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Oil Price Volatility and Industrial Production in Nigeria: A Dynamic Investigation

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ABSTRACT

In this study, we investigate the effect of oil price volatility on industrial production in Nigeria. We extend the effects of frequent oil price changes beyond macroeconomic performance to industry-level outputs in Nigeria. A dynamic framework is devised for the study by adopting appropriate estimation methods including the vector error correction mechanism (VECM) and the bi-variate GARCH model. We test for the relationships between the variables and also check if volatility in oil prices are transmitted to industrial output in Nigeria. The results from the study show that oil price volatility has a significant and negative direct short term impact on industrial output in Nigeria, though the impact is delayed in the short term. Also, oil price volatility is shown to have a significant negative long run direct impact on industrial output in Nigeria. We also find that oil price volatility tends to stimulate and perpetuate volatility in industrial output in Nigeria through volatility transfer.

Keywords: Oil price volatility, volatility transfer, industrial output, Nigeria

1. INTRODUCTION

The need to promote a virile industrial sector has continued to be a major concern of most developing economies. A strong industrial base provides a good background for developing sound economic systems with fluid linkages between the primary and tertiary sectors. However, despite efforts of by past administrations in Nigeria at promoting industrial development, there seems to be little outcome in this direction. Nigeria's experience with industrialization has been a series of traumatic episodes (Ikpeze et al, 2004). Manufacturing value-added as a percentage of GDP has been consistently below five percent over the past decade (less than the proportion at independence in 1960-8.6 percent), making Nigeria one of the 20 least industrialized countries in the world.

Industrialization in Nigeria soared during the oil boom era (1973-81 with manufacturing share of GDP reaching 11 percent), but has had a precipitous decline to less than five percent in 2011. In the same year, manufacturing export was barely 0.5 percent of exports, while import of manufactured goods was about 15 percent of GDP or more -than 60 percent of total imports. Thus, there has been rapid de-industrialization, continuing loss of market shares in traditional export markets, and increasing import dependence in the country (Ikpeze et al, 2004). This is in spite of government's huge investment in the industrial sector and institutionalized industrial policies. Moreover, four different national development plans (1962-1985) had industrialization as the major priority of successive governments in Nigeria.

Perhaps, the focus of the economy on the oil sector has been one of the major factors that has affected industrial sector development in the country. In addition to the monocultural structure of the production bases, there was the problem of oil price instability, which to a large extent has adversely affected industrial sector productivity in Nigeria since 1973. Substantial fluctuations in the international price of crude oil have had for strong implications for the country's macroeconomic policies over the years (Iwayemi, 1995).

As has been argued by Barnett and Asfaha (2007), countries that rely on oil and other nonrenewable resources for a substantial share of their economic activities face certain unique macroeconomic challenges: the revenue stream is exhaustible, uncertain, volatile, and largely originates from abroad. These problems raise several challenges for a comprehensive and sustainable industrial sector development. Instability in oil prices and fiscal revenue complicates industrial management, sectoral planning, and the efficient use of firm input resources. Large declines in revenues often cause sharp changes in exchange rate which is disruptive and costly for producers.

It is in this direction that this study is concerned with examining the impact of oil prices on industrial production in Nigeria and by extension show the patterns of input combinations in the industrial sector when oil prices are introduced into a production function. The main objective of the study is to empirically determine the impact of oil price instability on the industrial sector in Nigeria. Given that oil price movement by itself may have some effects on industrial output, the study examines the role of instability in oil prices on domestic industrial production in Nigeria and also assesses the relationship between capital and labour inputs in industrial production given shocks from unstable oil prices.

2. THE LITERATURE

Oil price effects on firm behaviour have theoretical foundations with uncertainties and risks in production. Thompson (2006) noted that fluctuations in oil prices generate substantial risks on firm production, especially in the long term. This arises because oil prices come into production as strong input effects on output. Studies on producers' behaviour under risk and uncertainty emphasize that producers often make their decisions in a risky environment that result from production (Arrow, 1971; Tveteras et al., 2011). Such risky production environments and conditions may be related to different factors that also vary according to the production type and the input factors used in production. For example, in the industrial sector, the market for and price of energy used as an input factor, as well as financial uncertainty, such as in the interest rate, may have significant impacts on the producer's decision and production outcome. In the agricultural sector, this uncertainty may arise from the weather, disease and pests.

The risks from production tend to be minimized through the adoption of different institutional and managerial tools (Binswanger, 1980). For example, they may change the level of different inputs used for optimal production (Hurd, 1994), change the level of utilization of capacity which might have different implications regarding the variability in the output (Tveteras et al., 2011). Thus, distributional properties for output in the case of output risk have implications for optimum input combinations and output for risk adverse producers.

According to Kumbhakar and Tsionas (2010), there are two main aspects of the concept of risk in production theory that have been studied. First, uncertainty arises from the change in the price of output, and second, uncertainty arises from the volume of output. The latter is often referred to as the production risk that can be explained by the inputs used in production. The quantity of inputs that determine the output volume also influences the degree of output inconsistency or variability. For example, in the financial and agricultural sectors respectively, interest rates and the use of fertilizers and pesticides may be risky, leading to an increase in the variation of the output, while technology and labor may decrease the output risk. Other risks may increase or decrease the output. For example, currency risk in the financial sector, which is related to changes in the rate of foreign exchange, will have positive/negative effects on the value of the asset held in that currency (Kumbhakar and Tveterås, 2003).

Since crude oil is the world's most actively traded commodity, both in volume and in value, the price changes could have large effects on industrial, economies. According to Hamilton (1996), oil price increases seem to be one of the main cause of recessions in USA prior to 1972. Within a vector auto regression (VAR) framework Hamilton found a strong causal and negative correlation between oil price change and real U.S. GNP growth from 1948 to 1980. Darrat, Gilley and Meyer (1996) showed that the insignificant effect of oil prices on output is not robust. First the pre- and post-1972 periods are two distinct regimes, especially for oil prices and their relationship with the economy.

Davis and Haltiwanger (2001) used an empirical base of quarterly plant level census data from 1972:2 to 1988:4 on employment, capital per employee, energy use, age and size of plant, product durability at four digit SIC level. They used vector auto regressions to test the response of job creation and destruction to separately defined, positive and negative oil price shocks. According to their study, the magnitude of effect of oil price shocks is about twice that of monetary shocks, and response of employment to oil price shocks is asymmetric, the response to positive shocks is ten times larger than that to negative shocks.

Blanchard and Gali (2007) have used structural VAR technique to analyze the effects of oil price changes on macroeconomic variables. Their results show that, the estimated response for employment and output become weaker over time, with point estimates becoming slightly positive for the most recent period. In the same vein, Eksi, Izgi and Senturk (2011) noted that the effects of a given change in the price of oil have changed substantially over time. They explain that one of the reasons for this change is the decline in wage rigidities.

3. MODEL AND METHODOLOGY

The theoretical foundations for evaluating the linkages between oil price movements and industrial production follows the postulations byBerk and Yetkiner (2003) on the theory of energy price and growth. In the model formulation, they attempted to derive and test the role of energy prices on industrial growth. They modified the Rebelo (1991) model such that consumption goods sector uses energy as an input along with capital. The model allows for them to show that the growth rate of energy price has a negative effect on the growth rates of energy use and general industrial sector performance.

The analytical research design is used in the empirical investigation in this study. In this direction therefore, two analytical tools are employed to carry out this research. First, a volatility estimation technique is used to investigate the effects of volatility in oil prices on industrial production using the Autoregressive Conditional Heteroskedasticity initially introduced by Engle (1982) and generalized as GARCH (Generalized ARCH) by Bollerslev (1986). A multivariate form of the GARCH model is used in this study to study the transfer of oil price volatility to industrial output in Nigeria. The second methodology is the use of the co integration methodology to obtain long run relationship between oil price volatility and industrial production in Nigeria.

3.1. Model Specification

The pattern of investigation in this study indicates that a function that relates industrial output oil price volatility is devised. Based on the theoretical framework provided above, a model of this structure will include the reference terms of trade in oil prices for Nigeria in the international market and the index of industrial production. This involves the application of the naira exchange rate since we assume that the main channel of oil price movement effects on the industrial sector is through distortions in exchange rate. The hypotheses of the study necessitate the adoption of the three methodologies in the study.

3.1.1. Volatility and Spillover Effects Model (Univariate and Bi-Variate GARCH Models)

According to the empirical literature, the information flow between an international market factor (such as oil prices) and domestic factor (industrial output in this case) may not be significant and visible when correlation in the first moment are used in the analysis; however, it may a have high volatility effect (correlation in the second moment). Volatility has been considered a better proxy of information by Clark (1973) and Ross (1983). The ARCH model, which was developed by Engle (1982) and later generalized by Bollerslev (1986), is one of the most popular methods for modeling the volatility of high-frequency financial time series data.

In this study, we consider the multivariate GARCH model for investigating the relationship between volatility in oil prices and industrial output. Following Mensi et al. (2013) the Bi-Variate GARCH model will be used in the estimation to allow for a focus on the interdependence of the conditional changes, conditional volatility and conditional correlations between the oil prices and industrial output in Nigeria. This model was proposed by Ling and McAleer (2003) and later applied by several researchers, such as Chan et al. (2005). In its basic form, the model includes the multivariate VECH model of Bollerslev (1990) as a special case in which correlations between system shocks are assumed to be constant to ease the estimation and inference procedure. This is the method that is adopted in this study.

The conditional mean equation of the Bi-Variate GARCH(1, 1) system is given by:

$$Y_t = c + \Phi T_{t-1} + \varepsilon_t \quad (3.7)$$

$$\varepsilon_t = h_t^{\frac{1}{2}} \eta_t \quad (3.8)$$

where :

Yt = (*liip*$_t$, *lopr*$_t$*lexrt*), in which *iip*is the index of industrial production (used to proxy industrial output), *opr* is oil prices and its volatility, and *exrt* is exchange rate.

$\varepsilon_t = \left(\varepsilon_t^{liip}, \varepsilon_t^{opr}, \varepsilon_t^{lexrt}\right)$, where ε_t^{liip}, ε_t^{opr} and ε_t^{lexrt} are the residual of the mean equations for industrial output, oil price volatility and exchange rate respectively.

$\eta_t = (\eta_t^{liip}, \eta_t^{lopr} \eta_t^{lexrt})$ = refers to the innovation and is an iid distributed random vector (see Mensi, 2013).

$h_t^{\frac{1}{2}}$is a diagonal matrix containing the conditional variances of iip_t, opr_t and $exrt_t$ respectively. These variances may be respectively represented as$\left(h_t^{liip}, h_t^{lopr}, h_t^{lexrt}\right)$. Thus based on the multivariate GARCH analysis, the associated variance equations for the three variables are given as:

$$h_t^{liip} = C_{liip} + \alpha_{liip}\left(\varepsilon_{t-1}^{liip}\right)^2 + \beta_{liip} h_{t-1}^{liip} + \alpha_{lopr}\left(\varepsilon_{t-1}^{lopr}\right)^2 + \beta_{liip} h_{t-1}^{lopr} + \alpha_{lextr}\left(\varepsilon_{t-1}^{lexrt}\right)^2 + \beta_{lexrt} h_{t-1}^{lexrt} \quad (3.9)$$

$$h_t^{lopr} = C_{lopr} + \alpha_{lopr}\left(\varepsilon_{t-1}^{lopr}\right)^2 + \beta_{lopr} h_{t-1}^{lopr} + \alpha_{liip}\left(\varepsilon_{t-1}^{liip}\right)^2 + \beta_{liip} h_{t-1}^{liip} + \alpha_{lextr}\left(\varepsilon_{t-1}^{lexrt}\right)^2 + \beta_{lexrt} h_{t-1}^{lexrt} \quad (3.10)$$

$$h_t^{lexrt} = C_{lexrt} + \alpha_{lextr}\left(\varepsilon_{t-1}^{lexrt}\right)^2 + \beta_{lexrt} h_{t-1}^{lexrt} + \alpha_{liip}\left(\varepsilon_{t-1}^{liip}\right)^2 + \beta_{liip} h_{t-1}^{liip} + \alpha_{lopr}\left(\varepsilon_{t-1}^{lopr}\right)^2 + \beta_{lopr} h_{t-1}^{lopr} \quad (3.11)$$

Equations: (3.9) and (3.11) show how volatility is transmitted over time across industrial output, oil price volatility and exchange rate. The cross value of the error terms $\left(\varepsilon_{t-1}^{lopr}\right)^2$, $\left(\varepsilon_{t-1}^{lopr}\right)^2$and $\left(\varepsilon_{t-1}^{lexrt}\right)^2$represent the volatility innovations in the oil prices across the corresponding naira exchange rate and industrial output at time (t-1) and represents the ARCH effect of past shocks, which captures the impact of the direct effects of shock transmission. The presence of h_{t-1}^{liip},$h_{t-1}^{lopr}$and h_{t-1}^{lexrt}captures the volatility spillovers or interdependencies between oil price markets and the domestic factors. These variables show the GARCH effects of past volatilities.

Based on the model shown above, the past shock and volatility of oil prices are allowed to impact the future volatilities of the industrial output (primarily via exchange rate distortions) in addition to its own future volatility. This model will also enable us estimate the conditional covariances between oil price volatility and industrial output in Nigeria.

3.1.2. The Autoregressive Model

Since the three variables included in the analysis all seem to be endogenous in the relationships, a Vector autoregressive scheme is adopted as the more appropriate means of identifying the dynamic linkages between them. Thus, we adopt the Vector Error Correction Method (VECM) for the analysis. The system of equations representing the short run relationships which is estimated in the Johansen method is a vector error correction model (VECM) derived from a standard unrestricted vector autoregressive model (VAR) of lag length *k*. The VAR system of equations can be algebraically re-arranged into a VECM, written as:

$$\Delta z_t = \Gamma_1 \Delta z_{t-1} + \cdots + \Gamma_{k-1} \Delta z_{t-k+1} + \Pi z_{t-1} + \mu + \varepsilon \quad (3.12)$$

where $z_t$is the vector of variables (here *iip*, *opr* and *exrt*) and μ is a vector of constants. The first group of terms on the right hand side of (1), up to and including z_{t-k+1}, represents the short run lagged effects of differences in the three variables in *z*, or Δz, on each variable in the system.

The next term, Πz_{t-1}, is the error correction term (ECT) that represents the long run cointegrating relationships between the levels of the variables in *z*. As all three variables are non-stationary, there should be more than one cointegrating relationships between them (Guest and Swift, 2008), with the number of cointegrating relationships given by the rank (*r*) of the matrix of long run coefficients *Π*. If at least one cointegrating relationship exists, *Π*can be factorised into $\Pi = \alpha\beta'$ where β'is the coefficients on the individual variables in the long run or cointegrating vectors, and αis the coefficient on the ECT itself, which represent the speed of adjustment to disequilibrium (Johansen and Juselius 1990).

3.2. Data Issues

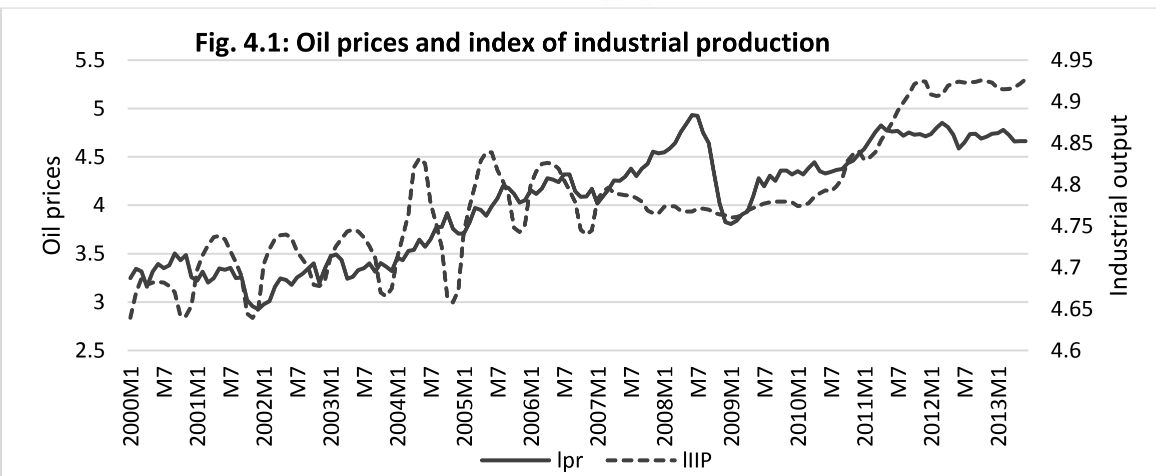
Data used in the study are monthly time series data that cover the period 2000 to 2013. The data is all sourced from the recent CIC study commissioned by the Central Bank of Nigeria. The use of monthly data is quite justified since the analysis involves dynamic implications in which high frequency data provide more robust outcomes.

4. EMPIRICAL ANALYSIS

The dynamic interaction between oil price volatility and industrial output in Nigeria is the focus of this empirical research. The nature of the research therefore requires that the time series properties of the data used in the study are to be investigated. This implies that the stationarity and long run properties of the data are examined in order to ensure that the estimates are representative of the time series being studied. Also, volatility analysis techniques are also deployed in the study. The procedure for this analysis involves the testing for unit roots among the time series in the analysis; the cointegration analysis which involves the investigation of the long run relationships among the variables.

4.1. Trends in Oil Prices and Industrial Production

In Figure 4.1, the trends in oil prices and index of industrial production are shown. In the chart, the logarithms of the variables are used. It can be seen that industrial output seems to have deeper swings than oil prices although the fluctuations in oil prices appear to be more frequent and rapid. The trends in their overall movements also appear to be similar in the chart.



In Figure 4.2, the trends in exchange rate and industrial output are shown. It can be seen that a particular pattern of relationship cannot immediately be seen in the chart. However, overll trend indicates that the two variables move together over time.

4.2. Unit Root and Cointegration Analysis

Two tests of stationarity are employed in this study in order to analyze unit roots. The results are presented in levels and first difference. This enables us determine in, comparative terms, the unit root among the time series and also to obtain more robust results. Table 4.1 presents results of Augmented Dickey Fuller (ADF) and Philip-Perron (PP) tests in levels and first differences without taking into consideration the trend in variables. The reason for this is that an explicit test of the trending pattern of the time series has not been carried out. In all cases, the three variables in log form, *liip*, *lopr* and lexrt, were non-stationary but their first differences were found to be stationary. That is, all variables (in log form) were I (1). It is therefore appropriate to use cointegration analysis to estimate the relationships between the variables, provided that the method chosen allows for the possible joint endogeneity of all three variables that as suggested by Guest and Swift (2008).

Fig. 4.2: Exchange rate and index of industrial production

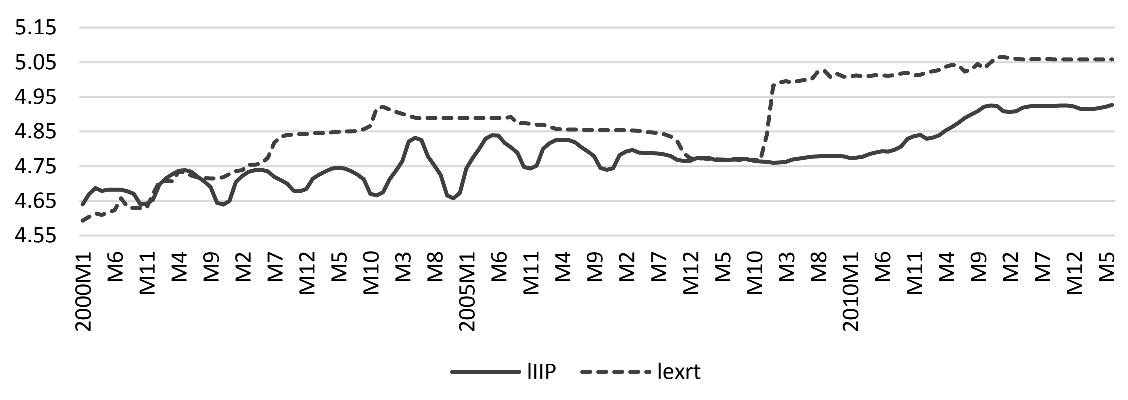


Table 4.1 Unit Root Test for Variables

Variable	ADF Test		Phillip-Perron Test		Order of Integration
	Levels	*First Difference*	*Levels*	*First Difference*	
Lip	-0.062	-3.69*	-0.137	-3.77*	I[1]
Lpr	-1.203	-10.6*	-2.008	-12.7*	I[1]
Lexrt	-1.767	-8.55*	-1.981	-9.08*	I[1]

Note: indicates significance at 5 percent level

Having established that the series in the analysis are not stationary in their levels, we move on to determine if they are cointegrated. The results from the multivariate cointegration test are presented in Table 4.2. As can be seen from the table, both the λ-max and Trace test statistics indicate that the three series are cointegrated and there is one cointegrating vector.

Table 4.2 Multivariate Cointegration Test Results

Null Hypothesis	***Trace Test***		***Maximum Eigenvalue Test***	
	Test Statistic	*Critical Value*	*Test Statistic*	*Critical Value*
*r = 0**	32.75	29.79	22.98	21.13
r ≤ 1	9.77	15.49	8.69	14.26
r ≤ 2	1.08	3.84	1.08	3.84

**(**) denotes rejection of the hypothesis at 5% (1%) significance level.*

4.3. VECM Results

Since the variables are all cointegrated, the vector error correction mechanism is employed for the systems estimation (VECM). The VECM results provide information about the direction of the impact and the relative importance between variables that simultaneously influence each other. The long run β coefficients on the individual variables in the error correction terms (ECTs) for the relationships are given in Table 4.3. This shows the impact of oil price fluctuations industrial output in the long run. It should be noted that the Johansen cointegration test has confirmed that a long run relationship exists between industrial output and oil price volatility. The cointegrating vectors are all normalised on the coefficient for log of industrial output (*liip*) to facilitate comparison of the relationship since this is the only variable that is shown as the basic endogenous variables. Table 4.3 also gives the α or speed-of-adjustment coefficients on the long run ECT in the error correction model (ECM) for each variable in the system. The coefficients on the lagged differenced variables that represent the short run effects on each variable are shown in Table 4.3.

The coefficients of log of oil price violatility and exchange rate in the long run result are both negative and significant in the standardized long run estimation. The long run coefficients in the results thus show a stable relationship between industrial output and both oil price volatility and exchange rate. A 1 percent rise in oil price volatility tends to reduce industrial output by about 0.49 percent in the long run. Also, a 1 percent increases in exchange rate (e.i. depreciation) causes industrial production to fall by as much as 0.35 percentage points. These results therefore clearly show that long run growth in industrial output will be hampered by any fluctuation in oil prices that persist for some time.

Moreover, the coefficient on the ECT (α) is negative for each of the variables. Thus, each of the variables will adjust to any deviation from the long run equilibrium that may occur in the short term. The goodness of fit for the short run results are all not quite impressive, judging from the R squared values reported in Table 4.3.

Table 4.3 Long Run Coefficients of the VECM

	liip	*lopr*	*lexrt*
coefficients of the errorcorrection term (ECT) – long run results	1.000	-0.49*	-0.355**
	-	(-2.93)	(-4.68)
Equations of the system:			
Dependent variable	*Δlprg*	*Δlinq*	*Δlhcap*
Coefficient on the ECT (α)	-0.151**	0.094*	0.018***
	(-4.42)	(-0.39)	(-0.49)
R^2	0.47	0.08	0.25
LM test for autocorrelation of the system: p-value = 0.615			
Doornik-Hansen test for normality of the system: p-value = 0.757			

For the short run VECM results, several interesting transmission patterns emerge from the examination of Table 4.4. it should be noted that only the results for industrial output and exchange rate are shown since oil prices are largely exogenously determined. The results show that short run changes in industrial output are mostly determined by its own lag and the second lag of oil price volatility. The coefficients of exchange rate are not significant in the short run estimates. This indicates that exchange rate only have long run impacts on industrial production in Nigeria. This result can be justified since industrial production is primarily dependent on foreign inputs. the results also indicate that oil prices tend to have a delayed negative impact on industrial production in Nigeria. When oil prices fluctuate, the effects are reflected on industrial output after sometime has elapsed. For the exchange rate, the coefficients of the two lags for oil prices and that of the first lag of exchange rate are significant. Apparently, oil prices have very strong direct short term impact on the naira exchange rate. As the fluctuations in oil prices deepen in the international market, exchange rate tends to immediately deteriorate. This is suggested by the significance of the negative oil price coefficients in the exchange rate equation.

Table 4.4 Short Run Dynamics based on the VECM

Dependent Variable	**$\Delta liip_{t-1}$**	**$\Delta LIIP_{t-2}$**	**ΔLPR_{t-1}**	**ΔLPR_{t-2}**	**$\Delta LEXRT_{t-1}$**	**$\Delta LEXRT_{t-2}$**	**R^2**
Δliip	0.59** [8.2]	0.10 [1.31]	-0.01 [-0.48]	-0.03* [-2.81]	-0.02 [-0.22]	-0.04 [-0.60]	0.47

Δlexrt	-0.06 [-0.78]	0.03 [0.37]	-0.03* [-2.61]	-0.04** [-3.02]	0.33** [4.23]	-0.13 [-1.66]	0.25

*Note: * and ** indicate significance at 5 percent and 1 percent respectively*

Finally, for the autoregressive estimates, we report the results of the Variance Decomposition based on the estimated VECM in Table 4.4. Again, only the decomposition of industrial output and exchange rate are shown. As noted in Nguyen (2011), Variance Decomposition 'tells how much a given variable changes under the impact of its own shock and the shock of other variables.' Therefore, the variance decomposition defines the relative importance of each random innovation in affecting the variables in the VECM. For industrial output decomposition, it can be seen that itself and exchange rate are the main factors that explain its variances over time. The effect of exchange rate tends to become more pronounced after twelve months (one year). This suggests that exchange rate tends to have a long term effect on industrial output in Nigeria. The effect of oil price volatility is rather weak in explaining variances in industrial output.

The decomposition of exchange rate shows that oil prices have very strong role to play in its determination. On the other hand, industrial output played weak role in its determination. This result fully highlights the fact that while oil prices have short term and direct impact on industrial output, exchange rate has long term impact. Moreover, oil price volatility has indirect impact on industrial output through its strong impact on exchange rate in Nigeria.

Table 4.5 Variance Decomposition Results

Period	LIIP	LOPR	LEXRT
Variance Decomposition of LIIP:			
2	99.91	0.03	0.07
4	98.79	0.61	0.60
8	91.68	0.94	7.37
12	79.49	3.24	17.28
16	71.82	4.62	23.55
20	66.66	5.17	28.17
24	61.85	5.72	32.43
Variance Decomposition of LEXRT:			
2	0.12	3.79	96.09
4	0.23	17.00	82.77
8	0.31	25.58	74.12
12	0.24	28.66	71.10
16	0.22	30.47	69.31
20	0.19	31.42	68.40
24	0.16	32.02	67.82

4.4. The Volatility Transmission Results

The results of the estimated Bi-variate GARCH model (used to show volatility transfer) using the Vector Conditional Heteroskedasticity (VECH) procedure is reported in Table 4.6. As mentioned in the previous chapter, volatility transmission from one variable to another is measured by considering the second moments of each of the variables. The VECH estimates report both the within-sample volatility and between variable volatility in the case of data in the series.

As shown in the results, both persistence and cross effects relationships are reported for the variables. Only the coefficient of IIP and OPR constants are significant; none of the cross constants has significant coefficients. This indicates that industrial output and oil prices are more basic in the estimates. The z-values for the coefficient of the ARCH term for all the variables are significant and positive. This indicates that news from previous period tends to affect the pattern of volatility of oil prices and well as industrial output in Nigeria. The ARCH term for the cross variables are also significant and show that news from previous periods tends to affect the pattern of interactions between the real exchange rate and oil price volatility. Since each of the coefficients of the ARCH terms are positive, the results suggest that previous news on volatility tends to stimulate current period volatility in each of the markets.

We focus on the GARCH terms which show persistence in volatility for the individual variables and transmission of volatility for the variables. The GARCH term passes the significance test for each of the variables and cross-interactions. This indicates that any volatility generated by oil prices tends to persist both for industrial output and exchange rate. Apparently, these two variables have long lasting responses from the oil price fluctuations.

The spillover terms each pass the significance test at the 1 percent level since its z-values are greater than the one percent critical value of 2.57. The results show that spill over from oil price volatility not only has a significant impact on both industrial output and the exchange rate in Nigeria, it also causes volatility in these variables. Volatility in oil prices tends to stimulate volatility in industrial output in Nigeria. Thus, volatility transfer is noted for the oil price-industrial output relationship in Nigeria. When the oil prices are unstable, industrial output also tends to be unstable. Thus, while oil price volatility has a direct negative impact on industrial output, the volatility also has a stimulating impact on industrial output fluctuations in Nigeria.

Table 4.6 The Bi-Variate GARCH spillover Results

VECH Output	Coefficient	z-Statistic	Prob.
IIP constant	0.028	3.54	0.00
IIP and OPR cross constant	-0.004	-0.32	0.75
IIP and EXRT cross constant	0.01	0.96	0.34
OPR constant	0.008	2.52	0.01
OPR and EXRT cross constant	0.00	0.05	0.96
EXRT constant	0.00	3.51	0.00
IIP ARCH TERM	0.813	2.54	0.01
Cross ARCH term (IIP and OPR)	0.846	2.63	0.01
Cross ARCH term (IIP and EXRT)	0.815	2.57	0.01
OPR ARCH term	0.856	2.63	0.01
Cross ARCH term (OPR and EXRT)	0.852	2.65	0.01
EXRT ARCH term	0.815	2.57	0.01
Volatility persistence for IIP	0.309	6.91	0.00
Volatility spiilover from OPR to IIP	0.156	5.19	0.00
Volatiltiy spillover from EXRT to IIP	0.244	6.47	0.00
Volatity persistence for OPR	0.090	2.69	0.01
Volatility spillover from OPR to EXRT	0.121	4.00	0.00
Volatility persistence for EXRT	0.203	5.39	0.00

5. CONCLUSION

This Study sets out to investigate the effect of oil price volatility on industrial output in Nigeria. It is well known that oil prices have exerted significant impacts on most macroeconomic variables in Nigeria (see Adegboye, 2013 and Akpan, 2019). This was the motivation for the current study. The Bi-variate GARCH model were used to test for the relationships and to check if volatility in oil prices are transmitted to industrial output in Nigeria. The results from the study showed that oil price volatility has a significant and negative direct short term impact on industrial output in Nigeria, though the impact is delayed in the short term. Also, oil price volatility had a significant negative long run direct impact on industrial output in Nigeria and oil price volatility tends to stimulate and perpetuate volatility in industrial output in Nigeria through volatility transfer.

The results from the empirical analysis are generally interesting and quite apt for policy directions, especially the appropriate nature of domestic sector relationship with foreign oil prices and the responses to external fluctuations. First, it is recommended that the dependence on oil and gas is required to be reduced in order to sustain industrial production in a more stable structure. Therefore, the authorities should take measure to increase the share of renewable energy sources in total energy use so as not to rise and fall with oil prices. Secondly, in terms of the dependence on foreign sources for both government revenue and industrial input, there is need for a better industrial policy that aims at fostering domestic provision of basic raw materials for the industries. The industrial base will continue to shrink and experience losses if the main raw materials continue to be sourced from abroad.

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