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The Dynamics of Monetary Policy and Inflation in Nigeria

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Abstract: *This study evaluated the dynamics of monetary policy and inflation in Nigeria. Monthly data from 2009-2017 were used to estimate the model derived. The Augmented Dickey-Fuller (ADF) unit root test, Johansen Cointegration test and Error Correction model (ECM) were adopted. The findings of the ADF revealed that except for money supply and exchange rate that are integrated at order two1(2), all other variables are stationary at order one 1(1). The Johansen Cointegration test reveals the presence of a long run relationship between inflation and all the variables adopted. The ECM result for the two estimated models show a self-equilibrating mechanism of 5.2% and 9.4% for the first and second models respectively. The findings brought us to the conclusion that money supply, exchange rate, monetary policy rate, treasury bills rate, reserve requirement and liquidity ratio have significant and effective impact on the inflation rate. Based on the foregoing, it is recommended that the CBN stay focused on its current foreign exchange rate policy as well as making an unrestricted use of the monetary policy tools in its attempt to arrive and remain at the 6-9% inflation threshold for Nigeria.*

Keywords: *CBN, ECM, exchange rate, inflation rate, monetary policy rate, money supply.*

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I. Introduction

Progress made in science and technology has brought countries all over the world into greater economic cooperation and integration. The impact of this integration can be felt in the closer economic integration of various countries in the world. Thus, "…no country is immune to external economic shocks which cause fluctuations of macroeconomic variables like output and inflation (Gajic, 2012 [1]; Okotori, 2017[1]). Inflation which is a sustained rise in general price levels in itself cannot be said to be adverse, but its rate of increase must fall within levels and bands that are peculiar to each country as regards its inflation threshold. De Grauve and Polan (2005[1]) observed that this country specificity increases as inflation increases.

Inflationary pressures in Nigeria are revealed through increases in prices of commodities in the country and these increases have drawn the attention of those who are in charge of the economy (Orubu, 2009[2]).The foregoing is controlled via macroeconomic policy which has two basic strands; (i) monetary policy and (ii) fiscal policy, though the International Monetary Fund (IMF) adds structural reforms as a third strand to complete an effective triad for macroeconomic stabilization.

Monetary policy is the use of money supply or interest rates to achieve macroeconomic goals, while fiscal policy deals with the use of tax revenue to influence economic activities in a country. Ajie et al (2007[1]) did state that macroeconomic policy has been the main tool for achieving output stabilization in the short run and a diversified self- sustaining economic growth in the long run.

Buiter (2014)[1] observed concerning the monetary/fiscal policy dichotomy that the unwillingness or inability of governments to use countercyclical fiscal policy measures has left monetary policy as the only tool in town. The economic and financial situation of a country is said to be based largely on the monetary policy being implemented in the country, (Ahiabor, 2013[3]).The Central Bank of Nigeria (CBN) had commenced the use of the monetary policy rate (MPR) as its main tool of stabilization by 2009 in an inflation targeting regime (Job, 2009[4]). In 2014 it seems the bank had soft pedaled on that move (Bassey & Essien, 2014[5]).

The CBN promised that open market operations (OMO), remained the main instrument of monetary policy, to be complemented by reserve requirement and discount window operations as well as the monetary policy rate (MPR) (Central Bank of Nigeria [CBN], 2015[2]; Okotori, 2017). The main thrust of the CBN's strategy for 2014/2015 was monetary targeting as well as a close monitoring of growth in money supply (MS). Policy makers don't need only to specify a set of objectives in order to succeed, but they need to understand the effects of policies designed to arrive at those objectives (Altavila & Ciccarelli, 2009[2]).

There is a need to investigate whether these monetary policy variables actually had the impact as stated in apriori expectation when tested empirically; (i) did the monetary policy variables adopted by the CBN have the desired significant effect on the inflation rate? (ii) did the combined effect of these variables have the desired

significant impact on the inflation rate? When there is a potent monetary policy instrument, it is expected that contractionary monetary policy shocks should be able to reduce inflationary pressure (Bonga-Bonga, 2017[3]).

1.1 Research Hypotheses

We did consider the following hypotheses that were tested in this research;

H_{01}: Bank reserve requirement movement has not made any significant impact in reducing the inflation rate over the period under study.

H_{02}: Broad money supply has no major impact in bringing down the rate of inflation.

H_{03}: The exchange rate movement has no significant effect in checking a spike in the inflation rate for the period under study.

H_{04}: Monetary policy rate has no significant effect in checking a spike in the inflation rate.

H_{05}: The treasury bills rate does not have a significant effect in restraining an increase in the inflation rate

H_{06}: The liquidity ratio has no significant effect in restraining an increase or decrease in the inflation rate

The rest of the study is divided into, Literature review, Data and Methodology, Data analysis and finally the conclusion of the study.

II. Literature Review

2.1 Conceptual Framework

Inflation refers to a situation whereby in the economy too much money is chasing too few available goods and services. Hamilton (2001)[2] saw inflation as an economic situation where the increase in the money supply is more than the additional output of goods and services produced in the economy. The impact of inflation is fare reaching because of its potentials to both influence positively as well as negatively any economy, hence the effort to control it via monetary policy (Okotori, 2017).

Monetary policy is the use of money supply to deliberately influence the economy in order to achieve some combination of inflation and output stabilization (Wrightsman, 1976[3]; Mathai, 2012[4]).The adjustment of money supply by the Central Bank is to avoid monetary disequilibrium, hence, monetary policy attempts to offset changes in money demand with changes in money supply (Salter,2014[5]).

2.2 Theoretical Framework

Keynesian analyses sees Demand pull inflation as the most important factor that raises the price level as rising quantity of money that is not accompanied by proportionate increase in output. The resulting negative output gap according to Frank and Bernanke (2003)[4] occurs from excessive aggregate demand that is expansionary and result in increased pressure on prices. There is also the Supply or Cost push inflation view that states that inflation arises based on supply side factors such as import or raw material prices, unit wage costs and various elements that are part of the cost of production (Riley, 2011[4]). Nguyen et al (2015)[5] discovered that in Non- CFA sub Saharan countries (including Nigeria) supply shocks account for 45% of inflation fluctuations, while Demand pull shocks account for 55% of total fluctuations.

Modern quantity theorists of the neo-classical school of economic thinking see inflation purely as a monetary phenomenon and that this occurs only as a result of a more rapid expansion in the quantity of money more than in output (Friedman, 1956[5]; Okotori, 2017). Friedman (1963)[6] was more explicit when he postulated that if the money stock growth rate is kept at a constant rate in relation to output growth rate, inflation will be checked. Though the Friedman exposition on a constant k principle was controversial, yet the money stock/ output ratio seem to be an effective way of looking at attempts at curtailing an inflationary spiral in the economy.

McCallum and Nelson (2011)[6] revealed that Friedman preferred to regard the quantity theory of money as a proposition exclusively about the demand function of money. McCallum (1984)[6] had suggested that Friedman constant growth rule can be improved with an adjustable growth rule, where the money supply growth rate is adjusted for changes in output and corrected for irregular changes in the velocity of money, declaring that such a rule would have stronger and automatic, countercyclical effect on aggregate demand. Nasser (2005)[7] observed that countries with underdeveloped financial markets generally rely on the existence of a stable money demand function in conduct of efficient monetary policy. In Nigeria, inflation is said to be directly related to monetary aggregates (CBN, 2007[8]; Oyejide, 1972[7]; Adeyeye & Fakiyesi, 1980[9]).In many developing countries, studies show that one of the dominant predictors of inflation is the growth of money (Onwumere et al, 2012[6]; Owoye, 1997[8]; Olanikpekun et al, 2013)[9].

The opinion of Ogbuagu et al (2014)[10] is that an increase in the ratio of money supply growth to GDP ratio or some price indexes can be referred to as liquid money increase, that the degree of financial development is generally measured by an economy's depth (that is, the relative size of its banking system or stock market). The literature on determinants of inflation in developing countries postulates a money demand function and this

is said to specify how expansionary monetary policy creates disequilibrium in the money and goods market, (Nasser, 2005; Toujas-Bernate, 1996[8]; Sacerdoti & Xiao, 2001[9]).

Mordi (2009)[9] saw the underpinning theory as the quantity theory and that was the basic reason the CBN in its monetary policy framework targets money. The operating target, base money is set on the relationship between money supply and base money and this is based on the assumption of a stable money multiplier k, which is illustrated as follows;

M2=kBM

Where M2 is broad money supply, k is the money multiplier and BM is base money.

The impact of the foregoing was well illustrated by Yu and Ming (2001)[7] that when the monetary authority adjusts the monetary base, then the financial fields will experience changes in money supply and interest rates leading to lending activities of deposit money banks and the financial situation of financial markets .In summary, monetarism suggests that in the long run prices are mainly affected by the growth rate of money, while having no real effects on economic growth. That if the growth in the money supply is higher than the economic growth rate, inflation will result (Assenmacher-Weche & Gerlach, 2006[11]).There is therefore the claim that in order to control inflation monetary policy must be used (Adalid & Detken, 2007[10]; Barro & Grilli,1994[7]; Markin, 2010[8]). Kilindo(1997)[12] opined that monetarist approach that money supply growth causes inflation can be tested by observing the correlation between the rate of inflation and the rate of monetary growth and that causality can be determined by statistical analysis and institutional evidence.

2.3 Tools of Monetary Policy

Table 2.1Monetary Policy Tools, Targets & Goals

Policy Instruments	Operating Targets	Intermediate Targets	Goals
Open Market Operations Discount rate Reserve Requirement	Short term Interest rate Reserve Money (Monetary Base) Required Reserve Non-borrowed reserves etc	Monetary Aggregates (M1, M2 etc) Interest rates (short & long term) Aggregate demand	Low unemployment rate Low inflation rate Financial market stability Stable exchange rate

Source-(Handa, 2009[8]; CBN, 2011a[11]; Okotori, 2017)

The Central Bank of Nigeria [CBN] (2011a) identified three issues that arise in its selection and use of the goals, intermediate variables, operating targets and instruments;

(i)Effort at establishing the existence or otherwise of a stable and predictable relationship between the ultimate goal variable, intermediate variables and operating targets.

(ii)Determine if the monetary authorities can actually achieve the desired level of the operating target with the instruments at their disposal.

(iii)Establishing the nature of the lag structure (short or long i.e. when a policy is made, implemented and when its effect is felt) which has the implication of influencing prediction of the future course of the economy as it becomes increasing less precise in the case of long lags, (Okotori, 2017).

The Central Bank of Nigeria's (CBN) use of monetary targeting is still its preferred monetary policy framework in Nigeria and this is based on its capacity in enabling the CBN handle domestic issues and the ability to immediately signal its policy stance (Okoroafor, et al (2018)[13].

2.4 Empirical Review

The preference for monetary policy over fiscal policy was revealed by Ajisafe and Foloronso (1999)[14] for the period 1970-1999 concerning the Nigerian economy, their finding was that monetary policy had a greater impact on economic activity than fiscal policy as was later confirmed by Adefeso and Mobolaji(2010)[15].

Simwaka et al (2012)[16] examined the relative importance of monetary factors in driving inflation in Malawi, using a stylized inflation model specification which included standard monetary variables, exchange rate and supply side factors. The results indicate that inflation in Malawi is as a result of both monetary and supply side factors, exchange rate adjustments played a relatively more significant role in fueling cost push inflation. Onwachukwu (2014)[12] using times series data from 1970 to 2010 employed the ordinary least squares(OLS) to estimate the model, found that the bank rate, deposit with the Central Bank, liquidity ratio and

broad money supply are statistically significant in explaining changes in inflation in Nigeria.

Gbadebo and Mohammed (2015)[17] explored the relationship between inflation and monetary impulses, adopting cointegration and error correction method approach on quarterly times series data spanning from 1980 Q1 to 2012 Q4. Their finding was that interest rate, exchange rate, money supply and oil price are the major causes of inflation in Nigeria. That the money supply variable shows a significant positive impact on inflation both in the short and long run. Hence, Nigeria's inflationary situatiation is driven by monetary impulses. While this is revealing there is the need to identify individual variable significance and the quantum impact of the combined variables that are operating and intermediate targets of the CBN.

Chuku(2015)[18] used structural Vector Autoregression (SVAR) model to trace the effects of monetary policy shocks on output and prices in Nigeria, found evidence that monetary policy innovation carried out on quantity based nominal anchor (M2) has modest effect on output and prices with a very fast speed of adjustment. While shocks on price based anchors (MRR and REER) has neutral and fleeting effects on output, concluding that the CBN should lay more emphasis on using quantity based nominal anchors. But Naoyuki et al (2012)[19] though discovered through their empirical analysis a strong support for the optimality of monetary over interest rate instruments, yet suggested that a combination of both instruments is superior to the two used separately. Tule et al(2015)[13] discovered that money supply as a policy instrument has a weakening effect on inflation in Nigeria, attributing this to the increasing sophistication of the Nigerian economy.

Emerenini and Eke (2014)[20] in investigating the determinants of inflation in Nigeria using monthly data from January 2007 to August 2014 adopted ordinary least squares (OLS) method and found that expected inflation, exchange rate and money supply influenced inflation, while annual treasury bills and monetary policy rate though rightly signed did not influence inflation in Nigeria within the period of investigation. The estimated model displayed that all the explanatory variables used for the analyses accounted for 90% variation in explaining the direction of inflation as regards its increase or decrease. The cointegration test showed that a long run relationship existed among the variables and they were stationary at order one 1(1). Though the analyses used monthly data for almost all the variables, the use of annual data for a very useful tool of monetary policy that is issued almost weekly in open market operation will tend to limit the predictive capacity of the annual treasury bills rate data employed. It might not adequately answer the two questions that were raised in this study; (i) did all the variables adopted by the CBN have a significant effect on the inflation rate? (ii) did the combined effect of all the variables have impact on the inflation rate?.The conclusion of Fatukasi(2015)[21] was that the causes of inflation in Nigeria are multidimensional, requiring a full knowledge at any point in time to be able to proffer solutions to inflationary trends in the economy(Okotori, 2017). This choice of policy instruments mix to be adopted in any given economic environment is hence very important..

III. Data and Methodology

The research employed quasi- experimental or ***Ex post facto*** as the investigation starts after the facts occurred (Okotori, 2017). The use of this research design is based on the fact that historical data was sourced from the National Bureau of Statistics and Central Bank of Nigeria statistical bulletin from 2009 to 2017), the fact is that the data is from events that have already occurred and cannot be controlled or manipulated by the researcher. ***Ex post facto*** design in its application is causal comparative and used when the researcher aims to establish between the independent and dependent variables with a view to establishing the causal link between them (Kerlinger, 1978[9]; Onwumere, 2005[10]). Multiple regression analyses of the ordinary least squares (OLS) is the estimation technique that is employed in this study to determine the effect of monetary policy on inflation in Nigeria.

3.1 Mode Specification

$INF=a+b_1MS +b_2 EXR +b_3 MPR + e$ (1)

$INF=a+b_1TBR +b_2 REQ +b_3LQR + e$ (2)

Where;
INF= Inflation rate
MS= Money Supply (MS2/GDP ratio)
EXR=Exchange rate
MPR= Monetary policy rate
TBR= Monthly Treasury bills rate
REQ= Reserve Requirement
LQR= Liquidity ratio
e= Error term

3.4 Description of variables

3.4.1 Inflation

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

3.4.2 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).

3.4.3 Money Supply

Money supply is the amount of money in circulation in an economy at any given time period. Nuutilainen (2016)[2] 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 use of that ratio as a proxy for Broad money supply. The apriori expectation is positive (+), (Okotori, 2017).

3.4.4 Exchange Rate (EXR)

Exchange rate is the price of a currency in terms of other currencies. Obadan (2012)[10] 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 in order to achieve the desired monetary policy objectives. Nwosa and Oseni(2012)[22] established empirically a bi-directional causality between inflation and exchange rate in Nigeria as did Yinusa and Akinlo(2007)[23] , hence the apriori expectation is positive (+),(Okotori, 2017).

3.4.5 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 add on to it. That baseline interest rate is the monetary policy rate. . The monetary policy rate (MPR) is expected to have a negative relationship with the inflation rate (-), (Okotori,2017).

3.4.6 Treasury Bills Rate (TBR)

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

3.4.7 Liquidity ratio (LQR)

The liquidity ratio refers to the ratio of liquid assets to the liabilities of a bank as stipulated by a countries monetary authority. These assets refer to the banks 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 aprioi expectation is negative on inflation(-).

IV. Data Analyses and Results

Chapter three in this work had established two different models derived from theoretical and empirical studies and presented a detailed description of the data used in this study. A monthly time series data was constructed from $2009_{01\text{-}12}$- $2017_{01\text{-}12}$. This Chapter presents the data analysis and results. The chapter looks at some trend and descriptive analysis, stationarity test, Johansen cointegration test, followed by some diagnostic tests, and finally, the vector error correction regression model for the determinants of inflation in Nigeria stated in the model.

4.1 Descriptive Statistics

Table 4.1 presents the summary of descriptive statistics for all variables. This table reports the mean, standard deviation, maximum, minimum and the number of observations for each of the variables.

Table 4.1Descriptive Statistics for Dependent and Independent Variables

Variables	Mean	Median	Max	Min	Stdev	Obs.
INF	12.15741	12.00000	18.70000	8.000000	2.921471	108
MS	23.03970	20.18927	37.95685	18.92846	5.580591	108

EXR	184.6405	157.4075	327.4421	121.3633	55.36718	108
MPR	10.87046	11.71451	14.49653	6.130000	2.644673	108
TBR	14.92069	16.25375	20.00000	4.635833	4.512610	108
REQ	2.116107	1.856748	6.584149	0.180000	1.577825	108
LQR	42.98737	42.39496	65.20139	15.64306	10.76548	108

Source: Authors own computation using E-views

The mean and median in the table above were computed to find the central tendency of each variable for 108 observations. The standard deviation indicates the sample's dispersion (spread) level of 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 money supply (MS), Exchange rate (EXR), monetary policy rate (MPR), treasury bill rate (TBR), reserve require (REQ) and liquidity ratio (LQR) recorded an average of 23 billion naira, 185 naira, 10.8% 14.9% 2.1% and 43%.

4.2 Multicollinearity

Table 4.2(a) 4.2(b) presents the correlation matrix and variance inflation factor (VIF) for all the independent variables used in the analysis. According to the results, there are no multicollinearity problems among the variables since the inter-correlations among the explanatory variables are low i.e. below 0.80 as the bench mark. To check further, another diagnostic test for multicollinearity is used, with the variance inflation factor (VIF) calculated for independent variables 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, then VIF has its minimum value of one (Maddala, $2001_{[11]}$). Therefore the closer the value of VIF to one, the degree of multicollinearity is lower. If one of the VIFs is greater than 10, then the multicollinearity is a problem (Gujarati, $2004_{[12]}$). Based on the results in table 4.2, all the VIF values are much lower than 10. Therefore there is no multicollinearity problem among the independent variables in model one and two.

Table 4.2a: Correlation Matrix and Variance Inflation Factors (model 1)

	MS	**EXR**	**MPR**
MS	1.000000		
EXR	-0.222125	1.000000	
MPR	-0.423811	0.688158	1.000000
VIF	1.217482	1.802546	2.072590

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	0.615220	1.000000	
LQR	0.503461	0.381560	1.000000
VIF	2.133199	2.056966	1.500867

Source: Authors own computation using E-views

4.3 Normality Test

Table 4.3 presents the summary of normality for all variables. This result reports 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*

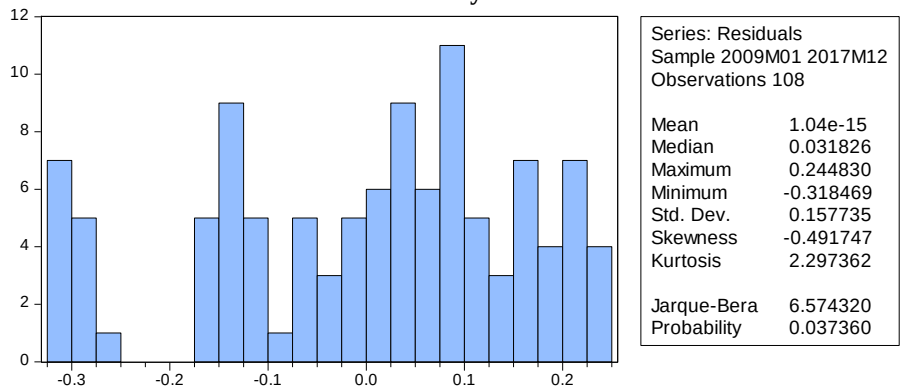
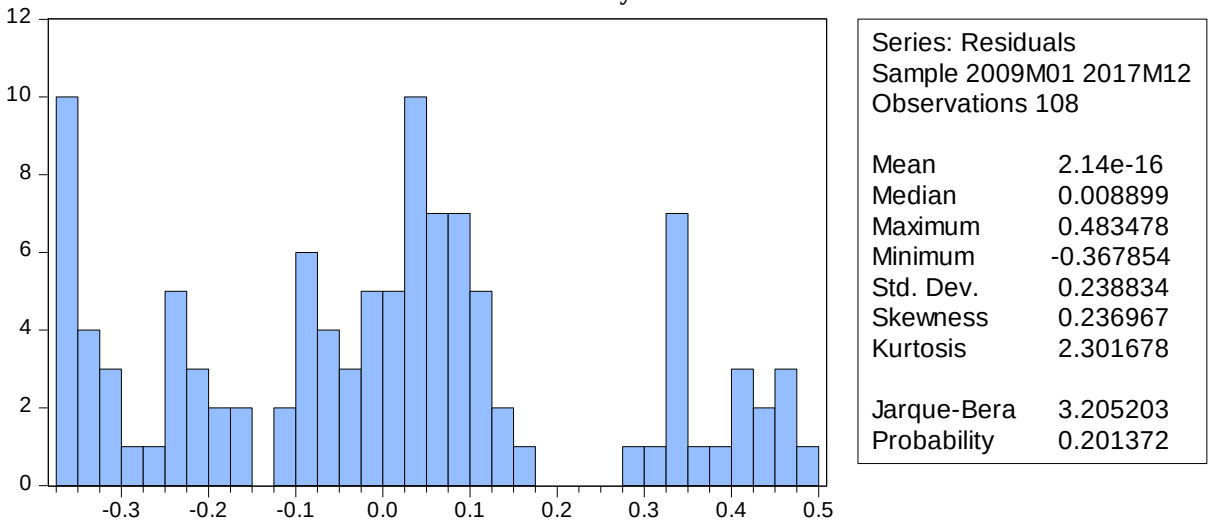


Table4.3b: Normality Test for model 2



Source: Authors own computation using E-views

From the above table the result shows that the variables are normally distributed because the value of the Jaque-Bera test statistic is greater the table value. Likewise the probability value is less than 5% which is statistically significant. Therefore the null hypothesis is rejected which state that the variables are not normally distributed.

4.4Test of Stationarity using ADF Unit Root Test

The Augmented Dickey–Fuller 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 widely used approach in most of the data analysis. The unit root tests are presented 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 Unit Root Test (ADF)

Variables	Augmented Dickey-Fuller Test			d (I)	Remark
	@ Levels	@ 1st Diff.	@ 2nd Diff.		
INF	-1.868245	-3.700142	-	I (1)	Stationary
MS	-2.754693	-2.752401	-11.11293	I (2)	Stationary
EXR	-1.226147	-2.358041	-7.779161	I (2)	Stationary
Log(MPR)	-2.470337	-9.950769	-	I (1)	Stationary
Log(TBR)	-1.852133	-4.268595	-	I (1)	Stationary
Log(REQ)	-0.662592	-9.591457	-	I (1)	Stationary
Log(LQR)	-1.678179	-9.821363	-	I (1)	Stationary
	1% level	-4.049586			
Test critical values	5% level	-3.454032			
	10% level	-3.152652			

Source: Authors own computation using E-views

Table 4.4 above presents the summary results of the ADF unit root tests. The results show that the null hypotheses of a unit root test for first and second difference series for all the variables (INF, MS, EXR, TBR, REQ and LQR) can be rejected at 5% critical value, indicating that the level series which is largely time-dependent and non-stationary can be made stationary at the first and second difference. Thus, the reduced form models follow an integrating order of 1(1) and I (2) process, respectively; and are, therefore, stationary at order one and two. 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 analysis helps to clarify the long-run relationship between integrated variables. Johansen's procedure is the maximum likelihood for finite-order vector autoregressions (VARs) and is easily calculated for such systems, so it is used in this study. The Johansen's technique was chosen not only because it is VAR based but also due to the evidence that it performs better than single equation and alternate multivariate methods. The results of the Cointegration test are presented in Table 4.5.

Table 4.5 Johansen Cointegration test
Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.358655	206.9034	125.6154	0.0000
At most 1 *	0.309236	161.1520	95.75366	0.0000
At most 2 *	0.298616	123.0465	69.81889	0.0000
At most 3 *	0.283290	86.51246	47.85613	0.0000
At most 4 *	0.244853	52.20476	29.79707	0.0000
At most 5 *	0.199669	23.27796	15.49471	0.0028
At most 6	0.003265	0.336830	3.841466	0.5617

Trace test indicates 6 cointegrating eqn(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	0.358655	45.75136	46.23142	0.0562
At most 1	0.309236	38.10550	40.07757	0.0820
At most 2 *	0.298616	36.53408	33.87687	0.0235
At most 3 *	0.283290	34.30770	27.58434	0.0059
At most 4 *	0.244853	28.92679	21.13162	0.0033
At most 5 *	0.199669	22.94113	14.26460	0.0017
At most 6	0.003265	0.336830	3.841466	0.5617

Max-eigenvalue test indicates 4 cointegrating eqn(s) at the 0.05 level
Source: Authors own computation using Eviews

The above result revealed that there are six (6) cointegrating equations in the model. Since Johansen tests showed that the trace and maximal Eigen statistics reveals the existence of six and four cointegrating relationships between inflation (INF) and its determinants at 5% level of significance (Table 4.5). The conclusion drawn from this result is that there exist a unique long run relationship between monetary policy variables and inflation in Nigeria. Since there are six cointegrating vectors, an economic interpretation of the long-run relationship between monetary policy dynamics and inflation in Nigeria can be obtained by normalizing the estimates of the unconstrained cointegrating vector on monetary policy instruments.

4.6 Error Correction Mechanism (ECM)

Having ascertained that the variables are non-stationary at their levels but stationary after differencing once, and that they are cointegrated, the stage is set to formulate an error correction model. The intuition behind the error correction model is the need to recover the long-run information lost by differencing the variables. The error correction model rectifies the problem by introducing an error correction term. The error correction term is derived from the long-run equation based on economic theory.

The error correction term enables us to gauge the speed of adjustment of the impact of monetary policy variables to its long-run effect on inflation. It gives the proportion of the disequilibrium errors accumulated in the previous period which are corrected in the current period. The results show that the speed of adjustment of inflationary trend to long-run equilibrium path is very low in model one and two. Specifically, about 5% and 9% of the disequilibrium errors, which occurred in the previous year, are corrected in the current year.

Table 4.6 Parsimonious Error Correction Model (ECM) 1
Dependent Variable: DLOG(INF)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.001412	0.004767	-0.296289	0.7678
DLOG(INF(-1))	0.491475	0.111800	4.396038	0.0000
DLOG(INF(-2))	0.137564	0.116652	1.179265	0.2419
DLOG(INF(-3))	0.402159	0.110236	3.648170	0.0005
DLOG(INF(-4))	-0.327254	0.119416	-2.740445	0.0076
DLOG(INF(-5))	0.076430	0.115212	0.663384	0.5091
DLOG(MS)	0.122517	0.095939	2.056869	0.0548
DLOG(MS(-2))	0.201615	0.514500	0.391866	0.6962
DLOG(MS(-3))	-0.239091	0.514252	-0.464931	0.6433
DLOG(MS(-5))	-0.217723	0.363025	-0.599747	0.5504
DLOG(EXR)	0.560198	1.701451	2.329247	0.0429
DLOG(EXR(-1))	0.899326	2.511119	0.358137	0.7212
DLOG(EXR(-3))	0.868935	2.503554	0.347081	0.7295
DLOG(EXR(-4))	-0.511079	2.504134	-0.204094	0.8388
DLOG(MPR)	0.045979	0.071223	2.645571	0.0205
DLOG(MPR(-2))	0.029149	0.084739	0.343983	0.7318

DLOG(MPR(-3))	0.043858	0.084127	0.521335	0.6036
DLOG(MPR(-5))	0.051157	0.071345	0.717037	0.4755
ECM1(-1)	-0.052817	0.019933	-2.649736	0.0098
R-Square = 0.642281, F-statistic = 5.760533, Prob(F-stat) = 0.000000, D-W = 1.9875				

Source: Authors own computation using Eviews

The coefficient of determination i.e. R-Square (R^2) of the estimated model 1 indicates that about 64% of the variations in constant increase in the prices of goods and services are explained by the combined effects of all the determinants (money supply, exchange rate and monetary policy rates). The F-Statistics is 5.7605, which is greater than the table value of 5% level. Both coefficient of determination (R-square) and F-statistics show that the overall regression model is significant at 5% levels. Furthermore, given the DW value of 1.99, there was no suggestion of serial or autocorrelation problems.

As shown in the table, money supply (MS) and exchange rates are positively related to inflation rate and are statistically significant at 5% level. This result is in agreement with a priori and theoretical expectation. The result revealed that if money supply increases by 100% general price level will increase also by 13% all things being equal. Likewise increase in the price of dollar by 100% will also increase the general price level in Nigeria by 56%.

On the other hand, Interest rate has a negative impact on inflation rate in Nigeria and is statistically significant at 5% level. That is if the cost of borrowing increase by 100%, it will increase the price of goods and services by 5%.

Table 4.7 Parsimonious Error Correction Model (ECM) 2

Dependent Variable: DLOG(INF)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000945	0.001705	-0.553936	0.5819
DLOG(INF(-1))	0.579569	0.130638	4.436461	0.0000
DLOG(INF(-2))	0.114694	0.152404	0.752563	0.4550
DLOG(INF(-3))	0.168817	0.150592	1.121023	0.2672
DLOG(INF(-5))	-0.206688	0.128462	-1.608947	0.1135
DLOG(TBR)	0.189752	0.147677	2.607758	0.0459
DLOG(TBR(-3))	-0.226421	0.190795	-1.186721	0.2405
DLOG(TBR(-4))	0.149078	0.188911	0.789146	0.4335
DLOG(TBR(-5))	0.052165	0.141331	0.369099	0.7135
DLOG(REQ)	-0.129477	0.025828	-2.141294	0.0588
DLOG(REQ(-2))	0.015319	0.030375	0.504322	0.6161
DLOG(REQ(-4))	0.022013	0.030312	0.726196	0.4709
DLOG(REQ(-5))	-0.040665	0.025976	-1.565508	0.1233
DLOG(LQR)	0.109311	0.023459	3.396891	0.0130
DLOG(LQR(-3))	-0.032710	0.030457	-1.073956	0.2876
DLOG(LQR(-4))	0.050590	0.030480	1.659769	0.1028
DLOG(LQR(-5))	-0.026805	0.028297	-0.947295	0.3477
ECM2(-1)	0.094172	0.006310	0.661213	0.0113
R-Square = 0.693282, F-statistic = 5.085740, Prob(F-stat) = 0.000000, D-W = 2.1548				

Source: Authors own computation using Eviews

The over parameterized model from which the parsimonious ECM emanated is presented above. The examination of the econometric models in Table 4.7 above shows that treasury bill rate, required reserve requirement and liquidity ratio variables explains 69% of the total variations in inflation rate in Nigeria. This is indicated by the values of the R^2 (0.693282). Given the F-values of 5.085740, reveals that the overall regression is statistically significant while the Durbin–Watson statistics of 2.15 indicated the absence of serial autocorrelation. As shown in Table 4.7, all the variables have the expected signs and conform to economic theory as well as significant both at 5% levels of significant. The coefficient of the error correction term is statistically significant and carries the expected negative sign at 5% level of significant. Hoverer, the speed of adjustment is slow, that is 9.4% of the adjustment to equilibrium inflation rate is expected to occur in the long run. This result indicates that ignoring error correction in non-stationary time series analysis would lead to misspecification of the underlying process to achieve real price stability in the Nigerian economy.

4.7 Hypothesis Testing.

From the results, we see that at 5% level of significance with a degree of freedom of 104(108-4), the tabulated value (t-table) is 1.96 for a two tailed test, while the calculated(t-statistics) for the three variables(Broad money supply, Exchange rate and the monetary policy rate are 2.06, 2.33 and2.65 respectively. Since the calculated value is greater than the tabulated value, it can be decided that Broad money supply, Exchange rate and monetary policy rate all have significant impact on the inflation rate in Nigeria, thereby rejecting all the null

hypotheses with respect to the aforementioned variables. In model two, at 5% level of significance with a degree of freedom of 104(108-4), the tabulated value (t-statistics) is 1.96 for a two tailed test. The calculated (t-statistic) for the three variables(Treasury bills rate, Reserve requirement and Liquidity ratio) are 2.61, -2.14 and 3.40 respectively, since the calculated value is greater than the tabulated value for a two tailed test, it can be concluded that Treasury bills rate, Reserve requirement and Liquidity ratio have significant impact on the inflation rate in Nigeria, thereby also rejecting the null hypothesis concerning these variables. The variables in model 1 and 2 had combined impact of 64% and 69% respectively on the inflation rate in Nigeria for the period under study.

V. Conclusion

Conclusively, we submit that the results show a causal relationship between the inflation rate and the selected monetary policy instruments as the determinants of the inflation rate in Nigeria, namely, broad money supply, exchange rate, monetary policy rate, Treasury bill rates, reserve requirement, and liquidity ratio. The relationship is not only significant, but they contributed to impacting on the inflation rate for the period under study. There is need for the CBN to have periodic research that determines the changing dynamics of the established relationship in order to have a far more effective policy intervention that will have traction on the economy as the inflation band of 6-9% is attained. The study is supportive of the notion that monetary policy impulses introduced by the CBN do have desired effect on the economy as the variables are effective at transmitting these impulses via the various channels of monetary policy transmission. The Central Bank of Nigeria has to identify the speed of transmission through the various policy channels in order to know the level of policy shocks to introduce and the anticipated effect. This calls for further research on the monetary policy transmission channels in Nigeria.

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Monthly Data for the period 2009-2017

YEAR	BOP	EXR	INF	LQR	MPR	MS	REQ	TBR
2009M01	-10.6141	121.3633	12	34.32211	9.6125	33.37732	0.5975	4.635833
2009M02	-11.0892	123.8667	12.6	33.38808	9.415	33.79364	0.575	4.771667
2009M03	-11.5643	126.37	13.1	32.53669	9.2175	34.20996	0.5525	4.9075
2009M04	-12.0394	128.8733	13.5	31.76794	9.02	34.62628	0.53	5.043333
2009M05	-12.5146	131.3767	13.8	31.08183	8.8225	35.0426	0.5075	5.179167
2009M06	-12.9897	133.88	13.7	30.47836	8.625	35.45893	0.485	5.315
2009M07	-13.4648	136.3833	13.4	29.95752	8.4275	35.87525	0.4625	5.450833
2009M08	-13.9399	138.8867	13.3	29.51933	8.23	36.29157	0.44	5.586667
2009M09	-14.415	141.39	13.1	29.16377	8.0325	36.70789	0.4175	5.7225
2009M10	-14.8901	143.8933	12.8	28.89086	7.835	37.12421	0.395	5.858333

2009M11	-15.3653	146.3967	12.6	28.70058	7.6375	37.54053	0.3725	5.994167
2009M12	-15.8404	148.9	12.5	28.59294	7.44	37.95685	0.35	6.13
2010M01	-14.8677	148.97	12.6	28.56794	7.330833	36.47761	0.335833	6.64
2010M02	-13.895	149.04	12.7	28.62558	7.221667	34.99837	0.321667	7.15
2010M03	-12.9223	149.11	12.8	28.76586	7.1125	33.51913	0.3075	7.66
2010M04	-11.9496	149.18	12.9	28.98877	7.003333	32.03989	0.293333	8.17
2010M05	-10.9769	149.25	12.9	29.29433	6.894167	30.56065	0.279167	8.68
2010M06	-10.0042	149.32	13.1	29.68252	6.785	29.08141	0.265	9.19
2010M07	-9.03145	149.39	13.3	30.15336	6.675833	27.60217	0.250833	9.7
2010M08	-8.05874	149.46	13.5	30.70683	6.566667	26.12293	0.236667	10.21
2010M09	-7.08604	149.53	13.8	31.34294	6.4575	24.64369	0.2225	10.72
2010M10	-6.11334	149.6	13.9	32.06169	6.348333	23.16446	0.208333	11.23
2010M11	-5.14063	149.67	13.9	32.86308	6.239167	21.68522	0.194167	11.74
2010M12	-4.16793	149.74	13.7	33.74711	6.13	20.20598	0.18	12.25
2011M01	-3.92779	150.0833	13.5	37.32882	6.385	20.13276	0.266667	12.89583
2011M02	-3.68765	150.4267	13.2	38.2684	6.64	20.05955	0.353333	13.54167
2011M03	-3.44752	150.77	13	39.1809	6.895	19.98634	0.44	14.1875
2011M04	-3.20738	151.1133	12.7	40.06632	7.15	19.91313	0.526667	14.83333
2011M05	-2.96724	151.4567	12.6	40.92465	7.405	19.83991	0.613333	15.47917
2011M06	-2.7271	151.8	12.3	41.7559	7.66	19.7667	0.7	16.125
2011M07	-2.48696	152.1433	12	42.56007	7.915	19.69349	0.786667	16.77083
2011M08	-2.24683	152.4867	11.6	43.33715	8.17	19.62028	0.873333	17.41667
2011M09	-2.00669	152.83	11.4	44.08715	8.425	19.54706	0.96	18.0625
2011M10	-1.76655	153.1733	11.1	44.81007	8.68	19.47385	1.046667	18.70833
2011M11	-1.52641	153.5167	11	45.5059	8.935	19.40064	1.133333	19.35417
2011M12	-1.28627	153.86	10.8	46.17465	9.19	19.32743	1.22	20
2012M01	-1.27057	154.1625	10.9	45.21088	9.424167	19.33149	1.274167	19.76667
2012M02	-1.25487	154.465	11	45.89282	9.658333	19.33555	1.328333	19.53333
2012M03	-1.23916	154.7675	10.9	46.61505	9.8925	19.3396	1.3825	19.3
2012M04	-1.22346	155.07	11.1	47.37755	10.12667	19.34366	1.436667	19.06667
2012M05	-1.20776	155.3725	11.1	48.18032	10.36083	19.34772	1.490833	18.83333
2012M06	-1.19205	155.675	11.3	49.02338	10.595	19.35178	1.545	18.6
2012M07	-1.17635	155.9775	11.6	49.90671	10.82917	19.35584	1.599167	18.36667
2012M08	-1.16065	156.28	11.8	50.83032	11.06333	19.3599	1.653333	18.13333
2012M09	-1.14494	156.5825	11.9	51.79421	11.2975	19.36396	1.7075	17.9
2012M10	-1.12924	156.885	11.9	52.79838	11.53167	19.36802	1.761667	17.66667
2012M11	-1.11354	157.1875	12.1	53.84282	11.76583	19.37208	1.815833	17.43333
2012M12	-1.09783	157.49	12.2	54.92755	12	19.37614	1.87	17.2
2013M01	-1.44394	157.475	11.9	63.36806	12	19.33883	1.95	16.87833
2013M02	-1.79004	157.46	11.7	64.22639	12	19.30152	2.03	16.55667
2013M03	-2.13614	157.445	11.4	64.81806	12	19.26422	2.11	16.235
2013M04	-2.48224	157.43	11.1	65.14306	12	19.22691	2.19	15.91333
2013M05	-2.82834	157.415	10.8	65.20139	12	19.1896	2.27	15.59167
2013M06	-3.17444	157.4	10.4	64.99306	12	19.1523	2.35	15.27
2013M07	-3.52054	157.385	10	64.51806	12	19.11499	2.43	14.94833
2013M08	-3.86664	157.37	9.8	63.77639	12	19.07769	2.51	14.62667
2013M09	-4.21275	157.355	9.5	62.76806	12	19.04038	2.59	14.305
2013M10	-4.55885	157.34	9.2	61.49306	12	19.00307	2.67	13.98333
2013M11	-4.90495	157.325	8.8	59.95139	12	18.96577	2.75	13.66167
2013M12	-5.25105	157.31	8.5	58.14306	12	18.92846	2.83	13.34
2014M01	-5.02552	157.6508	8.4	56.06806	12.16583	19.00576	2.928333	13.66583
2014M02	-4.79999	157.9917	8.3	53.72639	12.33167	19.08305	3.026667	13.99167
2014M03	-4.57446	158.3325	8.2	51.11806	12.4975	19.16035	3.125	14.3175
2014M04	-4.34894	158.6733	8.1	48.24306	12.66333	19.23765	3.223333	14.64333
2014M05	-4.12341	159.0142	8	45.10139	12.82917	19.31495	3.321667	14.96917
2014M06	-3.89788	159.355	8	41.69306	12.995	19.39224	3.42	15.295
2014M07	-3.67235	159.6958	8	38.01806	13.16083	19.46954	3.518333	15.62083
2014M08	-3.44682	160.0367	8	34.07639	13.32667	19.54684	3.616667	15.94667
2014M09	-3.22129	160.3775	8	29.86806	13.4925	19.62413	3.715	16.2725
2014M10	-2.99577	160.7183	8	25.39306	13.65833	19.70143	3.813333	16.59833
2014M11	-2.77024	161.0592	8	20.65139	13.82417	19.77873	3.911667	16.92417
2014M12	-2.54471	161.4	8	15.64306	13.99	19.85602	4.01	17.25
2015M01	6606.288	163.3637	8.2	45.38879	8.746528	19.28715	1.636311	14.54419
2015M02	5895.652	168.9861	8.4	44.6216	9.225694	19.7434	1.652421	14.90933
2015M03	5214.345	174.5536	8.5	43.9161	9.684028	20.17257	1.6759	15.25961
2015M04	4562.367	180.066	8.7	43.27226	10.12153	20.57465	1.706747	15.59502
2015M05	3939.72	185.5235	9	42.69011	10.53819	20.94965	1.744962	15.91558
2015M06	3346.403	190.9261	9.2	42.16963	10.93403	21.29757	1.790545	16.22127
2015M07	2782.415	196.2736	9.2	41.71082	11.30903	21.6184	1.843495	16.51211
2015M08	2247.758	201.5662	9.3	41.31369	11.66319	21.91215	1.903814	16.78808
2015M09	1742.43	206.8038	9.4	40.97824	11.99653	22.17882	1.971501	17.04919
2015M10	1266.432	211.9865	9.3	40.70446	12.30903	22.4184	2.046556	17.29544
2015M11	819.764	217.1142	9.4	40.49236	12.60069	22.6309	2.128979	17.52683
2015M12	402.4258	222.1869	9.6	40.34194	12.87153	22.81632	2.218769	17.74336

2016M01	14.41748	227.2047	9.6	40.25319	13.12153	22.97465	2.315928	17.94502
2016M02	-344.261	232.1675	11.4	40.22611	13.35069	23.1059	2.420455	18.13183
2016M03	-673.61	237.0753	12.8	40.26071	13.55903	23.21007	2.53235	18.30377
2016M04	-973.628	241.9282	13.7	40.35699	13.74653	23.28715	2.651613	18.46086
2016M05	-1244.32	246.726	15.6	40.51494	13.91319	23.33715	2.778243	18.60308
2016M06	-1485.68	251.469	16.5	40.73457	14.05903	23.36007	2.912242	18.73044
2016M07	-1697.71	256.1569	17.1	41.01588	14.18403	23.3559	3.053609	18.84294
2016M08	-1880.4	260.7899	17.6	41.35886	14.28819	23.32465	3.202344	18.94058
2016M09	-2033.77	265.3679	17.9	41.76351	14.37153	23.26632	3.358447	19.02336
2016M10	-2157.81	269.891	18.3	42.22985	14.43403	23.1809	3.521917	19.09127
2016M11	-2252.52	274.3591	18.5	42.75785	14.47569	23.0684	3.692756	19.14433
2016M12	-2317.9	278.7722	18.5	43.34754	14.49653	22.92882	3.870963	19.18252
2017M01	-2353.95	283.1303	18.7	43.9989	14.49653	22.76215	4.056538	19.20586
2017M02	-2360.67	287.4335	17.8	44.71193	14.47569	22.5684	4.249481	19.21433
2017M03	-2338.06	291.6817	17.3	45.48664	14.43403	22.34757	4.449791	19.20794
2017M04	-2286.12	295.875	17.2	46.32303	14.37153	22.09965	4.65747	19.18669
2017M05	-2204.85	300.0133	16.3	47.22109	14.28819	21.82465	4.872517	19.15058
2017M06	-2094.26	304.0966	16.1	48.18083	14.18403	21.52257	5.094932	19.09961
2017M07	-1954.33	308.1249	16.1	49.20224	14.05903	21.1934	5.324715	19.03377
2017M08	-1785.07	312.0983	16	50.28533	13.91319	20.83715	5.561865	18.95308
2017M09	-1586.48	316.0167	16	51.4301	13.74653	20.45382	5.806384	18.85752
2017M10	-1358.56	319.8801	15.9	52.63654	13.55903	20.0434	6.058271	18.74711
2017M11	-1101.31	323.6886	15.9	53.90465	13.35069	19.6059	6.317526	18.62183
2017M12	-814.733	327.4421	15.4	55.23445	13.12153	19.14132	6.584149	18.48169

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