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Nigerian Economic Performance: Exploring Dynamics of Exchange Rate, Inflation and Economic Output

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Abstract

This study explores the dynamic interaction between exchange rate, inflation and economic output in Nigeria between 1999 and 2017 using Vector Error Correction (VEC) granger causality test and Vector Error Correction Model (VECM). Results establish that there is unidirectional causality running from economic output (GDP) to exchange rate in Nigeria. The study further confirms that exchange rate significantly exerts a long run positive impact on economic performance in the country, while the impact of inflation on economic output in the long run is found to be negative. Furthermore, economic output exerts a negative impact on both inflation and exchange rate, but inflation positively influences exchange rate. Another evidence reveals that in the long run, exchange rate depreciation impacts positively on economic output, while inflation impacts negatively on output. The assertion that exchange rate depreciation leads to positive economic performance could be attributed to the positive long run effect of real sector development. Thus, the study suggests that policymakers should initiate measures that could aid financial and real sector development. Also, it is suggested that promoting the habit of consuming made in Nigeria goods, through awareness programmes and quality control measures could mitigate the inflationary effect of the external sector on Nigerian economy.

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1. Introduction

In many developing countries, literature has identified exchange rate movements as the key determinant of the inflationary phenomenon. Corroborating this argument, Okoli, Mbah, and Agu (2016) argues that high inflationary trend is a strong tendency of foreign exchange fluctuations. On the other hand, these authors also espouse to the postulation that exchange rate fluctuations could be exacerbated by the high inflationary incidence in the economy. Accordingly, inflation in a country is imported directly through depreciation or engendered by rising imported factors of production. It is often asserted that given the possible detrimental effect of inflation on the economy, policymakers need to consistently put under control factors that could trigger inflationary pressure in the economy.

Developing countries are often confronted with the menace of inflation in which their currencies lost power to effectively perform its original function of storing value and smoothly facilitating exchange. In Nigeria, therefore, exchange rate policies over the years have undergone phases of reforms with the aim of achieving a realistic, growth propelling exchange rate for the Naira and ensuring stable prices. These ranged from a fixed exchange rate regime prior to 1986, to various forms of floating exchange rate system following the liberalization of the foreign exchange market in 1986 (Ali, Ajibola, Omotosho, Adetoba, & Adeleke, 2015). Noticeably, changes in exchange rate regimes in Nigeria led to various movements of the real exchange rate with different consequences. The arrangement of exchange rates in Nigeria shifted from a fixed regime in the 1960s to a pegged arrangement between the 1970s and the mid-1980s, and finally, to the various types of the floating regime since 1986, following the adoption of the Structural Adjustment Programme (SAP). A regime

of managed float, without any strong commitment to defending any particular parity, has been the predominant characteristic of the floating regime in Nigeria since 1986. The fixed exchange rate regime induced an over-valuation of the naira and was supported by exchange rate control regulations that engendered significant distortions in the economy. This gave vent to massive importation of finished goods with adverse consequences for domestic production, balance of payments position, and the nation's external reserve level (Sanusi, 2004) .

Thus, caution becomes imperative, as efforts of policy makers in promoting the vitality of an economy through adjustments of certain macroeconomic indicators could spur negative reactions from other macroeconomic variables. Take for instance, devaluation of the Naira which occurred in November, 2014 was meant to correct the supply gap in the foreign exchange market, when the demand for dollars outpaced the supply occasioned by the declined crude oil prices, but eventually triggered inflationary trend upward. This phenomenon however exerted serious pressure on the Naira and prices of goods, and the intervention of the Central Bank of Nigeria in stabilizing prices at the time was not without the cost of depleting the reserves. In the same vein, the high government spending in 2000 to boost the economy and increase the real GDP growth brought about macroeconomic instability as inflation surged and the foreign exchange became unstable. These spurred several researchers to start probing into the possible connectivity among various macroeconomic variables.

Between inflation and economic performance, certain issues are prominent. Of such issues is the fact that a measure of inflation is required for investment boost and robust economic output. However, there is also the concern that if inflation is not restricted to an optimum low level, the objective of promoting output growth will be seriously compromised, as risks associated with high inflation might put investors off, and thus impair the output growth. Besides, high consumable prices erode the real value of a currency and consumers' real income, thereby worsening the impact of poverty which has caused severe economic hardship in many developing countries (Ahortor & Adenutsi, 2009).

Going by the population of over 160 million (Ajibefun & Daramola, 2003) and vast resources endowment, Nigeria has the potential to be the largest economy and one of the major players in the global economy than it is currently. Pattern of economic growth since a decade ago as revealed by Doguwa (2014) showed growth instability. Nigerian economy is underperforming (Uwakaeme, 2015). Hence, an investigation of the coinciding movements in the exchange rate, inflation and real GDP in recent times would reveal certain connectivity between exchange rate behavior and inflation as they both affect economic performance of Nigeria (NBS, 2015). Although there seems to be divergence of opinion in the discussion of possible impacts of inflation on an economy, there seems to be a generalization that high level of inflation, and most especially when it is prolonged affects an economy negatively (Li, 2004; Marburg, 1973).

Furthermore, the recessionary trend, being the recent economic experience in Nigeria, gives another dimension to the inflationary pressure prevailing in the country. In the last couple of years, macroeconomic indicators have deteriorated much faster than expected. Surprisingly, the case in Nigeria is such that even in the face of a recession, prices of goods double, triple and keep increasing on a daily basis. Life has become harder for an average Nigerian. Contrary to the analysis of Marburg (1973) that inflationary processes operate to the benefit of governments, debtors and most importantly entrepreneurs, Nigerian economic fundamentals are rather weakened in the last few years – interest rates trending upwards, the Naira depreciating unpredictably in all segments of the foreign exchange market, the external sector coming under serious pressure, and the inflationary pressure is getting worse (AFDB, 2003). Hence, the depreciation of the currency would increase prices of goods through the exchange rate when little or nothing could be done to immediately alter the pattern of imports demand (Omojimite & Akpokodje, 2010). Therefore, when a country depends too much on imports, susceptibility to inflationary pressures becomes inevitable.

The poor performance of Nigerian economy in the last decade has been worsened by persistent rising in prices of goods. Output growth slumped from 6.2% in 2014 to an estimated 3.0 in 2015. Meanwhile, inflation increased from 7.8% to an estimated 9.0% in the same period. Inadequate supply of foreign exchange is one of the reasons attributed to the slowdown in economic activity and its attendant inflationary pressure (NBS, 2015). The claim of Idris and Bakar (2017) that rapid money supply through expansionary fiscal policies of the public sector is the reason for inflationary trends in Nigeria, could not be supported by the rise of inflationary process in 2013, 2014 and 2015. Because when the GDP declined by -9.41%, -9.88% and -14.57% respectively, inflation rate averaged 8.1%. Thus, in order to ascertain the effect of money supply in inflationary process, a new study that will examine the relationship among exchange rate, inflation and output in Nigeria is central.

Given that empirical quests into relationships among macroeconomic variables have always generated diverse results, and that in all directions, the emphasis of how macroeconomic indicators influence one another cannot be overestimated, regarding the interrelationship among exchange rate, inflation and output certain connectivity could be established. For instance, while studying the impact of exchange rate and inflation on output in Nigeria between 1980 and 2010, Perpetua (2014) concluded that inflation and exchange rate are positively related and their joint impact is detrimental to economic growth, most especially when the inflation is excessively high. Similarly, Yiheyis and Cleeve (2016) researched on the dynamics of real exchange rate, inflation and output growth in Malawi. The author affirms this conclusion. Observations from the study

revealed that the exchange rate is influenced by output growth and inflation. The causality analysis of the study also established a causation running from exchange rate to inflation, and from inflation and exchange rate separately to output growth. Also, Vinh and Fujita (2007) established through their study that output and inflation are influenced by own shocks, and that real devaluation positively impacts both output and inflation. Nonetheless, a focus on the dynamic interrelationship between exchange rate, inflation and output is limited regarding Nigeria.

Hence, considering the economic situation in Nigeria between 1999 and 2017 is critical, as the economy was partly in a recession from 2015-2017 with the experience of soaring exchange rate and inflation (NBS, 2017). Furthermore, given the general economic antecedents in the country, and mixed conclusions from several research studies, examining the dynamic relationship between exchange rate, inflation and economic output within the period is central. Thus, the study's aim is to establish new facts about the dynamic relationship among exchange rate, inflation and economic output in Nigeria through which lessons for policy decisions could be drawn. For this reason, the paper is structured as follows: The next section centers on the literature review. Section 3 contains methodology. Section 4 presents results and discussion. Section 5 gives the presentation of results and discussion, while final section gives the concluding remarks.

2. Literature Review

In most developed countries, high inflation rates were last recorded around 1980s. Interestingly, years of economic expansions in these countries were characterized by low episodes of inflation. Particularly, inflation rate in the United States was kept low in the 1990s as the economy experienced substantial growth. This theory-opposing phenomenon is a diametrical opposite of the current situations in Nigeria and some other developing countries where high inflation rates are accompanied by poor economic performances. The divergence between actual experiences in these countries and theoretical presumption have spurred researchers to search for factors that were responsible for the unusual experiences. Import prices and exchange rates were cardinal factors identified to explain the relationship between economic performance and inflation in developed countries. More specifically, exchange rate appreciation and import price deflation were attributed to the disinflationary experience in these developed countries, coupled with foreign competitive pressures on domestic firms which were also considered to have restrained domestic inflation substantially (McCarthy, 2007).

Hyman (1996) investigates the relationships between Swedish producer prices, import prices and inflation; discovered that import prices have no significant impact on inflation in Sweden. In contrast, Rich and Rissmiller (2000) through their study explained inflationary behaviour in the United States using import prices. They found a significant relationship between import prices and US inflation. Also, McCarthy (2007) employs a VAR model to track pass-through from exchange rate fluctuations to each stage of the distribution chain in a simple integrated framework. Results of the study's impulse-response functions reveal that exchange rate shocks have modest effect on domestic inflation in most of the countries in the sample, but shocks from import prices reflect a larger effect. However, the variance decompositions of the study implied that the role of exchange rate and import price shocks in explaining volatility of inflation is mild. Kun, Ooi, and Ismail (2012) conducts empirical investigation on the relationship between exchange rate and inflation targeting regime in the three developed and three emerging Asian economies that have adopted inflation targeting (IT) regime. Using a multivariate GARCH model under BEKK specification, they investigated if exchange rate affect the performance of IT, while the performance of IT is compared between Asian and European economies. The comparison is made in terms of changes in economic structure and the disinflation cost. The results show significant correlation between exchange rate movements and inflation and output movements in both sub-periods. IT also has significant impacts on the movements of inflation, output and exchange rate. IT leads to higher volatility in exchange rate movement in majority economies. Comparing the performance of IT across economies, they observe that the volatility in exchange rate has increased dramatically and is very volatile in Asian compared to the developed economies. The decline in inflation impulse is larger in Asian than in developed economies. The implementation of IT does not lead to trade-off of inflation-output in Asia but the trade-off relationship is detected in developed economies.

In another study, Ecevit and Kayhan (2011) examine the Turkish economy by the beginning of inflation targeting era using monthly data for the period 2002 to 2009 to establish Taylor type monetary policy reaction function, and to test whether exchange rate has a place in reaction function by using structural VAR technique. They found that exchange rate has no weight on short term nominal interest rate decisions of the Central Bank of Republic of Turkey. According to Mohanty and Klau (2005) exchange rate is likely to assume special importance for monetary policy when the pass through of the exchange rate is high because it will affect real and financial sector directly and indirectly. It means that pass through effect is important for the central bank even if it does not target inflation. Kara and Nelson (2002) study of the UK found that neither of the above extremes had justification in empirical studies. Rather, in line with Campa and Goldberg (2005) analysis of the UK, the data reported a close and high correspondence between exchange rate changes and rates of change in prices of products labelled as imported consumer goods.

Bashir et al. (2013) empirically study the relationship among domestic price level and foreign price level with nominal exchange rate in Pakistan, using a daily data set for 13 years from July 2000 – June 2013. The regression analysis reveals that domestic price level has positive relationship with nominal exchange rate, but foreign price level has a negative relationship with nominal exchange rate in the long run. Similarly, the continuously increasing exchange rate in Pakistan since the last 20 years prompted (Shafi, Hua, Nazeer, & Idrees, 2015) to conduct a study probing into the relationship among inflation, money supply, FDI and the exchange rate. Results of their study show a very strong relationship among the variables investigated. Accordingly, upward trend in inflation, money supply and FDI justified increases in exchange rate and vice versa.

Also, Bibi, Ahmad, and Rashid (2014) through their study analyze the role of trade openness, inflation, imports and exports, real exchange rate and foreign direct investment in enhancing economic growth in Pakistan. Using time series data covering period 1980-2011, results of their study reveal long run relationship among the variables investigated. But findings establish a negative relationship between trade openness and economic growth, and consider foreign direct investment a vital element that improves economic growth. In the study of Tarawalie, Sissoho, Conte, and Ahortor (2012) the effect of changes in exchange rate on output and inflation in the West Africa Monetary Zone (WAMZ) economies was examined using vector auto regressive and variance decompositions techniques of estimation. The results show that exchange rate has significant impact on inflation in all the member states. Specifically, negative relationship between real exchange rate and real GDP growth for both Sierra Leone was identified, with the implication that depreciation of the real exchange rates in these countries could lead to output growth. Meanwhile, in Gambia, Ghana, Guinea and Nigeria; impact of exchange rate on output was positive, but weak, due to supply side factors.

Using quarterly data and the bounds testing approach to cointegration analysis to investigate the temporal causality and dynamics of real exchange rate, inflation and output growth in Malawi, Yiheyis and Cleeve (2016) find that real exchange rate is responsive in the long run to the growth rate of output and not to inflation. However, their analysis of short-run dynamics show that the real exchange rate was influenced by output growth and inflation. In summary, they conclude that domestic economic activity, monetary policy and availability of foreign exchange jointly determine exchange rate movements in Malawi. While addressing the inflationary phenomenon in Zimbabwe, Mandizha (2014) asserts that the hyperinflation and its attendant problems in Zimbabwe from 2000 to 2008 was self-inflicted. Excessive printing of Zimbabwe dollars was the reason suggested for hyperinflationary experience in the country. Moreover, the analysis of the effect of inflation, interest rates, and exchange rates on grow domestic product in Indonesia by Semuel and Nurina (2015) revealed that there is a significant negative relationship of interest rates on GDP and a significant positive relationship of the exchange rates on the GDP. While inflation was not a significant influence on GDP.

According to Amato, Filardo, Galati, Peter, and Zhu (2005) in small open economies, in particular emerging markets, capital inflows can fuel the expansion of domestic credit, and in turn a tightening of monetary policy might encourage those inflows further. This makes these economies vulnerable to a sudden withdrawal of foreign capital. Montiel (1989) applies a five variable VAR model (money, wages, exchange rate, income and prices) to examine sources of inflationary shocks in Argentina, Brazil and Israel. The findings indicated that exchange rate movements among other factors significantly explained inflation in the three countries. Other studies which have reached similar conclusions are Kamin and Rogers (1996); Odedokun (1996); Petkova and Zhang (2003).

Regarding Nigeria, Sani, Abdullahi, and Ibrahim (2016) used bounds tests to cointegration approach to examine the dynamics of inflationary process. Results of their empirical study indicated that past inflation and average rainfall were the main determinants of inflationary process in Nigeria over the study period. The proposition of the monetarists is also verified as strong evidence was found in support of the impact of money supply in the inflation process in Nigeria. Thus some scholars have argued that effectiveness of demand is primarily based on the willingness and ability of an individual to buy a good or service. The ability, according to them, is dependent on the availability of money. Hence, an increase in aggregate demand is a function of an increase in money supply, which is also assumed a factor for rising prices (Hyman, 1996). But, following CBN (Central Bank of Nigeria, 1974) cross-section analysis of the origins and development of inflationary trend in some African countries including Nigeria, changes in money supply and domestic credit did not have significant effects on the price level, but the real income had significant impact with a 60% estimate of determination, although lagged changes in money supply generated significant coefficients.

In addition to exchange rate fluctuations, money supply growth was identified by Idris and Bakar (2017) as being responsible for inflationary trends in Nigeria. The study adopted a descriptive method to analysis the relationship between inflation and GDP growth, and found inflationary trend in Nigeria to be excessive and detrimental to economic expansion. Similarly, Imimole and Enoma (2011) in their empirical investigation found exchange rate depreciation amidst other determinants, such as money supply and real gross domestic product as important determinants of inflation in Nigeria. Accordingly, they found that Naira depreciation was positive, and had significant long-run effect on inflation in Nigeria. By implication, exchange rate depreciation

will bring about increasing rate of inflation in Nigeria. However, a structural VAR model employed by Odusola and Akinlo (2001) examined the linkage between exchange rate, inflation and output in Nigeria. The model revealed that parallel exchange rate market influenced output growth negatively in the short run, and inflation dynamics were explainable by output growth and parallel exchange rate.

Also, Danmola (2013) studied the impact of exchange rate volatility on macroeconomic variables in Nigeria using ordinary least square method of analysis, and found a positive influence on gross domestic product, foreign direct investment and trade openness, but a negative influence on inflationary rate in the country. Meanwhile, Perpetua (2014) established a positive relationship between exchange rate and inflation, implying that the depreciation of the exchange rate will provoke inflation. But between exchange rate and economic growth, a negative relationship was identified. And between inflation and economic growth, moderate inflation would enhance investments and should be tolerated, even though it can be detrimental when it is high. Ebiringa, Onuorah, and Obi (2014) in their paper established a significant short run and long run relationship between inflation and exchange rate, using historical data on Nigeria between 1971 and 2010. Also, their interest rate data exhibited a negative relationship although it was insignificant.

Abiodun, Maharaj, Witbooi, and Okosun (2016) using quarterly data covering 20 years (1995-2015) and with the Johansen approach to cointegration and a vector error correction methodology, the effect of pass - through was found to be higher in import than in inflation. In the same vein (Okoli et al., 2016) investigated the impact of inflation on real exchange rate volatility in Nigeria using quarterly data of 181 series from the first quarter of 1970 all through to the last quarter of 2014, a unidirectional causality running from inflation to real exchange rate volatility was detected. Causality was also found running from the whole sample variable to imported inflation.

The assessment of literature from different countries revealed that, practical experiences of countries are explainable by theories. Substantial evidences showed that money supply is fundamental in the prevalence of inflationary trend in an economy. Other factors that generate inflationary pressures are similar to money supply. They include: credit to government, fiscal deficit, wages, food imports and so on. These studies also reveal some links between inflation and exchange rate. However, while many of the studies reviewed mainly examined exchange rate and output, and inflation and output separately with mixed results, studies of the dynamic interrelationship between exchange rate, inflation and output are not sufficiently available for Nigeria. Therefore, this study is motivated to fill the gap.

3. Methodology

3.1. Theoretical Framework

The theoretical framework found relevant to explain interrelationship between exchange rate, inflation and economic output is the traditional Keynesian theory of fluctuations and Mundell-Fleming model being an extension of the Keynesian IS-LM model and contribution made by Robert Mundell and Marcus Fleming in the 1960s. The reason for this adoption is because economic fluctuations present a recurring problem for economists and policy-makers. Recessions are very common and irregular. Sometimes they occur in quick interval and at another time there is a considerable distance in between them. More importantly, Keynesian accounts of macroeconomic fluctuations (prices, interest rates, etc.) typically assign important roles to many different kinds of shocks. For instance, Keynesian view explains cost related inflationary fluctuations in terms of shocks in wages and salaries, shocks in prices of raw materials, shocks in prices of imported goods and some other shocks. Accordingly, sluggish nominal adjustment causes changes in the aggregate demand for goods at a given level of prices to affect the amount that firms produce. Consequently, monetary disturbance is made to cause changes in output and employment. Hence, aggregate supply and aggregate demand models show how shocks to the economy lead to short-run fluctuations in output and employment.

Thus, Mundell-Fleming model showed the short run relationship between an economy's nominal exchange rate, interest rate, and output in contrast to the closed economy IS-LM model, which focuses only on the relationship between the interest rate and output. Mundell-Fleming model consist of GDP (Y), consumption (C), investment (I), government spending (G), money supply (M), the price level (P) and the net export (NX). Hence Mundell-Fleming model is expressed as:

$$Y = C + I + G + NX$$
$$M/P = L(i) \quad (1)$$

The only difference between Mundell-Fleming model Equation 1 and the Keynesian IS-LM model of short run fluctuations is the addition of external sector NX in the IS model. Accordingly, devaluation reduces balance of payment deficit but may not be true in all cases. Therefore, effectiveness of devaluation depends on Marshall-Lerner condition which states that when the sum of price elasticity of the demand for imports of any two countries trading their goods between them is greater than unity, then devaluation increases exports and decreases imports. However, the Figure 1 summarizes the Keynesian theory of short run fluctuations from which the Mundell-Fleming model derives.

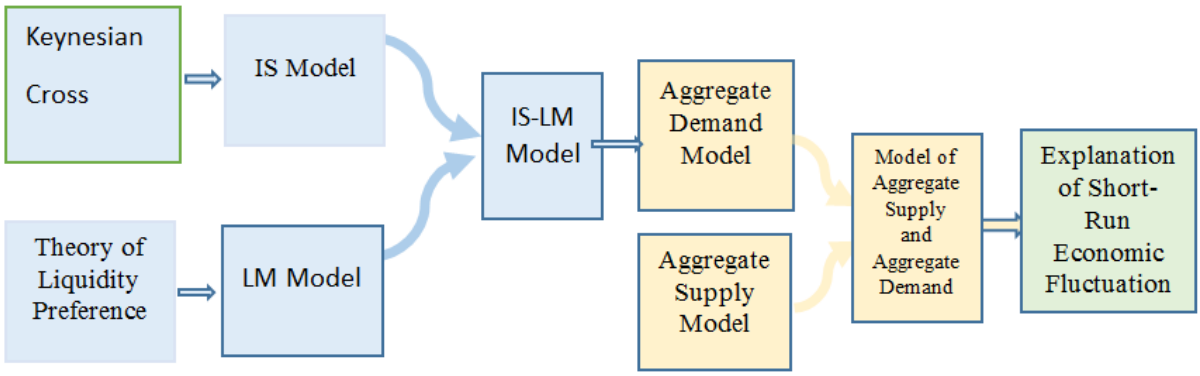

Figure-1. The theory of short run fluctuations.

Source: Mankiw (2001).

Keynes' theory of short-run fluctuations consists of several pieces of models that fit together. Starting from the Keynesian cross that explains the IS model, and the theory of liquidity preference which explains the LM model. The IS and LM model together yield the IS-LM model, which explains the aggregate demand model. Thus, this model forms the part of the model of aggregate supply and aggregate demand, which is used to explain short run fluctuations in economic activity. The whole process is summarized by Figure 1.

3.2. Model Specification

In line with the theoretical framework discussed in the previous section, the instrumental model formulated examines the dynamic relationship among exchange rate, inflation and output in Nigeria. The model was adapted from the multiple linear regression model as:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \mu \quad (2)$$

Thus, the model in its implicit form is expressed as:

$$GDP = F(EXCR + INFR) \quad (3)$$

In Equation 3, *GDP* is the proxy for output, *EXCHR* represents exchange rate, and *INFR* is the inflation rate. However, since neither the exchange rate nor the inflation rate can both sufficiently determine the level of output (GDP), it is therefore imperative to add some other variables which are relevant in the literature. Other variables include money supply (MS), which according to the monetarists is the major determinant of inflationary trend in every society; the interest rate (INT), which is the opportunity cost of holding wealth as cash; and trade balance TB, which reveals the performance of the economy in international trade. Hence, the model in its implicit form becomes:

$$GDP = F(EXCHR + INFR + TB + MS + INT) \quad (4)$$

Explicit form of the above equation can thus be specified as:

$$GDP = \alpha_0 + \alpha_1 EXCHR + \alpha_2 INFR + \alpha_3 TB + \alpha_4 MS + \alpha_5 INT + \mu \quad (5)$$

As described in Equation 3, GDP is the output, EXCHR represents exchange rate; INFR is inflation rate, TB is defined as the trade balance, MS is the money supply, INT represents the rate of interest, and μ is the error term.

3.2.1. Causality between Exchange Rate, Inflation and Economic Output (GDP)

In order to determine the causal relationship between exchange rate, inflation and output, the multivariate Granger causality test corroborated with the VEC Granger causality test was employed. The choice of this test is anchored by the quest for the direction of causality among the variables of interest. Although, cointegration test also reveals existence of causality among variables, it does not show the direction of causality among the variables. Hence, the multivariate VEC Granger causality models are stated below:

$$\Delta Y_t = \eta_t^y + \sum_{j-1}^{n} \beta_{1t} \Delta Y_{t-j} + \sum_{j=1}^{n} \beta_{2t} \Delta X_{t-j} + \sum_{j=1}^{n} \beta_{3t} \Delta FR_{t-j} + \rho^y \varepsilon_{t-1}^y + \mu_t^y$$

$$\Delta X_t = \eta_t^r + \sum_{j=1}^{n} \delta_{1t} \Delta Y_{t-j} + \sum_{j=1}^{n} \delta_{2t} \Delta X_{t-j} + \sum_{j=1}^{n} \delta_{3t} \Delta FR_{t-j} + \rho^x \varepsilon_{t-1}^x + \mu_t^x \quad (6)$$

$$\Delta FR_t = \eta_t^n + \sum_{j=1}^{n} \varphi_{1t} \Delta Y_{t-j} + \sum_{j=1}^{n} \varphi_{2t} \Delta X_{t-j} + \sum_{t-j}^{n} \varphi_{3t} \Delta FR_{t-j} + \rho^r \varepsilon_{t-1}^r + \mu_t^r$$

In Equation 6, t denotes time period, Y represents GDP, X represents exchange rate and FR stands for inflation rate. However, GDP and exchange rate are in logarithms so as to reconcile their results with that of inflation rate which is relatively in lower figures. Δ denotes the first-difference operator, η_t stands for the fixed effects, j denotes lag length, ε_{t-1} represents the one period lagged error correction term and μ_t is the serially uncorrelated error term with mean zero. The coefficients $\beta, \delta, and \varphi$ stand for the short-run dynamics while $\rho^k, k = y, x, r$ represents the speed of adjustment.

3.2.2. The Dynamic Interaction Model

The aforementioned variables are endogenized, based on Sims (1980) argument that with simultaneity among variables, the process of classifying variables should be given equal consideration, and so all should be treated as endogenous. Hence, Equation 7 is re-specified as a VAR model, with large variables expressed in log form. More specifically, the model incorporating direct and indirect linkages is presented as follows:

$$\Delta Y_t = \phi_1 + \sum_{i=1}^{m} \varphi_{1t} \Delta Y_{t-i} + \sum_{i=1}^{m} \gamma_{1t} \Delta X_{t-i} + \sum_{i=1}^{m} \eta_{1t} \Delta FR_{t-i} + \sum_{i=1}^{m} \kappa_{1t} \Delta TB_{t-i} + \sum_{i=1}^{m} \lambda_{1t} \Delta MS_{t-i} + \sum_{i=1}^{m} \varpi_{1t} \Delta IR_{t-i} + \varepsilon_{1t}$$

$$\Delta X_t = \phi_2 + \sum_{i=1}^{m} \varphi_{2t} \Delta Y_{t-i} + \sum_{i=1}^{m} \gamma_{2t} \Delta X_{t-i} + \sum_{i=1}^{m} \eta_{2t} \Delta FR_{t-i} + \sum_{i=1}^{m} \kappa_{2t} \Delta TB_{t-i} + \sum_{i=1}^{m} \lambda_{2t} \Delta MS_{t-i} + \sum_{i=1}^{m} \varpi_{2t} \Delta IR_{t-i} + \varepsilon_{2t} \quad (7)$$

$$\Delta FR_t = \phi_3 + \sum_{i=1}^{m} \varphi_{3t} \Delta Y_{t-i} + \sum_{i=1}^{m} \gamma_{3t} \Delta X_{t-i} + \sum_{i=1}^{m} \eta_{3t} \Delta FR_{t-i} + \sum_{i=1}^{m} \kappa_{3t} \Delta TB_{t-i} + \sum_{i=1}^{m} \lambda_{3t} \Delta MS_{t-i} + \sum_{i=1}^{m} \varpi_{3t} \Delta IR_{t-i} + \varepsilon_{3t}$$

Where t represents the time period, Y, X, FR; TB, MS, and IR, are GDP, exchange rate, inflation rate; trade balance, money supply, and interest rate respectively. All the variables are in logarithms form except inflation rate and interest rate. Δ denotes the first-difference operator, ϕ stands for the fixed effect, i stands for the lag length, ε_{it} is the serially uncorrelated error term with mean zero.

3.3. Measurement of Data and Sources

The research data employed to analyze the dynamic relationship between exchange rate, inflation and output in Nigeria between 1999 and 2017 are secondary data. The study utilized quarterly time series data for exchange rate, inflation rate and GDP in Nigeria. Data were sourced from the Central Bank of Nigeria statistical bulletin. In this study, the control variables are trade balance, interest rate, and money supply. The reason for the inclusion of trade balance is that, it accounts for the performance of the economy in international trade, the phenomenon which has grave implication for the movements of exchange rate. Interest rate is the opportunity cost of holding financial assets as cash while money supply is fundamental and theoretical factor of the inflationary phenomenon.

Gross Domestic Product (GDP): GDP is the representative variable for economic output. It measures the total expenditure on output of goods and services in the country. It generally gives information on the economic performance.

Exchange Rate (EXCHR): Exchange rate is the price of the country's currency expressed in terms of some other currency. It determines the relative prices of domestic and foreign goods, as well as the strength of external sector participation in the international trade (Adeniran, Yusuf, & Adeyemi, 2014).

Inflation Rate (INFR): Inflation rate is the proportional increase in the price level. INFR gives information in percentages, about how price level has changed from the previous month. Inflation rate is commonly proxied by the consumer price index.

Interest Rate (INT): Interest rate is the opportunity cost of credit. It is the rate, as a percentage of principal a borrower pays the lender on loans in excess of the principal. The interest rate is measured by the prime lending rate figures reported by the CBN and expressed in percentage.

Money Supply (MS): This measures the stock of money in circulation, and the demand deposits with commercial banks.

Trade Balance (TB): This measures the net worth of the country's transactions with the rest of the world. It is derived by the difference between total value of goods and services exported and the total value of goods and services imported.

4. Empirical Results and Discussion

4.1. Descriptive Statistics

In any time series study, it is good to assess the descriptive statistics in order to observe the distribution and the variability of the variables. Therefore, this section examines whether the variables are symmetric; how skewed the variables are; the values of kurtosis; and the standard deviation values. From Table 1, the mean and median of all the six variables are not close enough, thus suggesting that the distributions of the variables may not be symmetrical. The skewness statistics revealed that all the variables are positively skewed, except the interest rate. The kurtosis of EXCHR and TB exceed three, meaning that the series follow leptokurtic distribution. This indicates that the variables are greatly peaked relative to the normal distribution. On the contrary, GDP, MS, IR, and INFR follow platykurtic distribution, given that their kurtosis values are less than three. This indicates that the distributions of the series are less peaked relative to the normal distribution. Finally, the probability values of the Jarque-Bera statistics for GDP, TB, and MS fall below 5% significance level. This suggests the rejection of normal distribution for the variables. However, EXCHR, IR and INFR may be normally distributed.

Table-1. Descriptive statistics.

	GDP	EXCHR	TB	MS	IR	INFR
Mean	5549.167	136.5532	421436.3	7466.690	13.49752	10.30882
Median	156.5635	132.7973	335167.9	5394.435	14.00000	9.350000
Max	18533.75	196.9900	1911510.	20029.80	20.70000	18.90000
Min	98.06684	86.96590	29841.31	609.0302	6.000000	2.137867
S.D.	7448.581	24.34538	387870.2	6121.723	3.965392	4.084823
Skew.	0.667388	0.404680	1.843180	0.474958	-0.32582	0.334697
Kurt.	1.517223	3.183865	6.559306	1.814131	2.168052	2.316717
J-B	11.27739	1.951802	74.39741	6.541109	3.164205	2.592400
Prob.	0.003558*	0.376853	0.000000*	0.037985*	0.205542	0.273569
Sum	377343.4	9285.619	28657666	507735.0	917.8313	700.9996
Sum Sq. Dev.	3.72E+09	39710.75	1.01E+13	2.51E+09	1053.530	1117.947

* indicates rejection of normality assumption given that probability value is lower than 5% significance level.

4.2. Analysis of the Unit Root Test

Testing for the presence of unit roots and ascertaining the order of integration of the variables are crucial in time series modeling, because of the problems associated with non-stationary series. Hence, the study employed two techniques, which are the Augmented Dickey-Fuller (ADF) test (Dickey & Fuller, 1981) and the Phillip-Peron (PP) test (Phillips & Perron, 1988) with constant and linear trend.

Table-2. The augmented Dickey Fuller and Phillips-Perron unit root tests with intercept and linear trend.

Test	Augmented Dickey Fuller			Phillips Perron		
Variable	Level	First Diff	Status	Level	First Diff	Status
LGDP	-2.0238	-7.9911	I (1)	-2.0820	-7.9911	I (1)
	[0.5777]	[0.0000]*		[0.5461]	[0.0000]*	
LEXCHR	-1.7590	-6.9382	I (1)	-2.7007	-6.9445	I (1)
	[0.7134]	[0.0000]*		[0.2398]	[0.0000]*	
LTB	-3.2731	-8.3672	I (1)	-3.3732	-11.2010	I (1)
	[0.0797]	[0.0000]*	`	[0.0637]	[0.0000]*	
LMS	-1.1082	-9.1013	I (1)	-0.9680	-9.2079	I (1)
	[0.9197]	[0.0000]*		[0.9412]	[0.0000]*	
INTR	-1.1777	-8.3488	I (1)	-1.1623	-8.3488	I (1)
	[0.9068]	[0.0000]*		[0.9098]	[0.0000]*	
INFL	-2.9371	-9.3689	I (1)	-2.9797	-9.3309	I (1)
	[0.1579]	[0.0000]*		[0.1456]*	[0.0000]	

Note: * represent 1% (-4.1032), ** represent 5% (-3.4793), *** represent 10% (-3.1674 critical values. "[]" are probability values while the values without brackets are the t-statistical values.

The variables except inflation and interest rate are all expressed in log form because they behaved well when we took their logarithm. The results of the ADF and the PP tests are shown in Table 2. The decision rule for the tests is that if the absolute value of the ADF test or that of the PP test is lesser than the corresponding critical value, then it is adjudged that the tested variable is non-stationary at that significance level. On the other hand, if the absolute value of the ADF test or that of the PP test is greater than the corresponding critical value, then it is adjudged that the underlying variable is stationary. The results of the ADF indicate that Gross Domestic Product (GDP), Nominal exchange rate (EXCHR), Trade Balance (TB), Money Supply (MS), Interest Rate (INTR), and inflation Rate (INFR) are non-stationary in their level. These variables become stationary after taking first difference; that is, they are integrated of order one. Thus, the stationarity tests indicate that all the included variables are I (1); hence, giving credence to the choice of VEC model for estimation.

4.3. Lag Order Selection Criteria

In order to estimate the vector error correction model, it is appropriate to determine the optimal lag length to be used. To further prevent the misspecification and loss of degrees of freedom, there is the need to determine the optimal lag length before estimation. The selection of lag length rests on the outcomes of the various information criteria of which the Schwarz criterion is adjudged the most reliable. As shown in Table 3, the Schwarz criterion indicates optimal lag order of 1.

Table-3. VAR lag selection criteria.

Endogenous Variables: LGDP, LEXCHR, INFR
Exogenous Variables: LTB, LMS, IR C

LAG	LOGL	LR	AIC	SC	HQ
0	-159.32	NA	5.44	5.84	5.59
1	-57.65	180.73	2.49	3.21*	2.78*
2	-53.47	7.04	2.65	3.67	3.05
3	-51.72	2.77	2.88	4.21	3.40
4	-46.37	7.98	2.99	4.63	3.64
5	-19.36	37.74	2.42*	4.36	3.19

Note: * indicates lag order selected by criterion at 5% significance level. LogL: Log Likelihood; LR: Likelihood Ratio; AIC: Akaike Information Criterion; SC: Schwarz Information Criterion; HQ: Hannan-Quinn Information Criterion.

4.4. Cointegration Test

Having verified that the time-series data variables are all integrated of order one according to the ADF and PP unit root tests, the next task is to test for the existence of co-integration i.e. long run relationship among the variables. For this purpose and due to the time series properties of the data, the Johansen and Juselius (1990) approach to cointegration in a multivariate framework was used. Two test statistics assisted us in deciding the number of cointegrating relationships among the series. They are the Trace and Maximum Eigen statistics reported in Table 4 The decision rule for rejecting the null hypothesis for each level of cointegrating relation from zero (no cointegrating relationship) to three (maximum cointegrating relationships for this study) is that we observe the associated probability value of the Trace statistic if it is less than the corresponding level of significance. Based the results of the cointegration in Table 4, we can reject the null hypothesis of no co-integration among the variables at 5 and 10 significant levels. Since the trace statistic indicates 3 co-integrating relationships, implies that there exists long run relationship among the variables in the model.

Table-4. The trace statistic and max-eigen test.

Endogenous Series: LGDP, LEXCHR, INFR
Exogenous Series: LTB, LMS, IR

Null hypothesis	Alternative hypothesis	Eigen value	Trace statistic	Prob.
r = 0	r = 1	0.2165	30.955	[0.0366]**
r ≤ 1	r = 2	0.1668	15.098	[0.0573]***
r ≤ 2	r = 3	0.0485	3.2289	[0.0723]***

Note:* indicates significance at 1%, ** indicates significance at 5%, *** indicates significance at 10%.

4.5. Vector Error Correction (VEC) Granger Causality Test

The multivariate Vector Error Correction (VEC) granger causality test is employed to examine the causal link among exchange rate, inflation and economic output. The result of the causality test is presented in Table 5, where it is examined whether exchange rate, inflation and output granger cause one another. On the basis of the probability values of the associated test statistics, exchange rate does not granger cause either output or inflation. In the same vein, inflation appears to Granger cause neither gross domestic product nor exchange rate. However, causality runs from gross domestic product to exchange rate, while there is no causality running from gross domestic product to inflation. These results are similar to the study on the economy of

Malawi by Yiheyis and Cleeve (2016) where it was found that casusality runs from the growth rate of output to exchange rate, but differ from studies on some other developing economies like Zimbabwe, Brazil and Argentina where causality was identified between exchange rate and inflation (See Mandizha (2014); Montiel (1989)). In Nigeria, however, Sani et al. (2016) confirms that inflationary process in Nigeria are caused by past inflation. Generally, evidence on causality between exchange rate, inflation and output is mixed.

Table-5. The VEC granger causality test.

Variable	D(LGDP)	D(LEXCHR)	D(INFR)
D(LGDP)	-	70.29	1.222
	-	[0.0000]*	[0.9428]
D(LEXCHR)	1.602	-	2.645
	[0.9010]	-	[0.7545]
D(INFR)	9.129	3.272	-
	[0.1040]	[0.6581]	-

Note: * indicates significance at 1%; ** indicates significance at 5%.

4.6. The Vector Error Correction Mechanism (VECM)

Preliminary results have shown that the variables in this study are integrated of order one and are shown to be cointegrated. We can, therefore, justify the adoption of the vector error correction mechanism (VECM) to estimate the model. Thus, this study employs the vector error correction mechanism due to the notion that the major variables of the study (gross domestic product, exchange rate and inflation rate) are simultaneously related. Hence, we examine the dynamic interactions among them. In order to reconcile the gaps in the data, we take the logarithm of series (GDP, money supply, trade balance, and exchange rate) with large values so that they are comparable to other series (interest rate and inflation rate). The VECM results are presented in Table 6. The Table contains the results of three equations each presented on a column: first, where output measured with gross domestic product is the dependent variable; second, where exchange rate is the dependent variable; and the third part for the model where inflation rate is the dependent variable. However, although all the coefficients are statistically significant, results from models where GDP and inflation rate are the regressors should be taken with a pinch of salt as their error correction terms are not significant. On the other hand, the speed of adjustment of the second model where exchange rate is the dependent variable is both negative and significant as it ought to be.

As estimated in the second column of Table 6, exchange rate and trade balance showed positive and significant impact on output in the long run with the impact of exchange rate more profound. These finding corroborate the idea that the Nigerian economy is highly reliant on the external sector i.e. import dependent. The impacts of inflation rate, money supply, and interest rate on output in the long run are negative and significant. The error correction term of the model is incorrectly signed (positive) and statistically insignificant. The third column of Table 6 where exchange rate is the dependent variable indicates that gross domestic product and trade balance impact positively on exchange rate in the long run. The contributions of inflation rate, money supply and interest rate to exchange rate in the long run are negative and statistically significant. The error correction term for this model is both negative and significant.

Table-6. The VECM analysis.

Variables	LGDP	LEXCHR	INFR
LGDP (-1)	1.0000	0.0534	-2.7250
	-	[1.9099]**	[-2.0611]**
LEXCHR (-1)	18.7276	1.0000	-51.033
	[2.8133]*	-	[-3.2652]*
INFR (-1)	-0.3669	-0.0196	1.0000
	[-2.8136]*	[-3.0262]*	-
LTB (-1)	1.1915	0.0636	-3.2469
	[1.7295]**	[1.7195]**	[-1.7169]**
LMS (-1)	-5.7556	-0.3073	15.684
	[-4.7138]*	[-5.0573]*	[4.1149]*
IR (-1)	-0.4832	-0.2580	1.3166
	[-3.8922]*	[-2.577]*	[2.6822]*
C	-54.431	-2.9064	148.32
ECM(-1)	0.0058	-0.0677	-0.0126
	[0.1757]	[-1.6559]**	[-0.2283]

Note 1: * indicates significance at 1%, ** indicates significance at 5%, and *** indicates significance at 10%.
Note 2: 1% critical value: 2.326; 5% critical value: 1.645; 10% critical value: 1.282.
Note 3: GDP, EXCHR, INFR, TB, MS, IR represent gross domestic product, exchange rate, inflation rate, trade balance, money supply, and interest rate respectively.

From the last column of Table 6 where inflation rate is the dependent variable, gross domestic product, exchange rate and trade balance exhibit negative long run impacts on inflation rate in Nigeria with the most robust impact coming from exchange rate. As expected, money supply and interest rate exert significant positive impact on inflation rate in the long run. The error correction term for this model is also negative but insignificant.

4.7. The Dynamic Interaction

In order to assess the interplay of the dynamic interaction among the variables, we adopt the impulse response and the variance decomposition functions. The impulse response and the variance decomposition functions assist us in assessing the dynamic interaction among the non-stationary series. These techniques are tools for assessing how shocks to variables reverberate through a Vector Autoregressive system. The impulse response functions, expressed in Tables and Graphs, show the effects of shocks on the adjustment path of the variables. On the other hand, the forecast error variance decomposition measures the contribution of each type of shock to the forecast error variance – it offers a subtle way of analysing the contributions of policy variables to target variables in a VAR model.

4.7.1. The Impulse Response Function

The impulse response functions are depicted in the Figure 2 and Table 7, with the time horizon divided into five periods. The impulse response functions indicate that from period 1 to 5, exchange rates exert negative influence on economic output but a positive impact on inflation. Therefore implying that as exchange rate is depreciated, inflation is consequently triggered in Nigeria. Throughout the periods, inflation contributes negatively to gross domestic product (GDP) and positively to exchange rate. The response of gross domestic product on exchange rate is negative for all the five periods. This indicates that as output rises, exchange rate appreciates in the short run. Conversely, the impulse-response indicates positive effect of output on inflation in all the periods.

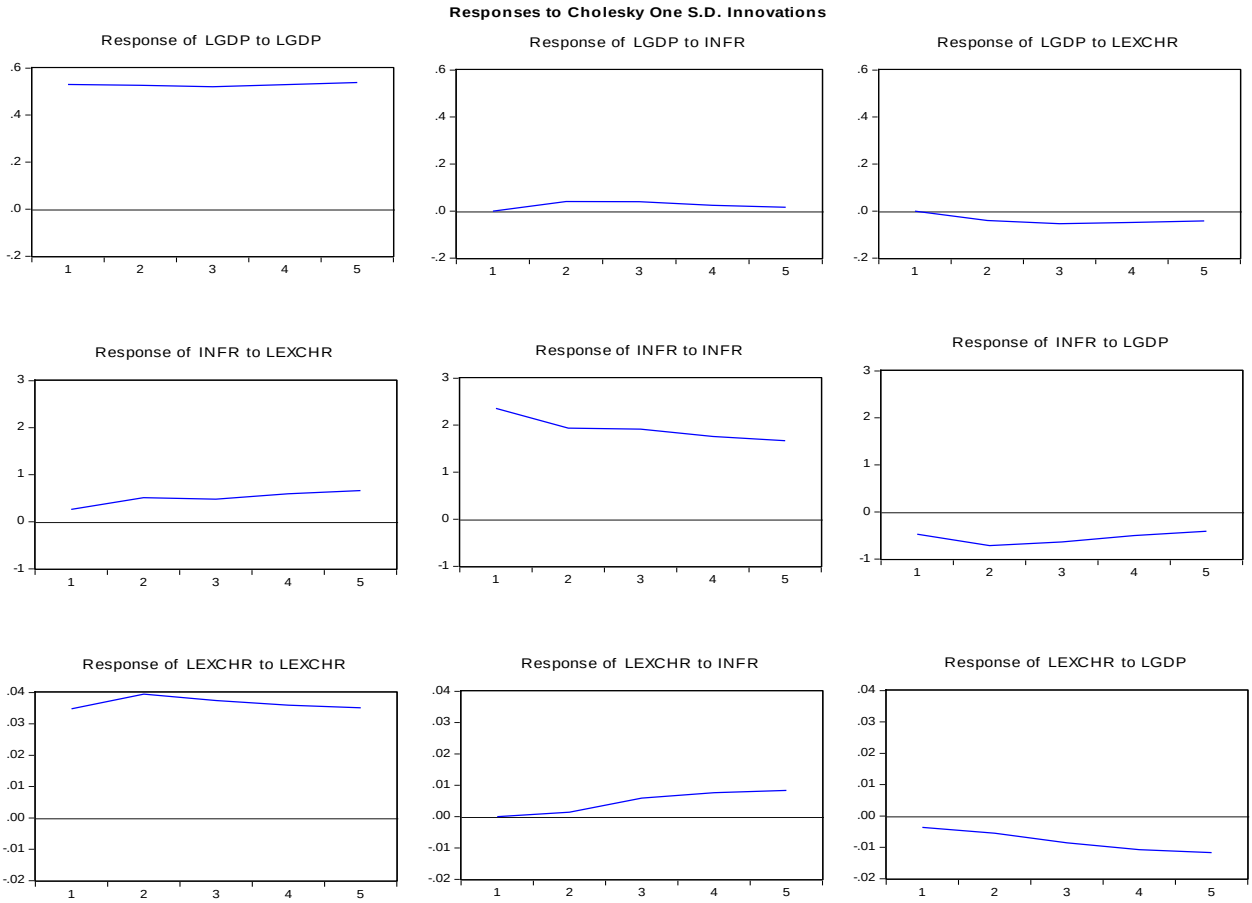

Figure-2. Responses to cholesky one S.D. innovation.

Table-7. Impulse response functions.

Impulse response of LGDP			
Period	**LGDP**	**LEXCHR**	**INFR**
1	0.531	0.000	0.000
2	0.527	-0.041	0.041
3	0.520	-0.054	0.039
4	0.529	-0.048	0.024
5	0.538	-0.042	0.016
Impulse response of LEXCHR			
Period	LGDP	LEXCHR	INFR
1	-0.004	0.035	0.000
2	-0.006	0.039	0.001
3	-0.009	0.037	0.006
4	-0.011	0.036	0.008
5	-0.012	0.035	0.008
Impulse response of INFR			
Period	LGDP	LEXCHR	INFR
1	-0.473	0.263	2.354
2	-0.715	0.514	1.939
3	-0.649	0.479	1.914
4	-0.502	0.596	1.759
5	-0.411	0.663	1.670

4.7.2. The Variance Decomposition Function

The variance decomposition functions are expressed in Figure 3 and Table 8. Own shock accounts for predominant variation in gross domestic product. Aside own shock, variations to output are accounted for by money supply, exchange rate, inflation, trade balance and interest rate in that order. Own shocks to exchange rate accounts for the biggest factor to explain exchange rate variations. Further, the exchange rate is affected mostly by trade balance, then followed by gross domestic product, money supply, inflation, and the least impact on exchange rate comes from interest rate. This shows that exchange rate and trade balance are closely linked in Nigerian economy. The policy implication for Nigerian economy is that the exchange rate depends more on import and export, rather than monetary variables (money supply, interest rate and inflation). Inflation in Nigeria is most influenced by its own shocks. The order in which the variables exert influence on inflation, output, exchange rate, interest rate, money supply and trade balance.

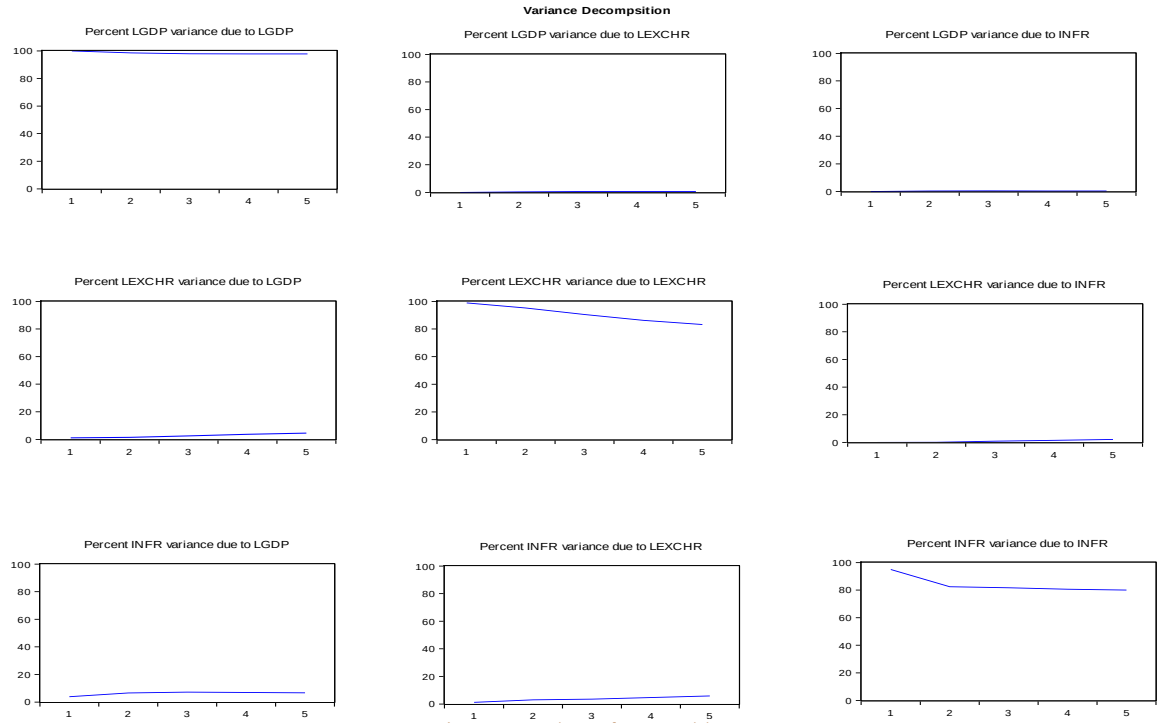

Figure-3. Variance decomposition.

Table-8. The variance decomposition function.

Variance decomposition of LGDP						
Period	**LGDP**	**LEXCHR**	**INFR**	**LTB**	**LMS**	**IR**
1	100.00	0.000	0.000	0.000	0.000	0.000
2	98.53	0.288	0.295	0.001	0.849	0.033
3	97.89	0.541	0.384	0.089	1.060	0.028
4	97.75	0.614	0.339	0.193	1.062	0.047
5	97.72	0.611	0.287	0.283	1.013	0.082
Variance Decomposition of LEXCHR						
Period	LGDP	LEXCHR	INFR	LTB	LMS	IR
1	1.097	98.90	0.000	0.000	0.000	0.000
2	1.489	95.20	0.069	2.034	1.019	0.185
3	2.523	90.48	0.808	3.630	2.033	0.522
4	3.654	86.32	1.502	4.635	2.828	1.059
5	4.582	83.19	2.047	5.339	3.364	1.467
Variance Decomposition of INFR						
Period	LGDP	LEXCHR	INFR	LTB	LMS	IR
1	3.835	1.181	94.98	0.000	0.000	0.000
2	6.521	2.951	82.48	0.138	2.004	5.906
3	7.206	3.540	81.64	0.277	2.252	5.086
4	7.015	4.606	80.66	0.765	2.186	4.767
5	6.644	5.756	79.78	1.214	2.082	4.325

5. Concluding Remarks

This study explores the dynamic interaction between exchange rate, inflation and economic output in Nigeria between 1999 and 2017. The study is informed by the argument concerning the way exchange rate and inflation influence each other, and the controversies from two opposing views (positive and negative correlation) in the literature regarding the relationship between inflation and economic performance. Appropriate estimation techniques were used to establish the relationship among exchange rate, inflation and output, and to determine causal links among the variables.

Hence, the study reveals that there exists a positive and negative relationship between the growth of exchange rate and inflation rate, and between the growth of inflation rate and output. Further evidence establishes that there is unidirectional causality running from economic output to exchange rate in Nigeria. It is confirmed that exchange rate significantly exerts a long run positive impact on economic performance in the country, while the impact of inflation on output in the long run is found to be negative. Furthermore, output exerts a negative impact on both inflation and exchange rate but inflation positively influences exchange rate.

In conclusion, evidence emerged from the findings is that the granger causality test has demonstrated evidence in support of output promotion in Nigeria. That is, policies that encourage productivity will be beneficial to the growth and development of the economy as a whole. In addition, the results reveal that in the long run, exchange rate depreciation impacts positively on economic output, but inflation impacts negatively on output. Evidence suggesting that exchange rate depreciation leads to positive economic performance could be attributed to the positive long run effects of real sector development. Thus, the study has shown that the goals of reducing inflation to the barest minimum, domesticating production for local consumption and maintaining appropriate exchange rate system for economic productivity are reasonable and achievable in Nigeria. Hence, the study suggests that policymakers should initiate measures that could aid financial and real sector development. Also, it is suggested that promoting the habit of consuming made in Nigeria goods, through awareness programmes and quality control measures could mitigate the inflationary effect of the external sector in Nigerian economy.

The present study has explored how exchange rate and inflation are interconnected with economic output with respect to Nigerian economy. Future research in this area may replicate this study on a larger scale involving cross country panel analysis. This could come in form of studies on Sub-Saharan African countries, ECOWAS countries, emerging economies, etc. provided that the countries shared similar state of economic peculiarities.

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