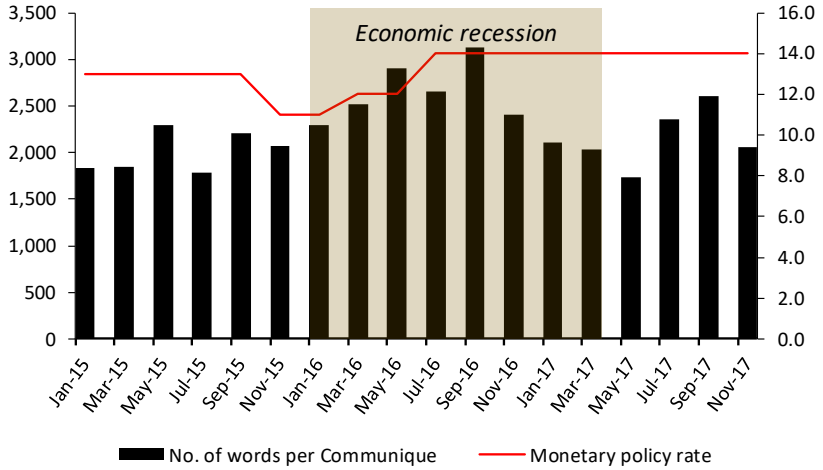
On the other hand, the average word count for the two communiques released when the MPC hiked the MPR was 2, 588, which is higher than the average word count for the sample period. This seems to suggest that there was increased communication whenever the policy rate was increased. It is important to 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.

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

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 an increase in the word count of the issued communiques.

Figure 1: Word count of MPC communique and monetary policy rate, 2015 - 2017



4.2 Frequency distribution of words in 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 86 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

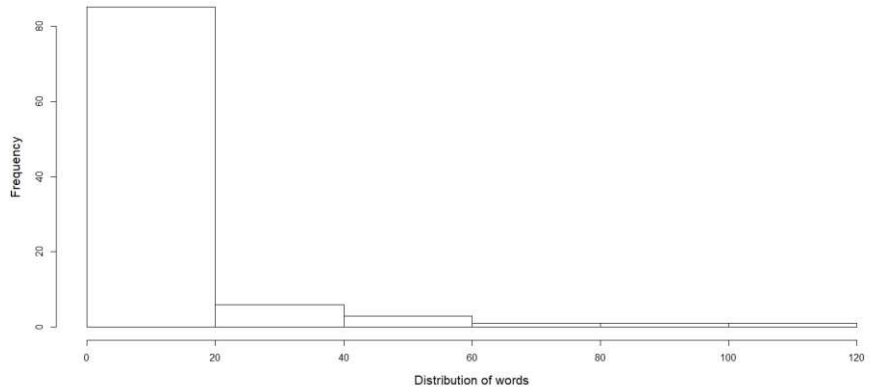


Table 2 presents the cumulative frequency regarding the character length of the 903 unique words contained in our corpus. As can be seen, the most frequent are six-character words with a frequency rate of 26.7 per cent; followed by five-character words with a frequency rate of 17.8 per cent. In other 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

4.3 Assessing the Readability of the Communique

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. It is also noteworthy that the readability index fell steadily from 19.8 for the communique of January 2015 to 14.5 for the communique of July 2017, indicating increased complexity in the understandability 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.

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

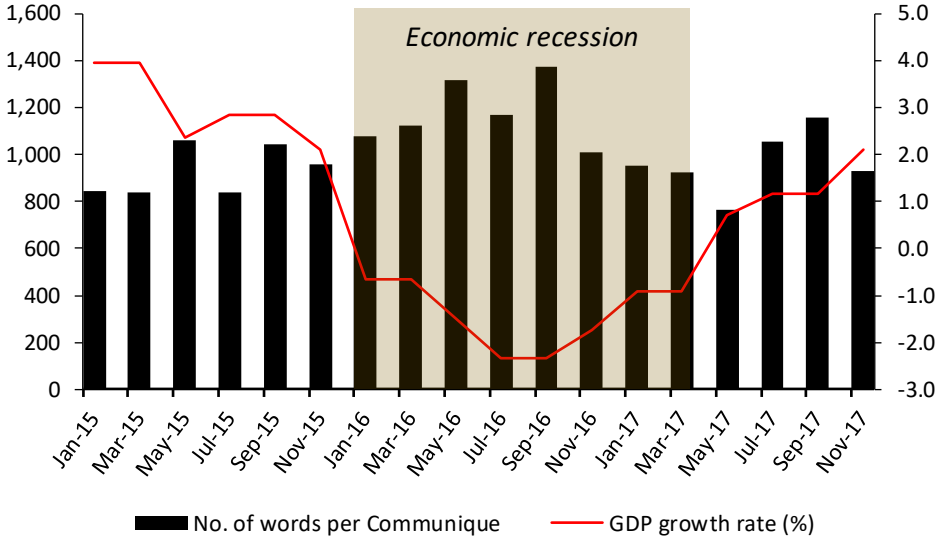
Communique No.	Meeting month	Coleman & Liau Readability Index
No. 99	Jan-15	19.8
No. 100	Mar-15	17.2
No. 101	May-15	18.0
No. 102	Jul-15	18.1
No. 103	Sep-15	16.5
No. 104	Nov-15	17.0
No. 105	Jan-16	16.8
No. 106	Mar-16	15.6
No. 107	May-16	15.9
No. 108	Jul-16	17.2
No. 109	Sep-16	17.6
No. 110	Nov-16	15.8
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*

4.4 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.

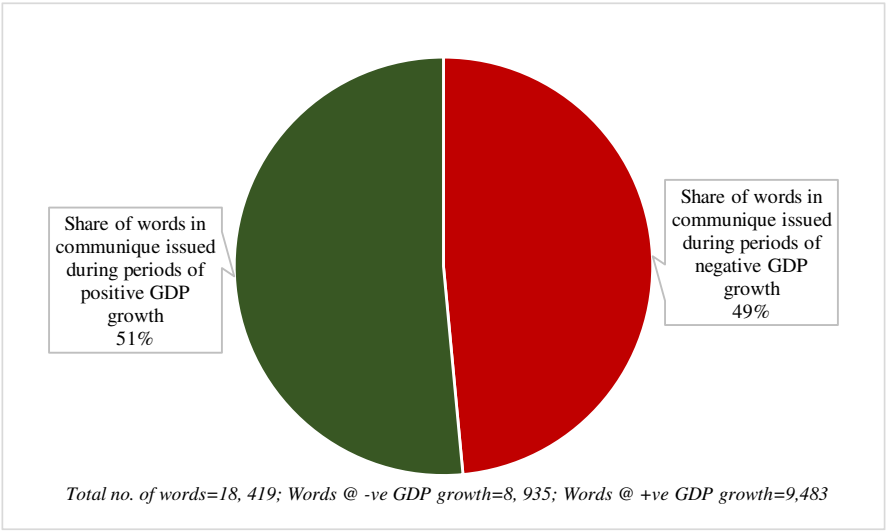
This observed behaviour is often borne out of the need for the central bank to effectively communicate their outlook about the economy, shape the expectations of economic agents, reinstate policy objectives, and explain the rationale behind its policy choices (see Apel and Grimaldi, 2014; Berger et al., 2011; Coenen et al., 2017; Eusepi and Preston, 2010; Luangaram et al., 2016; Siklos, 2013). Thus, we find evidence that the CBN demonstrates 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 and Wongwachara, 2017).

Figure 3: Word count of MPC communique in corpus and GDP growth rate, 2015 - 2017



To further buttress our observation, we analysed our corpus based on the word counts for two distinct periods: i) periods of negative GDP growth, and ii) periods of positive GDP growth. Figure 4 shows that of a total number of 18, 419 words analysed in our processed corpus, a total of 8, 935 words relate to the eight MPC meetings held during the period January 2016 to March 2017 when the economy recorded negative GDP growth rates (representing about 48.5 per cent of the total number of words analysed). The remaining 9, 483 words pertain to the communiques issued at the 10 meetings held during periods of positive GDP growth. This corresponds to an average of 1, 117 words per communique issued during the periods of negative GDP growth and an average of 948 words per communique issued during periods of positive GDP growth rate.

Figure 4: Word count of MPC communique by state of the economy, 2015 - 2017



4.5 What issues were of concern to the MPC during the 2015 – 2017 period?

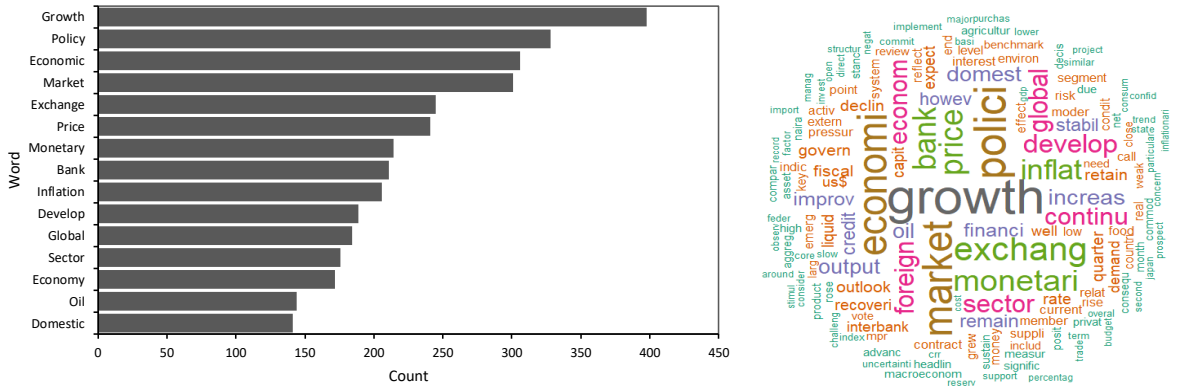
In this section, we employ term frequency and word clouds to gain insights into the main issues that were of concern to the MPC during our sample period. For ease of analysis and presentation, we first analysed our full sample corpus (comprising the 18 MPC communiques issued during 2015 - 2017) and show the results in section 4.1. 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 4.2.

4.5.1 Analysis for the full sample

Figure 5 presents a pictorial representation of the predominant words in the corpus for the full sample, 2015 - 2017. On the left side of the figure is a bar chart showing the most frequent words and their counts. On the right side is the word cloud. 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 5).

Figure 5: Frequent terms and word cloud, 2015 - 2017



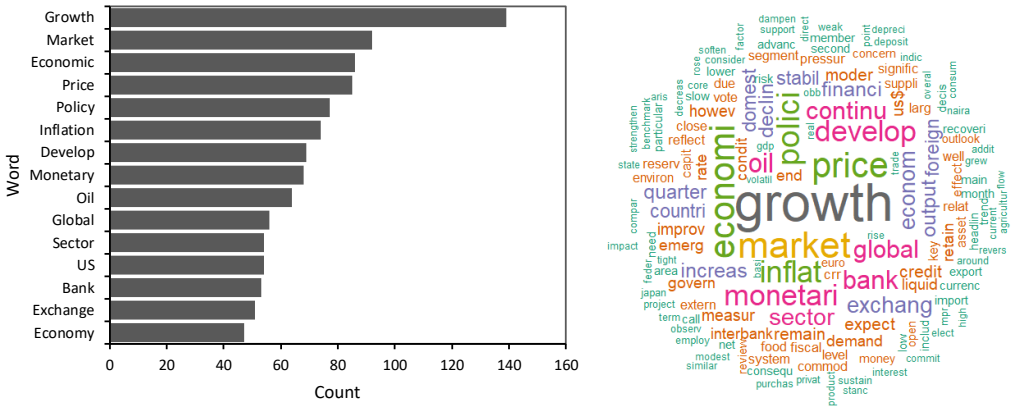
It is important to note that these words reflect the mandates of the CBN as well as the concerns of the MPC during the sample period. A careful examination of the word cloud as well as the bar chart shows that issues around economic growth and policies were of crucial importance to the MPC during the 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.

4.5.2 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. Figure 6 indicates 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.

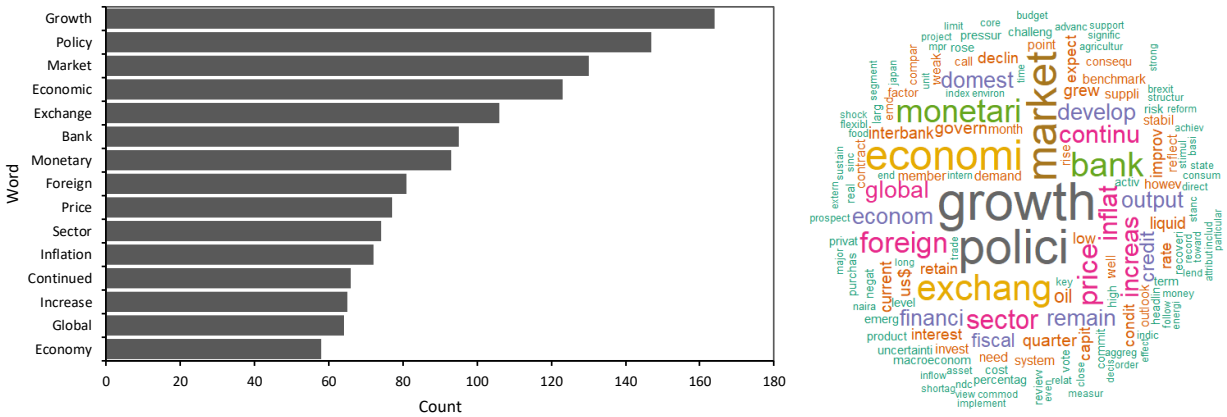
Figure 6: Frequent terms and word cloud, 2015



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. 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.

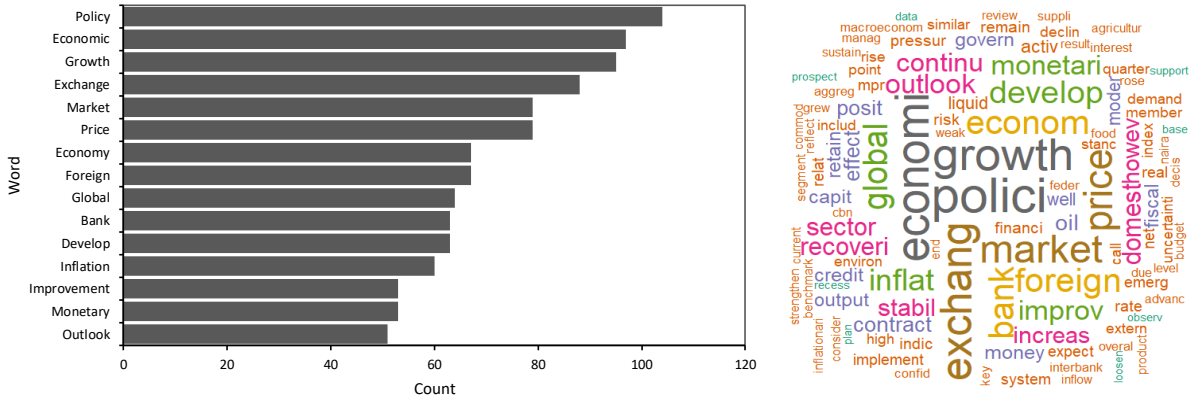
Figure 7: Frequent terms and word cloud, 2016



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 8). As can be seen in the word cloud, 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 i.e. 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”.

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”.

Figure 8: Frequent terms and word cloud, 2017



The analyses 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.

4.6 Topic modelling of the MPC communique, 2015 – 2017

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, et al. (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.

Table 4: Top probability terms driving the topics

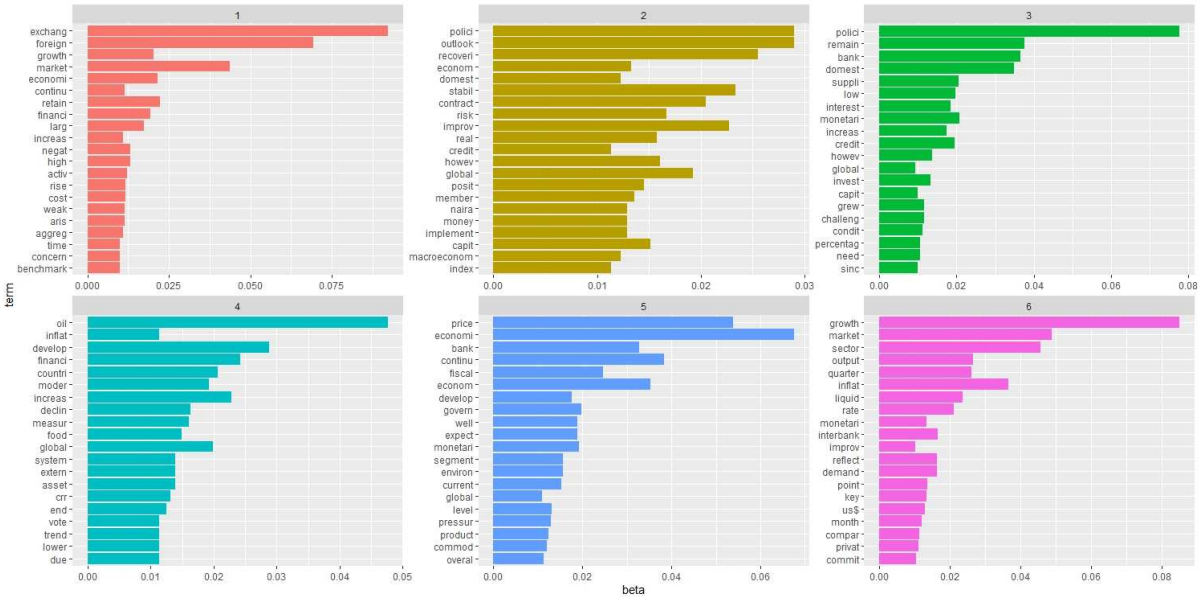
s/n	Topic 1	Topic 2	Topic 3	Topic 4	Topic 5	Topic 6
1	exchange	outlook	policy	oil	economic	growth
2	foreign	policy	remain	develop	price	market
3	market	recovery	bank	financing	continued	sector
4	retain	stability	domest	increase	economy	inflation
5	economic	improve	monetary	countries	bank	output
6	growth	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 1 is substantially defined by terms such as "exchange", "foreign", "market" (Table 4 and Figure 9). 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.

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

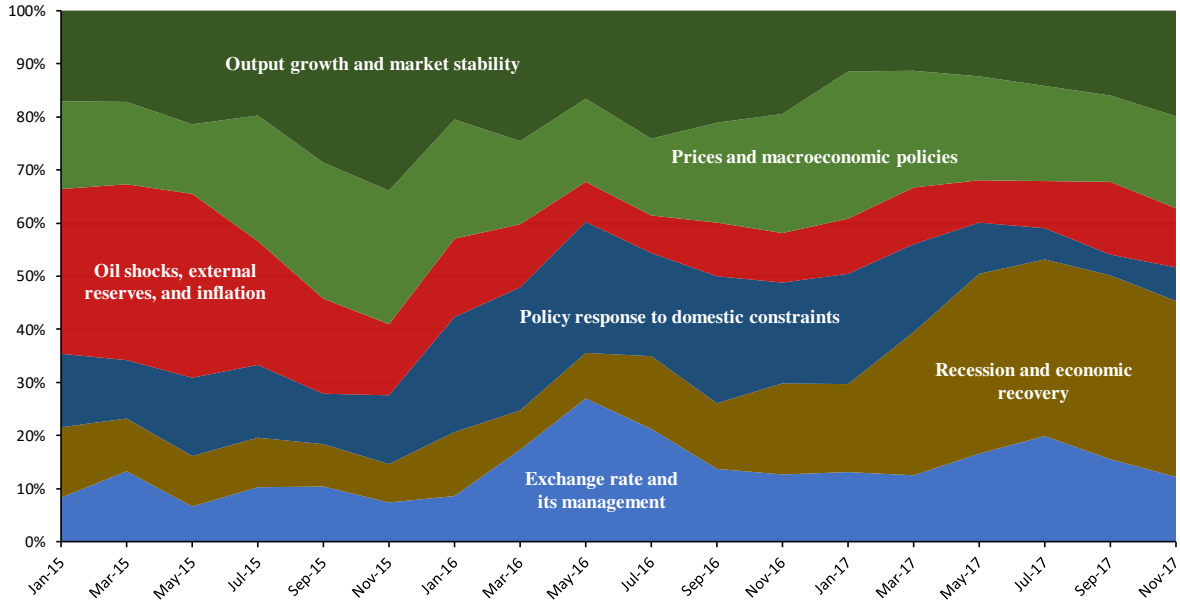
described as covering MPC discussions on output growth, sectoral policies, and stability in the foreign exchange as well as money markets.

Figure 9: Terms with their probabilities (betas) of occurring under a topic



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.

Figure 10: Evolution of topical issues in CBN communique



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.

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

In Figure 10, 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 and macroeconomic 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,

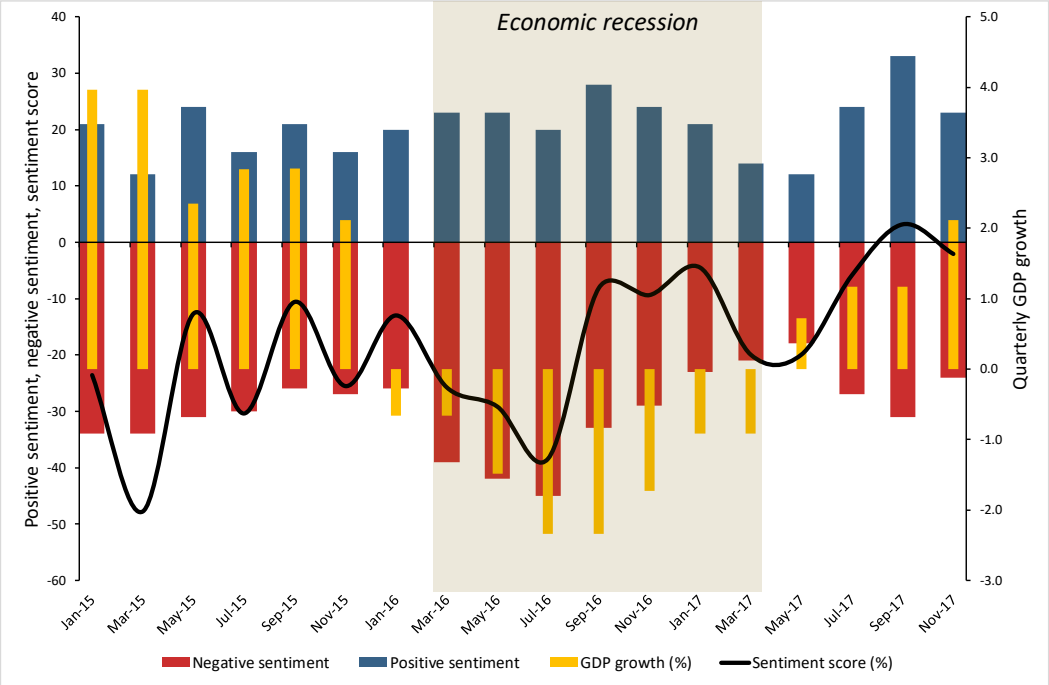
exchange rate, and inflation. In 2016, the contents of the policy communiques focused mainly on "exchange rate and its management", "policy response to domestic constraints", and to some extent on "output growth and market stability". However, the issues around monetary and fiscal policy response to inflation became more relevant in third quarter of 2016, culminating into the hike in MPR in the July 2016 meeting of the MPC.

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 macroeconomic policies; and exchange rate management. It is noteworthy that the issues concerning prices and macroeconomic policies were consistently of relevance to the MPC as the proportion of its contributions to the topics remained relatively substantial across the sample period.

4.7 Sentiment Analysis

Figure 11 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 11: 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…".

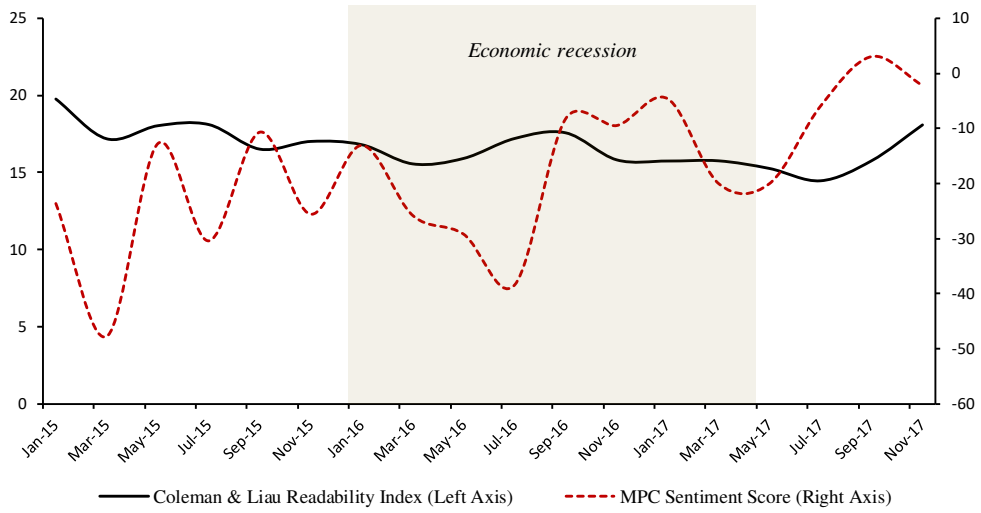
Table 6: Summary statistics of monetary policy sentiment, 2015 - 2017

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 postive word has a score of +1, each negative word has a score of -1***

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.

Figure 12: Coleman & Liau (1975) readability index and monetary policy net sentiment score



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. 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 12 displays the readability index of CBN 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.

5.0 Conclusion

Central bank communication has evolved over the years 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 Nigeria's 2016 economic recession. 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. First, we examined whether the CBN communicated more during the period of the economic recession by comparing the word counts of the published communiques over time. It was found that the average word count of the communiques released during the periods of negative GDP growth rates was much higher than the observed average during the periods of positive GDP growth. This seems to suggest that the CBN was conscious of the need for greater monetary policy transparency and increased communication during periods of economic difficulties and policy uncertainty.

In order to gauge the level of complexity of CBN communication, we computed the Coleman and Liau (1975) readability index for the documents in our corpus. Our results indicated that the level of readability of the published communiques declined over the sample period, especially at the beginning of the economic recession in the first half of 2016. We also found that the period of the recession was associated with negative sentiments in CBN communication as the number of words with negative sentiments outweighed the number of words with positive sentiments in the documents. We further showed that the negativity of the policy sentiments peaked in July 2016 after which the sentiment score recorded a turning point, indicating the gradual recovery of the economy and heralding the economy's eventual exit from recession in the second quarter of 2017. It was found that the readability level of the communiques declined during periods of high negativity in CBN's policy sentiments.

With regards to the linguistic content of the policy documents, results from our estimated topic model showed that concerns about oil shocks and its impacts on external reserves and inflation dominated in 2015 while the topic proportions for exchange rate and domestic policies for addressing domestic constraints were sizable in 2016. Starting from January 2017, the topic proportion for "exit from recession and economic recovery" increased substantially, indicating a shift in the MPC's communication in favour of issues pertaining to pulling the economy out of recession and strengthening the recovery process.

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