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Exchange Rate Fluctuation and Industrial Output Growth in Nigeria

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Abstract

This study examined the effects of exchange rate fluctuation on the Industrial Output Growth in Nigeria using time series data sparring from the period 1986 to 2015. Johansen's Co-Integration model was employed to explore the long-run relationship among the variables used, while the Vector Error Correction model (VECM) was used to evaluate the short and long-run dynamic among the variables and the Granger Causality used to measure contemporaneous relationship among the endogenous variables. The dynamic correlation of the variables was captured by the analyses of impulse response and variance decomposition. The results of the analysis indicate a unidirectional causality from Exchange rate to Industrial output. The response of industrial output to the shock from exchange rate was positive and significant; more specifically in the initial years, while response to shock from other variables was little in magnitude and not as significant as exchange rate. From the Forecast Error Variance Decomposition (FEVD), the study revealed that although the main source of variance in output are own shocks, innovation in the exchange rate accounted for a higher proportion in the variation of industrial output than that of other associated variables (Inflation, Interest rate and Net Export). The study concluded that exchange rate has potentials of causing significant changes in industrial output in Nigeria. Against this backdrop, the study recommended the need for more macroeconomic policy attention to the proper management of the exchange rate, and the need to strengthen the link between agriculture and the industrial sector to reduce the reliance of the sector on import of inputs to a reasonable level.

Keywords: Exchange rate; Industrial output; Net export; Gross domestic product; Inflation.

1. Introduction

The growing potentials of Industrial sector of an economy is strategic to the macro-economic framework of such a nation, to the extent that the sector plays a catalytic role and has many dynamic benefits that are crucial for economic transformation. It is an avenue for increasing productivity in relation to import substitution and export expansion, creating foreign exchange earning capacity, raising employment, promoting the growth of investment at a faster rate than any other sector of the economy, as well as wider and more efficient linkage among different sectors (Fakiyesi, 2005). In many economies, the performance of the Industrial Sector is the gauge for assessing the effectiveness of macroeconomic policies. Government policies; particularly exchange rate policies can only be deemed successful if they impact positively on the production and distribution of goods and services. A vibrant and productive Industrial arm of the economy creates more linkages in the economy and promotes internal and external balance. Variation in exchange rate is an important endogenous factor that affects economic performance, due to its impact on macroeconomic variables like outputs, imports, export, prices, interest rate and inflation rate. A sound and appropriate exchange rate policy is crucial condition for improving economic performance (Chang and Tan, 2008). In practice, however, no exchange rate is pure float or completely determined by market forces. Rather, the prevailing system is the managed float type, whereby there is periodic intervention by monetary authorities in the foreign exchange market to attain strategic objectives (Mordi, 2006). A managed floating exchange rate regime has been the most predominant in Nigeria since the introduction of Structural Adjuptment Programme in 1986.

The main objectives of exchange rate policy in Nigeria are to preserve the international value of the domestic currency and maintain a favourable external reserve position. According to Obaseki (2001), the Central Bank of Nigeria has implemented different techniques in the management of the exchange rate of the naira. Obadan (2002) believed that past exchange rate policies have been designed with a bias towards demand management in Nigeria, as the supply side has always been limited by the monoculture base of the economy, where foreign exchange inflow is dominated by- oil export proceeds. The management of any country's foreign exchange market is carried out within the ambit of a foreign exchange policy, which according to Obaseki (2001), is the sum total of the institutional framework and measures put in place to gravitate the exchange rate towards desired levels in order to stimulate the productive sectors, curtail inflation, ensure internal balance, improve the level of exports and attract direct foreign investment and other capital inflows. The inability of the system to achieve the major objectives of exchange rate policy led to the reversal of the policy in September 1986 to floating exchange regime with the introduction of SAP. However, Nigerian industrial sector had since faced with the challenge of consistent fluctuating

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exchange rate due to the failure to realise the goals of SAP subjected the Nigerian Industrial sector to the challenge of a constantly fluctuating exchange rate.

2.1. Statement of Problem

Following the depreciation of the Naira in 1986, a policy induced by the Structural Adjustment Programme (SAP), the subject of exchange rate fluctuations has become a topical issue in Nigeria. This is because it is the goal of every economy to have a stable rate of exchange with its trading partners. In Nigeria, this goal was not realized in spite of the fact that the country embarked on devaluation to promote export and stabilize the rate of exchange. The failure to realize this goal subjected the Nigerian industrial sector to the challenge of a constantly fluctuating exchange rate. This was not only necessitated by the devaluation of the naira but the weak and narrow productive base of the sector and the rising import bills also strengthened it (Opaluwa *et al.*, 2010). In order to stem this development and ensure a stable exchange rate, the monetary authority (i.e Central Bank of Nigeria) put in place a number of exchange rate policies. However, very little achievement was made in stabilizing the rate of exchange. Benson and Victor (2012) and Aliyu (2011) noted that despite various efforts by the government to maintain a stable exchange rate, the naira has depreciated throughout the 80's to date. It is sad to note that Nigerian economy is under-industrialized and its capacity utilization is also low. The industrial sector has become increasingly dependent on the external sector for import of non-labour input (Okigbo, 1993). Exchange rate reforms according to Bakare (2011) were expected to put the Nigerian economy on the path of macroeconomic stability, recovery and sustainable development. But rather, the country has continued to be at disadvantage in terms of macroeconomic performances. The different regimes have been accompanied by instability and uncertainties. Against this backdrop, this study aimed to evaluate the impact of exchange rate fluctuation on industrial output growth in Nigeria between 1986-2015.

2.2. Research Questions

Three main research questions addressed in this research work are as follows:

1. Does exchange rate fluctuation have any significant impact on Nigerian Industrial Output Growth?
2. Is there any contemporaneous relationship between Exchange rate fluctuation and Growth of Industrial Output in Nigeria?
3. Are there other determinants of Exchange rate and Industrial Output Growth in Nigeria?

2.3. Objectives of the Study

The broad objective of this paper therefore is to explore the trend of exchange rate changes in the country and to also empirically justify how the exchange rate fluctuations have impacted industrial output growth over the years. Specifically, the study seeks to achieve the following objectives:

1. To examine the impact of exchange rate fluctuation on the growth of Industrial Output in Nigeria.
2. To investigate the contemporaneous relationship that exist is between Exchange rate fluctuation and Growth of Industrial Output in Nigeria
3. To examine other determinants (economic fundamentals) of Domestic output Growth in Nigeria

2.4. Statement of Hypotheses

1. Hi: Exchange rate fluctuation has no significant effect on industrial output growth in Nigeria.
2. Hi: There is no contemporaneous relationship between Exchange rate fluctuation and Growth of Industrial Output in Nigeria.

2. Literature Review and Theoretical Framework

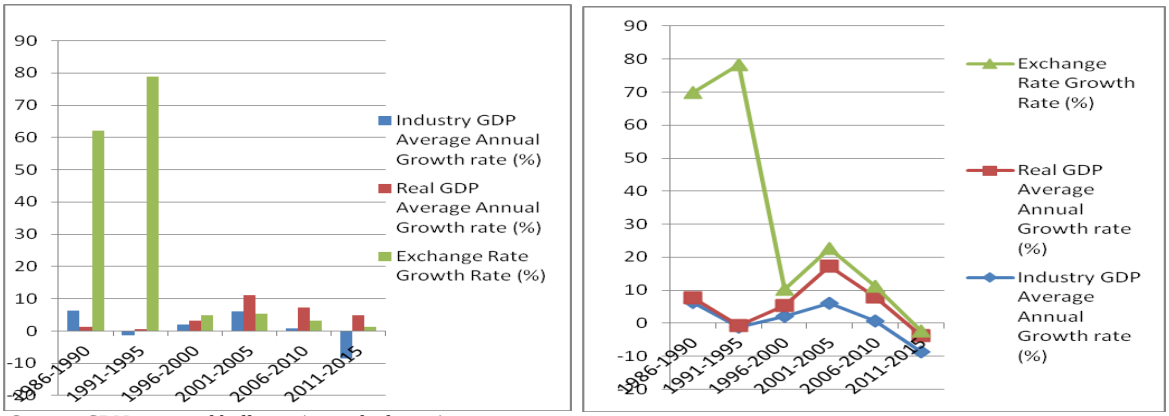
The relationship between Exchange rate changes and Industrial performance has attracted attention in Economics and Finance researches over the years. The introduction of Structural Adjustment Programme (SAP) in 1986 with the policy tenet of abolishing the fixed exchange rate system being replaced with flexible exchange rate system marked the beginning of growing interest. Thus, the topic has attracted.

2.1. Conceptual Literature

Literarily, an exchange rate implies the price of one currency in terms of another (Oloyede, 2002). In the Nigerian context, it is the units of naira needed to purchase one unit of another country's currency e.g the United States dollar (Campbell, 2010). Ahmed and Zarma (1997) posited that exchange rate is an important decision making variable in every nation, thus making it a crucial issue for any country desirous of economic growth. Exchange rate is a reflection of the strength of a currency when measured against another country's currency; usually determined in principle by the interplay of supply and demand in a free market environment. According to Onyeizugbe and Umeagugesi (2014), no currency is allowed to float, so nation monetary authorities regulate currency between the fixed and floating exchange rate systems and other regimes, such as dual managed. Fluctuations in exchange rate will cause weak purchasing power and hence, negatively impact on investment in import of inputs. On the other hand, changes in industrial output level will also affect investment in import of inputs and invariably the exchange rate.

Figure-1. Growth rate of real GDP, Industry GDP and Exchange Rate in Nigeria (1986-2015)

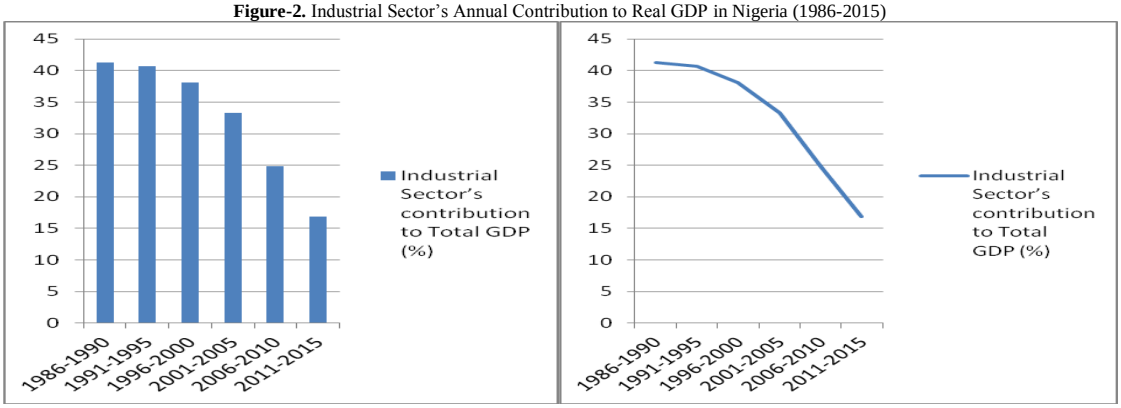
Trends in Exchange Rate Changes and Industrial Output Performances in Nigeria



Source: CBN statistical bulletins (several editions)

The Growth rate of real GDP, Industry GDP and Exchange Rate in Nigeria (on five-year basis) for the study period (1986-2015) is shown in figure 1. Following the adoption of the Structural Adjustment Programme (SAP) and the subsequent improvement in the management of the foreign exchange market, the persistent downward pressure on the domestic currency was stemmed for a while. Some improvements were recorded in the growth of GDP between 1986 and 1990. The average growth rate of the total GDP was negative between 1986 and 1987, it picked in 1988 all through to 1990 with the highest rate of 12.8% occurring in 1990. The improved performance of output during this period might be linked to the expansionary fiscal and monetary policies of the government during this period. The total GDP growth rate however, dropped after 1990 with average growth rate of 0.5% between 1990 and 1995. It however, picked between 2001 and 2005 with an impressive average growth of over 10%. The growth since 2006 to date has been on descending trend. The performance of Industry GDP followed almost the same trend with total GDP. The Industry GDP went through an undulating growth since 1986 to date. There was a huge average growth of 6.3% in 1986 and 1990 with the pick of 20.2% recorded in 1990, followed by a negative average of -1.3% between 1991 and 1995. The period 2001 and 2005 also recorded an exciting average growth of 6.1%. However, the year 2011 and 2015 was not the best period for Nigeria Industry as the growth rate plunged into a negative average of -8.6 due largely to a huge negative growth rate of -46.1 recorded in 2014. Epileptic power supply, insecurity and political instability affected the Industrial sector at this period.

Figure-2. Industrial Sector's Annual Contribution to Real GDP in Nigeria (1986-2015)



Source: CBN statistical bulletin (various issues)

Figure 2 explained the Nigerian Industrial sector annual contribution to the total GDP. The relationship observed is quite revealing about the sensitivity of Nigeria Industrial sector to Exchange rate fluctuation. The contribution of Industrial sector to total GDP has consistently followed a downward trend since the introduction of SAP in 1986. Between 1986 and 1990, the Industrial sector contributed on the average 41.3% to the nation's total GDP. The figure reduced marginally to 40.7% in the period 1991 & 1995, a further fall (38.1%) in 1996-2000. A significant plunge was recorded in 2006-2010 with the contribution standing at 24.8% and falling to the lowest figure of 16.9% between 2011and 2015.

2.2. Theoretical Framework

The output effect of exchange rate changes has been a subject of theoretical debate in the literature without consensus as to the direction of the effects. The traditionalist argued that exchange rate depreciation would promote trade balance, alleviate balance of payments difficulties and accordingly expand output and employment provided the Marshall-Lernar conditions are met (that if the sum of price elasticity of demand for export and the price elasticity of demand for imports is greater than unity). The monetarists on the other hand argued that exchange rate changes have no effect on real variables in the long run. The monetarist view is that exchange rate devaluation affect real magnitudes mainly through real balance effect in the short run but leaves all real variables unchanged in the long

run (Domac, 1977). This approach is based on the assumption that the Purchasing Power Parity (PPP) holds. It predicts that in the short run an increase in the exchange rate leads to increase in output and improves the balance of payments but in the long run, the monetary consequence of the devaluation ensures that the increase in output and improvement in BOP is neutralized by the rise in prices.

One other theoretical linkage between exchange rate and output in the literature is the IS-LM model. The main advantage of this model over some other models is that it includes consumption, investment, government spending, taxes, exports, imports, interest rate, exchange rate, current account, capital account and national output in a single framework. In this model, exchange rate does not affect output directly, it affects it indirectly through the import-export and the money supply channels. Depreciation is theoretically expected to have positive effect on export since it makes domestic goods cheaper to foreign consumers.

The modified Mundell–Fleming IS-LM model, also known as the IS-LM-BoP model, adopted by Kandil (2004) and Yaqub (2010) is the theoretical base of this study. This was an economic model first set forth (independently) by Mundell (1963) and Fleming (1962). The model is an extension of the traditional IS-LM Model extended by Hicks (1937) and Hansen (1953) as a mathematical representation of Keynesian macroeconomic theory. While the traditional LM-SM deals with a closed economy, the Mundell–Fleming model describes an open economy and portrays the short-run relationship between an economy's nominal exchange rate, interest rate, and output with the assumption that output is demand determined. The demand side of the economy consists of three markets, namely; the goods, money and the foreign exchange market, all of which must simultaneously be in equilibrium for the economy to be in equilibrium.

The Mundell–Fleming model is based on the following equations.
The **IS** curve: $\mathbf{Y = C + I + G + NX}$ (1)
where NX is net exports.
The **LM** curve: $M/P = L(i, Y)$ (2)

A higher interest rate or a lower income (GDP) level leads to lower money demand.
The **BoP** (Balance of Payments) Curve: $\mathbf{BoP = CA + KA}$ (3)
Where BoP is the balance of payments surplus, *CA* is the current account surplus, and *KA* is the capital account surplus.

IS components $\mathbf{C = C[Y-T(Y), I - }E(\pi)\mathbf{]}$ (4)

Where; E (π) is the expected rate of inflation. Higher disposable income or a lower real interest rate (nominal interest rate minus expected inflation) leads to higher consumption spending.
$\mathbf{I = I(I - }E(\pi)\mathbf{, }Y_{-1}$ (5)
where; Y_{-1} is GDP in the previous period. Higher lagged income or a lower real interest rate leads to higher investment spending.

$NX = NX(e, Y, Y^*)$ (6)
Where; *NX* is net exports, *e* is the nominal exchange rate (the price of domestic currency in terms of units of the foreign currency), *Y* is GDP, and *Y** is the combined GDP of countries that are foreign trading partners.

2.3. Empirical Literature Review

Empirical evidences on the impact of exchange rate fluctuation on the relative performance of industrial sector abound in the literature with contrasting results. While some studies found a significant effect of exchange rate variation on domestic output (Gylfason and Schmid, 1983; Kamin and Klau, 1998; Kandil, 2004; Musa and Sanusi, 2013), others found no significant relationship (Eme and Johnson, 2012; Ubok-Udom, 1999).

Gylfason and Schmid (1983) constructed a log-linear macro model of an open economy for a sample of ten countries, using different estimates of the key parameters of the model. Their results showed that devaluation was expansionary in eight out of ten countries investigated. Devaluation was found to be contractionary in two countries (the United Kingdom and Brazil). In the same vein, Kamin and Klau (1998) using an error correction technique estimated a regression equation linking the output to the real exchange rate for a group of twenty seven countries. They did not find that devaluations were contractionary in the long term. In addition, through the control of the sources of spurious correlation, reverse causality appeared to alternate the measured contractionary effect of devaluation in the short term although the effect persisted even after the introduction of controls.

Dhasmana (2015) explored the impact of real exchange rate changes on the performance of Indian manufacturing firms over the period 2000– 2012, using Panel- VAR. The empirical analysis showed that real exchange rate movements have a significant impact on Indian firms' performance but the impact varied across different firm and industry characteristics. Results from Panel- VAR also proved that appreciation and depreciation affect firms' performance differently.

Agenor (1991) using a sample of twenty-three developing countries, regressed output growth on contemporaneous and lagged levels of the real exchange rate and on deviations of actual changes from expected ones in the real exchange rate, government spending, the money supply, and foreign income. The results showed that real exchange rate depreciation actually boosted output growth. Morley (1992) analyzed the effect of real exchange rates on output for twenty eight developing countries that have devalued their currencies using a regression framework.

After the introduction of controls for factors that could simultaneously induce devaluation and reduce output including terms of trade, import growth, the money supply, and the fiscal balance, he discovered that depreciation of the level of the real exchange rate reduced output level. Rogers and Ping (1995) estimated a five-variable VAR model—output, government spending, inflation, the real exchange rate, and money growth—most variations in the Mexican output resulted from ―own shocks. They however noted that exchange rate depreciations led to a decline in output. However, in the work of Eichengreen and Leblang (2003) on 12 countries over a period of 120 years, they found strong inverse relationship between exchange rate stability and growth.

Bakare (2011), conducted an empirical analysis of the consequences of the foreign exchange rate reforms on the performances of private domestic investment in Nigeria using the ordinary least square multiple regression analytical method. The multiple regression results showed a negative but significant relationship between floating foreign exchange rate and private domestic investment in Nigeria.

Musa and Sanusi (2013) investigated the response of aggregate industrial output to relative change in prices and exchange rate in Nigeria between 1970- 2011, using a Vector Error Correction (VEC) model. Their empirical evidence indicated a significant relationship between exchange rate and industrial output; arguing that inflation and exchange rate have the potentials of causing significant changes in industrial output in Nigeria. This study therefore suggested that more policy attention should be given to proper management of the exchange rate and inflation. Opaluwa *et al.* (2010), examined the impact of exchange rate fluctuations on the Nigerian manufacturing sector during a twenty (20) year period (1986 – 2005), using Linear Regression tool. The result indicated an adverse but statistically significant effect of exchange rate on manufacturing output.

Onyeizugbe and Umeagugesi (2014), examined how Exchange rate particularly devaluation of the naira affects the survival of the industrial subsector in Nigeria during the period 1990-2013, using Ordinary Least Square (OLS) regression method. The result showed that manufacturing capacity utilization has positive relationship with exchange rate and export. The study thereby recommended that manufacturing firms should embark on production of quality goods and the Government should encourage the development of local industrial subsector. Asher (2012) studied the impact of exchange rate fluctuation on the Nigeria real economic growth for period of 1980 – 2010. The result showed that real exchange rate has a positive effect on the real economic growth. In his work, Jongbo (2014) evaluated the impact of real exchange rate fluctuation on industrial output of the Nigeria industrial sector using ordinary least square (OLS) and revealed that real exchange rate play a significant role in determining the industrial output.

It is important to mention the work of Odusola and Akinlo (2001) who examined the linkage among exchange rate, inflation and output in Nigeria. A structural VAR model was employed which captured the interactions between exchange rate and output. Evidence from the contemporaneous models showed a contractionary impact of the parallel exchange rate on Industrial output only in the short term. Prices, parallel exchange rate and lending rate were found to be important sources of perturbations in the official exchange rate. In addition, output and parallel exchange rate were significant determinants of inflation dynamics in Nigeria.

Ubok-Udom (1999) examined the relationship between exchange rate variation and growth of the domestic output in Nigeria (1971-1995); expressing growth of domestic output as a linear function of variations in the average nominal exchange rate. He however used dummy variables to capture the periods of currency depreciation. The empirical result showed that all coefficients of the major explanatory variables have negative signs. Eme and Johnson (2012) investigated the effect of exchange rate movements on real output growth in Nigeria for the period 1986 – 2010. The result revealed that there is no evidence of a strong direct relationship between changes in exchange rate and output growth. Rather, Nigeria economic growth has been directly affected by monetary variables.

3. Methodology

3.1. Description and Source of Data

The study employed time series data on Exchange rate (proxied by Annual Average Exchange rate) and Industrial sector Output (proxied by Industry share of Real Gross Domestic Product at 2010 constant base prices). The rate of exchange alone, stable or otherwise cannot influence output of the Industrial sector. Other variables: Interest rate, Inflation Rate, and Net Export play important role. Therefore, the models used in this study were estimated using annual time series Nigeria data on some macro-economic indicators, which includes Industrial sector share of Real Gross Domestic Products (GDP_I); Exchange Rate (EXR); Interest Rate (INR), Inflation Rate (INF) and Net Export (NE) for the period 1986 – 2015. The data were sourced from various issues of the Central Bank of Nigeria Statistical Bulletin and National Bureau of Statistics (NBS). The main type of data used in this study is secondary; from 1986 being the year the monetary authority shifted from fixed exchange rate regime to flexible exchange rate regime to 2015.

Table-1. Description of Variables

S/N	Variable	Description
1	Real GDP(Ind.)	The Industry Share of Real GDP at 2010 constant basic prices
2	Exchange Rate(EXG)	Annual Average Official rate of Naira vis-à-vis the United State's Dollar
3	Inflation (INF)	Inflation (INF) is measured as the annual percentage change in the Consumer Price Index (CPI)
4	Interest Rate(INT)	The prime lending rate
5	Net Export(NE)	The difference between total Export and total Import

3.2. Model Specification

To provide an empirical insight into the response of aggregate industrial output change in exchange rate in Nigeria, the multivariate VECM specifications of the variables employed in the study were presented in five endogenous variables using GDP (Industrial) , EXG, INF, INT. and NE, formulate as follows:

$$GDP\ (Ind)_t = \alpha_0 + EXG_t\,\alpha_1 + INF_t\,\alpha_2 + INT\alpha_3 + NE\alpha_4 + u_t \qquad (7)$$

Where α_o is the constant and α_1, α_2, α_3 and α_4 are coefficient to be estimated and u_t is an error term. GDP (Ind) is the Industry share of GDP, EXG is the Average Annual official exchange rate, INF is the consumer price index (yearly change in prices), INT is the interest rate and NE is the Net Export.

The General Basic Model of VAR has the Following Form:

$$X_t = m + \psi D_t + B1\,X_{t-1} + B_2 X_{t-2} \ \ldots\ B_k X_{t-k} + \varepsilon_t \qquad (8)$$

Where X_t is a column vector of five (5) variables, that is X_t = [GDP, EXG, INF, INT, NE]' modelled in terms of its past values. B_i are (k x k) matrix of coefficients to be estimated, m is a k x 1 vector of constants (vector of deterministic terms) , D_t is a vector of nonstochastic variables such as economic intervention and seasonal dummies and ε_t is a vector of white noise processes.

The VECM Form:

$$\Delta Y_t = \Pi Y_{t-1} + \Gamma \Delta Y_{t-1} + \ldots + \Gamma_{k-1} \Delta Y_{t-k+1} + m + \psi D_t + \varepsilon_t \qquad (9)$$

Where $\Pi = \alpha\beta$

In the VECM model, attention focuses on the $(n \times r)$ matrix of cointegrating vectors β , which quantify the "long-run" relationships between variables in the system, and the $(n \times r)$ matrix of error-correction adjustment coefficients α , which load deviations from the equilibrium ($i.e.\ \Pi\ y_{t-1}$) *to* ΔY_t for correction. Γ coefficients in (9) estimate the short-run effects of shocks on ΔY_t, and therefore allow the short-run and long run responses to differ. The term ΠY_{t-1} is the only one that includes I(1) variables. Hence, ΠY_{t-1} must also be I(0); thus, it contains the cointegrating relations. The $\Gamma_j s$ ($j = 1, \ldots, k-1$) are often referred to as the *short-run parameters*, and ΠY_{t-1} is sometimes called the *long-run* or *long-term* part.

4. Empirical Results and Discussion

4.1. Descriptive Statistics of Variables

Table 2 below summarizes the basic statistical features of the data under consideration including the mean, the minimum and maximum values, standard deviation, skewness, kurtosis and the Jarque-Bera test for the data.

Table-2. Descriptive Statistics

	REALGDP	_EXG_	_INF_	_INT_	NE
Mean	9314.138	91.53633	19.79133	18.53767	1702.362
Median	8546.755	107.0250	12.20000	18.27000	628.3400
Maximum	13028.05	199.0500	72.73000	31.65000	5822.600
Minimum	6135.330	2.020000	5.420000	9.930000	-85.56000
Std. Dev.	2143.578	59.99877	18.10755	4.711283	1948.762
Skewness	0.306581	-0.286429	1.619486	0.427031	0.735333
Kurtosis	1.840287	1.768422	4.392783	3.567792	2.039070
Jarque-Bera	2.151127	2.306188	15.53847	1.314763	3.857805
Probability	0.341106	0.315659	0.000423	0.518206	0.145308
Sum	279424.1	2746.090	593.7400	556.1300	51070.85
Sum Sq. Dev.	1.33E+08	104395.7	9508.615	643.6895	1.10E+08
Observations	30	30	30	30	30

Source: Author's computation, 2016 (Eview-9.0)

From table 2, there seems to be evidence of significant variations as shown by the huge difference between the minimum and maximum values for the variables under consideration. The skewness of the data series indicates normal distribution for all the variables except for Exchange rate that has an asymmetric or non-normal distribution as the series relatively deviates from normality maintaining negative skewness. The kurtosis statistic equally shows that GDP, Exchange rate and Net Export are platykurtic in nature while Inflation and Interest Rate on the other hand are leptokurtic. The Jarque-Bera test is a test of normality. The null hypothesis for the test is that the series under consideration is normally distributed. Based on our results using the P-values associated with the Jarque-Bera statistics, all the variables, except Inflation are normally distributed.

4.2. The Formal Pre-Tests

4. 2.1. Unit Root Test

Before using the data in the estimation of VAR/VECM, we needed to know time series properties of all the variables. Accordingly, a series of unit root test, such as Augmented Dickey and Fuller (1981) and Phillip and Perron (1988) tests were used to determine the order of integration for each series. The ADF unit root tests used Akaike information criterion for lag order selection and PP unit root tests lag length were decided based on VAR/VECM method to apply. The null hypothesis for ADF and PP is that an observable time series is not stationary (i.e. has unit root).

Table-3a. ADF and PP Test at Levels

Variables	Constant				Constant & Trend			
	ADF Test		PP Test		ADF Test		PP Test	
	t-Statistic	Prob	t-Statistic	Prob	t-Statistic	Prob	t-Statistic	Prob
IND.GDP	-1.742921	0.400	-1.854433	0.3480	-0.821019	0.9518	-1.128151	0.0960
EXG	0.4533	0.6538	-0.1968	0.8454	-2.4337	0.3559	-2.4583	0.3446
INF	-2.38774	0.1557	-2.5577	0.1131	-2.9828	0.1577	-3.6466	0.1376
INT	1.5520	0.9980	-2.5450	0.1157	-3.4464	0.6647	-3.4475	0.064
NE	-1.3301	0.6018	-1.2140	0.6545	-2.3733	0.3845	-2.2845	0.4286

Table-3b. ADF and PP Test at first difference

Variables	Constant				Constant & Trend			
	ADF Test		PP Test		ADF Test		PP Test	
	t-Statistic	Prob	t-Statistic	Prob	t-Statistic	Prob	t-Statistic	Prob
IND.GDP	-4.6834	0.0009	-4.6840	0.0009	-5.0367	0.0019	-5.3035	0.0019
EXG	-5.3501	0.0002	-5.3672	0.0001	-5.2169	0.0012	-5.1707	0.0014
INF	-2.6557	0.0969	-5.3383	0.0002	-3.4976	0.0524	-5.1971	0.0013
INT	-5.6210	0.0000	-5.9177	0.0000	-6.1307	0.0001	-6.1724	0.0001
NE	-5.6210	0.0000	-5.9177	0.0000	-5.5233	0.0006	-5.6770	0.0004

The Augmented Dickey Fuller (ADF) and Philip Peron (PP) tests shown in tables 3a & b above, established that all the variables are non stationary (possess unit roots) at their levels since each reported p-statistics greater than 5% (0.05) significance level ; meaning accepting the Null Hypothesis. However, there was evidence that the variables were stationary after first differencing at 5% significance level. It follows that the variables in the model followed I (1) process.

4.2.2. Johansen Co integration Test

Table-4. Cointegration Test Results

Date: 07/05/16 Time: 09:32
Sample (adjusted): 1990 2015
Included observations: 26 after adjustments
Trend assumption: Linear deterministic trend
Series: GDP IND EXG INF INT NE
Lags interval (in first differences): 1 to 3

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.994839	274.7238	69.81889	0.0000
At most 1 *	0.941859	137.7912	47.85613	0.0000
At most 2 *	0.854728	63.82413	29.79707	0.0000
At most 3	0.374352	13.66633	15.49471	0.0926
At most 4	0.055086	1.473186	3.841466	0.2248

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.994839	136.9326	33.87687	0.0000
At most 1 *	0.941859	73.96704	27.58434	0.0000
At most 2 *	0.854728	50.15781	21.13162	0.0000
At most 3	0.374352	12.19314	14.26460	0.1036
At most 4	0.055086	1.473186	3.841466	0.2248

Max-eigenvalue test indicates 3 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

The co-integration analysis was done using Johansen Co-integration Test. The variables are Ind. *GDP*, *EXG*, *INF*, *INT* and NE are found co-integrated. Results in Table 4 suggested that the maximum eigenvalues and trace test statistics indicate that the hypothesis of no cointegration among the variables is rejected at the 5% significance level. The results established that there are three cointegrated equations. Hence, provide strong evidence of long-run equilibrium relationship among the variables in the study. The existence of a long-term equilibrium relationship among the variables necessitated and justified the use of the VECM.

4.3. Granger Causality Test

Table-5. Granger Causality Test Results

Pairwise Granger Causality Tests
Date: 07/07/16 Time: 11:50
Sample: 1986 2015
Lags: 3

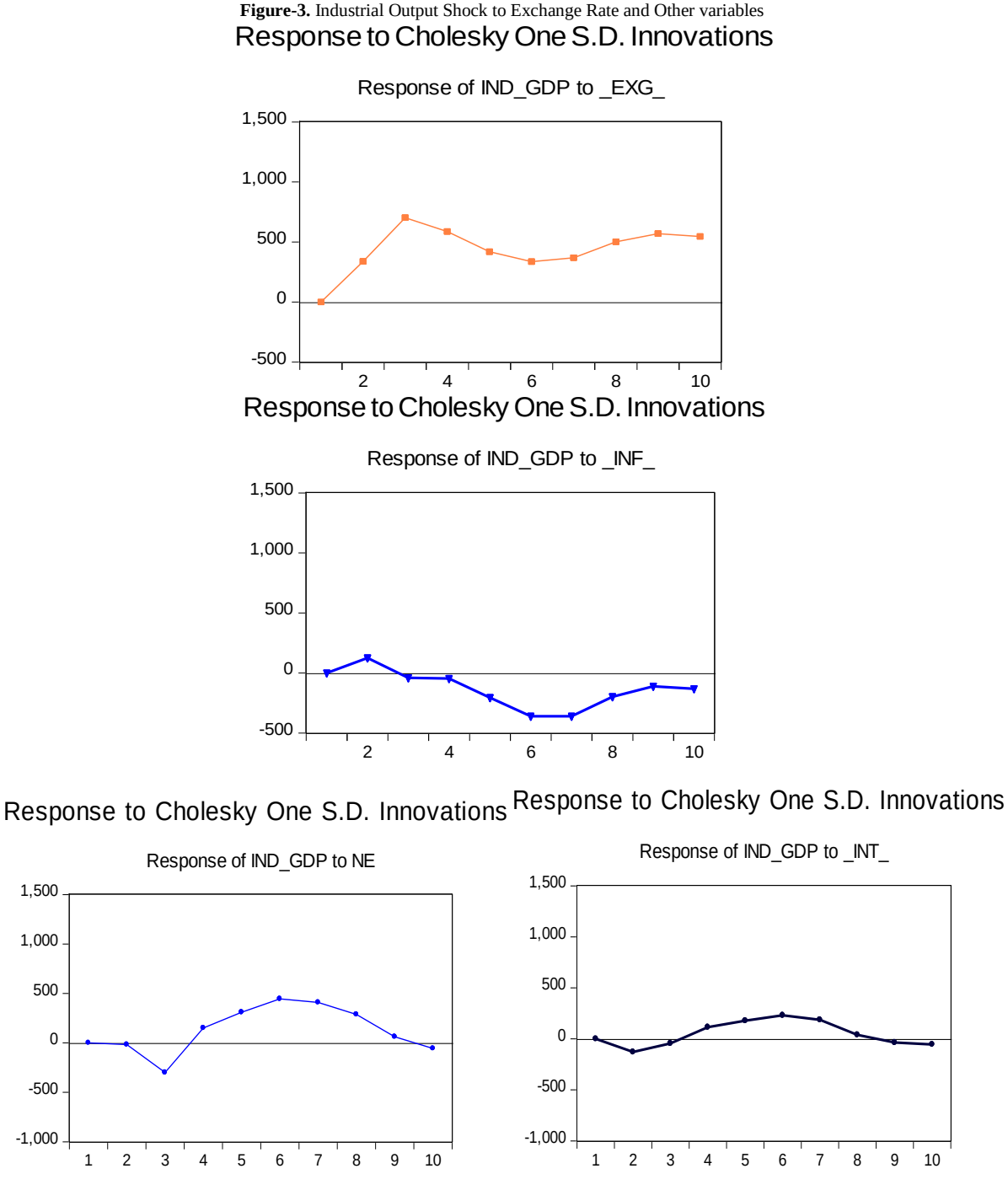
Null Hypothesis:	Obs	F-Statistic	Prob.
EXG does not Granger Cause IND_GDP	27	0.80847	0.5040
IND_GDP does not Granger Cause _EXG_		2.98000	0.0490
INF does not Granger Cause IND_GDP	27	0.23884	0.8682
IND_GDP does not Granger Cause _INF_		0.38925	0.7620
INT does not Granger Cause IND_GDP	27	0.30628	0.8205
IND_GDP does not Granger Cause _INT_		3.59456	0.0317
NE does not Granger Cause IND_GDP	27	1.06705	0.3853
IND_GDP does not Granger Cause NE		2.11100	0.1309
INF does not Granger Cause _EXG_	27	0.77474	0.5218
EXG does not Granger Cause _INF_		2.71506	0.0720
INT does not Granger Cause _EXG_	27	2.87458	0.0618
EXG does not Granger Cause _INT_		3.46395	0.0356
NE does not Granger Cause _EXG_	27	2.21477	0.1179
EXG does not Granger Cause NE		1.53216	0.2370
INT does not Granger Cause _INF_	27	4.60685	0.0131
INF does not Granger Cause _INT_		3.39403	0.0380
NE does not Granger Cause _INF_	27	0.43265	0.7319
INF does not Granger Cause NE		0.12957	0.9414
NE does not Granger Cause _INT_	27	2.88192	0.0614
INT does not Granger Cause NE		0.40396	0.7517

From the granger causality test in table 5 , it was indicated that the Exchange rate does not Granger cause GDP but GDP does Granger cause Exchange rate since their P-value are 0.5040 and 0.0490 respectively, the null hypothesis is accepted, uni-directional causality that IND.GDP cause Exchange rate. The causality test results suggested a bi-directional causation between the INT and INF. This implies that changes in interest rate may cause changes in Inflation rate and vice versa. Some of the other variables suggested unidirectional causality. Some of which are GDP granger cause Interest rate. In addition, there is uni-directional causality that Exchange rate granger cause Interest rate. In the other words, there is no "reverse causation". Furthermore, there is independence, "no causation" between the Inflation rate and GDP, Net Export and Ind.GDP, Inflation rate and Exchange rate. This is a clear indication of the relative positive or negative (as the case may be) impact exchange rate and other monetary policy indicators played on the Industrial output growth.

4.4. Estimated VECM

4.4.1. Response of Industrial Output to Exchange Rate and Associated Variables

Figure-3. Industrial Output Shock to Exchange Rate and Other variables



Source: Author's computation, 2016 (Eview-9.0)

The Cholesky One S.D figures 3, shows that the response of Industrial output (GDP) to exchange rate fluctuation is positive, more specifically at third year but increase subsequent to another positive level which continued even after the tenth year's period. This implies that Exchange rate has a positive significant influence on Industrial Output variables. Other variables have weak positive or negative influence on Industrial output. The hypothesis states that Exchange rate variation has no significant effect on Industrial output in Nigeria, but based on the Cholesky One S.D figures, the study rejected the null hypothesis and concluded that exchange rate actually have a significant impact on Industrial Output growth in Nigeria. It is also obvious from the results that the response of Output to other variables seems to be small in magnitude and not as significant as with the response of the output to exchange rate, but all the same, they all confirmed positive or negative of the Industrial output to shock in the economic fundamentals under study.

4.1.2. VEC Model Forecast Error Variance Decomposition Results

Table-6. Variance Decomposition of Industrial Output

Variance Decomposition of IND_GDP:

Period	S.E.	IND_GDP	_EXG_	_INF_	_INT_	NE
1	1448.792	100.0000	0.000000	0.000000	0.000000	0.000000
2	2084.799	96.91386	2.634042	0.358933	0.017011	0.076153
3	2440.663	84.87195	10.20265	0.289402	3.409008	1.226990
4	2658.694	76.82081	13.48258	0.273174	7.785749	1.637687
5	2835.824	72.99606	14.03435	0.767526	10.07578	2.126294
6	3053.526	72.59850	13.31455	2.055752	10.06327	1.967931
7	3345.785	73.14846	12.30309	2.877158	9.718547	1.952753
8	3610.541	72.78434	12.49452	2.772993	10.07629	1.871868
9	3808.934	71.13893	13.45877	2.575762	10.78817	2.038370
10	3938.238	69.34237	14.51222	2.522069	11.50198	2.121362

Source: Author's computation, 2016 (Eview-9.0)

Forecast Error Variance Decomposition (FEVD) in table 6 above explains the variation in an endogenous variable that is accounted for by its own structural shocks as well as those from other endogenous variables in the system. From the table, industrial GDP output accounted for its contemporary variance from its own innovations with 100 per cent in the first year, although it shows gradual decline from 100% in the first year to about 69 % in the tenth term. In the later periods, there were some variation caused by Exchange rate, Interest rate, Inflation Rate and Net Export. In later periods, these other variables increasingly contributed to variations of industrial output with more than 1%. It is readily seen that about 14.5% of the variation in real GDP was attributed to Exchange rate in the peak period, while interest rate, inflation and Net Export accounted for around 11.5%, 2.5% and 2.1% respectively. Thus, we infer that the exchange rate is critical to the variation in industrial output.

5. Summary, Conclusion and Recommendations

This study investigated the response of aggregate industrial output to exchange rate fluctuation in Nigeria using a battery of techniques- The study used Johansen cointegration test to see if there is present of long-run relation among the variables under study. The results of which provide evidence of long-run equilibrium relationship among the variables. Since, there is evidence of long-run relationship among the variables, a vector error correction (VEC) model was employed and the dynamic correlations of the variables were captured by the analyses of impulse response and variance decomposition. For Impulse response function, the response of Industrial output (GDP) to exchange rate innovations was positive more specifically at second year but reduced subsequent to another positive level which continued even after the tenth year's period. From the Forecast variance decomposition, the study revealed that although the main source of variance in output are own shocks, innovation in the exchange rate accounted for a higher proportion in the variation of industrial output than other variables (I.e Interest rate , inflation rate and Net Export). The granger causality test established a unidirectional relationship between Industrial Output and Exchange rate; meaning a limited impact of exchange rate on Industrial Output. The findings in this study conformed to Musa and Sanusi (2013). Jongbo (2014) Opaluwa *et al.* (2010). The study concluded that exchange rate fluctuation has the potentials of causing significant changes in industrial output in Nigeria. In addition, other economic fundamental like Inflation rate, Interest rate and trade balance also have potentials of causing changed in Industrial Output.

In view of the above findings, this study recommended that:

(1) The effort of the government should be geared towards maintaining a stable and sustainable exchange rates, since the stability of this could enhance industrial output. In other words, more policy attention should be given to proper management of the exchange rate in Nigeria. In addition, efforts must be put in place to ensure the existence of consistent monetary and fiscal policy.

(2) There is need to strengthen the link between agriculture and the industrial sector through local sourcing of raw materials thereby reducing the reliance of the sector on import of inputs to a reasonable level. More also, efforts should be put in place to check the importation of goods that could be locally produced so as to improve the performance of the manufacturing sector.

(3) The Nigerian government should encourage the export promotion strategies in order to maintain a surplus balance of trade and also conducive environment, adequate security, effective fiscal and monetary policy, as well as infrastructural facilities should be provided so that foreign investors will be attracted to invest in Nigeria.

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Appendices

Appendix-1. Macroeconomics Performance Indices (1986-2015)

Year	Real GDP ₦'Billion	Ind, RealGDP ₦'Billion	Exchange Rate (EXR)-N/US$ 1.00	Inflation Rate (INF) %	Interest Rate (INT)%	Net Export(Export-Import)
1986	15,237.99	6,234.41	2.02	6.25	9.93	2.94
1987	15,263.93	6,135.33	4.02	11.77	13.96	12.5
1988	16,215.37	6,474.98	4.53	34.24	16.62	9.74
1989	17,294.68	7,100.76	7.39	49.02	20.44	27.11
1990	19,305.63	8,531.59	8.04	7.8	25.30	64.17
1991	19,199.06	8,094.63	9.91	12.20	20.04	32.05
1992	19,620.19	8,170.47	17.30	44.57	24.76	62.46
1993	19,927.99	8,122.08	22.05	57.14	31.65	53.14
1994	19,979.12	7,917.40	21.89	57.42	20.48	43.27
1995	20,353.20	7,985.54	81.02	72.73	20.23	195.53
1996	21,177.92	8,450.31	81.25	29.29	19.84	746.91
1997	21,789.10	8,561.92	81.65	10.67	17.80	395.94
1998	22,332.87	8,515.83	83.80	7.86	18.18	-85.56
1999	22,449.41	8,031.92	92.69	6.62	20.29	326.44
2000	23,688.28	8,808.65	102.11	6.94	21.27	960.70
2001	25,267.54	9,351.86	111.94	18.87	23.44	509.77
2002	28,957.71	9,061.67	120.97	12.88	24.77	231.48
2003	31,709.44	10,893.91	129.36	14.03	20.71	1,007.65
2004	35,020.55	11,418.60	133.50	15.00	19.18	2,615.73
2005	37,474.95	11,674.74	132.15	17.86	17.95	2,724.40
2006	39,995.50	11,481.76	128.65	8.22	16.90	4,216.20
2007	42,922.41	11,332.36	125.83	5.42	16.94	4,397.80
2008	46,012.51	11,068.22	118.57	11.58	15.48	4,794.50
2009	49,856.10	11,353.42	148.88	12.54	18.36	3,125.60
2010	54,612.26	12,033.20	150.30	13.72	17.59	3,847.50
2011	57,511.04	12,874.25	153.86	10.80	16.02	4,240.80
2012	59,929.89	13,028.05	157.50	12.20	12.00	5,372.70
2013	63,218.72	13,014.51	157.31	8.50	12.00	5,822.60
2014	67,152.79	7,011.81	158.55	8.00	13.00	2,421.70
2015	69,144.89	6,689.96	199.05	9.60	11.00	2,895.08

Source: National Bureau of Statistics (NBS) and CBN Statistical Review

Appendix-2. GDP and Exchange Rate Annual Growth Rate (1986-2015)

Year	Real GDP ₦'Billion	Ind. Real GDP ₦'Billion	Ind. GDP Annual Growth rate (%)	GDP Annual Growth rate (%)	Industry GDP % contr. to Total GDP	Exchange Rate (EXR)-N/US$ 1.00
1986	15,237.99	6,234.41	-2.3	-8.8	40.91	2.02
1987	15,263.93	6,135.33	-1.6	-10.8	40.20	4.02
1988	16,215.37	6,474.98	5.5	7.5	39.93	4.53
1989	17,294.68	7,100.76	9.7	6.5	41.05	7.39
1990	19,305.63	8,531.59	20.2	12.8	44.19	8.04
1991	19,199.06	8,094.63	-5.1	-0.6	42.16	9.91
1992	19,620.19	8,170.47	0.9	0.4	41.64	17.30
1993	19,927.99	8,122.08	-0.6	2.1	40.76	22.05
1994	19,979.12	7,917.40	-2.5	0.9	39.62	21.89
1995	20,353.20	7,985.54	0.9	-0.3	39.23	81.02
1996	21,177.92	8,450.31	5.8	5.0	39.90	81.25
1997	21,789.10	8,561.92	1.3	2.8	39.29	81.65
1998	22,332.87	8,515.83	-0.5	2.7	38.13	83.80
1999	22,449.41	8,031.92	-5.7	0.5	35.77	92.69
2000	23,688.28	8,808.65	9.7	5.3	37.18	102.11
2001	25,267.54	9,351.86	6.2	4.4	37.01	111.94
2002	28,957.71	9,061.67	-3.1	3.8	31.29	120.97
2003	31,709.44	10,893.91	20.2	10.4	34.36	129.36
2004	35,020.55	11,418.60	4.8	33.7	32.61	133.50
2005	37,474.95	11,674.74	2.2	3.4	31.15	132.15
2006	39,995.50	11,481.76	-1.7	8.2	28.71	128.65
2007	42,922.41	11,332.36	-1.3	6.8	26.40	125.83
2008	46,012.51	11,068.22	-2.3	6.3	24.05	118.57
2009	49,856.10	11,353.42	2.6	6.9	22.77	148.88
2010	54,612.26	12,033.20	6.0	7.8	22.03	150.30
2011	57,511.04	12,874.25	7.0	4.9	22.39	153.86
2012	59,929.89	13,028.05	1.2	4.3	21.73	157.50
2013	63,218.72	13,014.51	-0.1	5.4	20.59	157.31
2014	67,152.79	7,011.81	-46.1	6.3	10.44	158.55
2015	69,144.89	6,649.96	-5.2	3.0	9.61	199.05

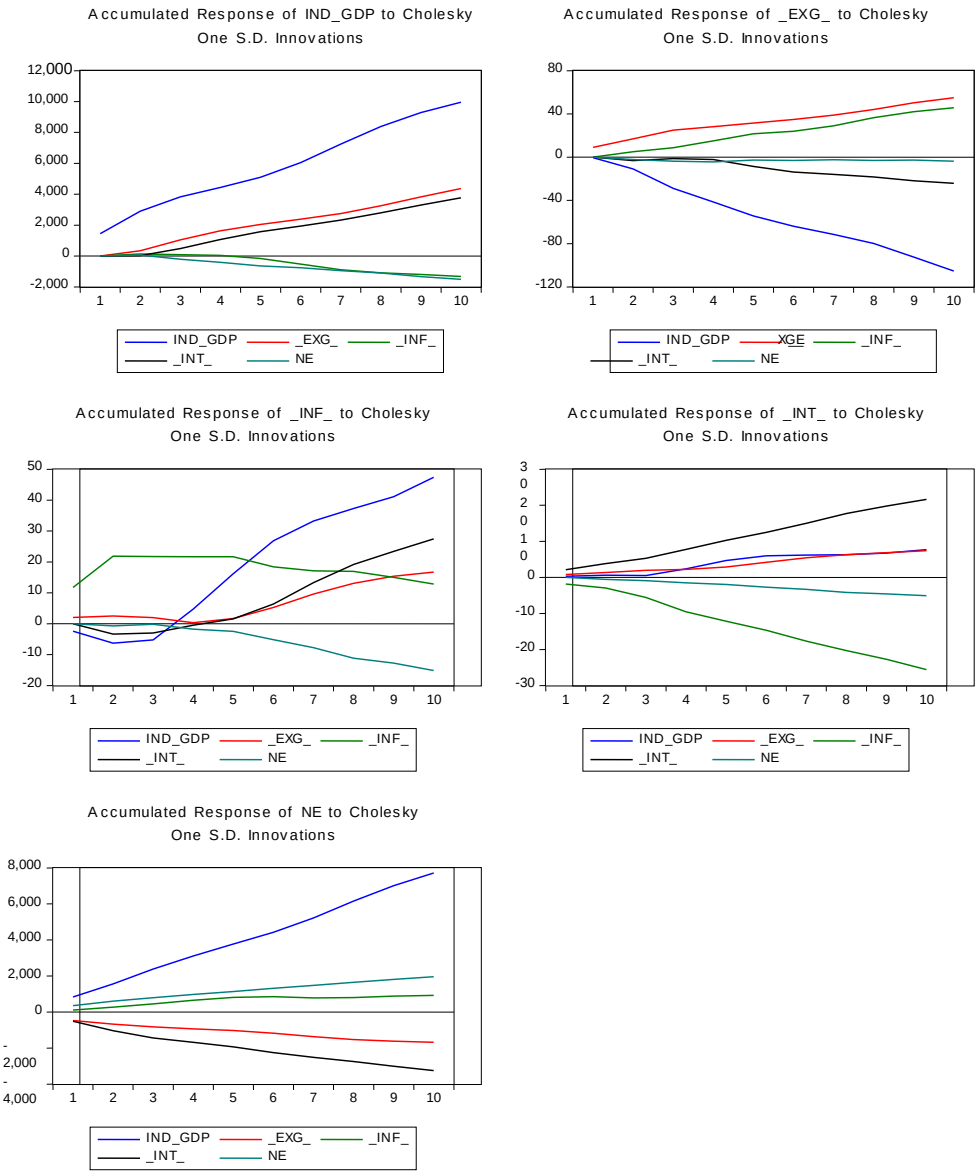
Source: Constructed by researcher from National Bureau of Statistics (NBS) and CBN Statistical Bulletin (various editions)

Appendix-3. GDP and Exchange Rate Periodic Growth Rate (1986-2015)

Period	Industry GDP Average Annual Growth rate (%)	Real GDP Average Annual Growth rate (%)	Exchange Rate Growth Rate (%)	Industrial Sector's contribution to Total GDP (%)
1986-1990	6.3	1.4	62.1	41.3
1991-1995	-1.3	0.5	79.0	40.7
1996-2000	2.1	3.3	4.8	38.1
2001-2005	6.1	11.1	5.4	33.3
2006-2010	0.7	7.2	3.2	24.8
2011-2015	-8.6	4.8	1.4	16.9

Source: Constructed by researcher from National Bureau of Statistics (NBS) and CBN Statistical Bulletin (various editions)

Appendix-4. Generalized impulse response functions.



Source: Author's computation, 2016 (Eview-9.0)