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CBN Monetary Policy and Inflation Nexus in Nigeria: An empirical approach

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Abstract

Purpose: The study explored monetary policy effect on inflation stabilization in Nigeria. Increasing levels of indebtedness may have reduced the fiscal space for fiscal policy intervention and this leaves monetary policy as the real tool of choice for macroeconomic stabilisation. The question we need to ask then is, how effective is this tool of choice?

Methodology: Monthly time series data from 2009-2018 were used in estimating the model. The ADF test for the stationarity, the johansen cointegration test and the vector error correction model were utilized in testing the variables. The findings from the unit root test did indicate stationarity at first difference 1(1). The cointegration (Johansen) test indicates that there was a nexus linking inflation and all the regressors adopted in the long term.

Findings: The result of the VECM for the two estimated models shows a self-equilibrating mechanism of 14 per cent and 32 per cent for the first and second models respectively. The findings further reveal that the variables; liquidity ratio, policy rate (MPR), exchange rate, reserve requirement and treasury bills rate all had an effective impact on the inflation rate and that that effect was very significant. Hence, the CBN's monetary policy shocks do seem to have the expected traction on the Nigerian economy.

Unique Contribution: The results make it pertinent for the CBN to utilize all the policy measures adopted in order to keep inflation within acceptable thresholds and prepare to keep inflation within the targeted range of 6-9 per cent, no matter the anticipated or unanticipated strong head winds.

Keywords: CBN, VECM, ADF, Monetary policy, Cointegration, Unit root,

JEL Classifications: E4, E5, E6, F6.

1.0 Introduction

Globalization has brought countries all over the world far more aggressively into a global village via technological advances in the last three decades. Thus, all countries are exposed to external economic shocks and these have implications for macroeconomic variables like inflation and output (Gajic, 2012; Okotori, 2017; 2019). Increases in the prices of goods and services exert inflationary pressures on the economy and mitigating these has captured policymaker's attention in Nigeria (Orubu, 2009).

The policies that focus on macroeconomic variables have been the basic tools of macroeconomic stabilization; hence they have been the main tools to reaching short-run stabilization of output and subsequent growth of the economy in the long run as well as making it to become diversified and self-sustaining (Ajie, Akekere & Ewubare, 2007). Macroeconomic policy is anchored on a twin policy thrust such as; the monetary authority's policy (monetary policy) and the fiscal policy of the fiscal authority. Monetary policy is the tinkering of the amount of money that circulates in any economy in order to achieve a balance between hitting the target on inflation as well as output (Mathai, 2012). Fiscal policy is simply the raising of revenue through taxation and other means and decision on public expenditure that can be used to shape the economy (Anyanwu, 1993; Okotori, 2017). Mester (2020) did agree to the fact that policymakers need to be anticipatory and not simply being reactionary as the monetary authorities policy moves affects the economy with a lag as their attempts to determine the best path that can be achieved; via the Apex policy making body's "dual mandate goals of price stability and maximum employment over the longer run, and this is based on a country's economic situation and its attendant risks".

Buiter (2014) opined that it was just a case of deliberate unwillingness or helplessness of governments to utilize a countercyclical fiscal policy that has made monetary policy the tool of choice. Moses et al., (2015) discovered that the supply of money growth/inflation nexus has weakened from the results of their empirical research on the Nigerian economy. But Bawa et al., (2016) observed a strong and important impact of money supply as a credible factor in the mitigation of the process of inflation, and this supports the usefulness of the monetarist prediction on inflation as regards its dynamics for the Nigeria economy. De Grauwe and Polan (2005) found out empirically that for countries having an inflation rate of 10 per cent and above the assumptions of the quantity theory did hold for the money growth inflation nexus, but when a country has an inflation rate of below ten per cent the money growth inflation nexus was weak and does not follow the assumptions of the long run and proportional relationship envisaged in the quantity theory. The mixed results from previous studies cast doubt regarding the real effect of the monetary authority's toolkit in inflation stabilisation. The existence of a monetary policy tool is followed by; the anticipation that a countercyclical policy move might reduce spikes in the inflation rate (Bonga-Bonga, 2017). It is in this

context that the current research takes a definitive look at the supply of money growth/inflation nexus, an important relationship that underlies policies of the CBN in Nigeria.

The study is an attempt to establish if monetary policy is still an effective tool to control inflation in Nigeria. Specifically the following objectives were considered; (i) to assess if monetary aggregates still play an effective part in inflation stabilisation, (ii) to evaluate the impact of price based tools in control of inflation. (iii) to ascertain how CBN's toolkit operations impacts on the inflation rate in terms of the aggregate effect of all instruments in that toolkit. The forgoing leaves us with the need to ascertain empirically if monetary policy variables had the effect as stated in apriori expectation ; (i) has the CBN's monetary policy variables any major effect on the inflation rate? (ii) did the synergy of adopted policy tools/instruments have the desired serious impact on the inflation rate? The rest of the study is subdivided into 2-Review of related literature, 3-Methodology, Results and discussion of findings, as well as 4- Conclusion and Recommendation

2.0 Review of relevant literature

2.1 Theoretical Framework

Monetarists' restating of the nexus between the monetary aggregates and the level of economic activity has received much attention in finance literature (Moses et al., 2015). The Quantity Theory of Money (QTM) in its earliest form proffered a strong case for monitoring and targeting the monetary aggregates as a means in stabilizing inflation. The conclusion of Mordi (2009) was that what underpins CBN's targeting of money is the QTM. The focus of the theory is the links between SM which refers to the money stock and output it finances (PY), here P refers to the general level of price and Y refers to the output. SM is connected to P and k; k is the proportionality factor. The following expresses that nexus;

$$SM=kPY..... (1)$$

$$\frac{SM}{P}=kY..... (2)$$

k is taken as a constant

Equation (2) can be written as:

$$SMV=PY..... (3)$$

Where V = 1, SM=PY and this is the money ratio or the velocity of money (income). Income (nominal GDP) to money stock or the number of the times the stock of money turns over in a given period in financing the flow of nominal income. This means that V is a useful concept in policymaking. A situation where a prediction can be made on the foregoing, it will lead to the ability that determines the desired real growth and inflation rate via the value of V that can be derived.

The number 3 equation also has growth form as well,
 $\Delta SM= \Delta P + \Delta Y+ \Delta V..... (4)$

If V is constant, then $\Delta V = 0$ so that (4) yields

$$\Delta SM = \Delta P + \Delta Y \dots\dots\dots (5)$$

and the CBN's monetary targeting is anchored on this relationship.

Base money is the operating target and is it linked to its nexus with the supply of money on the prediction of the impact of a stable money multiplier; k has given in the equation (6) below,

$$SM_2 = k BMS \dots\dots\dots (6)$$

Where SM_2 is the broad money supply, k is the money multiplier and BMS is base money. Thus, the CBN influences the supply of money by adjusting the amount of base money (Mordi, 2009). The monetary base can be increased by a rise in the government budget deficit, and when oil price increase also increases the Central Banks foreign assets. The available quantity of money is increased by an increase in the monetary base via the money multiplier in the economy. The increase in the available quantity of money impacts on the interest rate by reducing it and this increases aggregate demand and investment. (Sadeghi & Alavi, 2013). Monetary policy can be summarized thus; in the long-run money growth has a proportional relationship with inflation and output growth is orthogonal to money growth. There is an assertion that one of the most established postulations in monetary economics/finance and that is the link that expresses the fact that monetary policy might be stated as that; (1) money growth relates proportionally with inflation on one on one basis and (2) output growth is orthogonal to money growth in the long-run this "Quantity Theory" relationship seems firmly established at least since Friedman and Lucas (Tele and Uhlig, 2013; Okotori, 2017; 2019)).

Friedman (1963) posited that where the growth in money stock might be kept at a constant rate in relation to the rate of growth in output, inflation will be checked. While this articulation by Friedman has generated intense debate over the years as regards the constant k principle, the consideration of the money stock/output ratio portends to present a useful tool for macroeconomic stabilization. The position of McCallum and Nelson (2011) was that Friedman saw the QTM mainly as an exposition that describes the demand function of money. The earlier position of McCallum (1984) was that Friedman constant growth rule can be improved with an adjustable growth rule, where the money supply growth rate is controlled in line with the direction of output and also moved for fluctuations in the velocity of money, positing further that a measure like that will be more effective in impacting on aggregate demand (Okotori, 2019).

Nasser (2005) opined that in the conduct of an efficient monetary policy, countries whose financial markets are underdeveloped depend on existence of a demand function that rests entirely money and that this is stable. Monetary aggregates have been found to relate directly related with inflation (Oyejide, 1972; Adeyeye & Fakiyesi, 1980; CBN, 2007). There are many findings on developing countries, which see money growth as the most effective determinant of inflation (Owoye, 1997; Onwumere et al, 2012; Olanikpegun et al, 2013; Okotori, 2019). Ogbuagu et al (2014) posited that the money supply/GDP ratio or suitable price indexes can also be termed an increase in liquid money, and that an economy's depth is an indication of the level of development of the financial system (that is, the relative size of its banking system or stock market). Most research findings on factors that cause inflation in developing countries had

settled on the money demand function as the major cause of inflation and links monetary policy that is accommodative as creating disequilibrium in both markets that deal on goods and money, (Toujas-Bernate, 1996; Sacerdoti & Xiao, 2001; Nasser, 2005; Okotori, 2019). Tule et al. (2018) in their study confirmed empirically that broad money supply was still a major benchmark for monetary policy implementation in Nigeria.

2.2 Empirical Literature Review

The Lemmens et al (2008) adopted the granger causality test in their study, and the money rate (call) was used as the major monetary policy instrument. There was a bidirectional flow in causality for the rate of inflation, output and the policy rate, the foregoing tend to show that when considering policy, the monetary authority takes inflation into consideration in India. Alturki and Vtyurina (2010) attempted to show forecast inflation and its short and long-term dynamics for Tajikistan using VECM as well as ARMA methodology. The study found that the presence of excess liquidity (broad money supply) causes inflation; whether in the short or long run. Their findings further show that local prices are strongly impacted upon the rate of exchange and international inflation rate. The conclusion was for the monetary authority in Tajikistan to enhance the viability its toolkit by improving on the rate of interest channel to improve its effectiveness, as well as increase the usefulness of its monetary policy implementation and to achieve stable inflationary conditions.

Jabeen et al (2013) employed econometric methodology of a VDF (variance decomposition function) and an impulse response function and for the period that spanned from 1991Q1-2007Q4, the focus was to determine the reason behind Pakistan's missed inflation targets. It was discovered that the supply of money and the rate of exchange, price of crude oil in the world, as well as government credit from state bank originate shocks that create the inflation gap. The result from variance decomposition analysis shows that a major part of the variation in deviation from the target and this is revealed by the derived lagged values as well as variation in government loan from Central Bank.

Emerenini and Eke (2014) adopted monthly data from 2007-2014 to explore the causes of Nigeria's inflation. The rate of exchange, the monetary aggregate (M1) as well as the expected rate of inflation impacts on Nigeria's rate of inflation, but the annual value of the treasury bills rate and MPR were insignificant though rightly signed. The specified model exhibited features that showed that all the regressors explained 90 per cent of the movement in the inflation rate. The use of monthly data and using annual treasury bills rate may have affected the significance of the treasury bills rate in its traction on the inflation rate.

Chaudhry et al (2015) carried out a study that aimed at investigating the influence of the growth in money supply and its links to Pakistani the rate of inflation. The study period spanned 1973-2013 and the annual time series was employed in the analysis. The short and long run dynamics of money growth/inflation nexus shows that money growth impacts on the rate of inflation in Pakistan; being the main focus of this research. The ARDL test reveals a mix order of integration and this depended on the properties in the times series as regards the given data. Their findings show the importance of the long-run effect of the selected monetary aggregate and interest rate, but that the short-run dynamics of GDP, impacts more on the inflation rate. This brings

to fore the earlier postulation of watching money growth/GDP in tackling spikes in the inflation rate.

Kiganda (2015) carried out an empirical investigation to confirm the presence of a nexus between inflation and money supply in Kenya by seeking to determine the validity of the monetarist's theory; through the examination the nexus between expansion in of the amount of money and inflation in the Kenya economy. The results indicated a significant positive long-run linkage connecting the inflation rate to the supply of money in Kenya is significant error-correcting at 68 per cent annually. There was unidirectional causality established as flowing from the supply of money growth to the rate of inflation, thus validating the monetarist theory. The study found that the inflation rate has significant determinants such as the long run supply of money in Kenya. The findings were a validation of the Monetarist theory and the recommendation was for the Kenyan government to rely on a tight monetary policy anchored on the broad money supply to stabilize inflation.

Ngerebo (2016) examined the influence of the monetary authority's policy instruments in mitigating the negative effect of inflation. Times series data (annual) for the period 1985–2012 were adopted to carry out the analysis used to estimate the three multiple regression models drawn. Findings from the test show that while the MLR, TBR, MPR, NDC and PLR were found to be insignificant, but NCG, M1g, CPS, M1g, and SR were significant as factors that cause inflation as regards the Nigerian economy. These findings distinguish instruments of monetary policy on bases of their effectiveness controlling inflation. But there was no consideration of the combined impact of these tools on inflation.

Salunkhe and Patnaik (2017) estimated the causal relationship between the monetary authority's tool of choice and the achieving of targeted goals such as; GDP, and inflation pressures in India. Their results show that a bidirectional linkage exists; connecting the policy rate to inflation and output, this mean that India's monetary authority focuses on both inflation and output when articulation its monetary policy. The foregoing poses a policy dilemma as any attempt to mitigate a spike in the inflation rate impacts on the output and this affects the inflation rate; which in effect frustrates the growth process. There was found a positive nexus linking the output gap to inflation, as reported in earlier studies for India. Additionally, it was discovered that the impact of the output gap on inflation only existed in the short-to -medium-run. Similar experience also poses a policy dilemma and the need to bring inflation within the required threshold of 6-9 per cent.

Dany-Knedlik and Garcia (2018) investigated the path of the development as regards the dynamics of inflation in some five countries in Asia that spanned the period 1997-2017. The study attempted to account for monetary policy framework changes right from the Asian Financial Crisis (AFC). Country specific Phillip's curve was utilized, while allowing for time varying parameters. The findings show the presence of an increase focus of anticipatory moves; this shows an effective response in taking care of inflation expectations, which has improved monetary policy frameworks in Asia.

Opeyemi(2018) explored the monetary policy's usefulness as a tool in Nigeria inflation control. The research utilized the ADF test, Johansen cointegration and the ECM to evaluate the effect of the supply of money, the rate of interest and the rate of exchange on Nigeria's inflation dynamics. The findings from of the ECM revealed that

both the rate of interest and the supply of money are statistically significant in explaining variation in the rate of inflation, while the nexus linking the rate of inflation and the rate of exchange nexus was tenuous. The study concluded that the policy toolkit of the CBN has been successful in stabilizing the inflation rate in Nigeria.

Von Wyngard et al (2018) investigated whether the utilisation of the rate of interest and the supply of money by the monetary authority in South Africa, had been able to control the types of inflation that is typical to the country. An autoregressive distributive lag model was used to analyse the data for long-run co-integration while an ECM was utilized to analyze the short-run dynamics. The results from this study reveal that between the variables there was a long and short-run impact. There also the existence of cost-push as well as structural inflation in the South African economy, hence the current policy prescriptions seem to be ineffective on mitigating an inflation spiral or even spur growth in output.

This research is an attempt at validating previous findings and this creates avenues for further research in the considered subject area.

3.0 Methodology

This research employed quasi- experimental or Ex post facto as the investigation starts after the facts occurred (Okotori, 2017; 2019). Ex post facto design in its application is causal comparative and used when the researcher aims to establish the link that connects the independent and dependent variables in order show the causal link between them (Kerlinger, 1978; Onwumere, 2005). The population of study is time series data in research design depends on a sample of elements that a retrieved from a population of interest which is measured for the relevant period under consideration. These were applied as variables in this study for the required analysis, they are the inflation rate, supply of money (M2/GDP), the monetary policy rate, the rate of exchange, the cash reserve requirement, the treasury bills rate, and the statutory liquidity ratio. The study tries to show the real impact of the CBN's toolkit on inflation, by the use of these variables. Monthly time series data that spanned the period 1st January 2009 to December 2018. Adoption of this research design is based on the fact that historical data was retrieved from Nigeria's Bureau of Statistics and CBN statistical bulletin from 2009 to 2018), the reason being that the data is from events that have already occurred and cannot be controlled or manipulated by the researcher.

3.2 Model development and variable description

The mathematical model is based on the functional relationship as revealed below; from the theoretical and empirical literature review, we can see the possible existence of a nexus that links inflation and each of the regressors as considered in this research work.

3.2.1 Inflation

This has been referred to as a persistent increase in the average level of price in an economy. The findings of Deme and Fayissa (1995) found empirical evidence of the inflationary effects of money supply growth, (Okotori, 2017).

3.2.2 Bank reserve requirement (REQ)

The monetary authority in any nation would require deposit money banks to keep a predetermined amount of funds on hand against depositors' liabilities, according to the Board of Governors of the Monetary Policy Committee. Hence the apriori expectation is negative (-), (Okotori, 2017).

3.2.3 Broad money supply

The broad description of money supply refers to the total quantity of money in an economy at any given time period. Nuutilainen (2016) referred to the position of Milton Friedman that if money supply percentage growth rate in relation to GDP percentage growth is kept at a constant k , there will be no inflation. The CBN in 2008 opted to watch that ratio as a means of its monetary targeting regime. Hence, the broad money supply is proxied by this ratio. The apriori expectation is positive (+), (Okotori, 2017; 2019).

3.2.4 The rate of exchange (EXR)

The rate of exchange is the amount a particular fiat currency is exchanged for other currencies. Obadan (2012) stated that the CBN is the main regulator of the foreign exchange market and it monitors developments from time to time, issuing guidelines and circulars guiding the conduct of trading activities and operators so as to obtain the desired monetary policy objectives. Nwosa and Oseni (2012) established the causality that links effectively the rate of inflation and the rate of exchange is bi-directional in Nigeria as did Yinusa and Akinlo (2007), hence the apriori expectation is positive (+), (Okotori, 2017).

3.2.5 The monetary policy rate (MPR)

There is an established fact that banks borrow like every other corporate entity on a daily basis from each other and from their respective monetary authorities who set the baseline interest rate in the economy and every other interest rate adds on to it. That baseline rate of interest refers to the MPR. The MPR has an apriori expectation that indicates a negative relationship with the inflation rate (-), (Okotori, 2017).

3.2.6 The treasury bills rate (TBR)

Treasury bills are issued by the monetary authority as short-term investments and are referred to as being a relatively risk-free investment. The bills are purchased at a discount and are held until maturity date. Hence the apriori expectation is negative as regards inflation (-).

3.2.7 Liquidity ratio (LQR)

The liquidity ratio refers to the liquid assets to the liabilities ratio of a bank as stipulated by a country's monetary authority. These assets refer to the bank cash balance plus all other assets owned by the bank that can be easily converted into cash as against the liabilities owed by the bank, especially depositors' money in the bank. Where the liquidity ratio is high it has a contractionary impact on inflation. The apriori expectation is negative on inflation (-).

In this study, as stated earlier, we use monthly data from January 2009 to December 2018.

3.2 Mode specification

$$INF = a + b_1MS + b_2 EXR + b_3 MPR + e \dots\dots\dots (7)$$

$$INF = a + b_1TBR + b_2 REQ + b_3LQR + e \dots\dots\dots (8)$$

Where; INF= Inflation rate

MS= Money Supply (MS2/GDP ratio)

EXR= rate of exchange; MPR= Monetary policy rate; REQ= Reserve Requirement; TBR= Monthly Treasury bills rate; LQR= Liquidity ratio; LQR=Statutory liquidity ratio; e= Error term.

3.3 Method of data analyses

This research uses the VECM analysis. VECM is a form of VAR that this restricted VAR developed by Sims in 1980 as an alternative model from models Auto Distributed Lag (ADL) focussed on minimizing the theoretical approach to be able to explain economic phenomena as well (Widarjono, 2009), in VECM analysis consists of Stationarity; Cointegration and VECM tests.

4.0 Results and discussion of findings

Chapter three in this work had established two different models derived from theoretical and empirical studies and presented a detailed description of the utilized data. A monthly time series data was constructed from 200901-12-201801-12. There is a presentation of the results from data analysis and the subsequent results. The chapter looked at some trend and descriptive analysis, followed by stationarity test, Johansen cointegration test, some diagnostic tests, and finally, the vector error correction regression model for the factors that impact on inflation in Nigeria stated in the model.

4.1 Data presentation

Table 4.1 presents the statistical fact that describes all variables in the given model. This table reveals the maximum, minimum, mean, standard deviation, etc for each of the variables.

Table 4.1 Descriptive statistics for dependent and independent variables

Variables	Mean	Median	Max	Min	St. dev.	Obs.
INF	12.15500	11.90000	18.70000	8.000000	2.801496	120
MS	22.69873	19.88458	37.95685	18.92846	5.390517	120
EXR	196.7848	157.5704	327.4421	121.3633	63.99163	120
MPR	11.18342	12.00000	14.49653	6.130000	2.679152	120
TBR	14.88362	15.76708	20.00000	4.635833	4.280495	120
REQ	2.626036	2.078278	7.215400	0.180000	2.144389	120
LQR	45.18863	43.63182	65.20139	15.64306	12.17313	120

Source: Authors own computation using E-views

Central tendency is measured through the median and mean in the table above were computed with respect to each variable for 120 observations. The standard deviation reflects the sample's dispersion (spread) level for all the variables. According to the above table, the average inflation rate is 12.1% which means the consumer price index during the period under study is approximately 12%, while the supply of money (MS), the rate of exchange (EXR), the monetary policy rate (MPR), the treasury bill rate (TBR), the reserve require (REQ) and the liquidity ratio (LQR) recorded an average of 23 billion, 187 nairas, 11.2% 14.9% 2.6% and 45% respectively.

4.2 The Analysis

4.2.1 Multicollinearity test

Table 4.2(a) and (b) shows results for the variance inflation factor (VIF) and correlation matrix concerning all the regressors used in the analysis. Based on the findings, no multicollinearity was observed amongst the variables as a low inter-correlation was seen in the regressors, i.e. they were below the standard benchmark of below 0.80. Here we adopt another test to still determine for the presence of multicollinearity, with the variance inflation factor (VIF) calculated for the regressors as follows: $VIF (Bi) = 1 / (1-R^2)$, where R^2 is the squared multiple correlation coefficient between independent variables. When R^2 is equal to zero, the position of the VIF will be a minimum value of one (Maddala, 2001). The degree of multicollinearity will be lower if the value of the VIF is closer to one. In a situation where the value of the VIF is more than 10, this shows the presence of multicollinearity (Gujarati, 2004). From the results in table 4.2, all the values for the VIF are much lower than 10. The tests show that multicollinearity does not exist among all the regressors in the two given models.

Table 4.2a: Correlation matrix and variance inflation factors (model 1)

	MS	EXR	MPR
MS	1.000000		
EXR	-0.287848	1.000000	
MPR	-0.456491	0.729672	1.000000
VIF	1.270263	2.150568	2.491587

Source: Authors own computation using E-views

Table 4.2b: Correlation Matrix and Variance Inflation Factors (model 2)

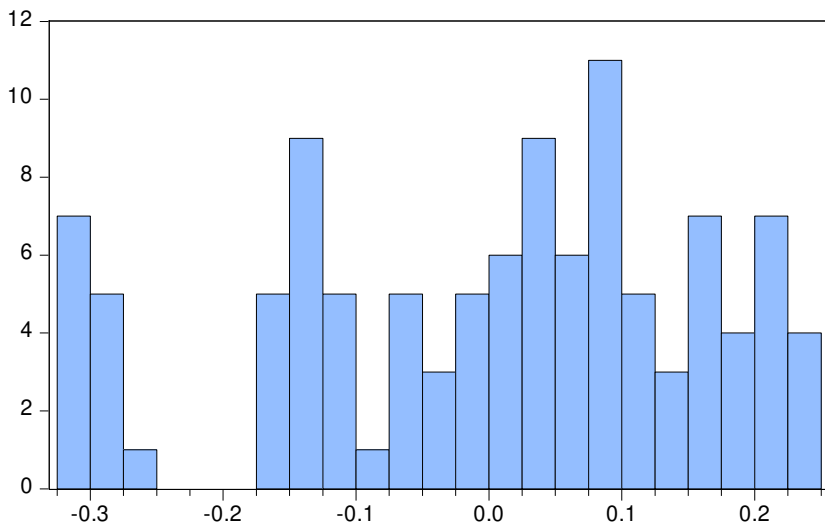
	TBR	REQ	LQR
TBR	1.000000		
REQ	0.410408	1.000000	
LQR	0.407841	0.613506	1.000000
VIF	1.261807	1.686831	1.682581

Source: Authors own computation using E-views

4.3 Normality test

The table 4.3 shows a summary of normality for all variables. The results show the mean, median standard deviation, maximum, minimum and the skewness of the variables. The probability and Jaque-Bera values shall be used as a measure to test the normality of the variables.

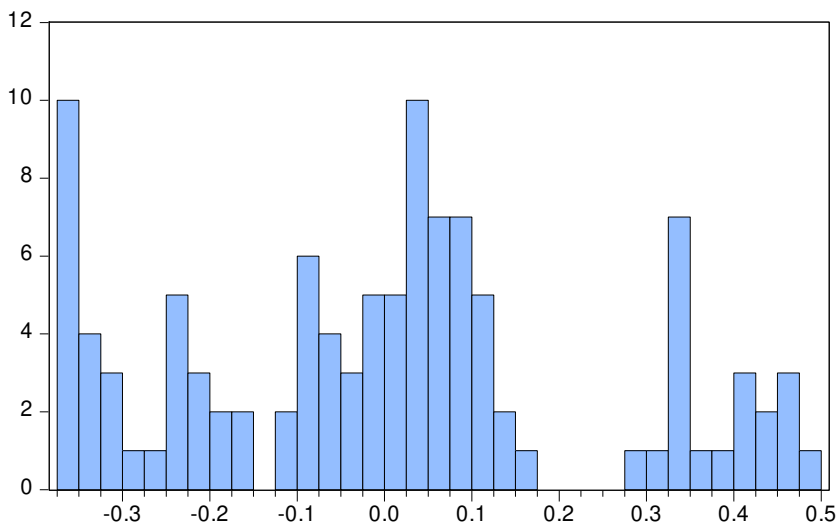
Table 4.3a: Normality test for model 1



Series: Residuals	
Sample 2009M01 2017M12	
Observations 108	
Mean	1.04e-15
Median	0.031826
Maximum	0.244830
Minimum	-0.318469
Std. Dev.	0.157735
Skewness	-0.491747
Kurtosis	2.297362
Jarque-Bera	6.574320
Probability	0.037360

Source: Authors own computation using E-views

Table 4.3b: Normality test for model 2



Series: Residuals	
Sample 2009M01 2017M12	
Observations 108	
Mean	2.14e-16
Median	0.008899
Maximum	0.483478
Minimum	-0.367854
Std. Dev.	0.238834
Skewness	0.236967
Kurtosis	2.301678
Jarque-Bera	3.205203
Probability	0.201372

Source: Authors own computation using E-views

4.4 Test of stationarity using ADF

The ADF test statistic is used in testing the null hypothesis that there is a unit root in a particular time series of interest. The ADF is not the only test available, but it represents a widely used approach in most of the data analysis. The test for stationarity (unit root test) is a in Table 4.4. The lag length used in the ADF test is based on minimizing the Schwarz Information Criterion (SIC), starting with maximum lag length.

Table 4.4 Stationarity test (ADF)

Variables	Augmented Dickey-Fuller Test			d (I)	Remark
	@ Levels	@ 1 st Diff.	@ 2 nd Diff.		
INF	-1.776	-3.593	-	I (1)	Stationary
EXR	-2.039	-4.355	-	I (1)	Stationary
LQR	-1.754	-6.797	-	I (1)	Stationary
MPR	-2.487	-6.913	-	I (1)	Stationary
MS	-2.752	-3.603	-	I (1)	Stationary
REQ	-0.836	-6.601	-	I (1)	Stationary
TBR	-1.200	-5.296	-	I (1)	Stationary
Test critical values	1% level	-4.038			
	5% level	-3.449			
	10% level	-3.149			

Source: Authors own computation using E-view

The results displayed in table 4.4 shows the ADF test results. The test results reveal that the null hypotheses as regards the stationarity test for the first and second difference series for all the variables (INF, MS, EXR, MPR, TBR, REQ and LQR) will not be accepted at 5% critical value, this shows that the series can become stationary at the first difference, hence is time dependent. Thus, reduced form models follow an integrating order of 1(1) process, respectively; and are, therefore, stationary at order. From the above result, the entire monetary policy instruments and macroeconomic variables have first difference stationarity. Furthermore, this indicates that the short-run static regression result is spurious and cannot be used for analysis. That is to say, all the variables are individually stationary and stable.

4.5 Cointegration Test

Cointegration reveals the presence amongst the adopted variables; a nexus that in the long run. Johansen's procedure is finite-order VAR's based on the maximum likelihood and is easily computed for these systems, as adopted in this study. The Johansen's approach is utilized based on it being VAR based and its efficiency when compared to other alternative approaches or methods. Below are the cointegration test results in table 4.5.

Table 4.5 Cointegration (Johansen) test

Unrestricted cointegration rank test (Trace)

Hypothesized	Trace	0.05		
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**

None *	0.409480	212.9156	125.6154	0.0000
At most 1 *	0.333528	152.3392	95.75366	0.0000
At most 2 *	0.290336	105.6771	69.81889	0.0000
At most 3 *	0.225392	66.23617	47.85613	0.0004
At most 4 *	0.170029	36.86540	29.79707	0.0065
At most 5	0.121992	15.43344	15.49471	0.0511
At most 6	0.004096	0.471966	3.841466	0.4921

Trace test indicates 5 cointegratingeqn(s) at the 0.05 level

Unrestricted cointegration rank test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.409480	60.57645	46.23142	0.0008
At most 1 *	0.333528	46.66209	40.07757	0.0079
At most 2 *	0.290336	39.44090	33.87687	0.0098
At most 3 *	0.225392	29.37076	27.58434	0.0292
At most 4 *	0.170029	21.43197	21.13162	0.0454
At most 5 *	0.121992	14.96147	14.26460	0.0387
At most 6	0.004096	0.471966	3.841466	0.4921

Max-eigenvalue test indicates 6cointegratingeqn(s) at the 0.05 level

Source: Authors own computation using Eviews

The results from table 4.5 shows there are five (5) cointegrating equations that are expressed in trace statistics and six (6) cointegrating equations in maximum Eigenvalue in the model. Since Johansen tests showed that the trace and maximal Eigen statistics show the existence of five (5) and six (6) cointegrating relationships between inflation (INF) and its explanatory variables at 5 per cent level of significance (Table 4.5). These results expose the existence of a long-run nexus connecting monetary policy dynamics and inflation in Nigeria. The fact that we have six cointegrating vectors; the normalization of the estimates of the unconstrained cointegrating vector on monetary policy instruments help give the economic interpretation of the long-run link connecting monetary policy instruments dynamics and inflation with respect to the economy of Nigeria.

4.6 Error Correction Mechanism (ECM)

The process of determining whether the variables are non-stationary at their levels, but stationary when differenced once; is followed by the formulation of the ECM. The basic idea behind the ECM is the resolve to recapture the lost long run based on the differencing of the variables. The ECM solves this by the use of an error correction term. Apriori expectation is the basis for the derivation of the error term.

The error correction term has enabled us to measure the adjustment speed at which the effect of the dynamics of the monetary authority's policy instruments and its long-run effect on inflation. It expresses the amount of errors due to disequilibrium that are recovered in the present time period. The findings have shown that the inflationary trends speed of adjustment to equilibrium in the long run is low for the two models estimated. Specifically, about 5 per cent and 9 per cent of errors due to the

disequilibrium, which occurred in the proceeding period, is corrected in the present time period.

Table 4.6 Parsimonious error correction model (ECM) 1

Dependent Variable: INF

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.061574	0.038054	-1.61807	0.1092
D(INF(-1))	0.504947	0.103098	4.897738	0.0000
D(INF(-3))	0.409507	0.100133	4.089631	0.0001
D(INF(-4))	-0.376274	0.10742	-3.50283	0.0007
D(MS)	0.061043	0.020539	2.972053	0.0322
D(MS(-2))	0.034404	0.005914	5.817382	0.0202
D(MS(-5))	-0.085471	0.112883	-0.75716	0.4510
D(EXR)	0.092214	0.030389	3.034453	0.0318
D(EXR(-1))	0.022108	0.010645	2.076844	0.0407
D(EXR(-2))	0.012241	0.010887	1.124369	0.2639
D(EXR(-5))	-0.014646	0.010049	-1.45746	0.1485
D(MPR)	-0.115745	0.048966	-2.36378	0.0486
D(MPR(-2))	0.043707	0.052663	0.829938	0.4088
D(MPR(-3))	0.054494	0.052772	1.032631	0.3046
D(MPR(-5))	0.064519	0.051011	1.264806	0.2092
ECM1(-1)	-0.145535	0.065796	-2.21191	0.0049

R-Square = 0.7138, F-statistic = 9.2498, Prob(F-stat) = 0.0000, D-W = 2.0606

Source: Authors own computation using Eviews

From the above result the error correction coefficient has the expected sign and is significant at 5 per cent level. The result revealed that about 14 per cent of the error that occurs in the last period will be corrected. Furthermore, the derived coefficient of determination i.e. the R^2 of the estimated model indicates that about 71 per cent of the variations in the consistent spike in the price of goods and services are affected by the dynamics through all the regressors (the broad money supply, the rate of exchange and the nominal rate of interest i.e. MPR). The F-Statistics is 9.2498, which is bigger than the table value of 5 per cent level. Both coefficient of determination (R-square) and F-statistics show that the overall regression model is significant at 5 per cent levels. Furthermore, given the DW value of 2.06, there was no suggestion of serial or autocorrelation problems.

As shown in the table, money supply (MS) and exchange rates are connected to the rate of inflation in a positive way at 5 per cent level of significance. This result is in agreement with a priori and theoretical expectation. The result revealed that if the money supply increases by 100 per cent price level (general) will increase also by 6 per cent ceteris paribus. Likewise, a rise in the price of the dollar by 100 per cent will also increase the general price level in Nigeria by 9 per cent of all things being equal.

The rate of interest (MPR) impacts negatively on the rate of interest in Nigeria and is significant (statistically) at 5 per cent level. That is if the cost of borrowing increase by 100 per cent, it will increase the price of goods and services by 11 per cent of all things being equal.

Table 4.7 The parsimonious error correction model (ECM) 2

Dependent Variable: INF

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.013455	0.038626	-0.348340	0.7284
D(INF(-1))	0.587601	0.104748	5.609663	0.0000
D(INF(-2))	0.159177	0.11128	1.430418	0.1561
D(INF(-3))	0.396122	0.105781	3.744736	0.0003
D(INF(-4))	-0.425855	0.11156	-3.817273	0.0002
D(TBR)	0.066136	0.017434	3.793506	0.0490
D(TBR(-1))	0.112026	0.105188	1.065007	0.2898
D(TBR(-5))	-0.097861	0.098166	-0.996893	0.3215
D(REQ)	-0.073009	0.034465	-2.118351	0.0109
D(REQ(-3))	-0.014098	0.268299	-0.052545	0.9582
D(REQ(-5))	0.025102	0.23192	0.108235	0.0825
D(LQR)	0.043461	0.014421	3.013729	0.0276
D(LQR(-2))	0.038493	0.026698	1.441793	0.0511
D(LQR(-5))	-0.010445	0.024023	-0.434791	0.0648
ECM2(-1)	-0.323225	0.116361	-2.777777	0.0593

R-Square = 0.6855, F-statistic = 8.0831, Prob(F-stat) = 0.0000, D-W = 2.0217

Authors own computation using E views

The parsimonious ECM is obtained from an over parameterized model as given above presented above. The examination of the econometric models in Table 4.7 above shows that the treasury bill rate, required reserve requirement and liquidity ratio variables explain 69% of the total variations in inflation rate in Nigeria. This is indicated by the values of the R2 (0.6855).

The fact that the F-values of 8.0831, indicates that the regression is significant (statistically) and Durbin–Watson statistics of 2.02 reveals there is serial autocorrelation. From Table 4.7, we see that all the variables are rightly signed according to apriori expectation and are significant both at 5 per cent levels of significant. The ECT coefficient was found to be significant statistically with a negative sign. The correction term coefficient is negatively signed and statistically significant. However, the rate which the dynamic relationship is restored to equilibrium is slow, that is 32 per cent of the long run adjustment to equilibrium inflation rate is expected to occur. The implication of the foregoing is that there will be a misspecification of the underlying process if the ECM for time series that is non-stationary time series. This is needed in order the real stability of the economy of Nigeria.

4.7 Test of hypotheses

The model that was tested:

$$INF = a + b_1MS + b_2 EXR + b_3 MPR + e$$

$$INF = a + b_1TBR + b_2 REQ + b_3LQR + e$$

$$H_0 - b_{1-3} = 0$$

$$H_1 - b_{1-3} < 0$$

Decision rules, (1) where the calculated t is bigger when compared to the table value, the null hypothesis will be rejected, while the alternative hypothesis will be accepted. (2) When the 5 per cent level of significance is lower than the p-value, we reject the null hypothesis and accept the alternative hypothesis. The p-value for model 1 is as follows; MS-0.03, EXR-0.0318, MPR-0.0486 and model 2 was TBR-0.0490, REQ-0.0109, and LQR-0.0276. The results show that the null hypotheses are rejected for both models.

4.7.1 The F-test:

The F-statistics measures the total significance of all the independent variables in explaining the dependent variable. The F-statistics value must be less than 50 per cent for all the variables to be significant. Model 1 has a $F=9.2498$, and model 2 is $=8.0831$.

4.7.2 Goodness of fit test (R^2):

This reveals that the dependent variable (endogenous variable) is explained by all the independent variables. For model 1 & 2 is 0.7138 and 0.6855 respectively. This shows that for model 1 & 2, the dependent variables are explained by the independent variable to the magnitude of 71% AND 69% approximately.

5 Conclusion and recommendations

5.1 Conclusion

The results from analysis of the two models show that the alternative hypotheses indicate a significant link between monetary policy tools impact in the stabilization of inflation in Nigeria. The forgoing is indicated by the various p-values of the regressors at 5 percent level of significance. F-Statistics show that the overall significance of all the independent variables do explain adequately the dependent variable. The R^2 for the two models point to the fact that the endogenous (dependent variables) were well explained by all the independent variables or regressors adopted in the study. Conclusively, the results show a nexus that links the inflation rate and selected monetary policy instruments as the determinants of the inflation rate, namely, broad money supply, the rate of exchange, monetary policy rate, Treasury bill rates, reserve requirement, and liquidity ratio. Monetary policy measures when deployed seem to have had traction on the economy via its impact on macroeconomic variables like inflation. Adopting a monetarist approach, the CBN should invest more in this observed relationship. But the conclusions of De Grauvre and Polan (2005) should make the CBN consider the anomalous behaviour of the inflation/ money supply growth nexus in that when the inflation target (6-9%) is reached the dynamics also changes.

5.2 Recommendation

The CBN had over the period not been aggressive enough as regards its monetary policy stance in seemingly factoring GDP growth projections in its stabilization moves. At the high of the spike in the inflation rate in 2015/16 Ghana had about +3% real interest rate, while Nigeria had about -3% real interest rate. The CBN should be more aggressive in bringing inflation within the 6-9% inflation threshold that is growth inducing. The impact of instruments within the CBN's toolkit is not an assumption, but an empirically proven fact. The study had been able to show by its use of monthly date that there is a strong link between inflation stabilization and the adopted monetary

policy instruments in the CBN's toolkit. The study on monetary policy and inflation nexus is dynamic and not static, it is fluid and evolving, hence the need to determine the relationship over periodic intervals. There is need to address the issues that relate to the optimal policy stance that takes care of output growth and the management of inflation; this is an area for further study.

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