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Developing Artificial Intelligence-Powered Monetary Policy Communication Indicators for Macroeconomic Inquiries in Ghana

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Abstract

Central bank communication is a valuable source of information designed to shape the expectations of economic agents within and outside an economy. In particular, the content of Monetary Policy Committees' press releases and statements reflects the central banks' view of current and future macroeconomic developments, making them useful for creating high-frequency indicators as alternatives to traditional, but slower-to-publish, macroeconomic indicators. In this study, Artificial Intelligence (AI)-powered text-mining techniques were employed to create monetary policy communication-based indicators, namely the Monetary Policy Readability Index (MPRI), the Monetary Policy Sentiment Index (MPSI), and the Monetary Policy Uncertainty Index (MPUI), using press releases from the Bank of Ghana's monetary policy committee spanning January 2003 to December 2022. The findings suggest that while readability and sentiments generally declined over the sample period, uncertainty increased, indicating persistent macroeconomic imbalances and vulnerabilities in the domestic economy. The newly developed time series-based indicators demonstrate Granger causal relationships with key macroeconomic variables, affirming their relevance to the central bank, the Ministry of Finance, researchers, investors, and development partners. Notably, the indicators can serve as an early warning system for monitoring and predicting the country's macroeconomic risks, forecasting lagging indicators, assessing the effectiveness of the Bank's monetary policy communication, and addressing monetary policy inquiries.

Keywords

Artificial Intelligence, Central Banks, Macroeconomic Indicators, Ghana, Monetary Policy Communication

INTRODUCTION

Economists rely on leading macroeconomic indicators to predict the business cycle. This is also to establish early warning systems to pick up signals of imminent economic risks and shocks in real time and prepare sufficiently to either prevent or reduce their impact on the economy (Jung & Jeong, 2011;

Sutrisno et al., 2021). Owyang and Stewart (2022) identify the decline in disposable income, real Gross Domestic Product (GDP), employment of non-farmers, survey-based employment, real household consumption expenditures, real retail sales, and industrial production as some of the leading indicators of recession in the United States (U.S). Similarly, Kiley (2022) posits that high inflation and low employment are indications of high risks of recession in the U.S. in the near to medium term.

However, the use of these indicators to monitor the macroeconomic environment in most emerging market and developing economies is limited because of their unavailability or publication lags. In Ghana, for instance, annual and quarterly GDP estimates are published with six-month and four-month lags, respectively, while inflation rates are published with a two-week delay, even though price data are collected during the first week of the month (GSS, 2020). The delay in publishing these statistics could be attributed to the unavailability of data, inadequate resources (funding, logistics and human resources), weak central coordinating system for statistics, poor standardisation of statistical activities, and lack of technological infrastructure (NDPC/GSS, 2018).

Therefore, relying solely on traditional macroeconomic indicators and other anecdotal evidence in an attempt to predict business cycle dynamics may be inadequate, incomprehensible and outmoded in the Fourth Industrial Revolution (4IR), which is driven by "Big Data". In this context, big data refers to the voluminous amount of unstructured, semi-structured and structured data which require advanced information technology tools and techniques to store, pre-process and analyse (Tissot, 2017).

Kelley (2019) and Ismail et al. (2022) have argued that there could be other novel and robust indicators for predicting impending economic recessions or expansions and other macroeconomic developments in an economy in real time. In this regard, a few researchers have been exploring the possibility of analysing and developing indices from textual reports, including newspapers and social media, for economic analysis (Baker et al., 2022; Ahir et al., 2022; Blinder et al., 2022). Given that communication has become an important tool in the toolbox of (inflation targeting) central banks for implementing monetary policy leading to the anchoring of expectations, a number of useful indices can be developed from their documents. Some of these documents are the Monetary Policy Committee's (MPC) press releases, statements and communiqués, monetary policy reports, banking reports, speeches by governors, and media interviews published on their corporate websites and social media platforms (Oksiutycz, 2012).

Monetary policy committees are primarily responsible for formulating and implementing monetary policy decisions for promoting and preserving monetary stability. In discharging this responsibility, they meet regularly to assess the macroeconomic environment with a special focus on key indicators, such as inflation, economic growth, employment, financial stability, and fiscal balance, among others. Presently in Ghana, the MPC of the Bank of Ghana (BoG) meets bi-monthly and concludes its meetings by issuing a MPC press release to announce the monetary policy rate (MPR) and the reasons underpinning their decisions. The MPR signals the monetary policy stance and anchors short-term interest rates in the money market to achieve price stability.

Even though the Bank has conducted the MPC process for two decades, between 2003 and 2022, and issued 109 MPC press releases, not much has been done to quantitatively analyse their content and construct text-based indicators using Artificial Intelligence (AI)-powered text-mining techniques. With rigorous analysis of these press releases, we assessed the readability and effectiveness of the central bank's monetary policy communication, as well as estimated the causal relationships among key macroeconomic indicators. In particular, we constructed the Monetary Policy Readability Index (MPRI), the Monetary Policy Sentiment Index (MPSI), and the Monetary Policy Uncertainty Index (MPUI), following the study of Bhohat et al. (2015) and Blinder et al. (2022). Furthermore, this study sought to develop an automated AI-tool for analysing the rendition and orientation of MPC press releases. Some earlier studies attempted analysing MPC press statements especially in advanced countries (e.g. Bhohat et al., 2015; Blinder et al., 2022; Oshima & Matsubayashi, 2018). However, there had been no or little effort to construct longer time series indicators and further estimate their causal relationships with traditional macroeconomic variables.

In the context of this study, the MPRI measures the extent of rendition, understanding and clarity

of the Bank's MPC press releases. Effective communication requires information in the right quantity, leading to a better understanding of monetary policy decisions and less uncertainty. The MPSI assesses the level of optimism or pessimism about the prospects of economic conditions as expressed in the MPC press releases. Finally, the MPUI gauges the degree of predictability of the economic environment based on the MPC press releases. These indicators are theoretically and intuitively expected to have casual relationships with some key domestic and external macroeconomic variables. Also, the newly developed indicators are expected to have strong predictive power to nowcast or forecast lagging macroeconomic indicators, including inflation, real GDP growth rate, MPR, exchange rate, consumer sentiments, business confidence, and inflation expectation rate.

This article expands the strand of literature in two significant ways. First, the study assessed the readability of MPC press releases using the Flesch Readability Ease Index (FREI), which had been used extensively in other fields of study other than monetary policy communication. The FREI is the most widely recognised and reliable readability analysis formula and compares with the Flesch-Kincaid Grade Level, the Gunning-Fog Index, the Simple Measure of Gobbledygook Index, the Coleman-Liau Index, and the Automated Readability Index (Liguori, 1978; Loughran & McDonald, 2021; Spadaro et al., 1980). Second, the study employed the novel Loughran and McDonald master financial dictionary, unlike many other studies which used non-financial dictionaries like the Relative Sentiment Shift (RSS), SentiWordNet, SentiWords, Vader, and natural language sentiment analysis to construct financial/economic-related indicators (Nyman & Tuckett, 2015; Segawa, 2021). The Loughran and McDonald (2021) master dictionary contains 86,533 financial and economic terms/words for sentiment and uncertainty analyses in the field of economics and finance. This dictionary was chosen primarily because it is purposefully designed for economic-financial analyses and contains more words than other dictionaries. Lastly, we conducted a validation and robustness test by estimating the bivariate correlation and causal relationships between the text-based indicators and some key macroeconomic variables with the assumption that central bank communication would influence these variables positively.

The rest of the article is structured as follows: Section 2 discusses the related literature on the subject, while section 3 covers the description of the data and methodology employed in the study. Section 4 presents the empirical and robustness test results, and the final section entails the conclusion and policy recommendations.

LITERATURE REVIEW

Central Bank Monetary Policy Communication

Central bank (CB) communication can be examined from the Rational Inattention (RI) theory propounded by Christopher Albert Sims in his seminal work in 2003. The RI theory states that economic agents are "picky and choicy" in their information absorption even when information is readily available (Sims, 2003; Maćkowiak, et al., 2021). Sims argues that human beings are not able to pay full attention to every available piece of information, but pay more attention to what they consider to be important to them. By extension, Blinder et al. (2022) and Maćkowiak et al. (2021) established that households and firms have little interest in monetary policy-related news compared to banks, financial market participants and investors, mainly as a result of the communication style of central banks. Monetary policy communication is important to anchoring inflation or target interest rate expectations among economic agents. Previously, central banks' communication was secretive, due mainly to the infamous phrase of the former Governor of the Bank of England, Montagu Norman, that one should "never explain, never excuse." On the contrary, the former Federal Reserve Chairman and Nobel Laureate, Ben Bernanke, underscored the crucial role that effective monetary policy communication plays in central banking (Bernanke, 2015). He posited that, "When I was at the Federal Reserve, I occasionally observed that monetary policy is 98 percent talk and only 2 percent action. The ability to shape expectations of future policy through public statements is one of the most powerful tools the Fed has". In a way, Bernanke's remark suggests that central bank communication is a policy tool in itself.

Naghdaliyev (2011) proposed a conceptual framework for monetary policy communication in central banks and argued that they should have clear objectives with regard to communication to prevent information overload. Figure 1 depicts the modified conceptual framework of Naghdaliyev (2011). It indicates that the objectives of monetary policy communication should encompass intermediate goals of transparency, accountability, and financial education, which must result in credibility and anchored expectations. It is argued that greater transparency leads to higher monetary policy credibility. Monetary policy credibility has recently been identified as a central banks' most important asset, given its role in expectations formation in line with their targets (Akosah, 2020; Al-Mashat et al., 2018). This implies that a CB with low policy credibility may experience slower monetary policy transmission than those with high policy credibility, and vice versa.

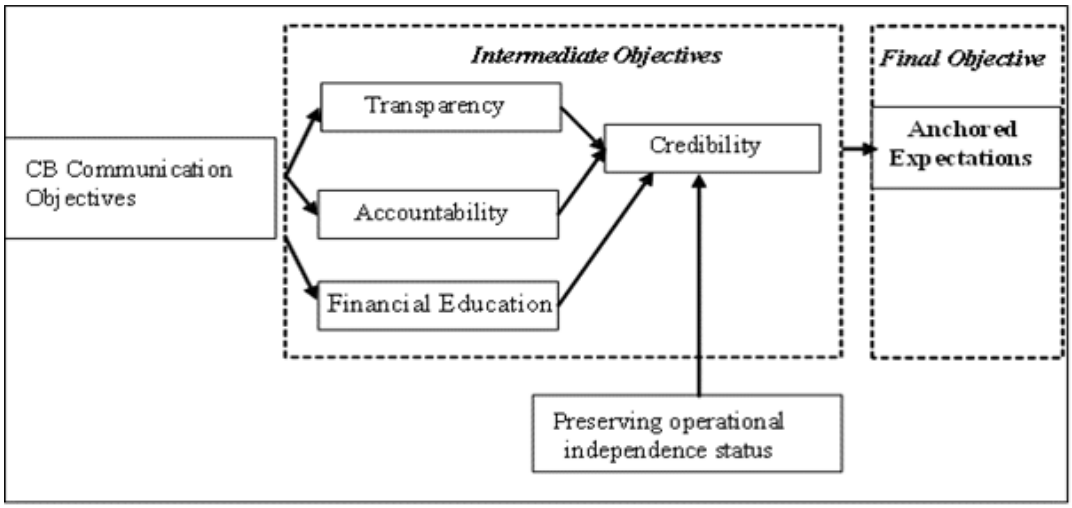

Figure 1: Modified Conceptual Framework of Central Bank Communication

Also, Casiraghi and Perez (2022) argued that there is no "one-jacket-fits-all" prescription for communications in central banks. They, however, proposed that best practices and the idiosyncrasies of the jurisdiction should underpin the choice of CB communication strategies coupled with key elements such as clarity, candidness (truthfulness), and transparency, comprehensiveness of communication, regular schedule of communication, symmetry of communication, and institutional-driven communication (Casiraghi & Perez, 2022; Haung & Simon, 2021). Segawa (2021) and Tumala and Omotosho (2019) examined the readability of the South African Reserve Bank and the Central Bank of Nigeria's MPC press statements/communiques, respectively. This study therefore extended the earlier empirical work by constructing a longer time series of the Monetary Policy Readability Index (MPRI), the Monetary Policy Sentiment Index (MPSI), and the Monetary Policy Uncertainty Index (MPUI), and further estimated their bivariate correlations and causal relationships with both domestic and external macroeconomic variables.

Big Data and Artificial Intelligence (AI) in Central Banks' Communication

AI-powered text-mining techniques, also known as natural language processing (NLP), have become a powerful big data tool for extracting useful information and insights from voluminous text-based reports. Historically, text-mining is said to have been first introduced in linguistics and has continued to gain massive attention in other domains, including central banking (Bholat et al., 2015). Presently, only a few empirical studies have employed text-mining techniques to analyse central bank press statements, financial stability reports, banking sector reports, annual reports and social media to assess their readability, effectiveness of communication strategies, as well as sentiments expressed in these reports (Barbaglia et al., 2022; Bholat et al., 2015; Pejic´-Bach et al., 2019). Naghdaliyev (2011) asserted

that central bank transparency and credibility are influenced by the effectiveness of their communication to the financial market, investors, and the general public.

Tobback et al. (2018) constructed the Economic Policy Uncertainty Index (EPUI) in Belgium using the text-mining approach. The researchers identified pre-defined keywords relating to economic and policy uncertainties in tumultuous periods. Using the support vector machine (SVM) classification method, they forecast ten macroeconomic indicators, including sovereign bond yields and consumer sentiments on a monthly basis. Similarly, Baker et al. (2022) relied on the U.S. and European newspapers to construct the economic uncertainty index to serve as an early warning signal for economic policymakers. Tumala and Omotosho (2019) also analysed the MPC communiqués published by the Central Bank of Nigeria from 2004 to 2019 and found that the communiqués were increasingly complex with low readability.

As revealed by the above review, this study was motivated to extend the literature by constructing three main indices for policy analysis and macroeconomic forecasting purposes. In particular, even though interest in the application of text-mining with respect to central bank (monetary policy) communication is growing, the review thus far has revealed the unavailability of high-frequency indicators (HFIs) and longer time series text-based indices developed from central bank's monetary policy committee (MPC) press releases. This underscored the relevance of developing the monetary policy readability index (MPRI), the monetary policy sentiment index (MPSI), as well as the monetary policy uncertainty index (MPUI). These indicators are novel in the context of central banking and economic analysis, especially with respect to inflation targeting (IT) central banks in Africa, where HFIs are few. Meanwhile, Mishkin (2008), Piechocki (2016) and Blinder et al. (2022) revealed that among the cardinal challenges facing IT in central banks in emerging markets and developing economies are untimely and poorly designed communication strategies, the unavailability of real-time data, and substantial macroeconomic uncertainty. This article is therefore relevant in addressing some of the preceding challenges.

METHODOLOGY

This section presents the research methodology employed in the study. Specifically, it describes the data sources and the analytical flowchart employed to address the research objectives. The data (MPC press releases) were scraped from the Bank's website for pre-processing and text analytics (see Figure 2).

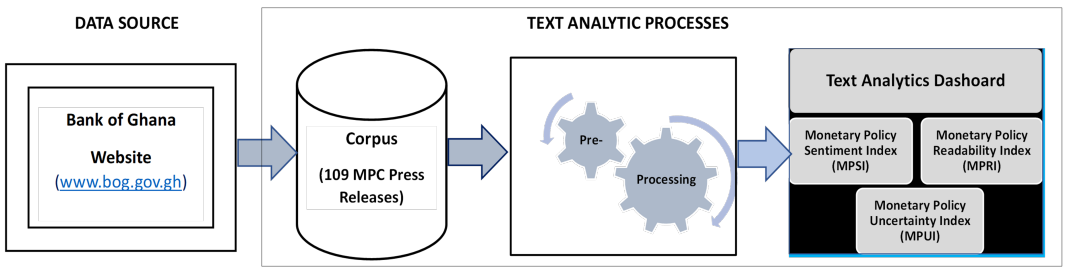

Figure 2: Text-Mining Flowchart

Data and Data Sources

The corpus for the study comprised 109 Monetary Policy Committee (MPC) press releases issued by the BoG between January 2003 and December 2022. The press releases were extracted from the Bank's website (https//www.bog.gov.gh) using a Python library called Beautiful Soup. Detailed description of the corpus is summarised in Appendix A. Presently, MPC meetings are held six times a year and, on each occasion, the Committee publishes several reports, including the MPC press release, the transcript of the MPC press briefings and flash reports aimed at achieving greater transparency and accountability, as key tenets of an Inflation Targeting monetary policy framework.

Theoretically and intuitively, central bank communication is expected to influence macroeconomic indicators and anchor expectations among economic agents (Ahir et al., 2022; Blinder et al., 2022; Gardner et al., 2022; Granziera et al., 2023). We therefore tested the above theory by estimating the

(casual) relationships between the new indices and some selected domestic and external macroeconomic indicators. The domestic variables including inflation, real GDP growth rate, monetary policy rate (MPR), exchange rate, interbank lending rate, consumer confidence index, and business confidence index and inflation expectation rates were obtained from the Bank of Ghana. Similarly, the external variables such as the US inflation, the Fed rate, and the JB Morgan Ghana Sovereign Bond Spread (GSBS) were sourced from the Federal Reserve Economic Data (FRED) among others.

DATA ANALYTICS AND MODELLING

Data Cleaning and Pre-Processing

The MPC press releases downloaded from the Bank's website were Portable Document File (PDF) documents. For easy text-mining analysis, we converted the PDF documents to text files. Using standard data cleaning and pre-processing procedures in text-mining, the corpus was read into R software to remove numbers, punctuation marks, whitespaces, stop words and special characters, as suggested by Benchimol et al. (2022) and Huang and Simon (2021). Furthermore, the corpus was stemmed to reduce words into their root words (lemma) for easy matching with the standard Loughran and McDonald master financial dictionary. Although there are other dictionaries, such as the General Inquirer, the MPQA Subjectivity Lexicon, the Bing, and the NRC for sentiment analysis, the Loughran and McDonald dictionary is the only economic- and finance-based dictionary, making it the most suitable for this study. Also, it has more words (86,533) classified into six 'feelings' categories – namely constraining, contentious, negative, positive, superfluous, and uncertain – compared to the others.

Monetary Policy Readability Index

In this context, readability means the ability of economic agents to easily read and understand MPC press releases in order to form the desired expectations about monetary policy actions and comply with a key requirement of increased transparency and accountability. Coleman and Liau (1975) proposed and developed the Coleman-Liau Index (CLI), with parameters such as the number of characters, words and sentences, while the constants are pre-determined. The CLI is specified as follows:

$$CLI = 141.8401 - 0.21459\left(\frac{N_{char} * 100}{N_{words}}\right) + 1.079812\left(\frac{N_{sent} * 100}{N_{words}}\right) \quad (1)$$

Where *CLI* represents the Coleman-Liau Index; N_{char} denotes the number of characters in a given document; N_{words} represents the number of words per document; and N_{sent} denotes the number of sentences in a document. Comparatively, Flesch (1948) also developed a readability index called the Flesch Readability Ease Index (FREI), which appears to be more robust and comprehensive than the CLI as it incorporates syllables (the length of words). The FREI reflects the extent of readability and comprehensibility a piece of content. It is the most widely used readability analysis technique compared to the Flesch-Kincaid Grade Level, the Gunning-Fog Index, the Simple Measure of Gobbledygook Index, the Coleman-Liau Index, and the Automated Readability Index (Liguori, 1978; Segawa, 2021; Spadaro et al., 1980). As argued by Segawa (2021), the FREI performs better when the number of words exceeds 200. This, therefore, affirms the appropriateness of the FREI in this context, given that the minimum number of words contained in the BoG's MPC press releases is 576. The index is specified as follows:

$$FREI = 206.835 - 1.015\left(\frac{N_{words}}{N_{sentenses}}\right) - 84.6\left(\frac{N_{syllables}}{N_{words}}\right) \quad (2)$$

Where N_{words} represents the number of words per document; N_{sent} denotes the number of sentences in a document; and $N_{syllables}$ represents the number of syllables in a document. The interpretations of the Flesch Readability Ease scores are contained in Table 1 below.

Table 1: Interpretation of Flesch Readability Ease Scores

Score	US School Level	Ghanaian school equivalence	Interpretation
90 – 100	5th Grade	Primary 5	Very easy to read. Easily understood by an average 11-year-old student.
80 – 89	6th Grade	Primary 6	Easy to read and understand. Conversational English for readers.
70 – 79	7th Grade	Junior High School (JHS) 1	Fairly easy to read and understand.
60 – 70	8th & 9th Grades	Junior High School (JHS) 2 & 3	Standard/Plain English. Easily understood by 13- to 15- year-old students.
50 – 60	10th to 12th Grade	Senior High School (SHS)	Faily difficult to read and understand.
30 – 50	College	Undergraduate	Difficult to read and understand.
10 – 40	College Graduate	University graduate	Very difficult to read. Best understood by university graduates.
0 – 10	Professional	Professional	Extremely difficult to read. Best understood by university graduates.

Source: Adapted from Liguori (1978) and Spadaro et al. (1980).

Monetary Policy Sentiment Index

Sentiment analysis from economic and financial reports and news relies on using the Loughran-McDonald (2021) master dictionary with 354 positive lexicons and 2,346 negative lexicons. As seen in Equation 3, the sentiment index is based on the number of positive terms (including favourable, profit, outperform, adequate, achieve, and improve among others) and negative terms (e.g., depreciation, volatility, instability, losses, non-performing, default, and deplete among others) in a given press release. Drawing from Benchimol et al. (2022), the Monetary Policy Sentiment Index (MPSI) is specified as follows:

$$MPSI = \left(\frac{P_i - N_i}{P_i + N_i}\right) * 100 \qquad (3)$$

Where P_i represents the number of positive words in a given document; and N_i denotes the number of negative words in a given document. This implies that a document is classified as having positive sentiment if $P_i > N_i$ and negative if $P_i > N_i$. Positive sentiments are desirable as they signal hope about the economy.

Monetary Policy Uncertainty Index

According to Calvo-González et al. (2018), uncertainty in monetary policy communication is likely to result in capital flight and reduced investment and economic growth in the long run. Based on this, we applied the Loughran-McDonald's (2021) dictionary, which contains 294 uncertainty-related words such as volatility, uncertainty, risk, depreciation, unlikely, and unpredictability, among others, to estimate the level of uncertainty contained in the Bank's monetary policy communication. The Monetary Policy Uncertainty Index (MPUI) is constructed using the formula in Equation 4.

$$MPUI_i = \frac{UN_{words(i)}}{ATW_{words}} * 10{,}000 \qquad (4)$$

Where $UN_{words(i)}$ represents the total number of uncertainty and uncertainty-related words in a given document; ATW_{words} represents the average value of the total numbers of words contained in MPC documents between 2003 and 2005. A higher MPUI suggests heightened uncertainty, which is undesirable in an economy.

EMPIRICAL RESULTS

Descriptive Statistics

Table 2 presents descriptive statistics on the tenure of the governors, the number of MPC meetings they presided over, the number of characters, the words and the sentences contained in their respective press releases. With respect to the tenure of the governors, Governor A's tenure was between January 2001 to September 2009. Governor B was appointed in October 2009 and superintended MPC meetings between October 2009 and August 2012. Similarly, Governor C presided over MPC meetings from August 2012 to March 2016, while Governor D was the chairman of the MPC between April 2016 and March 2017. Governor E has been the chairman of the MPC since April 2017. Over the sample period, the results show that the corpus had a total of 1,148,016 characters, 215,458 words, 21,716 sentences and 38,058 syllables. Also, Governor A presided over/issued 35 (32.11%) of the 109 MPC press releases, while Governor E issued 34 (31.19%) press releases as at December 2022. Governor C issued 19 (17.43%) press releases, while Governor B and Governor D issued 15 (13.76%) and 6 (5.50%) MPC press releases, respectively. This suggests that the governors did not have an equal number of MPC meetings, largely due to changes in government. In Ghana, although the central bank is financially and operationally independent, the President of the Republic appoints the Governor (Chairman), two Deputy Governors and Non-Executive Directors for a four-year tenure. Hence, computing the average scores of the parameters provides a better basis of comparison.

On average, press releases issued under the Governor A-led MPC contained 10,734.49 characters, 2,044.23 words and 212.17 sentences for the 35 meetings he presided over. Similarly, Governor B presented 10,712.13 characters, 2,042.07 words and 223.40 sentences, respectively over 15 meetings, while Governor C's 19 press releases contained 8,826.26 characters, 1,668.84 words and 180.37 sentences, on average. Governor D issued 4,199.00, 746.67 and 59.17 characters, words and sentences, respectively for six MPC meeting, while Governor E's 34 press releases contained, on average, 12,315.71 characters, 2,267.38 words, 210.50 sentences and 438.21 syllables.

We also computed the proportion of characters, words and sentences communicated by each Governor over the sample period, as shown in Figure 3. In terms of characters, the Governor E-led MPC accounted for the highest proportion of characters (26.3%) compared to 22.9 percent each for Governors A and B, followed by Governor C with 18.9 percent and Governor D with 9.0 percent. Similarly, Governor E was found to have communicated more words on average, representing 25.9 percent as compared to 23.3 percent each for Governors A and B, and 19.0 percent and 8.5 percent for Governors C and D, respectively. In terms of sentences, Governors B and A-led MPCs produced 25.2 percent and 24.0 percent of the number of sentences respectively, while Governors E, C and E accounted for 23.8 percent, 20.3 percent and 6.7 percent, respectively. With regard to the use of complex words (syllables), Governor E-led MPC had generated 27.7 percent, followed by Governor B (23.3%), Governor A (20.1%), Governor C (18.7%) and Governor D (12.2%).

Overall, it is observed that Governor E provided more information to stakeholders and the general public than all other governors. This is evidenced by the average number of characters and words contained in the press releases issued during his tenure, suggesting a high level of transparency and accountability. Governors A and B followed in the second and third positions, respectively, while Governor C took the fourth position and Governor D came fifth. A further investigation into the significantly low number of characters, words, sentences and syllables recorded under Governor D revealed that the number of pages of MPC press releases issued under him dropped substantially to an average of 4.17 pages, compared to the 8.71 pages under Governor A, 8.47 pages under Governor B, 8.24 pages under Governor E, and 7.05 pages under Governor C. IMF (2020), highlighting the argument of Ehrmann et al. (2010) that transparency guides economic agents' decision-making processes and helps to anchor their market expectations and conduct leading to effective monetary and financial policy implementation.

Table 2: Descriptive Statistics

Governors	Tenure/ MPC Periods	Number of MPC Meetings	Total Number of				Average Number of			
			Characters	Words	Sentences	Syllables	Characters	Words	Sentences	Syllables
Governor A	Jan 2001 – Sept 2009	35	375,707	71,548	7,426	11,176	10,734.49	2,044.23	212.17	319.31
Governor B	Oct 2009 – Aug 2012	15	160,682	30,631	3,351	5,289	10,712.13	2,042.07	223.40	353.60
Governor C	Aug 2012 – Mar 2016	19	167,699	31,708	3,427	5,633	8,826.26	1,668.84	180.37	296.47
Governor D	Apr 2016 – Mar 2017	6	25,194	4,480	355	1,061	4,199.00	746.67	59.17	176.83
Governor E	Apr 2017 – Dec 2022 (to date)	34	418,734	77,091	7,157	14,899	12,315.71	2,267.38	210.50	438.21
Total/Average		**109**	**1,148,016**	**215,458**	**21,716**	**38,058**	**9,357.52**	**1,753.84**	**177.12**	**316.88**

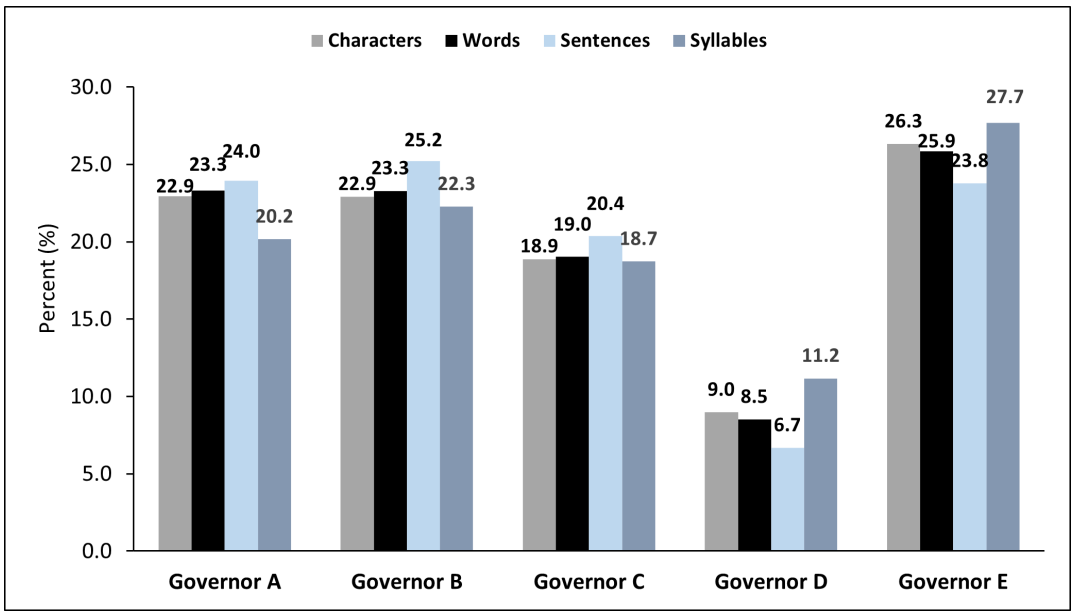

Figure 3: Distribution of Characters, Sentences, Words and Syllables by Governors

Monetary Policy Readability Index (MPRI)

Results from Appendix B show trends in the key variables useful in constructing a readability index. From Figure B1a, we see a general increase from 4,676 characters in year 2003 to the high levels of 18,134 characters around year 2009, then a decline to a record low of 3,343 in 2015. The trend, however, recovered gradually from 2016 through to 2022. The other variables (see Figure B2-4) also followed similar trends. We then applied Equation 2 to compute the Monetary Policy Readability Index (MPRI) spanning January 2003 to November 2022, with the results presented in Figure 4. The Monetary Policy Readability Index (MPRI) generally trended downwards over the sample period, largely on account of the increasing number of complex words (syllables). The index dipped significantly between 2015 and 2016 as a result of

a substantial reduction in the number of pages of the MPC press releases from an average of 5.71 pages in 2015 to 4.00 pages in 2016. The index, however, recovered somewhat between 2017 and 2022 by an average value of 53.44, as the average number of page numbers also surged to 8.24. Whilst there could be other important factors accounting for the fluctuations in the readability index, it appears the number of pages of the MPC press release is equally critical.

The average readability score for the entire corpus is 57.1 out of 100.0. This score is lower than the desired readability score of 60.0-70.0 for financial statements in English (Fakhfakh, 2015). This suggests that, generally, MPC press releases are fairly difficult for a senior high school graduate to read and understand, according to the FRE score interpretation in Table 2. This result confirms the finding of Tumala and Omotosho (2019), who conducted a similar study in Nigeria. Thus, the Bank's MPC press releases require one to have some level of sophistication in terms of education to read and understand easily. The implication is that economic agents with basic education might find it difficult to understand the contents of the MPC press releases, although the only requirement for participation in a financial activity in the country is to be at least 18 years of age. Practically, the ease of reading MPC press releases has the potential to contribute to the monetary policy transmission through the expectations channel (Blinder et al., 2022; Segawa, 2021). Hence, the relatively low readability score could suppress confidence in the domestic economy.

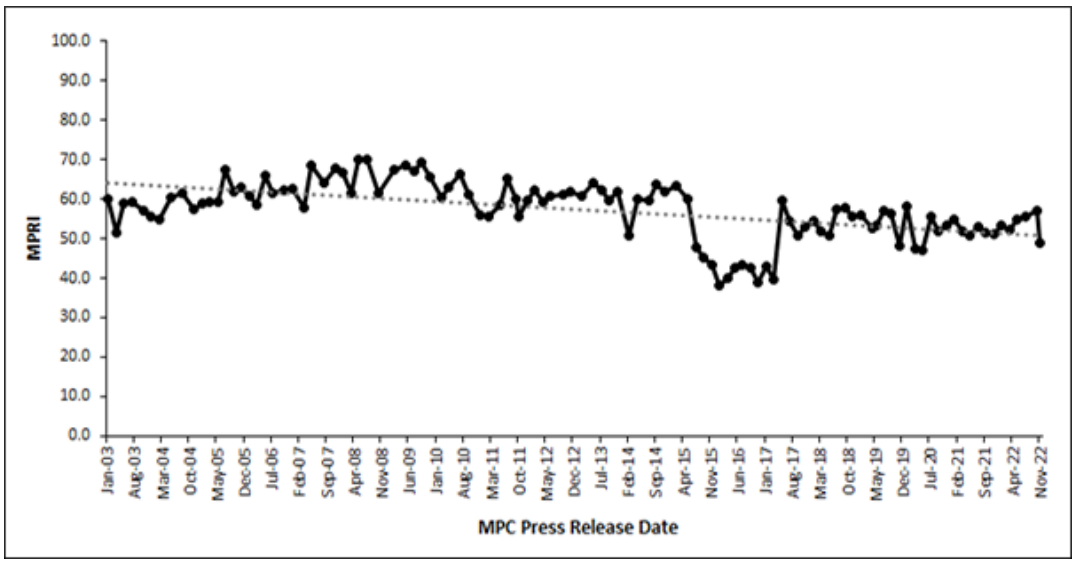

Figure 4: Trends in Monetary Policy Readability Index

Monetary Policy Sentiment Index (MPSI)

It has been theoretically and empirically demonstrated that economic agents' feelings (sentiments) about the prospect of the economy, to a large extent, influence their economic and financial decisions. Nyman and Tuckett (2015) acknowledge the role of sentiment, narrative and news effects in human decision-making. Figure 5 shows the evolution in sentiments expressed in the Bank's MPC press releases and how they predicted key macro-environmental events in the country. In this context, macro-environmental factors include economic, political, socio-cultural, technological, demographic, and ecological factors.

The results reveal that the MPC press releases were dominated mainly by 'negative' words, as the average sentiment score over the entire sample period was -20.7. This is suggestive of a high degree of pessimism about the domestic economy, reflecting the frequent adverse shocks to the economy. In particular, the highest sentiment score of 83.3 percent was contained in the 26th January 2006 press release. This coincided with the announcement of the cancellation of US$4.2 billion of the country's external debt under the HIPC/Multilateral Debt Relief Initiative (MDRI) programme. The MPC press

release was indeed positive at the time when most of the country's macroeconomic indicators, such as inflation, economic growth, trade balance, commodity prices, and external debt stock were trending in the right direction. A paragraph in the MPC Press Release of January 2006 confirmed the above assertion:

> Looking ahead, maintaining a strong monetary/fiscal policy anchor should underpin the transition to reduced annual inflation and accelerated growth, with the private sector crowded in. The removal of the external debt burden under the Multilateral Debt Relief Initiative (MDRI), envisaging the cancellation of $4.2 billion of Ghana's external debt, should reinforce this process and serve to strengthen investor confidence in the economy.
>
> - MPC Press Release, January 2006:5

Additionally, the index accurately captured the effect of the Global Financial Crisis (GFC) between 2007 and 2009. Ghana and many African countries were initially believed to be insulated from the global financial crisis, but this position was later revised by the World Bank. The Bank subsequently classified Ghana as 'highly exposed' to the debilitating impact of the financial crunch, with low GDP and worsening inflation. Similarly, the significant exchange rate depreciation recorded in May 2014, the sluggish economic growth due to erratic power supply ("Dumsor", local parlance for frequent and unplanned power outages to homes, businesses and other facilities), coupled with commodity price shocks and consequent entry into an IMF programme in 2015 suppressed sentiments about the economy. The change in government in 2017 and relatively improved macroeconomic conditions somewhat improved the sentiment score to 7.14 in November 2017. However, the twin impact of COVID-19 and the Russo-Ukranian war contributed to a steep rise in inflation and currency depreciation, compelling the government to seek an extended credit facility from the IMF. These events collectively suppressed sentiments in recent times.

Also, the results show a higher average sentiment score for Governor A (MPSI = -14.28) relative to the others. This could be attributed to the significant external financial supports the government/economy received during the period as a result of the HIPC initiatives. Governor D's average sentiment score was -16.48, reflecting a slow recovery from the nationwide erratic power supply, exchange rate depreciation, and commodity price collapse shocks. Also, Governor E obtained an average sentiment score of -18.65 over periods of COVID-19 and the Russo-Ukranian war. The tenure of Governor B recorded a sentiment score of -25.84, on average, at the time of the GFC, while Governor C obtained an average sentiment score of -33.51 during the period characterised by exchange rate crisis and Dumsor throughout the country.

Sentiment or news effects are considered critical 'soft' data in monetary policy formulation and analysis. This is because the nature of sentiment (negative or positive) conveyed by the press releases invariably impacts public perception and trust in the Bank's monetary policy decisions. Viegi and Demertzis (2016) observed that credibility is the most important asset of any central bank, especially during economic turbulence and high uncertainty.

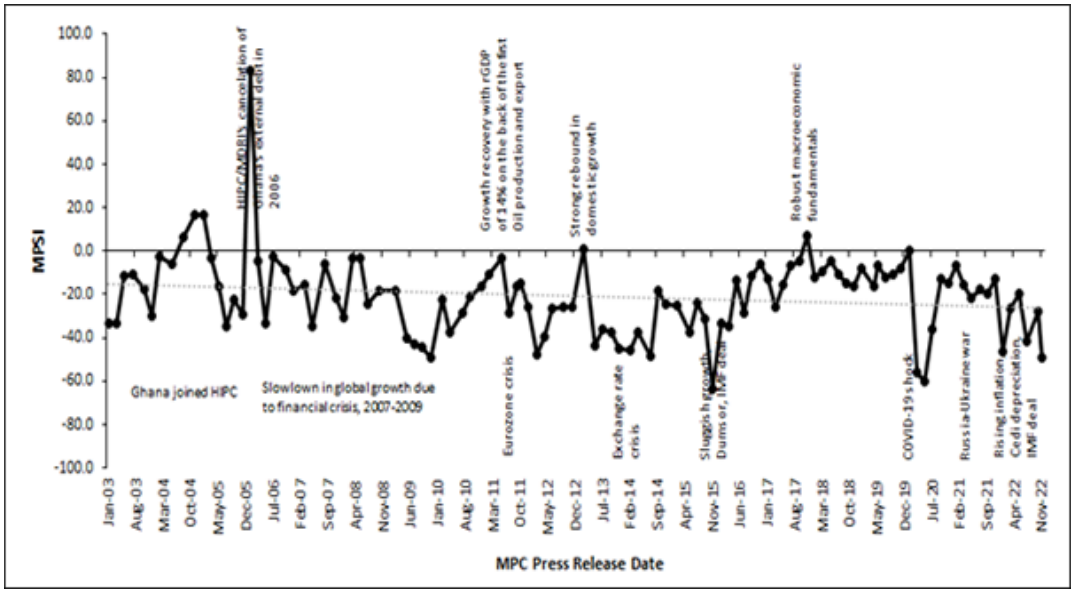

Figure 5: Trends in MPSI and Macro-Environmental Events

Monetary Policy Uncertainty Index

Figure 6 reveals that Ghana's monetary policy uncertainty index (MPUI) has evolved and exhibited pronounced fluctuations over the years, traceable to some major global and domestic macro-environmental dynamics. More importantly, the researchers established that the lowest uncertainty score of 27.12 was recorded in October 2003 on the back of a relatively stable macroeconomic environment. Conversely, the highest uncertainty score of 359.32 was contained in the Bank's July 2009 MPC press release, reflecting the severe impact of the Global Financial Crisis (GFC) on the domestic economy, in line with findings by Tobback et al. (2014). The long-term trend further confirms a sustained uncertainty in the domestic economy.

Empirically, higher values of the index signal heightened uncertainty, and as such constituted an early warning signal for policymakers and vice versa. More specifically, we found that uncertainty was generally low between 2002 and 2006, when the country signed up for the Highly Indebted Poor Countries (HIPC) initiative, culminating in the cancellation of a substantial portion of the country's external debt. Uncertainty, however, heightened during the 2012 Election Petition hearing at the Supreme Court of Ghana. It was believed that many investors and development partners (such as the World Bank, the IMF, and the African Development Bank, among others) held back on their investments and budget support due to the high level of uncertainty surrounding the outcome of the petition.

Furthermore, economic uncertainty increased during the energy crisis coupled with exchange rate volatility in July 2014, and after the announcement of an IMF-supported economic programme around May 2015. There is also evidence of increased uncertainty at the commencement of the banking sector clean-up and re-capitalisation exercises in August 2017. This event was reflected in the September 2017 MPC press release as follows:

> Reforms to strengthen and re-position the financial sector as a major growth driver are ongoing and banks are positively adjusting to the latest developments. Since the last MPC meeting, the Bank has revoked the licenses of two insolvent banks to safeguard the potential spillover threat on the financial sector. The roadmap towards recapitalisation in accordance with the capital restoration plans set out in April has ended satisfactorily. The Bank of Ghana is working towards building a strong and more sophisticated banking sector

> backed by robust capital frameworks due to increasing risk exposures. In particular, the Bank is introducing risk-based capital requirements under the Basel II and III framework as well as enhancing prudential regulations, governance structures of banks, and macro prudential oversight to support a stronger and more sophisticated financial system.
>
> - MPC Press Release, September 2017:2

Figure 6 also reveals how global economic developments, particularly the COVID-19 pandemic in March-July 2020, the outbreak of the Delta variant of COVID-19 in July 2021 and the Russo-Ukranian war in February 2022 collectively contributed to heightened uncertainty in the MPC press releases during the period. Also, uncertainty increased in the July 2022 MPC press release because of the announcement of a possible economic recovery programme with the IMF. Similarly, the spontaneous rise in both global and local inflation rates particularly from March 2022 to November 2022 further worsened the level of uncertainty expressed in the MPC press releases. For example, part of the MPC Press Release of November 2022 says:

> Global headline inflation remains elevated and has broadened beyond food and energy prices, with several other factors adding to inflationary pressures. On the domestic front, inflation has remained elevated, with strong underlying inflationary pressures. Price developments suggest that the upturn of headline inflation in October 2022 was driven largely by food price pressures and to some extent additional pressures from the currency depreciation. Since the last MPC meeting, headline inflation has increased further to 40.4 percent in October 2022, from 37.5 percent in September. Food inflation increased by 4.9 percentage points to 43.7 percent in October 2022 from 38.8 percent in September, while non-food inflation increased by 1.3 percentage points to 37.8 percent from 36.5 percent underlying inflationary pressures have also heightened further. The Bank's measure of core inflation, defined to exclude energy and utility prices, increased from 36.2 percent in September 2022 to 39.7 percent in October 2022, an indication of broad-based inflationary pressures. At the same time, consumer, business, and financial sector inflation expectations went up.
>
> -MPC Press Release, November 2022:1

Headline inflation jumped to 40.4 percent in October 2022 from 38.8 percent in September 2022. This further worsened in November and December 2022 when it increased from 50.3 percent to 54.1 percent against the Bank's medium-term target of 8.0±2 percent. For the entire period, the average uncertainty score was 128.00, suggesting a relatively heightened unpredictability in the country's economy. The fluctuations in the index clearly represent instability in the country's macroeconomic environment over the sample period. The combined effects of structural deficiencies, a weak domestic currency, fiscal vulnerabilities, and external shocks have continued to derail the economic trajectory of the country. These developments appear to be well captured in the MPC press releases of the central bank as a key policymaker in the country.

In terms of governors' performance, Governor D's tenure between May 2016 and March 2017 witnessed the lowest average uncertainty score of 82.49. This coincided with the government securing a 3-year IMF programme aimed to "restore debt sustainability and macroeconomic stability to foster a return to high growth and job creation, while protecting social spending" (IMF, 2015:1). The relatively low uncertainty score suggests that the IMF programme truly brought stability and reduced uncertainty in the economy. Also, uncertainty was relatively under control under Governor A from January 2003 to September 2009, with an average score of 92.59 reflecting the huge fiscal space created by the HIPC initiative. The MPC press releases issued by Governors B and C contained averaged uncertainty scores of 130.62 and 139.88,

respectively, while Governor E's tenure between May 2017 and November 2022 recorded an average score of 164.71. This period witnessed the global economic downturn caused by COVID-19 and the Russo-Ukranian war, leading to seeking another IMF-supported programme in July 2022.

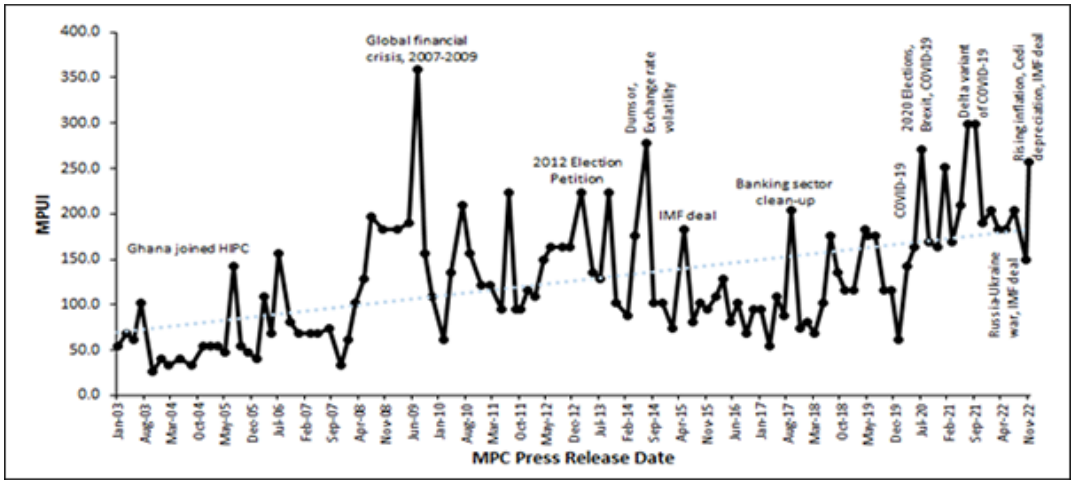

Figure 6: Trends in MPUI and Key Macro-Environmental Events

Validation Test Results

As stated earlier, central bank communication-based indices, such as MPRI, MPSI, and MPUI are expected to correlate with domestic and external macroeconomic indicators to affirm their accuracy, reliability, consistency, and robustness. We computed the correlation test between the variables, and the results are summarised in Table 3. The results showed that MPRI has a significant negative relationship with MPR, the exchange rate, interbank lending rate, financial sector inflation expectations index, and the JP Morgan GSBS. This suggests that the ease of reading and understanding BoG's MPC press releases could contemporaneously result in lower exchange rate depreciation, lower interbank lending rate, lower MPR, and a reduced risk premium on the country's sovereign bonds, and vice versa. Also, a higher clarity of press releases could lead to an improvement in GDP, and business confidence, and vice versa. Similarly, we found that there is an inverse correlation between MPSI and inflation, the interbank lending rate, the T-bill rate, business confidence inflation expectations, financial sector inflation expectations, and the JP Morgan GSBS. The implication is that improved sentiments in the Bank's MPC press release will likely result in greater interest in government's securities, bonds and the other way round.

Conversely, we find a significant positive correlation between MPSI and GDP, consumer confidence, and business confidence, suggesting that positive sentiments could lead to improvement in GDP, consumer confidence and business confidence, and vice versa. In addition, the results showed that the MPUI was negatively (albeit insignificantly) related to MPR, consumer confidence, business confidence, and the Fed rate, while it was positively related with the exchange rate. This suggests that high uncertainty usually leads to lower MPR, lower consumer and business confidence.

Table 3: Pearson's Correlation between Monetary Policy Communication and Macroeconomic Indicators

	MPRI	MPSI	MPUI	Inflation	Real GDP growth rate	MPR	Exchange rate	Interbank lending rate	T-Bill rate	Business Confidence Index (BCI)	Business Confidence Inflation Expectations rate	Consumer Confidence Index (CCI)	Consumer Confidence Inflation Expectations rate	Financial Sector Inflation Expectations rate	US Inflation	Fed funds rate	JP Morgan Ghana Sovereign Bond Spread (GSBS)
MPRI	1.000																
MPSI	0.004	1.000															
MPUI	0.030	-0.311**	1.000														
Inflation	-0.064	-0.143	-0.074	1.000													
Real GDP growth rate	0.308**	0.183*	-0.083	-0.230*	1.000												
MPR	-0.475**	-0.149	-0.142	0.669**	-0.315**	1.000											
Exchange rate	-0.526**	-0.141	0.422**	0.159	-0.255**	0.275**	1.000										
Interbank lending rate	-0.384**	-0.205*	-0.031	0.576**	-0.282**	0.890**	0.240*	1.000									
T-Bill rate	-0.088	-0.322**	0.093	0.717**	-0.278**	0.750**	0.137	0.823**	1.000								
Business Confidence Index (BCI)	0.289**	0.444**	-0.444**	-0.359**	0.376**	-0.479**	-0.638**	-0.518**	-0.600**	1.000							
Business Confidence Inflation Expectations rate	-0.014	-0.217*	-0.011	0.838**	-0.207*	0.658**	0.195	0.585**	0.733**	-0.477**	1.000						
Consumer Confidence Index (CCI)	0.060	0.465**	-0.270**	-0.557**	0.354**	-0.332**	-0.379**	-0.212*	-0.462**	0.607**	-0.520**	1.000					
Consumer Confidence Inflation Expectations rate	0.441**	-0.060	-0.048	0.248*	0.128	-0.261**	-0.310**	-0.409**	-0.043	0.213*	0.242*	-0.318**	1.000				
Financial Sector Inflation Expectations rate	-0.197	-0.376**	0.047	0.938**	-0.315**	0.770**	0.486**	0.682**	0.860**	-0.684**	0.926**	-0.576**	0.163	1.000			
US Inflation	0.011	0.127	0.096	0.215*	0.155	-0.087	0.345**	-0.301**	-0.205*	-0.016	0.139	-0.262**	0.255*	0.256*	1.000		
Fed funds rate	0.278**	0.309**	-0.346**	0.043	0.015	-0.194*	-0.149	-0.314**	-0.327**	0.421**	-0.066	0.059	0.231*	0.251*	0.293**	1.000	
JP Morgan Ghana Sovereign Bond Spread (GSBS)	-0.264**	-0.224*	0.041	0.458**	-0.232*	0.546**	0.145	0.478**	0.571**	-0.365**	0.365**	-0.206*	-0.034	0.365**	-0.124	-0.435**	-0.397**

***p<0.01; *p<0.05*

Granger Causality Test Results

Given that correlation does not necessarily imply causality, we examined the Granger causal (with lag of 2) relationships between the new indices and some indicators (see Table 4). The results showed that there is a significant unidirectional casual effect from exchange rate to Monetary Policy Readability Index (MPRI) (F=5.1054, p<0.01). This suggests that exchange rate crisis could suppress readability of the Bank's press release. Furthermore, the study found a bi-directional causality between MPSI and business confidence, confirming that the MPC was concerned with the survival/growth of businesses, while business executives also value the communication of the MPC. This also means that these variables can accurately predict each other in case there is a lag in the release of any of them. There is a unidirectional Granger causal effect from business confidence inflation expectations to monetary policy sentiment index (MPSI), while MPSI is found to Granger cause economic growth (F=3.0962, p<0.05). Similarly, the Granger causality test revealed a unidirectional impact from monetary policy sentiment index to financial sector inflation expectations (F=4.1211, p<0.05). This suggests that sentiments expressed in the Bank's press release can influence inflation expectations. This confirms the finding of Segawa (2021) that the tone of MPC statements are important in inflation expectations formation in South Africa.

Concerning causality between the Monetary Policy Uncertainty Index (MPUI) and the macroeconomic variables, the test shows a unidirectional causality between MPUI and business confidence (F=5.1054, p<0.01). Conversely, we established that financial sector inflation expectations Granger causes monetary policy uncertainty index, albeit unidirectionally. Also, the exchange rate has a causal effect on monetary policy uncertainty index, suggesting that exchange rate volatility (particularly depreciation) results in high level of uncertainty in the MPC's press release of the Bank. An example of a statement on exchange rate which induced high uncertainty is as follows:

> In the year to September 2022, the Ghana Cedi has depreciated by 37.5 percent, 24.1 percent, and 27.5 percent against the US dollar, the pound, and Euro, respectively. In comparison with the same period of last year, the Ghana Cedi fared better, depreciating by 1.8 percent and 0.5 percent against the US dollar and the pound, respectively, and appreciated by 4.0 percent against Euro. The depreciation of 7 percent of the currency was driven by higher crude oil product import bill on the back of rising prices, non-roll over of maturing bonds by non-resident investors, portfolio reversals and sudden exit of non-resident investors in the bond market, as well as loss of market access to Eurobond resources. The effect of these factors has been exacerbated by the strength of the US dollar, resulting in depreciation of the local currency from the beginning of the year-to-date.
>
> -MPC Press Release, October 2022:6-7

Table 4: Results from Granger Causality Test

No.	Null Hypothesis	*F*-value	Conclusion
Monetary Policy Readability Index (MPRI)			
1	MPRI does not Granger cause exchange rate	1.3670	Unidirectional
	Exchange rate does not Granger cause MPRI	3.7081*	
Monetary Policy Sentiment Index (MPSI)			
2	MPSI does not Granger cause business confidence	8.0266**	Bi-directional
	Business confidence does not Granger cause MPSI	3.0282*	
3	MPSI does not Granger cause business inflation expectations	2.9517	Unidirectional
	Business confidence inflation expectations do not Granger cause MPSI	4.1349*	
4	MPSI does not Granger cause real GDP Growth rate	3.0962*	Unidirectional
	Real GDP Growth rate does not Granger cause MPSI	0.5308	
5	MPSI does not Granger cause financial sector inflation expectations	4.1211*	Unidirectional
	Financial sector inflation expectations do not Granger cause MPSI	2.0900	
Monetary Policy Uncertainty Index (MPUI)			
6	MPUI does not Granger cause business confidence	5.1054**	Unidirectional
	Business confidence does not Granger cause MPUI	0.6924	
7	MPUI does not Granger cause exchange rate	0.0453	Unidirectional
	Exchange rate does not Granger cause MPUI	3.6558*	
8	MPUI does not Granger cause financial sector inflation expectations	2.3052	Unidirectional
	Financial sector inflation expectations do not Granger cause MPUI	3.5284*	

***p < 0.01; *p < 0.05*

CONCLUSION AND POLICY RECOMMENDATIONS

Monetary policy communication via MPC press releases contains useful information for economic research and investigation. However, these press releases are usually qualitative in nature and difficult to quantify, as well as to construct indicators from to serve as "snapshots" of the macroeconomy. This study employed AI-powered text-mining techniques to construct monetary policy communication-based indicators, namely, the Monetary Policy Readability Index (MPRI), the Monetary Policy Sentiment Index (MPSI), and the Monetary Policy Uncertainty Index (MPUI), which are useful in monitoring macroeconomic developments in an economy. The study involved the analysis of 109 MPC press releases issued by the Bank of Ghana between January 2003 to December 2022.

The results showed that readability of the MPC press releases witnessed a gradual downward trend over the years with an average score of 57.1 out of 100.0, which falls below the recommended range of 60.0-70.00 for economic and financial statements (see Fakhfakh, 2015). This suggests that the Bank's MPC press releases were quite difficult for less-educated readers (senior high school graduates) to understand. This trend might confirm the proposition that central banks generally find it difficult to communicate clear convincing messages during acute crises, thereby adopting the use of complex terminologies or technical jargon to explain the happenings (Vayid, 2013). Also, we obtained an average sentiment score of -20.70 for the press releases analysed, while the upward trend seen in the uncertainty index suggests highly volatile macroeconomic environment during the period, in line with the macroeconomic fundamentals.

Furthermore, to establish the accuracy, reliability and robustness of the newly-constructed monetary policy communication-based indicators (i.e. MPRI, MPSI, and MPUI), we computed correlations between them and a number of macroeconomic indicators, such as inflation, real GDP growth rate, monetary policy rate (MPR), exchange rate, interbank lending rate, treasury bill (T-bill) rate, consumer confidence, consumer inflation expectations indices, business confidence, business inflation expectations indices, financial sector inflation expectations index, US inflation, Fed rate, and the JP Morgan Ghana Sovereign

Bond Spread (GSBS). The indicators developed appear to have significant relationships with the domestic and external macroeconomics mentioned earlier. Thus, the indicators generally predict the macroeconomic environments such that when they worsen, the general economy also witnesses a downturn and vice versa. This is consistent with the findings of Baker et al. (2022), Ahir et al. (2020) and Kelley (2019). The implication is that these indicators can be alternative measures of certain important macroeconomic indicators (e.g. inflation and real GDP growth rate) with significant publication lags.

Inferentially, the Granger causality results showed that there is a bi-directional Granger casual effect from Monetary Policy Sentiment Index (MPSI) to business confidence index. Also, there is unidirectional causality from MPSI to economic growth, and financial sector inflation expectations. Similarly, the study found that the Monetary Policy Uncertainty Index (MPUI) Granger causes business confidence index, while exchange rate, and financial sector inflation expectations Granger cause MPUI. We also found a unidirectional causality from exchange rate to Monetary Policy Readability Index (MPRI).

The Bank of Ghana, researchers and investors can use these time series-based indicators as an early warning system (EWS) (see Table B1 in Appendix B) to monitor and predict the country's macroeconomic shocks, forecast the economic growth trajectory and address a number of policy inquiries. The Bank's Monetary Policy Committee (MPC) should use these indicators as a benchmark to measure the effectiveness of its monetary policy communication and fine-tune its press releases, if necessary, for the desired impact. In particular, efforts should be made by the Bank/MPC to improve the readability, sentiments and uncertainty expressed in the press releases for better inflation expectations anchoring. The Bank should also develop a communication policy document which defines the audiences, content and structure of the Bank's press releases.

Future studies may employ wavelet-techniques or Time-Varying Parameter Vector Autoregressions (TVP-VARs) to assess the behaviour and impact of the new indices on macroeconomic variables. Also, researchers may consider using the variables to nowcast/forecast slower-to-publish indicators such as inflation and real GDP growth rate. The study could be extended to other central banks in advanced, emerging market and developing economies for a comprehensive comparison and benchmarking of these indicators.

COMPETING INTERESTS

The authors have declared that no competing interest exists.

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DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author, upon request.

DISCLAIMER

The views expressed in this article are those of the authors and do not necessarily represent the views of the Bank of Ghana or affiliated institutions.

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Appendix A: Details of the Corpus

MPC round	Year	Press release date	MPC round	Year	Press release date	MPC round	Year	Press release date
1	2003	Jan-03	41	2010	Dec-10	81	2018	Mar-18
2	2003	Mar-03	42	2011	Feb-11	82	2018	May-18
3	2003	May-03	43	2011	May-11	83	2018	Jul-18
4	2003	Jul-03	44	2011	Jul-11	84	2018	Sep-18
5	2003	Oct-03	45	2011	Sep-11	85	2018	Nov-18
6	2003	Dec-03	46	2011	Oct-11	86	2019	Jan-19
7	2004	Feb-04	47	2011	Dec-11	87	2019	Apr-19
8	2004	May-04	48	2012	Feb-12	88	2019	May-19
9	2004	Aug-04	49	2012	Apr-12	89	2019	Jul-19
10	2004	Nov-04	50	2012	Jun-12	90	2019	Sep-19
11	2005	Jan-05	51	2012	Sep-12	91	2019	Nov-19
12	2005	Mar-05	52	2012	Nov-12	92	2020	Jan-20
13	2005	May-05	53	2013	Feb-13	93	2020	Mar-20
14	2005	Jul-05	54	2013	May-13	94	2020	May-20
15	2005	Sep-05	55	2013	Jul-13	95	2020	Jul-20
16	2005	Nov-05	56	2013	Sep-13	96	2020	Sep-20
17	2006	Jan-06	57	2013	Nov-13	97	2020	Nov-20
18	2006	Mar-06	58	2014	Feb-14	98	2021	Feb-21
19	2006	May-06	59	2014	Apr-14	99	2021	Mar-21
20	2006	Jul-06	60	2014	Jul-14	100	2021	May-21
21	2006	Oct-06	61	2014	Sep-14	101	2021	Jul-21
22	2006	Dec-06	62	2014	Nov-14	102	2021	Sep-21
23	2007	Mar-07	63	2015	Feb-15	103	2021	Nov-21
24	2007	May-07	64	2015	May-15	104	2022	Jan-22
25	2007	Aug-07	65	2015	Jul-15	105	2022	Mar-22
26	2007	Nov-07	66	2015	Sep-15	106	2022	May-22
27	2008	Jan-08	67	2015	Nov-15	107	2022	Jul-22
28	2008	Mar-08	68	2016	Jan-16	108	2022	Oct-22
29	2008	May-08	69	2016	Mar-16	109	2022	Nov-22
30	2008	Jul-08	70	2016	May-16			
31	2008	Oct-08	71	2016	Jul-16			
32	2009	Feb-09	72	2016	Sep-16			
33	2009	May-09	73	2016	Nov-16			
34	2009	Jul-09	74	2017	Jan-17			
35	2009	Sep-09	75	2017	Mar-17			
36	2009	Nov-09	76	2017	May-17			
37	2010	Feb-10	77	2017	Jul-17			
38	2010	Apr-10	78	2017	Sep-17			
39	2010	Jul-10	79	2017	Nov-17			
40	2010	Sep-10	80	2018	Jan-18			

Source: BoG Website (www.bog.gov.gh)

Appendix B

Figure B1: Number of Characters

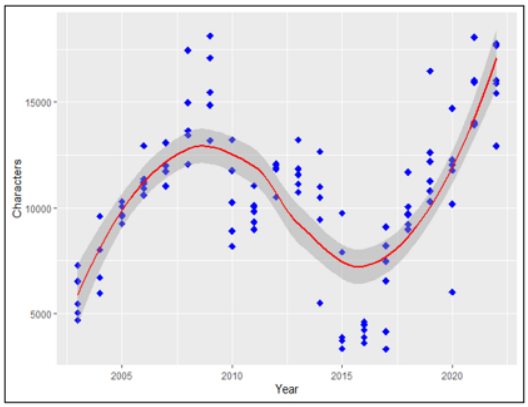

Figure B2: Number of Words

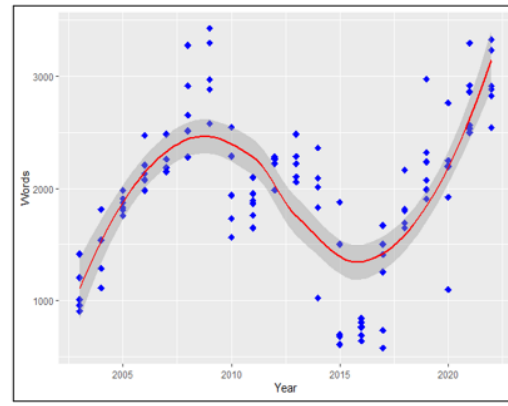

Figure B3: Number of Sentences

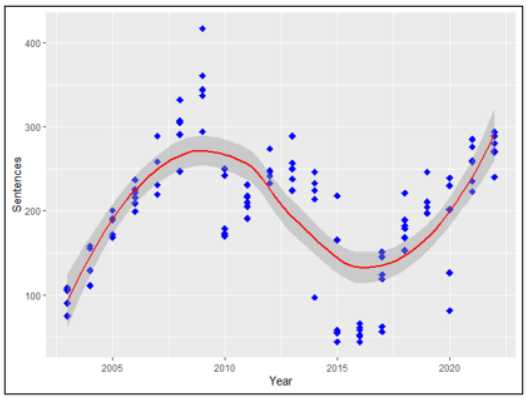

Figure B4: Number of Syllables

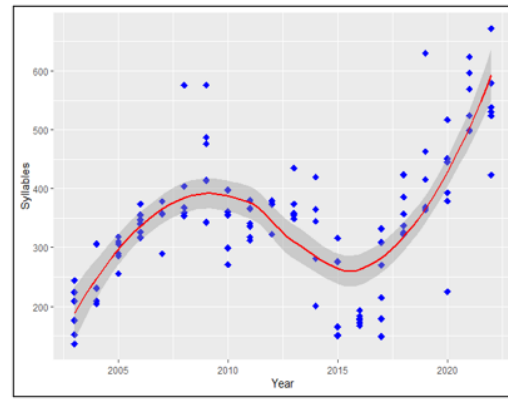

Figure B: Trends in Number of Characters, Words, Sentences, and Syllables