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INFLATION, INTEREST RATE AND EXCHANGE RATE IN NIGERIA: AN EXAMINATION OF THE LINKAGES AND IMPLICATIONS FOR MONETARY POLICY

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ABSTRACT: This study examined the linkages among inflation, interest rate and exchange rate along with money supply and GDP with the aim of showing how the interactions among variables should influence monetary policy decisions in Nigeria using quarterly data from 2010 to 2018. The relationship among variables was captured in a Vector Autoregressive (VAR) model. Co integration test was used to examine the long run relationship among variables and consequently the estimates of a Vector Error Correction (VEC) model was used to examine the short run relationship among variables. In our findingsexchange rate is indicated as the most important monetary policy variable because it has a significant link with all variables in the model. The findings show that price stability and economic growth could be achieve through effective exchange rate and interest rate policies. It is recommended that the monetary authority should continue to intervene in the foreign exchange market to stabilize exchange rate because as shown in this study, exchange rate in Nigeria has significant links with inflation, interest rate, money supply and GDP; and increase in money supply to boost domestic production by givinglow cost credit to firms that make use of more domestic inputs in production to ensure that the increase in money supply does not lead to increase in import.

I. INTRODUCTION

One of the goals of monetary policy is to maintain price stability and there is a considerable acceptance among economists that price stability is the most important goal of monetary policy because of the greater influence of monetary variables on prices as well as the economic and social consequences of price instability. Price instability causes uncertainty, which can have adverse effect on the expectations of economic agents, bringing undesirable effect on investment, output and employment (Audu and Amaegberi, 2013). The Nigerian economy has a fair share of these problems.For example, in recent times, the CBN has injected a significant amount of foreign exchange into the Foreign Exchange (FOREX) market in order to stabilize the value of the naira, government is establishing alternative ways to make funds available for businesses because most businesses cannot borrow at the market rate in commercial banks, and a lot of other strategies are being put in place to reduce inflation.

These policy directions of the monetary authorityindicate that, the levels of interest rate, exchange rate and inflation in Nigeria is has not been satisfactory and despite these policies, there is still much concern about high interest rate, low value of the naira, and high inflation. These undesirable economic conditions require economic policies that are not just theoretically plausible but also policies that suit the peculiarities of the Nigerian economy. This prompts a study of the interrelations among the three variables and the policy implications of such relationships because maintaining stable prices involves managing prices in the real, financial and the external sectors of the economy, which entails managing inflation, interest rate and exchange rate.

Around the world, low inflation, low lending interest rate and a stable exchange rate are desirable macroeconomic conditions for many countries including Nigeria because such stability are the enablers of economic growth. Theoretical expositions such as the International Fishers Effect(IFE), Interest Rate Parity (IRP) and some empirical findings suggest that these variables are interrelated and may therefore involve a trade-off. Whether or not the relationships among these variables conform to conventional theories, efficient management of these variables will depend among other things on how their interrelations are understood,

again, prompting a study of the interrelations among these key variables and the monetary policy implications of such relationships.

Inflation, interest rate and exchange rate are important policy variables which the central banks around the world seek to influence in the quest to achieve price stability which is considered the most important goal of monetary policy.The desirable outcome of any effort to maintain stable prices are lower inflation, lower interest rate (lending rates) and high naira value (low exchange rate). The decision on which variable(s) to target is usually informed by the magnitude of effect of such variable(s) on the rest of the macroeconomic policy variables through empirical research.Most empirical research such Nwanu and Eke, 2017; Uyaebo et al, 2016; Inam, 2015; Adeniji, 2013 and others cited in this study uses annual data of inflation, interest rate and exchange rate about Nigeria to study their relationships.

One disadvantage of using annual data in empirical research is the inability to draw inferences that reflect short period changes. Yearly trends usually present an aggregate picture of these variables whereas changes that usually occur within a year do cause a considerable level of distortion in the economy, prompting some policy actions.This suggests that a more disaggregated perioddata analysis could give better insight into their interrelations and policy implications because these policy actions are taken with some level of frequency within a year due to the frequent swings in these variables.Thus, in this study, we examined the links among inflation, interest rate and exchange rate along with money supply and GDP using a more disaggregated period data (quarterly data). From our result, we identify which monetary policy variables should be targeted to achieve price stability and economic growth in Nigeria.The specific objectives of this study are as follows;

i) To investigate the existence of a long run relationship among variables
ii) To examine the short run interactions among variables
iii) To draw out the monetary policy implications of the identified long run and short run relationships.

The rest of the paper is organized as follows; section two is the literature review, section three discusses the methodology of the study, section four contains the empirical result and discussion of findings and section five is the conclusions and recommendations.

II. LITERATURE REVIEW

2.1 Theoretical Literature

Theories discussed in connection with the relationship among inflation, interest rate and exchange rate are the Purchasing Power Parity (PPP), the Fisher's Effect(FE) and Uncovered Interest Rate Parity(UIP). We discussed the tenet of each theory, their relevance to this study and the empirical issues associated with them. These theories have remained the theoretical basis for studying the relationship among these variables in many empirical researches.

2.1.1 Purchasing Power Parity (PPP) Theory: The PPP is a theory of exchange rate determination and a method of doing cross-country comparison. As a theory of exchange rate determination in its absolute version, it states that exchange rate between two countries equals the ratio of the two countries price level.This means that there is a direct and proportional relationship between exchange rate and the price level. If prices increase by a certain percentage, there will be a proportional increase in exchange rate(currency depreciation).Symmetrically, PPP predicts that a fall in the general prices (an increase in the currency's domestic purchasing power) will lead to a proportional decrease in exchange rate(currency appreciation). The relative PPP is a more dynamic version of the PPP. In the relative version of the PPP theory, changes in exchange rate between countries are assumed to be dependent on inflation rate differentials between countries. The assumption here is that the actions of importers and exporters which are motivated by cross country price differences, causes changes in the exchange rate(Lafrance and Schembri, 2002).

ThePPP theory performs poorly when applied to empirical data because of real world complexities such astransportation cost, trade restrictions and lack of perfect information about market conditions. These factors define the real-world cross border trade which does not allow a one-to-one relationship between inflation and exchange rate to hold.The poor empirical performance of the PPP is seen mostly in its non-conformability to parity conditions because many empirical studies about the relationship between exchange rate and inflation conforms to the direction of relationship of the PPP theory but not on a one-to-one basis, especially studies about less developed economies. Many studies about Nigeria such as, Enoma(2011),Nwosa and Oseni (2012), Adeniji(2013) Chuba (2015) Nwaru and Eke (2017)show that changes in exchange rate have significant effect on domestic prices. If we relaxed the assumption of the PPP and say that importers and exporters do not respond quickly to deviations in the prices of products between countries due to previously identified reasons such as

lack of perfect information about market conditions and that exchange rate is not solely determined by trader's behavior but also by investor's activities, the PPP will be seen more as a theory that predicts the direction of relationship between exchange rate and domestic prices.

2.1.2 Fishers Effect (FE): Fisher's effect is a popular theory in monetary economics that explains the relationship between nominal interest rate and inflation. It explains the response of nominal interest rate to inflation expectation. It is explained that expected inflation is completely absorbed into nominal interest rate.This indicates that nominal interest rate in any period is the sum of real interest rate and expected inflation. This is because lenders in the economy usually include inflation premium to take care of the effect of expected inflation on real interest rate. If there is perfect information among market participants, it implies a direct and proportional relationship between nominal interest rate and inflation. This means that a 1 percent increase in inflation will cause a1 percent increase in nominal interest rate, leaving real interest rate unchanged(Krugman, Obstefeld and Melitz, 2012).

The implication of the FE is that changes in inflation leads to equal changes in nominal interest rate leaving real interest rate unchanged. The empirical test of the FE is common in monetary economics research. This is because the crucial role of nominal and real interest rate in determining the behavior economic agents in the real and financial sectors of the economy and such behavior determine the effectiveness of monetary policy (Uyaebo, et al2016). Many empirical tests of the Fisher's hypothesis about Nigeria identified the existence of partial Fisher's effect(Alimi and Awomuse, 2012; Ogbonna, 2013; Adegboyega, Odusanya, and Popoola, 2013; Inam, 2014; Amaefula, 2016). This underscores the relevant of the FE in Nigeria's policy space.

2.1.3 Uncovered Interest Rate Parity (UIP): Uncovered interest rate parity theorystates that the difference in interest rate between two countries will be equal to the relative change in currency exchange rate between the two countries over the same period (Fama, 1984). This means that in the event of carry trade (if an investor borrows money from the country with lower nominal interest rate, and invests in the country with higher interest rate), an investor will not be better off because when the investor reconverts the invested amount to the borrowed currency, the exchange rate would have moved to offset the earnings from the high interest rate country, such that the investor earns exactly the same amount as if he had invested in the country with lower interest rate. This suggests a positive and proportional relationship between nominal interest rate and exchange rate.

The concept of UIP recognized the fact that investors have the choice of holding domestic assets offering a particular rate of return (interest rate) and foreign assets also offering a certain rate of return while taking into consideration expected change in exchange rate within the period of investment. The UIP theory assumes that investors are risk neutral. It also assumes that market participants have rational expectation about future change in exchange rate (Fama, 1984).The theory assumes implicitly that the action of international financial investors whose transactions are recorded in the capital account cause changes in exchange rate. However, some studies have little empirical evidence to support the UIP theory. According to Guender and Cook (2010), a survey of empirical literature in the 1980s and 1990s were unanimous in their rejection of the UIP theory andmore recent studies also shows that many countries with high interest rateexperience currency appreciation instead of depreciation and this goes at variance with the UIP theory.

Economists have given various explanations for the failure of the UIP theory. The most fundamental explanation is the non-fulfillment of the fundamental assumptions of the UIP theory that market participants are risk neutral and that they have rational expectations about exchange rate changes. It is explained that investors usually require risk premium to hold foreign assets instead of domestic assets to offset the possible change in exchange rate that will affect profitability. It is also argued that if investors systematically make errors when forming expectations of future exchange rates, there will be opportunity for investors to make profit from arbitrage, leading to failure of the UIP (Guender and Cook, 2010).

The failure of the UIP has also been attributed to the conduct of monetary policy. According to McCallum (1994), standard empirical tests of UIP produce negative results in countries where the central bank uses the short-term interest rate as a policy instrument to respond to exchange rate changes. Chinn and Meredith (2004) also argued that the conduct of monetary policy makes short-term interest rate differentials between countries highly volatile, thus contributing to the failure of UIP when tested over short time horizons. Whether UIP theory holds in most cases or not, UIP theory and the accompanying empirical arguments are relevant to this study because it gives insight into the possible relationship between interest rate and exchange rate.

2.2 Empirical Literature

The relationships among inflation, interest rate and exchange rate have featured prominently on empirical research.Researchers employed a variety of econometric methodology and models such as cointegration test, granger causality test, ordinary least squares regression, error correction model, vector autoregressive model among others, using different data span (mostly annual data) with varying outcomes. An exploration of these

empirical literature shows that many researchers focused on the relationship between two of the three variables at a time. Consequently, the literature review is organized in the followingsubheadings: inflation and interest rate; inflation and exchange rate; interest rate and exchange rate.

2.2.1 Inflation and Interest Rate

Jaradat and Al-Hhosban(2014) examined the causal relationship between interest and inflation in Jordan using annual data between 1990 to 2002. They employed Johannsen Cointegration test, Granger Causality test, and a simple Ordinary Least Squares (OLS) regression model. Their result shows a positive relationship between interest rate and inflation and two-way (bidirectional) causality between the two variables.

Uyaebo et al (2016) examine the Fisher's Effect (FE) hypothesis in the presence of structural breaks and adaptive inflationary expectations in Nigeria using annual data from 1970 to 2014. They used Gregory and Hansen Cointegration test. The result confirmed the existence of a long-run relationship between nominal interest rates and inflation, with a structural break in 2005. The study obtained Fisher coefficient in the co integrating relation of 0.08, implying a weak form of Fisher effect in the long-run and nonexistence in the short run. They explained that the obtained partial Fisher effect indicated that changes in monetary policy is capable of altering long term real interest rate and influencing economic growth through the interest rate channel.

Amaefula (2016) studied the long run relationship between interest rate and inflation in Nigeria using monthly data from 1995 to 2014. He used Johansson Cointegration and granger causality test to examine the long run and short relationships between the variables. The relationship was model as a Vector Autoregression (VAR). The result shows the existence of a long run relationship and a weak unidirectional causal relationship that runs from interest rate to inflation. The result suggests that low interest rate will lead to high inflation in the long run.

Amata, Muturi and Mbewa (2016) studied the relationship between interest rate, inflation and stock market volatility in Kenya using monthly data from January 2001 to December 2014. They employed Cointegration test to examine the long run relationship, Granger Causality test and Error Correction(ECM) model to study the short run dynamics. Their result shows the existence of a significant long run relationship between interest rate and inflation.

2.2.2 Inflation and Exchange Rate

Nwosa and Oseni (2012) investigated the nexus between exchange rate and inflation rate in Nigeria and how they relate to monetary policy. They used data for the period 1986 to 2010 and employed cointegration techniques and multivariable Vector Error Correction Model (VECM). The results revealed amongst other things the existence of a bi-directional causality between inflation rate and exchange rate. This finding was also similar to some of the empirical studies reviewed in their work.

Ogundipe and Egbetokun(2013) studied the exchange rate pass through to inflation in Nigeria from 1970 to 2008. They used a Vector Error Correction (VEC) model. The degree of exchange rate pass through was estimated using impulse response function from the estimated VEC model. Evidence of large pass through was found and was attributed to the continuous depreciation of the naira over the period of the study. They argued that one of the reasons for a large pass through is the large share of import in the Nigerian consumption basket.

Adeniji(2013) studied the effect of exchange rate volatility on inflation in Nigeria using annual data that spans from 1986 to 2012. He used JohanssenCointegration, Vector Autoregressive (VAR) Model, Impulse Response Function, Variance Decomposition and Granger Causality Test. The result reveals a significant positive relationship between inflation and exchange rate volatility and a two-way causal link between exchange rate and inflation. The study recommends that it is imperative for the government to understand and control the various channels through which exchange rate transmit to affect inflation, check the growth of money supply, increase productivity and reduce public recurrent expenditure for more capital expenditure.

Nwaru and Eke (2017) studied the effect of exchange rate on inflation in Nigeria using annual data from 1970 to 2014. They adopted the econometric technique of Johansson Cointegration, Granger Causality Test and Ordinary Least Squares (OLS) regression. Their findings indicate that inflation was responsive to lagged inflation, exchange rate, money supply and import prices at 5% significance level with the conclusions that exchange rate is a viable tool to manage inflation in the country. Consequently, they recommended exchange rate targeting, exploration of more policies on monetary growth, and creating the enabling environment for industrial growth.

2.2.3 Interest Rate and Exchange Rate

Kwan and Kim (2004) in their study investigated the empirical relationship between exchange rate and interest rate for four crisis countries in Asia (Indonesia, Korea, Philippines and Thailand). They used a bivariate VAR-GARCH model to examine the empirical relationship between exchange rates and interest rates, and also investigate how the dynamics between them have changed following the post-Asia crisis. Their findings

suggested that these countries did not use interest rate policy more actively to stabilize exchange rates after the crisis, and provided evidence that their domestic currencies exhibited greater sensitivity to competitors. Their result also indicated that increased exchange rate flexibility did not lead to greater stability in interest rates in these economies. Thus, there is no strong evidence that an increase in exchange rate variability is associated with an increase in interest rate volatility in any of the four countries.

Utami and Inanga (2009) examined the influence of interest rate differentials on exchange rate changes in the light of the IFE theory in Indonesia using quarterly and yearly data for the period of six years (2003-2008). They used four foreign countries namely: the USA, Japan, Singapore and the UK and Indonesia as the home country and they found that interest rate differentials have positive but no significant influence on changes in exchange rate for the USA, Singapore and the UK, relative to that of Indonesia. On the other hand, interest rate differentials have negative significant influence on changes in exchange rate for Japan.

Alam, Alam and Shuvo (2011) examine the empirical evidence of IFE in Bangladesh with India and China using quarterly data of interest rate differential and exchange rate from 1995 to 2008. The study employed OLS regression to examine the causal relationship between the two variables. The empirical results suggest that there is a little correlation between exchange rates and interest rates differential for Bangladesh with China and Bangladesh with India, and the relationship between the variables is also not noteworthy for Bangladesh. They advocate that forecasting of exchange rates with the hypothesis of IFE is not realistic for these countries.

The review of literature indicates that the relationships among inflation, interest rate and exchange rate have been researched extensively in literature likely because of their policy relevance. As stated earlier, the relationship between two of three variables are studied at a time in most studies. However, since these three variables reflect prices in the real, financial and external sectors respectively, as well as the variables that are usually the target of monetary policy, a study of this nature that bringsthem together along with money supply and GDP which are also essential policy variables will enable us to study the effect of each variable on each other, producing a comprehensive empirical framework for monetary policy recommendations. This is what we set out to achieve in this paper.

III. METHODOLOGY

3.1 Data and Sources

Data used for this study are; average quarterly prime and maximum lending rates (%), average quarterly official and Bureau De Change exchange rate (NG/USD). This averaging is done to reflect all activities in the money and foreign exchange market. Others are; quarterly inflation rates (%), quarterly money supply (Billions), and quarterly GDP(Billions). The period covered in the selection of data is from 2010 to 2018. Quarterly data is used to reveal the relationships usually hidden when annual data is used. Although more disaggregated period data is available for inflation, interest rate, exchange rate and money supply, GDP which a key variable in this study is available only on quarterly basis. Data were sourced from the Central Bank of Nigeria (CBN) online data base and Central Bank's Statistical Bulletin.

3.2 Descriptive Statistics

The descriptive statistics of the variables used for analysis is presented in terms of measures of central tendency(mean and median), extreme values(maximum and minimum), standard deviation (S.D), skewness and kurtosis and Jarque-Bera (JB) statistics. To be able to make comparison of the relative dispersion of each variable from its own mean value, we also present the ratio of standard deviation (S.D) to the mean of each variable.

Table 1 shows the mean, median, maximum, minimum and standard deviation of each of the data series used for analysis in this study among other descriptive measures.A consideration of the ratio of standard deviation to the mean(S.D/Mean) of each variable shows that on the average exchange rate (EXR) has the highest dispersion from its own mean value in relative terms during the period under study with SD/Mean value of 0.37220. It is followed by inflation (INF) with a value of 0.26573 and money supply (M2) with a value of 0.24849 while interest rate (INT) and GDP has the lowest spread respectively with a value of 0.10493 and 0.07803.

Table 1: Descriptive Statistics of Inflation (INF), Interest Rate (INT), Exchange Rate (EXR), Money Supply (M2) and GDP from 2010: Q1 to 2018:Q4

	INF	INT	EXR	M2	GDP
Mean	11.86028	21.47333	222.7939	17544.35	16046.69
Median	11.55000	21.14000	166.2550	17966.55	16067.61
Maximum	18.45000	24.46000	389.0600	24140.60	19041.44
Minimum	7.820000	18.89000	151.4800	10845.50	12583.48
Std. Dev. (S.D)	3.151672	1.675663	82.92298	4359.557	1683.795

S.D/Mean	0.26573	0.078035	0.37220	0.24849	0.10493
Skewness	0.485455	0.386747	0.773521	-0.063098	-0.139225
Kurtosis	2.175523	2.210678	1.886870	1.594498	2.242984
Jarque-Bera (JB)	2.433642	1.831981	5.448591	2.987041	0.975910
(P-Value)	(0.296170)	(0.400120)	(0.065592)	(0.224581)	(0.613880)
Data Points	36	36	36	36	36

Source: Author's computation using Eviews 9

A consideration of the skewness, kurtosis and the JB statistics shows that each data series is approximately normally distributed at 5% level of significance. From the p-values of the JB statistics which are 0.296170, 0.400120, 0.065592, 0.224581 and 0.613880 for inflation (INF), interest rate (INT), exchange rate (EXR), money supply (M2) and GDP respectively, the null hypothesis of the JB test procedure for each data series which states that the data series is normally distributed cannot be rejected. Thus, the data for each variable is appropriate for the application of vector autoregression (VAR) econometric technique which all variables enters the model as endogenous variable.Also, the estimation of standard errors and other test of statistical significance are reliable.

3.3 Model Specification

The relationship among variables is described in a Vector Autoregressive (VAR) model. Sims (1980),proposed VAR as a theory-free model used in estimating economic relationships and thus serves as an alternative to most economic models usually restricted by a particular theory. The unrestricted VAR model is expressed in its reduced form as follows;

$$Y_t = c_i + \sum_{n=i}^{n} \Phi i Y_{t-i} + E_t \quad \ldots\ldots (1)$$

Where

Y_t = vector matrix (n x 1) of all endogenous variables in the VAR system

Ci = vector matrix (n x 1) of all intercept in the VAR system

Φi = square matrix (n x n) of the autoregressive coefficients

Y_{t-i}= square matrix (n x n) of the lags of all variables in the VAR system

Et = vector (n x 1) of error terms

Equation (1) can also be expressed in its structural form to show all the specific variables of the VAR system for this study as follows;

$$INFt = \delta_1 + \Sigma\delta_2 INF_{t-i} + \Sigma\delta_3 INT_{t-i} + \Sigma\,\delta_4 EXR_{t-i} + \Sigma\delta_5\, M2_{t-i} + \Sigma\delta_6 GDP_{t-i} + E_{1t} \ldots\ldots (2)$$

$$INTt = \beta_1 + \Sigma\beta_2 INT_{t-i} + \Sigma\beta_3 INF_{t-i} + \Sigma\,\beta_4 EXR_{t-i} + \Sigma\,\beta_5\, M2_{t-i} + \Sigma\beta_6 GDP_{t-i} + E_{2t} \ldots\ldots (3)$$

$$EXRt = \phi_1 + \Sigma\phi_2 EXR_{t-i} + \Sigma\,\phi_3 INF_{t-i} + \Sigma\,\phi_4 INT_{t-i} + \Sigma\phi_5 M2_{t-i} + \Sigma\phi_6 GDP_{t-i} + E_{3t} \ldots\ldots (4)$$

$$M2t = \psi_1 + \Sigma\psi_2 M2_{\,t-i} + \Sigma\psi_3 INF_{t-i} + \Sigma\psi_4 INT_{t-i} + \Sigma\psi_5 EXR_{t-i} + \Sigma\psi_6 GDP_{\,t-i} + E_{4t} \ldots\ldots (5)$$

$$GDPt = \omega_1 + \Sigma\omega_2 GDP_{t-i} + \Sigma\omega_3 INF_{t-i} + \Sigma\omega_4 INT_{t-i} + \Sigma\omega_5 EXR_{t-i} + \Sigma\omega_6 M2_{t-i} + E_{5t} \ldots\ldots (6)$$

Where

INFt= Average quarterly inflations rate (%) at time t (consumer price index (CPI))

INTt= Average quarterly lending rate (%) of commercial banks at time t

EXRt= Average quarterly exchange rate of Naira to Dollar at time t

M2t = Average quarterly money supply at time t measured in billions

GDPt =Quarterly real GDP at current period measured in billions

INFt-i = lag inflation rate (%) at time t (consumer price index (CPI))

INTt-i = lag of average quarterly lending rate (%) of commercial banks at time t

EXRt-i = lag of average quarterly exchange rate of Naira to Dollar at time t

M2t-i = lag money supply measured in billions

GDPt-i= lag real GDP measured in billions

$\delta, \beta, \phi, \psi, \omega$ = parameters of the model

E_{1t}, E_{2t}, E_3t are the error term.

3.4 Estimation Techniques

We used Johannsen cointegration to test for the existence of a long run relationship among variables. Data was subjected to Augmented Dickey Fuller (ADF) and Phillip Perron(PP) unit root test which are pre estimation test for cointegration. The existence of cointegration among variables provides a strong basis for modeling economic variables in an error correction framework which brings together the short run and long run information in modeling economic variables. As informed by the result of our cointegration test, we estimate a vector error correction (VEC) model. The VEC model is an extension of the single equation error correction model to a multivariate one. From the VAR model of this study, the VEC model could be derived by subtracting $Y_{t-1}$from both sides of equ (1) and rearranging the terms as follows;

$$\Delta Y_t = ci + \sum_{n=i}^{n} \Phi i \Delta Y_{t-i} + \Pi Y_{t-1} + E_t \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where

ΔY_t= vector matrix of the first difference of all endogenous variables in the VEC model
ci= vector matrix of all intercept in the VEC model
ΔY_{t-i}= matrix of the difference of all lag variables in the VEC model
Φi = matrix of the VEC model coefficients
ΠY_{t-1}= vector of error correction term
$\Pi = \beta i - 1$
Et= vector of error term

IV. RESULTS AND ANALYSIS

In this section, empirical results from the applied econometrics techniques are presented, interpreted and discussed. The results are; unit root test, cointegration test, VEC estimates, impulse response and variance decomposition. This is followed by discussion of findings and policy implications of findings.

4.1 Unit Root Test Result

Unit root test is used to check the stationarity of time series variables in an empirical research. In the words of Gujarati(2004), a series is stationary if its mean, variance and covariance are constant overtime. The need for unit root test arises from the fact that if variables are not stationary or have unit root, regression performed on such variables will be spurious. In this study, the Augmented Dickey Fuller (ADF) and Phillip Peron (PP) unit root test was applied and the results are presented as follows;

Table 2: ADF Unit Root Test Result

Variables	ADF stat	Critical Values			P Value	Remarks
		10%	5%	1%		
INF	-3.185994	-2.614300	-2.951125	-3.639407	0.0296	I(1)
INT	-3.660564	-2.614300	-2.951125	-3.639407	0.0095	I(1)
EXR	-3.711400	-2.617434	-2.957110	-3.653730	0.0087	I(1)
M2	-7.151765	-2.614300	-2.951125	-3.639407	0.0000	I(1)
GDP	-18.56881	-2.617434	-2.957110	-3.653730	0.0001	I(1)

Source: Author's computation using Eviews 9

Table3: PP Unit Root Test Result

Variables	PP stat	Critical Values			P Value	Remarks
		10%	5%	1%		
INF	-3.176707	-2.614300	-2.951125	-3.639407	0.0303	I(1)
INT	-3.559626	-2.614300	-2.951125	-3.639407	0.0122	I(1)
EXR	-3.841608	-2.614300	-2.951125	-3.639407	0.0060	I(1)
M2	-11.59038	-2.614300	-2.951125	-3.639407	0.0000	I(1)
GDP	-8.826842	-2.614300	-2.951125	-3.639407	0.0000	I(1)

Source: Author's computation using Eviews 9

The unit root test result above using ADF and PP test shows that all variables are stationary at first difference (I (1)) at 5% level of significance. This means that data for all the variables were not stationary at levels but became stationary when the data was transformed to their first difference.

4.2 Cointegration Test Result

Since all variables are stationary at first difference, the test for cointegration was carried out to check for the existence of a long run relationship among the variables.

Table 4: Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.782585	103.0092	69.81889	0.0000
At most 1*	0.529264	52.65293	47.85613	0.0166
At most 2	0.394122	27.78881	29.79707	0.0838
At most 3	0.238625	11.25329	15.49471	0.1964
At most 4	0.066094	2.256510	3.841466	0.1331

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
Source: Author's computation using Eviews 9

Table 5: Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.782585	50.35631	33.87687	0.0003
At most 1	0.529264	24.86412	27.58434	0.1073
At most 2	0.394122	16.53552	21.13162	0.1951
At most 3	0.238625	8.996776	14.26460	0.2864
At most 4	0.066094	2.256510	3.841466	0.1331

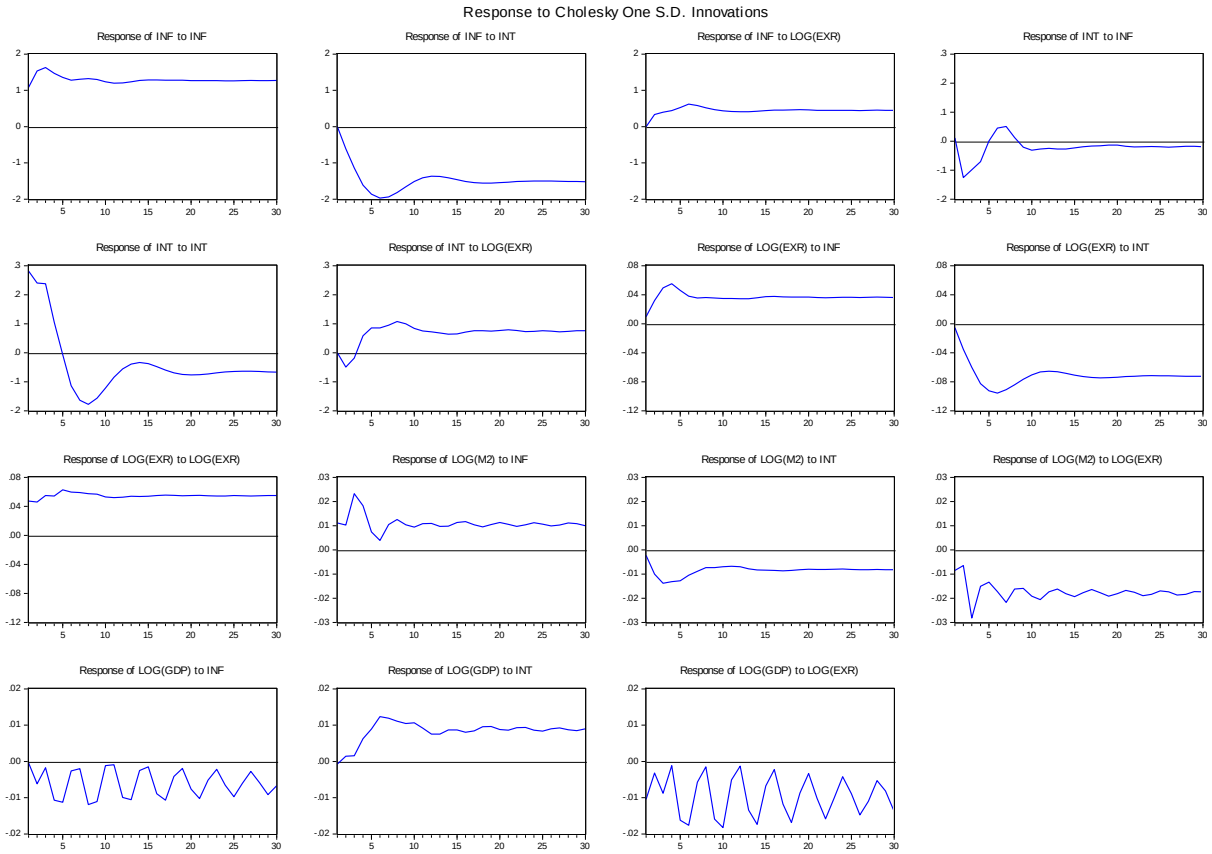
Max-eigenvalue test indicates 1 co integratingeqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
Source: Author's computation using Eviews 9

The result of co integration test shows that trace statistics indicate two cointegrating equations while max-eigen value indicates one cointegrating equation. This shows that a long run relationship exists among variables used in the model of this study.

4.3 Vector Error Correction (VEC) Estimate

Following the co integration test result which indicates the existence of a long run relationship among variables, a VEC is estimated to capture the short run behavior of variables. The estimation is also done with EXR,M2 and GDP in their log form in order to make the figures of all the variables even because some variables(M2 and GDP) are in very large figures (in billions). This is done to avoid the risk of having explosive coefficient.Such transformation does not alter the real pattern of the data and therefore, the real analytical outcomes are realized. The estimation was in 2 lags which was found to be the optimal lag for the model. The LM Autocorrelation test, Normality test and heteroscedasticity test shows that the regression assumptions of absence of autocorrelation, normal distribution of the error term and heteroscedasticity are all fulfilled, indicating that the estimates are reliable. The estimation produced a total of 60 coefficients as presented at the appendix. However, the impulse response function and variance decomposition which provide a clear pattern of how the variables are interrelated is presented and discussed as follows;

4.4 Impulse Response Function (IRF)



Figue 1: Impulse Response function
Source: Author's computation using Eviews 9

The impulse response graph in figure 1 depicts how each variable in the model respond to one standard deviation shock from other variables in the model. The impulse response function of this study traces these responses in 30 periods. Inflation respond positively to shocks in itself throughout the period, respond negatively to shocks in interest rate and positively to shocks in exchange rate. It also responds positively to shocks in money supply and GDP but the responses are closer to zero. Interest rate responds to shocks in inflation with a sharp fall in the short run and a sustained negative response in the long run. Interest rate falls shapely in respond to shocks in itself in the short run and remains negative throughout the period. Interest rate also responds positively to shocks in exchange rate and money supply throughout the period while its responses to shocks in GDP are approximately zero.

Exchange rate responds positively to shocks in inflation throughout the period but negatively to interest rate and remains highly negative throughout the period. The response of exchange rate to shocks in itself remains positive throughout the period. Its response to shocks in money supply and GDP are positive but very close to zero. Money supply responds positively to shocks in inflation throughout the period but with fluctuations. It responds negatively to interest rate and exchange rate but positively to shocks in itself with fluctuations. Its response to shocks in GDP is approximately zero. GDP respond negatively to shocks in inflation and exchange rate with significant fluctuations throughout the period. It responds positively to interest rate and money supply, but its response to money supply has significant fluctuations, GDP oscillates in response to shocks in itself throughout the period but the oscillation reduces over time.

4.5 Forecast Error Variance Decomposition (FEVD)

The FEVD table at the appendix shows that within the first 20 periods (quarters) of forecast, the contribution of inflation to its forecast errors falls from 100% in the first period to 41% in the twentieth period. The rest of the forecast errors are taken up majorly by interest rate with an increase from 9% in the second period to 54% in the twentieth period and exchange rate with a slow increase from 3% in the second period to 5% in the twentieth period. The contributions of money supply and GDP are infinitesimal. This shows that among the variables, interest rate and exchange rate have significant effects on inflation.

The contribution of interest rate to its own forecast error fall steadily from 99.9% in the first period to 55% in the twentieth period. The rest of the variation was explained mainly by inflation in the early periods with an increase from 0.14% in the first period to 12% in the fourth period and thereafter falls slowly to 7% in the twentieth period. Money supply explain the forecast error in interest rate mainly in the long run with an increase from 4.3% in the fourth period to 21% in the twentieth period followed by exchange rate with an increase from 2.5% in the fourth period to 17% in the twentieth period. This shows that inflation, exchange rate and money supply have significant effects on interest rate.

The contribution of exchange rate to its own forecast error falls significantly from 95% in the first period to 31% in the twentieth period. The rest of the forecast error is accounted for mainly by interest rate with an impressive rise from 1% in the first period to 54% in the twentieth period. Inflation explains exchange rate mainly in the short run with an increase in forecast error from 4% in the first period to 23% in the fourth period and thereafter falls slowly to 14% in the twentieth period. Money supply and GDP also contributes a little in the short run but falls to less than 1% in the twentieth period.This shows that interest rate and inflation were the major variables that had effects on exchange rate within the period of this study.

The contribution of money supply to its forecast error falls with fluctuations from 87% in the first period to 62% in the twentieth period. The rest of the forecast error in money supply is accounted for by exchange rate with some fluctuating increase from 4% in the first period to 22% in the twentieth period. The contribution of inflation increases in the early periods and falls to 10% in the twentieth period. The contribution of interest rate also increases a little in the short run and latter falls slowly to 6% in the long run, showing that inflation, interest rate and exchange rate had noticeable effect on money supply. The contribution of GDP to its forecast error fluctuates between 63% and 24%. Money supply, interest rate, inflation and exchange rate all hardly their fair share in their contribution to the forecast of GDP throughout the periods. This means that money supply, interest rate, inflation and exchange rate had significant effect on GDP.

[

4.6 Discussion of Findings

4.6.1 Inflation and Interest Rate

The result of the analysis shows that interest rate has a significant effect on inflation. Inflation also has effect on interest rate. High interest rate usually contributes to high cost of production which is manifested in form of high prices of commodities, contributing significantly to inflation. Also, lenders of financial resources usually take into consideration the expected inflation while setting their lending rates by incorporating inflation premium.

4.6.2 Inflation and Exchange Rate

The result shows that exchange rate has a significant positive effect on inflation. This conforms to the postulations of the PPP theory but does not fulfill parity conditions. Inflation also has a significant positive effect on exchange rate. This finding indicates that increase in exchange rate (naira depreciation) leads to increase in the general price level due perhaps, to the import dependent nature of the Nigerian economy. Producers import capital equipment and raw materials for domestic production. Thus, a rise in exchange rate (naira depreciation) leads to high cost of production which is reflected as higher prices of commodities. Consumers in Nigeria also depend on import for some durables such as electronics and cars and this further worsen exchange rate, leading to the use of more naira to purchase such foreign product, contributing to the increase in the general price level.

4.6.3 Interest Rate and Exchange Rate

Interest rate has a significant negative effect on exchange rate. This is at variance with the International Fishers Effect (IFE) theory that higher nominal interest rate will lead to exchange rate depreciation (increase in exchange rate). Exchange rate also has a significant positive effect on interest rate.This finding suggests that an increase in interest rate attracts the inflow of portfolio investment leading to an increase in demand for naira and this has a reducing effect on exchange rate (naira appreciation). The monetary authority usually keeps interest rate high to attract and sustain more portfolio capital into the domestic economy and also stabilized exchange rate especially in the face of naira depreciation. This may well explain the significant positive effect of exchange rate on interest rate.

4.6.4 Inflation, Money Supply and GDP

Inflation has a positive effect on money supply. One of the possible explanations to why inflation induce increase in money supply could be that as the value of money depreciates, assets are liquidated and deplored for transactions leading to increase in narrow money supply (currencies and demand deposit).Inflation

has a significant effect on GDP, indicating that higher prices may have served as incentives for producers to increase production.

4.6.5 Interest Rate, Money Supply and GDP

The IRF shows that money supply response negatively to shocks in interest rate and the FEVD also shows that money supply is a good predictor of interest rate over time. Thus, one can allude to the usual economic reasoning that the high interest rate in Nigeria has limited money supply in the economy. The IRF also shows that GDP response positively to increase in interest rate showing that prolonged high interest rate in Nigeria has not limited GDP growth significantly.This may likely be because prolonged high interest rate has shifted the attention of many producers away from bank lending as a way of financing their production activities. Many producers may have resorted to alternatives such as crowd funding which has become popular in recent times as well as other strategies. Thus, the amount of money in circulation and production activities is not significantly related to the rise or fall in interest rate.

4.6.6 Exchange Rate, Money Supply and GDP

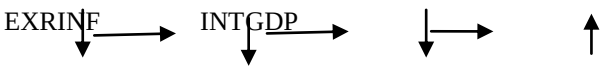
Exchange rate has a negative effect on money supply and GDP respectively. But this is likely not through the effect of increase in exchange rate(naira depreciation) on prices because the empirical links also show that increase in exchange rate leads to increase in prices(inflation) and increase in prices has a positive short run effect on money supply and GDP. The negative effect that exchange rate has on money supply and GDP could be traced to shocks in the economy that may have come from policy uncertainties.For example, policy uncertainties in Nigeria between 2015 and 2016 due to the historic change of government affected investors expectation, leading to a withdrawal of significant funds by foreign investors and this worsen exchange rate conditions during this period and also result in negative GDP growth (economic recession). Increase in exchange rate (naira depreciation) usually reduced the value of financial assets by foreigners when converted to foreign currency (dollar) and further expected fall in exchange rate may cause foreigners to withdraw their investments to prevent loses and this reduces the stock of money available for economic activities leading to a fall in the GDP.Money supply has a significant effect on GDP, indicating that increase in money supply stimulates domestic production.

4.7 Policy Implications of Findings

The findings of this study have highlighted the key monetary policy variables in Nigeria and their level of influence on each other, giving insight about monetary policy target options, the effects of such targets on the economy and their transmission mechanism. The findings have reiterated the fact that inflation, interest rate, exchange rate and money supply are key monetary variables in Nigeria because of their significant interrelations and potential impact on output. Interest rate, exchange rate and money supply stand out as important monetary policy variables in this study because of their influence on the price level. However, exchange rate stands out more prominently because it has a significant link with all the variables in the model. The role of interest rate in exchange rate stability and the role of inflation in determining interest rate also stand out. These findings therefore bring into perspective the fact that targeting exchange rate, interest rate, and money supply are possible strategy options and what could be the optimal monetary policy path to achieving price stability in Nigeria.

From the findings of the study, the desired monetary policy outcomes could be achieved through the following mechanism;

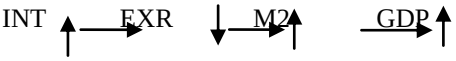
Exchange Rate Channels



As explained in the findings, changes in exchange rate bring about changes in inflation through the effect of exchange rate on the prices of goods and services, changes in inflation bring about changes in interest rate through the effect of inflation on inflation premium usually added to interest rate by lenders of financial resources and this further bring changes in inflation through the effect of interest rate on the cost of production. This can also lead to changes in output. For example, stabilization of exchange rate through intervention in the foreign exchange market reduces or stabilizes inflation through its effect on prices of commodities.The reduction in inflation will also make it possible for a reduction in interest rate because inflation premium is usually added to interest rate. A fall in interest rate will reduce the total cost of production, allowing sellers to charge more competitive prices, leading to more stable general prices.The fall in interest rate also stimulates borrowing for investment, leading to a rise in output.

Changes in exchange rate is shown to affect changes in inflation as explained in the first exchange rate channel above. Changes in inflation can in turn leads to changes in economic output.For example, stabilization of exchange rate through intervention in the foreign exchange market reduces or stabilizes inflation, leading to growth in real GDP.

Interest rate Channel



Changes in interest rate affect exchange rate through the inflow of foreign portfolio capital. Changes in exchange rate affect money supply, and money supply affect changes in economic output. An increase in interest rate attracts the inflow of foreign capital and this leads to increase demand for naira, making the naira to stabilize, appreciate (fall in exchange rate) or depreciate slowly depending on the size of capital inflow.The inflows of funds through the purchase of financial assets increase the stock of money in circulation for domestic economic activities, leading to a rise in economic output. This strategy, however, keeps the Nigerian economy dependent on foreign portfolio capital. But a fall in interest rate which may attract less foreign capital may still increase money supply through increase in bank borrowing because as shown in the impulse response analysis, money supply is still sensitive to changes in interest rate.

V. CONCLUSION AND RECOMMENDATIONS

This study has shown that inflation, interest rate and exchange rate have continued to be key variables to be taken into consideration in any monetary policy decision. Their interrelations among these variables presented a challenging puzzle to the monetary authority in their effort to maintain price stability and economic growth. The source of this puzzle comes from the fact that in many cases, the linkages among these variables suggest that there must be a delicate trade-off between these monetary policy objectives of low inflation, low interest rate and stable exchange rate. Such trade-off requires much dexterity and ingenuity on the part of policy makers.

The Finding of this study have identified exchange rate as both an effective major and intermediate monetary policy target because it has a significant link with all variables in the model of this study.The study shows that a fall in interest rate would be possible if inflation falls first, otherwise real interest rate will be very low such that financial institutions may not be able to operate with profitability at such low real interest rate. Therefore, inflation reducing policies should precede interest rate reducing policies.The findings of this study suggest that the desirable outcomes of exchange rate stability,low inflation, and low interest rate which constitute price stability is possible if these objectives are pursued in the most rational sequence. It has shown that exchange rate policies can reduce inflation and inflation reduction can allow a fall in monetary policy rate and hence lending interest rate which in turn can stimulate growth in domestic economic output.

From the findings of this study, the following recommendations are given: The Monetary authorities should continue to intervene in the foreign exchange market to stabilize exchange rate because as shown in this study, exchange rate in Nigeria has significant links with inflation, interest rate, money supply and GDP and this place exchange rate as a crucial monetary policy variable; The Monetary authorities should use innovative ways to increase money supply to boost domestic production. This could be done by giving special and low-cost credit to firms that make use of more domestic inputs in production to ensure that the increase in money supply does not lead to increase in import.To achieve interest rate reduction, inflation reducing policies should precede interest rate reducing policies because as explained from the findings of this study, inflation is usually taken into consideration while setting policy interest rate by the monetary authority and lending interest rate by financial institutions.

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APPENDIX 1

VEC REGRESSION RESULT

Standard errors in ( )& t-statistics in [ ]

Error Correction:	D(INF)	D(INT)	D(LOG(EXR))	D(LOG(M2))	D(LOG(GDP))
CointEq1	**-0.206814***	**-0.062805***	-0.002439	-0.004147	**-0.021163*****
	(0.15055)	**(0.03921)**	(0.00677)	(0.00586)	**(0.00408)**
	[-1.37372]	**[-1.60184]**	[-0.36038]	[-0.70740]	**[-5.18692]**
CointEq2	**-**	**-**	**-0.056478****	-0.027482	-0.002083

	1.566668* **	**0.466787*** **			
	(0.57243)	**(0.14908)**	**(0.02573)**	(0.02229)	(0.01551)
	[-2.73686]	**[-3.13113]**	**[-2.19504]**	[-1.23299]	[-0.13429]
D(INF(-1))	**0.535928****	-0.052769	**0.021138****	0.004606	**0.013991****
	(0.22101)	(0.05756)	**(0.00993)**	(0.00861)	**(0.00599)**
	[2.42496]	[-0.91682]	**[2.12784]**	[0.53527]	**[2.33591]**
D(INF(-2))	-0.207306	**0.111365****	0.002022	**0.019940****	**0.019366*****
	(0.24614)	**(0.06410)**	(0.01106)	**(0.00958)**	**(0.00667)**
	[-0.84224]	**[1.73732]**	[0.18273]	**[2.08058]**	**[2.90323]**
D(INT(-1))	-0.433233	**0.302438****	**-0.044304****	-0.000165	0.005412
	(0.54859)	**(0.14287)**	**(0.02466)**	(0.02136)	(0.01487)
	[-0.78972]	**[2.11687]**	**[-1.79672]**	[-0.00772]	[0.36401]
D(INT(-2))	**0.973014***	0.124392	0.004678	-0.002816	-0.014063
	(0.59014)	(0.15369)	(0.02653)	(0.02298)	(0.01599)
	[1.64879]	[0.80936]	[0.17634]	[-0.12254]	[-0.87928]
D(LOG(EXR(-1)))	2.205872	**2.546301***	-0.104392	-0.070113	-0.121885
	(5.97535)	**(1.55617)**	(0.26858)	(0.23266)	(0.16194)
	[0.36916]	**[1.63626]**	[-0.38868]	[-0.30135]	[-0.75265]
D(LOG(EXR(-2)))	**8.684987****	-0.099322	-0.282829	**-0.626953*****	**-0.245335****
	(5.06062)	(1.31794)	(0.22747)	**(0.19704)**	**(0.13715)**
	[1.71619]	[-0.07536]	[-1.24339]	**[-3.18179]**	**[-1.78882]**
D(LOG(M2(-1)))	-0.352531	-1.317130	0.279409	-0.211373	**0.724703****
	(4.99758)	(1.30153)	(0.22463)	(0.19459)	**(0.13544)**
	[-0.07054]	[-1.01199]	[1.24385]	[-1.08625]	**[5.35069]**
D(LOG(M2(-2)))	-5.112142	0.177747	-0.144369	**-0.382578***	**-0.385924****
	(6.54773)	(1.70523)	(0.29431)	**(0.25495)**	**(0.17745)**
	[-0.78075]	[0.10424]	[-0.49053]	**[-1.50062]**	**[-2.17481]**
D(LOG(GDP(-1)))	-2.028571	0.312678	-0.324593	0.054171	**1.301204*****
	(8.97401)	(2.33711)	(0.40337)	(0.34942)	**(0.24321)**
	[-0.22605]	[0.13379]	[-0.80471]	[0.15503]	**[5.35018]**
D(LOG(GDP(-2)))	-1.509531	0.082443	-0.370907	0.085621	**0.516696****
	(8.34826)	(2.17415)	(0.37524)	(0.32505)	**(0.22625)**
	[-0.18082]	[0.03792]	[-0.98846]	[0.26341]	**[2.28375]**
C	0.221405	**0.169717***	**0.042160****	**0.053242*****	**0.029085*****
	(0.38701)	**(0.10079)**	**(0.01740)**	**(0.01507)**	**(0.01049)**
	[0.57209]	**[1.68387]**	**[2.42362]**	**[3.53320]**	**[2.77303]**
R-squared	0.580966	0.622645	0.609873	0.474459	0.911797
VEC LM TEST	Lag 1: stat 25.99933; P Value 0.4076		Lag 2 stat 24.13900; P Value 0.5114		
VEC Normality Test	Joint Stat: 7.684476; P Value: 0.6596				

VEC Heteroscidasticity Test	Joint Stat: 361.9002; P Value: 0.4619

Critical Values of t-distribution at 20 df: $t_{0.1}$= 1.325; $t_{0.05}$= 1.725; $t_{0.01}$= 2.528
* indicates 10% statistical significant
** indicates 5% statistical significant
*** indicates 1% statistical significant
Source: Author's computation using Eviews 9

FORECAST ERROR VARIANCE DECOMPOSITION (FEVD)

INF: Period	S.E.	INF	INT	LOG(EXR)	LOG(M2)	LOG(GDP)
1	1.080836	100.0000	0.000000	0.000000	0.000000	0.000000
2	2.007502	87.28797	9.395165	2.793032	0.522162	0.001668
3	2.862291	75.27292	20.48871	3.291620	0.920264	0.026486
4	3.633565	63.07695	32.45956	3.525617	0.890349	0.047523
5	4.341326	53.97066	41.13557	3.928739	0.892966	0.072068
6	4.981460	47.60581	46.87008	4.523772	0.927645	0.072702
7	5.536546	44.06733	50.19570	4.756318	0.904551	0.076099
8	6.000773	42.37621	51.92160	4.788665	0.831290	0.082240
9	6.377973	41.64373	52.73657	4.767319	0.762116	0.090264
10	6.685454	41.31305	53.12024	4.765482	0.709990	0.091229
11	6.950537	41.19382	53.27257	4.768431	0.674608	0.090579
12	7.197894	41.19909	53.28313	4.773831	0.652226	0.091733
13	7.444034	41.27249	53.22647	4.770704	0.636226	0.094116
14	7.696009	41.34059	53.17501	4.768399	0.622279	0.093724
15	7.953281	41.32848	53.19027	4.776065	0.612973	0.092206
16	8.211427	41.21799	53.29262	4.788580	0.608320	0.092483
17	8.466710	41.05758	53.45104	4.794365	0.602663	0.094355
18	8.716840	40.89455	53.61732	4.799288	0.594139	0.094708
19	8.959647	40.74112	53.76780	4.810822	0.586361	0.093898
20	9.193175	40.60413	53.89929	4.821993	0.580485	0.094099

INT Period	S.E.	INF	INT	LOG(EXR)	LOG(M2)	LOG(GDP)
1	0.281483	0.143549	99.85645	0.000000	0.000000	0.000000
2	0.393977	10.21194	88.02031	1.572964	0.045745	0.149041
3	0.472192	11.51937	86.54121	1.247145	0.569409	0.122864
4	0.502225	12.20368	80.89636	2.464062	4.319906	0.115992
5	0.524809	11.17599	74.09946	4.889823	9.721340	0.113388
6	0.557137	10.56957	69.91942	6.682619	12.64641	0.181980
7	0.598789	9.859146	68.03963	8.289965	13.60593	0.205332
8	0.641248	8.631659	67.02479	10.02360	14.12014	0.199810
9	0.674584	7.897645	65.98775	11.22417	14.67068	0.219750
10	0.696475	7.616473	64.96893	11.98237	15.16132	0.270910
11	0.709952	7.480038	63.94034	12.63628	15.64824	0.295113
12	0.719831	7.399870	62.80483	13.29156	16.20924	0.294498
13	0.728525	7.362398	61.60734	13.84934	16.88141	0.299515
14	0.736687	7.338761	60.46327	14.29154	17.58183	0.324601
15	0.744819	7.278387	59.40778	14.72630	18.24653	0.340997
16	0.754200	7.162817	58.34055	15.24734	18.91010	0.339193
17	0.765390	7.006319	57.25521	15.79541	19.60403	0.339033
18	0.777342	6.835073	56.30560	16.26202	20.24052	0.356788
19	0.789067	6.664448	55.55023	16.67194	20.74015	0.373232
20	0.800815	6.501085	54.85595	17.10830	21.16145	0.373223

Period	S.E.	INF	INT	LOG(EXR)	LOG(M2)	LOG(GDP)
1	0.048582	4.056745	1.383159	94.56010	0.000000	0.000000
2	0.083737	15.89952	18.32020	61.93340	2.664131	1.182756
3	0.126956	22.02818	30.35162	45.52139	1.514756	0.584061
4	0.170524	22.70153	40.37378	35.34208	1.054265	0.528357
5	0.209302	19.86782	46.33768	32.47748	0.876416	0.440598
6	0.241090	17.42954	50.68678	30.59344	0.785049	0.505190
7	0.266795	16.00287	53.00006	29.83856	0.671715	0.486799
8	0.287971	15.30074	54.05890	29.56880	0.592648	0.478911
9	0.305439	14.93262	54.34577	29.70706	0.538259	0.476295
10	0.319969	14.78624	54.40745	29.81111	0.494835	0.500359
11	0.332813	14.75156	54.29550	29.98653	0.458188	0.508215
12	0.345039	14.72577	54.10843	30.23073	0.429500	0.505561
13	0.357179	14.67647	53.93355	30.47441	0.411080	0.504488
14	0.369414	14.65096	53.85150	30.58694	0.396850	0.513759
15	0.381864	14.65747	53.83429	30.60983	0.380917	0.517490
16	0.394486	14.64711	53.85775	30.61604	0.366745	0.512355
17	0.407003	14.59022	53.91973	30.62448	0.356931	0.508636
18	0.419129	14.51768	54.01639	30.60514	0.347855	0.512930
19	0.430790	14.46267	54.10845	30.57588	0.336525	0.516488
20	0.442048	14.42003	54.16592	30.57467	0.325423	0.513955

EXR

Period	S.E.	INF	INT	LOG(EXR)	LOG(M2)	LOG(GDP)
1	0.042084	6.929041	0.318451	4.143400	88.60911	0.000000
2	0.057134	6.981643	3.260862	3.542406	86.21110	0.003986
3	0.073649	14.10628	5.517867	16.83452	63.52972	0.011615
4	0.082422	16.17466	6.958407	16.78001	59.37425	0.712674
5	0.091148	13.87892	7.669938	15.86967	61.99473	0.586746
6	0.098379	12.07093	7.728526	16.69852	62.99652	0.505493
7	0.105032	11.57928	7.499422	18.95071	61.52447	0.446116
8	0.110837	11.67831	7.181121	19.16830	61.36357	0.608705
9	0.116873	11.28455	6.862450	19.11025	62.15370	0.589061
10	0.122602	10.83734	6.558119	19.82710	62.24166	0.535781
11	0.127854	10.68616	6.313010	20.82316	61.68225	0.495417
12	0.132701	10.59977	6.140585	21.04684	61.66035	0.552454
13	0.137707	10.33941	6.028446	20.93253	62.13917	0.560450
14	0.142714	10.09033	5.952783	21.10162	62.33333	0.521928
15	0.147410	10.04279	5.908786	21.51180	62.04620	0.490432
16	0.151787	10.06655	5.888439	21.65290	61.88132	0.510795
17	0.156155	9.948726	5.872651	21.56763	62.08762	0.523370
18	0.160523	9.764398	5.842218	21.63060	62.26609	0.496694
19	0.164672	9.681827	5.802077	21.90938	62.13395	0.472767
20	0.168579	9.685987	5.764184	22.06928	62.00088	0.479663

M2

Period	S.E.	INF	INT	LOG(EXR)	LOG(M2)	LOG(GDP)
1	0.029292	0.018188	0.067275	12.65262	24.68182	62.58010
2	0.031890	3.761231	0.251754	11.66925	21.61867	62.69909
3	0.036833	3.051812	0.373398	14.46997	19.08565	63.01917
4	0.042453	8.647604	2.452360	10.96907	30.48387	47.44710
5	0.051895	10.48686	4.592252	17.09963	25.90734	41.91391
6	0.056440	9.078741	8.651799	24.22349	22.09304	35.95293

GDP

7	0.060277	8.066538	11.47640	22.15159	20.07295	38.23252
8	0.065204	10.21244	12.69090	18.98378	25.39340	32.71949
9	0.071174	11.00791	12.79670	20.93087	24.46773	30.79679
10	0.074252	10.13970	13.81886	25.25863	22.48297	28.29984
11	0.076430	9.583722	14.47680	24.28235	21.72983	29.92729
12	0.079495	10.42520	14.27462	22.47144	24.97726	27.85149
13	0.083398	11.08338	13.77840	23.01358	25.25907	26.86558
14	0.085705	10.58218	14.07266	25.88807	23.96283	25.49426
15	0.087284	10.23145	14.56021	25.56088	23.38387	26.26359
16	0.089582	10.70651	14.62335	24.33127	25.07843	25.26044
17	0.092713	11.32506	14.47293	24.33092	25.56040	24.31068
18	0.094937	10.99177	14.81907	26.34739	24.52659	23.31518
19	0.096358	10.70938	15.38821	26.40071	23.99392	23.50778
20	0.098219	10.91667	15.60750	25.52439	24.92954	23.02190

APPENDIX II

EMPIRICAL DATA

YEARS	EXR(NG/USD)	INT(%)	INF(%)	GDP(N' Billion)	M2(N' Billion)
2010	151.48	21.05	14.95	12583.48	11023.3
	152.05	20.59	14.02	12934.53	10845.5
	152.01	19.62	13.45	14304.44	11224.8
	152.77	18.93	12.68	14789.82	11525.5
2011	154.81	18.89	11.99	13450.72	11653.6
	156.64	18.94	11.29	13757.73	12172.1
	157.99	19.05	9.68	14819.62	12618.1
	160.95	19.99	10.45	15482.97	13303.5
2012	160.42	20.12	12.2	13915.51	13271
	160.12	20.17	12.82	14323.05	13483.1
	160.57	20.29	11.91	15645.43	14065.3
	158.29	20.58	12	16045.9	15483.8
2013	158.41	20.2	9.05	14535.42	15669.2
	159.43	20.59	8.79	15096.76	15593.2
	162.01	20.66	8.3	16454.37	14362.5
	163.54	21.01	7.86	17132.16	15689
2014	166.86	21.29	7.82	15438.68	17732.9
	165.19	21.19	8.01	16084.62	17576.6
	165.65	21.09	8.38	17479.13	18200.2
	174.97	21.04	7.99	18150.36	18913
2015	200.09	21.57	8.34	16050.6	19132.4
	206.96	21.49	8.98	16463.34	18811.4
	211.24	22.11	9.32	17976.23	18718
	217.78	21.94	9.41	18533.75	20029.8
2016	255.26	21.75	11.26	15943.71	20470.4
	272.54	21.7	15.26	16218.54	22078
	350.21	22.2	17.53	17555.44	22013.8
	374.71	22.67	18.45	18213.54	23591.7

2017	389.06	23.3	17.92	15797.97	22304.3
	343.49	24.1	16.53	16334.72	21980.6
	335.65	24.46	16.01	17760.23	21954
	334.21	24.45	15.73	18598.07	24140.6
2018	334.2	24.45	14.27	16106.73	22691.7
	333.85	24.19	11.77	16580.51	22928.8
	332.63	23.81	11.22	18081.34	23253.7
	334.54	23.56	11.33	19041.44	23091.25

SOURCES: CBN Statistical Bulletin 2018; CBN online database