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Modeling the Impact of Oil Price Shocks on Energy Sector Stock Returns: Evidence from Nigeria

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Abstract

This study examines the effect of oil price shocks on energy stock returns in Nigeria for the period from January, 2000 to December, 2015. The study employs the Augmented Dickey-Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests for Unit root and a General Autoregressive Conditional Heteroscedasticity (GARCH 1, 1) modeling approach. The mean equation reveals that if oil price increases by one percent, energy sector stock returns will decrease by 74%. If exchange rate increases by $1, energy sector stock returns increases by about 0.78%. Furthermore, a unit increase in interest rate differential will cause a decrease in energy sector stock returns by about 25%. On the other hand, results of the variance equation, which captures volatility, suggest that oil price shocks and energy stock returns are negatively related.

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1. Introduction

Over the years, the oil price has experienced incessant gyration, and this has called attention to its spillover effect on the aggregate economy and specifically on the energy sector's stock returns. This is on the basis that investors are interested in understanding the dynamic and pass-through effects of oil price shocks on the sector. As a result, Ready (2013) asserts that due to the obvious relevance of oil prices, it is normal to investigate the link between oil prices and equities. Furthermore, it is worthy to note that the effects of oil price shocks differ in oil exporting and importing countries respectively.

It is expected that an increase in the price of oil would lead to a rise in the stock returns of oil exporting countries and vice versa. This is because the increase would raise income and consequently investment. Whereas, an increase in the price of oil would depress stock returns of oil importing countries and vice versa. This explanation is given on the premise that oil importing countries spend huge revenue on oil consumption during a period of high oil price. As a result, there would be a trade-off between oil importation and stock investment as these two would compete for the available income. In support of this scenario in an oil importing country, Berk and Aydogan (2012) reported that "when the stock market is efficient, positive crude oil price shocks would negatively affect the cash flows and market values of companies, causing an immediate decline in the overall stock market returns".

However, the outcome for Nigeria is puzzling since it is both an oil exporting and importing country. Against this backdrop, it is pertinent to investigate the effect of oil price shocks on energy-related stock returns in a dual role country. According to Broadstock, Cao and Zhang (2012), understanding how international oil prices may impact on oil-related companies is an interesting question and may further be extended to all energy-related industries. Thus, this study seeks to be specific with respect to the impact of oil price shocks on the stock returns of the energy sector in Nigeria. It also examines the robust determinants of energy sector stock returns. It is noteworthy that it is the first to investigate the oil-stock nexus, scaling it down to the stocks of energy-related sector. This is informed by the fact that it is expected that the spillover effect of oil price shocks on the energy sector should be swift. Furthermore, this study is timely due to the current oil price crash in the international market and the consequent depletion of Nigeria's foreign reserves. It is the first known to the authors to narrow down the nexus to the energy sector stocks in Nigeria. This is because the effect of oil price shocks is likely to be felt first in the energy sector before trickling down to other sectors of the economy.

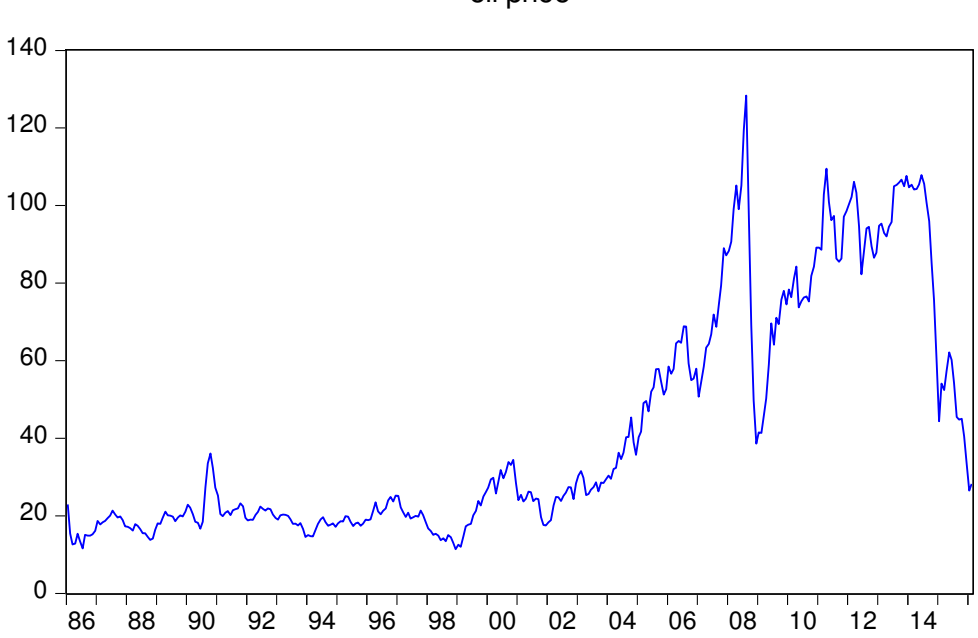
2. Stylized Facts of Global Oil Price and Domestic Crude Oil Consumption

Figure 1 below illustrates crude oil price volatility in US dollar from January 1986 to February 2016. From the graph, oil price fluctuates, moving from peaks to troughs within the period. The peak of $128.33 was attained in August 2008 just before the impact of the global financial crisis. When compared with the previous year's price of $68.71 in August 2007, the price almost doubled. The price of oil persistently, but moderately increased for six months from November 2001 until April 2002. The corresponding prices were $17.65, $17.53, $18.33, $18.89, $22.64 and $24.88.

The last obvious observed peak during the period of study was $100.75 in August 2014. When compared with the peak of $128.33 reached six years earlier, it can be observed that the price of oil declined by $27.58. This indicates a 21.5% crash. Within a period of one year, the price of oil declined from $54.06 in February 2015 to $28.25 in February 2016. This shows a 47.7% deficit. It can also be noticed that within that same period oil price has been declining. The peak was $62.16 in May 2015, while the trough was $26.5 in January 2016. January 2016 price was little below that of February 2016 by $1.75. This 6.60% positive shock followed an announcement for non-OPEC member

nations' readiness to cut down oil production. From this, it can be inferred that speculations and expectations are important factors that contribute to crude oil price shocks.

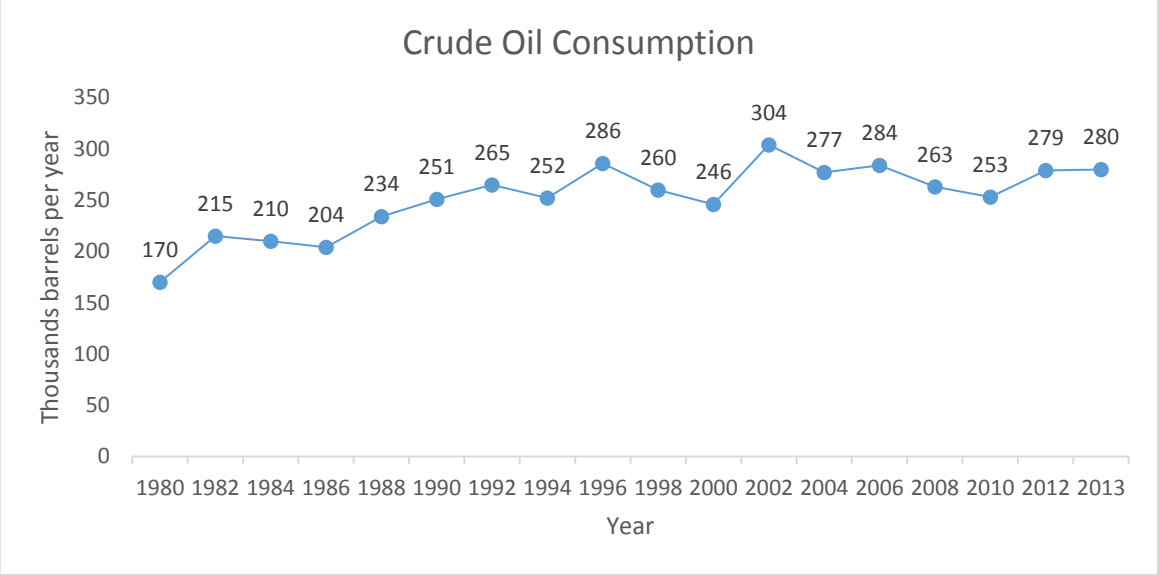
Figure 1: OPEC Crude Oil Price in US Dollar from January 1986 to February 2016



Source: Computed by authors with data from OPEC monthly market basket price

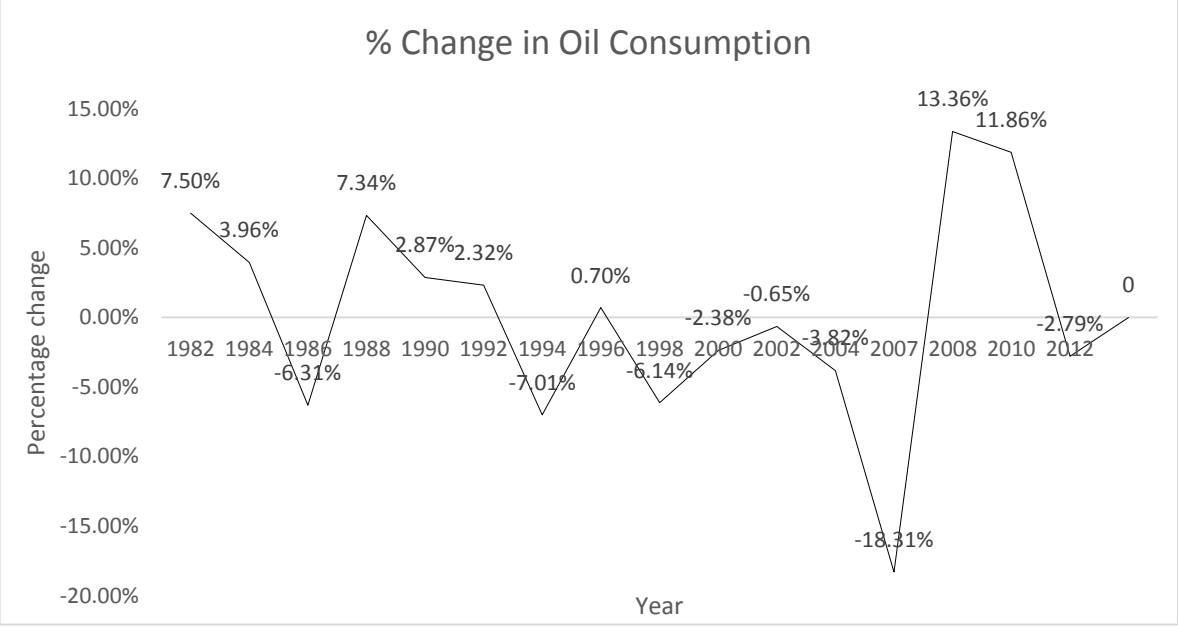
Figures 2 and 3 below presents a snapshot of Nigeria's crude oil consumption in thousand barrels per year and percentage change from 1980 to 2013. Nigeria's consumption revolved around 220,000 thousand barrels between 1981 and 2000 but jumped to 306,000 thousand barrels in 2001 giving rise to a peak percentage change of 24.39 within the reference period. It is noteworthy that, immediately after the Structural Adjustment Programme (SAP) of 1986, there was a sustained increase in crude oil consumption for seven years (1987-1993). In 2001, 2002 and 2005 crude oil consumption was more than 300,000 barrels respectively. The highest crude oil consumption of 312, 000 barrels was experienced in 2005. After this, consumption fell following the global financial crises and reached an all-time minimum of -18.31% change in 2007. This period coincided with the period of sharp increase in crude oil price as shown in figure 1 above. Due to this scenario, the Nigeria increased her crude oil export and reduced domestic consumption to take advantage of the rise in price.

Figure 2: Nigeria's Total Crude Oil Consumption and Percentage Change



Source: Computed by authors with data from Indexmundi

Figure 3: Percentage Change in Crude Oil Consumption



Source: Computed by authors with data from Indexmundi

3. Empirical Literature

Previous studies have provided mixed insights into the relationship between oil price shocks and the stock market in general. But whether the country under study is an oil importer or exporter is very important. For instance, Park and Ratti (2007) reported that oil price shocks impact significantly on real stock returns in the U.S and 13 European countries studied. Norway as an oil exporter shows a

positive response to an oil price increase. This is similar to the finding of Bjørnland (2008), but for many European countries, except the U.S. where there is no evidence of asymmetric effects on stock returns as further confirmed by Alsalman and Herrera (2013), increased volatility of oil prices significantly depresses real stock returns.

However, Kilian and Park (2007); Kang, Ratti, and Vespignani (2015) provided further insight into this by reporting that the response of aggregate U.S. real stock returns may differ greatly depending on whether the increase in the price of crude oil is driven by demand or supply shocks in the crude oil market. Positive oil supply shock has a statistically significant positive effect on the U.S real stock returns. In a similar study of eight countries (Australia, Canada, France, Germany, Italy, Japan, the U.K, and the U.S), Apergis and Miller (2008) showed that international stock market returns do not respond in a large way to oil market shocks. Similarly, Cong, Wei, Jiao and Fan (2008) reported that oil price shocks do not have any significant impact on stock returns in China.

Lin, Fang, and Cheng (2009) compared their findings for China, Hong Kong and Taiwan with that of Kilian and Park (2007). The results suggest that the impact of oil price shocks on stock returns of Taiwan is similar to the U.S. stock market. On the other hand, while global supply shock has a positive significant impact on Chinese stock return, global demand shock and the oil specific demand shock have no significant impacts. Similar to Park and Ratti (2007), Donoso (2009) reported that the U.S stock market is the most sensitive to oil price changes out of the three countries (The US, Japan and U.K) studied. However, Balke, Brown, and Yücel (2010) claimed that changes in oil prices in the U.S are endogenous and domestic shocks are responsible for output fluctuations with productivity shocks contributing to weakness in the 1970s and 1980s and strength in the 2000s. Similarly, Masih, Peters and De Mello (2010) were of the view that oil price movements significantly affect the South Korean stock market.

Similarly, Kumar, Managi, Matsuda (2012) used three clean energy data to investigate the relationship between stock prices of clean energy firms and oil and carbon markets. The results suggest that oil prices and technology stock prices have an impact on stock prices of clean energy firms individually. But there is no significant relationship between carbon prices and the stock prices of the firms. Furthermore, according to investors' viewpoint, there is no difference between the stocks of clean energy firms and that of high technology firms. Managi and Okimoto (2013) conducted a similar study but employed Markov-switching VAR model to capture structural breaks in the market. The results show that there was a significant rise in the price of oil in 2007. In addition, the study reported a positive link between oil prices and clean energy prices after 2007.

Ono (2011) showed that in Brazil, China, India, and Russia real stock returns positively respond to some of the oil price indicators with statistical significance for China, India and Russia, while those of Brazil do not show any significant responses. Focusing on causal relationship, Oskooe (2011) reported that the variance of oil price fluctuations does not cause the variance of Iranian stock returns. This means that there is no volatility spillover effect between Iranian stock market and international oil market. Arouri, Bellalah, and Nguyen (2011) showed that there exist strong short-run positive links between oil prices and stock markets in Qatar, the UAE, and to some extent Saudi Arabia, while the positive long-run relationship is found only in Bahrain. When causality exists, it generally runs from oil prices to stock markets. However, Zhu, Li, and Yu (2011) reported a nonlinear cointegration for the oil–stock nexus. The causality tests indicate a bidirectional long-run relationship between crude oil shocks and stock markets for OECD and non-OECD countries. Meanwhile, Olsen and

Henriz (2014) showed that oil price shocks have a negative impact on real stock returns in five OECD countries - Portugal, Ireland, Italy, Greece, and Spain.

Broadstock, Cao, and Zhang (2012) are of the viewpoint that investors in the Chinese stock market, especially for energy-related stocks, are more sensitive to the shocks in the international crude oil market. Valdés, Vázquez, and Fraire (2012) reported a positive conditional correlation between oil price and stock market returns in Mexico. Berk and Aydogan (2012); Ergun and Ibrahim (2013) were of the view that it was global liquidity conditions that account for the greatest amount of variation in the Turkish stock market returns. Thus, Abdalla (2013) showed that crude oil price fluctuations lead to increase stock market returns volatility in Saudi Arabia. Similarly, Aye (2015) reported that oil price uncertainty has a negative but marginally significant effect on stock returns in South Africa.

Studies on the Nigerian economy are scanty with mixed findings. For instance, Asaolu and Ilo (2012) reported a negative relationship between oil price and stock returns, while Adaramola (2012) reported a significant positive relationship in the short-run and a significant negative relationship in the long-run. The causal link runs from oil price shocks to stock returns. As a result, Ogiri, Amadi, Uddin and Dubon (2013) explained that oil price changes are important factors in understanding stock price movement.

However, these studies (Asaolu and Ilo, 2012; Adaramola, 2012; Ogiri, Amadi, Uddin and Dubon, 2013) by employing VAR model, estimated the interaction of oil price level and stock market returns rather than shocks. This methodology may not be appropriate for this type of study due to the fact that it has to do with volatile oil price. Thus, they failed to show how long it takes for oil price shocks to transmit into the stock market in general and specifically in the energy sector stocks.

4. Methodology and Data

The study employed high-frequency weekly data from OPEC, the Nigerian Stock Exchange (NSE), Central Bank of Nigeria (CBN) and World Development Index (WDI), for the period of January 2000 to December 2015. This was based on data availability. The model specified below was utilized to test for the It is the oil-energy related stock nexus:

$$OSR_t = \Phi_0 + \Phi_1 OILP_t + \Phi_2 EXV_t + \Phi_3 IRD_t + \varepsilon_t \quad \text{..... (1)}$$

where $OSR_t = energy$ sector stock returns; $OILP_t$ = OPEC oil price for which its volatility was generated and utilized during the estimation; EXV_t = exchange rate volatility; IRD_t = interest rate differentials (the difference between global interest rate and domestic interest rate); and ε_t = residual.

Φ_0 to Φ_3 are the intercept and slope coefficients respectively. To capture elasticity for the estimates, equation (1) was transformed into a semi double log model as follows:

$$LnOSR_t = \Phi_0 + \Phi_1 LnOILP_t + \Phi_2 EXV_t + \Phi_3 IRD_t + \varepsilon_t \quad \text{..... (2)}$$

Due to the fact that Nigeria plays a dual role – as an oil exporter and importer, it is not possible to specify the sign of the coefficients from the outset. Equation (2) above is called the mean equation, but to capture oil price shocks which is the main objective of this study, we specified the variance equation of Generalised Autoregressive Conditional Heteroscedasticity GARCH (1, 1):

$$V_t = \alpha_4 + \alpha_5 V_{t-1} + \alpha_6 \varepsilon_{t-1}^2 + \alpha_7 OILP_t + \alpha_8 EXV_t + \alpha_9 IRD_t \quad \text{..... (3)}$$

The residual generated from the mean equation (2) was used in deriving the variance equation (3). Where V_t = variance of the residual or error term derived from equation (2). It is also known as the current week's volatility of oil stock returns. V_{t-1} = previous week's residual volatility of oil stock returns. It is also called the GARCH term. ε_{t-1}^2 = previous period's squared residual derived from

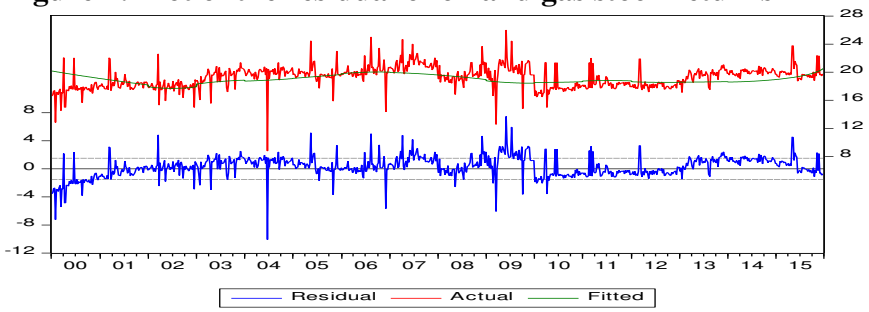
equation (2). It is known as the previous week's oil stock returns information about volatility. It is also called the ARCH term. α_4 = is the variance equation intercept; α_5 to α_9 are the slope coefficients. $OILP$, EXV, and IRD remain as defined and are also known as the variance equation regressors due to the fact that they contribute to the volatility of V_t in equation (3).

We employed the Augmented Dickey-Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests to make the series stationary. The lag length was selected based on the Schwartz-Bayesian criterion. We also estimated the volatility impulse response functions to examine the transmission of shocks from oil price to energy-related stock returns. The following steps were adopted to estimate the variance equation (3), viz: Firstly, we estimated equation (2) and derived the residual. Secondly, we plotted the residual in a graph from equation (2). Finally, we estimated equation (3). Equation (3) is a GARCH (1, 1) model as it has one GARCH term (V_{t-1}) and one ARCH term (ε_{t-1}^2). In other words, it refers to the first-order GARCH term and first-order ARCH term respectively. However, higher order GARCH could be estimated, but we chose GARCH (1, 1) due to the fact that GARCH (1, 1) provides more robust results. Thus, we estimated the mean equation (2) and variance (3) simultaneously. We used three types of distributions, viz, Normal Gaussian distribution, Student's t with fixed df, and generalized error distribution assumption. The three distributions gave us similar results. The study employs the GARCH model due to the fact that it captures volatility which is common with oil price. However, in order to capture structural breaks which are common in stock markets, some studies employ Markov switching model (see Managi, Okimoto and Matsuda, 2012; Managi, and Okimoto, 2013).

5. Empirical Results

To ascertain if GARCH model is appropriate for this study, we plotted the residual of energy-related stock returns from the mean equation presented in figure 4 below. From the diagram, there is a prolonged period of low volatility from weeks 1 to 2 and a prolonged volatility from weeks 4 to 7. This means that periods of low volatility were followed by periods of low volatility, while periods of high volatility were followed by periods of high volatility. This shows that the residual or error term is conditionally heteroscedastic and thus, ARCH and GARCH models can be applied.

Figure 4: Plot of the residual of oil and gas stock returns



A battery test of unit root was conducted to ascertain the order of integration of the series. The results suggest that the variables were stationary after first difference.

Table 1: ADF and KPSS Unit Root Tests

Variable	ADF	KPSS
lnOSR	-28.05*	0.21*
ΔlnOILP	-7.56*	0.50*

ΔEXV	*8.26	*0.53
ΔINTRD	-6.64*	0.281*

Note: * indicates significance at 5% level for both ADF KPSS respectively.

Furthermore, the logarithmic forms of energy stock returns and oil price were estimated to capture elasticity. Thus, the result presented in table 2 suggests that oil price significantly impacts on oil and gas stock returns. This result suggests that a one percent increase in the price of oil will result to about 74% decrease in energy-related stock returns. According to Abdelaziz, Chortareas and Cipollini (2008); Broadstock, Cao, and Zhang (2012); and Berk and Aydogan (2012), in an oil importing country, the oil price has a negative relationship with stock returns. This is due to huge amount of money being spent by oil importing country during a period of high oil price. A country like Nigeria spends huge money on the importation of refined oil thereby leaving little for stock investment resulting to falling national income. Again, it is noteworthy that this finding is consistent with the finding of Asaolu and Ilo (2012). Thus, the Nigerian oil-energy stock nexus is driven by precautionary demand for oil.

On the other hand, the result shows that $1 increase in exchange rate leads to about 0.78% increase in energy-related stock returns. This finding is not consistent with theory. This is because if Nigeria's currency appreciates (decrease in exchange rate), there will be a follow-up increase in investment in stock which leads to a rise in stock returns. However, if there is depreciation in the currency (increase in exchange rate), there will be a corresponding decrease in stock investment due to a decrease in income. This second scenario best defines Nigerian economy. Because the exchange rate between the naira and US dollar is always high, there are low stock returns vis-à-vis investment. The result obtained from the interest rate differential shows a statistically significant, but a negative relationship. It suggests that a percentage increase in interest rate differential will lead to about 25 percent decrease in energy-related stock returns. This shows that if the gap between global and local interest rate is high, there will be a reduction in energy-related stock returns. Thus, the finding of this study suggests that if the cost of borrowing in Nigeria is high relative to the global cost of borrowing, investors would prefer to move their investment abroad and vice versa.

Table 2: Results of the Mean Equation

Dependent variable log(OSR)

Variable	Coefficient	Standard Error	Z-Statistic	Probability
Log(OILP)	-0.7457702	0.077668	-9.601128	0.0000
EXR	0.007875	0.001678	4.692675	0.0000
INTRD	-0.25846	0.016966	-15.23415	0.0000

The results of the variance equation are presented in table 3 below. The results indicate that oil price shocks and energy-related stock returns have a negative relationship. This means that when oil price displays negative (or positive) shocks, the energy sector stock displays positive (or negative) returns. The p-value is less than 0.05 showing that the negative impact of oil price shocks on oil stock returns is significant. This result gives insight into the impact of oil import-dependency on energy stock returns in Nigeria. It shows that the expected negative relationship between these two variables in an oil importing economy outweighs the positive relationship expected in an oil exporting country like Nigeria. This is interesting due to the fact that Nigeria is both an oil exporting and importing country. Thus, the impact of oil price shocks due to importation crowds out the expected positive impact

attributed to oil exportation. This appears to be true due to the fact that oil price is denominated in US dollar which has more value than the naira. On the other hand, the impact of exchange rate volatility on the oil stock price is negative, but not significant. This suggests that exchange rate volatility does not influence energy sector stock returns.

The ARCH(1) and GARCH(1) are the internal shocks and influence oil stock returns due to the fact that their p-values are both significant. ARCH(1) shows that the energy-related stock returns retain information about its previous one week's volatility. This further shows that information plays a very significant role in energy-related stock returns vis-à-vis the Nigerian stock market. GARCH(1) suggests that the previous week's residual volatility of energy related stock returns affects the current volatility of energy-related stock returns in Nigeria.

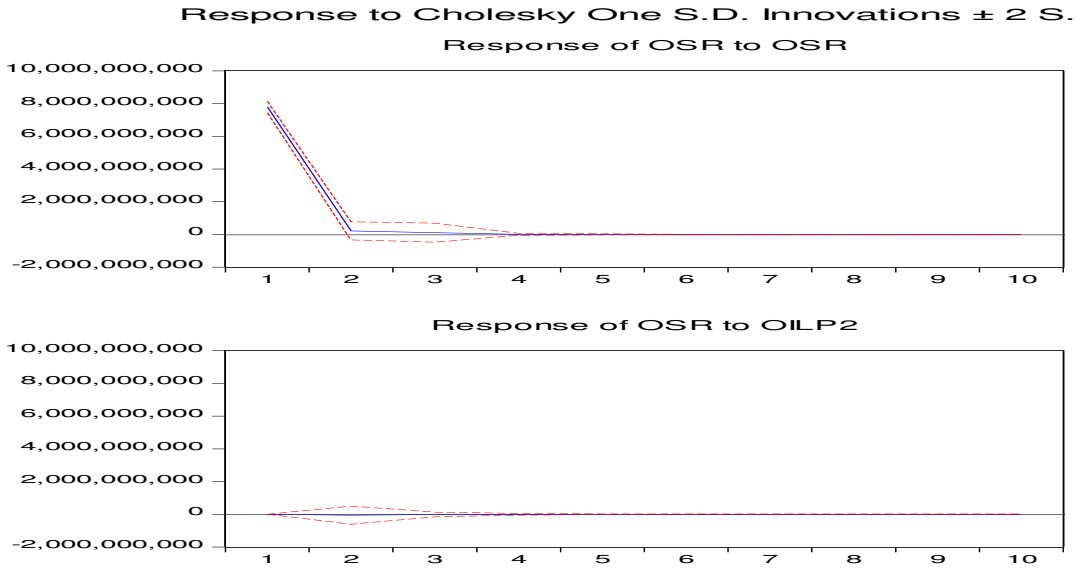
Table 3: Generalized Autoregressive Conditional Heteroscedasticity (GARCH 1, 1). Results of the Variance Equation

Dependent variable log(OSR)

Variable	Coefficient	Standard Error	Z-Statistic	Probability
C	2.092131	0.514765	4.064246	0.0000
ARCH(1)	0.681685	0.078188	8.718590	0.0000
GARCH(1)	-0.25846	0.016966	-15.23415	0.0000
Log(OILP)	-0.220933	0.089627	-2.465024	0.0137
EXV	-0.001599	0.001174	-1.362255	0.1731

The impulse response as shown in the solid line and the one deviation error bands shown by the dotted lines are presented in Figure 5 below. The impulse responses show that positive and negative oil price shocks are inclined toward increasing and reducing oil stock returns significantly at an equal proportion. Before shocks, stock returns were at 30%, but fluctuated to -30% due to negative shock and went back to 30% following a positive shock after one week. The dynamic effect of both the negative and positive oil price shocks effect dies off after about 4 weeks. Thus, for the fact that the effect of the negative and positive shocks are equal in absolute terms, the study concludes that the responses are symmetric.

Figure 5: Response of energy-related stock returns to negative and positive oil price shocks



6. Conclusion and Policy Implications

The study was conducted to empirically address the impact of oil price shocks on energy sector stock returns in Nigeria with high-frequency data from January 2000 to December 2015 inclusively. The motivation behind this study was the effect of the recent oil price crash in the international market on the Nigerian economy. Aside from testing the effect of oil price shocks on energy sector stock returns, other macroeconomic variables such as exchange rate and interest rate differential were included in the model. The mean equation reveals that if international oil price increases by one percent, energy sector stock returns will decrease by 74%. Thus, this suggests that the relationship between the two variables is driven by precautionary demand in Nigeria. If exchange rate increases by $1, energy sector stock returns increases by about 0.78%. Furthermore, a unit increase in interest rate differential will cause a decrease in energy sector stock returns by about 25%.

On the other hand, results of the variance equation, which captures volatility, suggest that Nigeria's oil price shocks and energy stock returns are negatively related. It shows that the expected negative relationship between these two variables in an oil importing economy like Nigeria crowds out the positive relationship expected in an oil exporting country. Exchange rate volatility negatively impacts on energy sector stock volatility. On the other hand, results of the impulse response suggest that the effect of the negative and positive shocks are equal in absolute terms. Thus, the study concludes that the responses are symmetric.

The negative significant effect of oil price shocks on energy stock returns suggests that the gyrations experienced in the Nigerian energy sector stock returns and the consequent decline in investment in that sector are due to the fall in oil price in the international market. This further shows that each time there is a fall in oil price, it would be followed by a fall in energy stock investment and vice versa. Thus, this serves as a policy guide to policy makers in Nigeria to always endeavour to cushion its effect in the energy sector. This will ensure a conducive investment climate that would attract both local and foreign investors to Nigeria.

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