American Finance & Banking Review; Vol. 3, No. 1; 2018
ISSN 2576-1226 E-ISSN 2576-1234
Impact Factor: 4.1
Published by Centre for Research on Islamic Banking & Finance and Business

Oil Price Volatility, Exchange Rate Movements and Stock Market Reaction: The Nigerian Experience (1985-2017)

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To cite this article: Ogbulu, O. (2018). Oil Price Volatility, Exchange Rate Movements and Stock Market Reaction: The Nigerian Experience (1985-2017). *American Finance & Banking Review*, 3(1), 12-25. Retrieved from http://www.cribfb.com/journal/index.php/amfbr/article/view/200

Received: October 10, 2018 **Accepted:** October 25, 2018 **Online Published:** November 12, 2018

Abstract

Given the observed volatility in crude oil prices in the international oil market and the role which oil and gas play in the Nigerian economy, this paper is an attempt to investigate the impact of crude oil prices and foreign exchange rate movements on stock market prices in Nigeria. In addition, the paper examined whether there is any volatility pass-through between the dollar price of Nigerian crude oil, foreign exchange rate of the Naira and stock market prices respectively. Data employed for the study are monthly values of the Nigerian Stock Exchange (NSE) All-Share Index (ASI), Dollar price of Nigerian Crude Oil (DPO) and the Official Exchange Rate of the Naira to the US Dollar (FXR) from January, 1985 to August, 2017. The methodology adopted for the study include the ADF unit root tests, Johansen co-integration tests, the ECM technique, Granger causality tests, variance decomposition as well as the GARCH(1,1) to model the volatility relationships among the variables. Findings reveal that there is one long-run dynamic co-integrating relationship among the variables ASI, DPO and FXR while the ECM results indicate that Crude oil price (DPO) significantly impact on Stock market prices. The Granger causality test reports a bi-directional causality relationship between ASI and DPO and a unidirectional causality running from FXR to ASI. The ARCH-GARCH volatility analysis demonstrates vividly that stock market prices in the NSE exhibit ARCH effect with a significant and positive first order ARCH term. The GARCH term is also positive and significant indicating that previous month's stock market price volatility significantly influences current stock market volatility in the NSE. In addition, findings show that the volatility of dollar price of Nigerian oil (DPO) in the world oil market is significantly transmitted to the volatility of stock market prices in Nigeria. The pass-through effect of the volatility of exchange rate (FXR) to the volatility of stock market prices is also positive and significant. These findings offer significant informational signal to policy makers, portfolio managers/advisors and the investing public in achieving optimal asset and portfolio profile.

Keywords: Crude Oil Prices, Stock Market Price, Exchange Rates, Volatility, ARCH-GARCH, Variance Decomposition.

1. Introduction

Ever since the discovery of oil in Oloibiri, Nigeria on Sunday, 15th January,1956 and the coming on stream of its first oil field producing about 5,100 bpd in 1958, the oil and gas sector has continued to playa central role in the economic development of Nigeria and even in the current world economy. For instance, oil contributes about 90% of all foreign exchange earnings of Nigeria, account for as high as 20% of GDP, 80% of total government revenue and about 65% of total trade. Given the level of interdependence among Nations in today's global economy, fluctuations in crude oil prices in the international oil market are bound to have profound impact on different sectors of the economy including the stock markets and the foreign exchange markets.

The nature and extent of this impact depends to a large extent on whether the country is an oil-importing or oil-exporting country. For oil-importing countries, rising oil prices obviously leads to increases in production costs, lower output levels and lower stock returns whereas oil-exporting countries would be happy with rising oil prices since this would translate to higher disposable incomes, consumption, investments and cash flows. Thus, the transmission mechanisms through which oil prices impact on real economic activity include both supply and demand channels (Ogbulu and Torbira, 2012). In addition, the magnitude of these supply-side and demand-side effects is in turn stronger the more the shock is perceived to be long-lasting..

The literature of finance is replete with several studies conducted by scholars to explore the nature of the relationship between changes in crude oil prices and stock markets and other key macroeconomic variables such as real economic growth. However, the controversy has not been settled as there is as yet no consensus on the raging controversy. For example, while studies conducted by authors like Muhtaseb and Al-Assaf (2017), Ono (2011), Iheanacho (2017), Basher and Sadorsky (2016) find significant and positive impact of oil price shocks on stock market returns, the works of others like Yusuf (2015), Bastianin and Manera (2014) as well as Berk and Aydogan (2012) found mixed results for the impact of oil price shocks on stock market volatility.

The objective of this paper therefore is to empirically examine the nature and extent of the relationship between fluctuations in crude oil prices in the international oil market and stock market prices in Nigeria. In addition, the paper investigates whether there is any volatility relationship between crude oil prices and stock market prices and the extent to which volatility in crude is transmitted to stock market prices in Nigeria.

The paper is arranged as follows. Section 1 contains the Introduction while in Section 2, we have Literature Review. Methodology and data are in Section 3, while Results and Discussion of Findings are presented in Section 4. Section 5 contains the Conclusion and Recommendations.

2. Literature Review

2.1 Theoretical Framework

The theoretical foundation of asset valuation can be traced to the seminal work of Gordon (1959), Lintner (1965) and Mossin (1966) who demonstrated that the value of an asset at any particular point in time (t) depends on the stream of benefits to be derived by the holder of the asset over the life of the asset. Thus, the price an asset would command in the market is a function of the expected stream of benefits accruable to the investor as well as the risk attendant on the investment. However, it has been observed by many scholars and practitioners alike that numerous factors both economic and non-economic, affect the price of assets in the stock market and this has given rise to the emergence of many theories of valuation of assets. A brief survey of these theories includes the Fundamentalist Approach, The Technicalist Approach, The Efficient Market Hypothesis Model as well as the Arbitrage Pricing Theory.

As amply cited by Ogbulu (2012), the Fundamental approach is predicated on the assumptions that every security has an intrinsic value and that the intrinsic value of every security is reflected in the market price of that security. It is also assumed that the basic economic and fundamental facts and features about a firm or corporation determine the intrinsic value of securities issued by the firm or corporation. Thus according to the Fundamentalists, the task of the rational investor is to undertake rigorous fundamental analysis of the basic economic facts relating to assets to determine their intrinsic values as a prelude to identifying mis-priced assets in the market. Hence, armed with information on mis-priced securities the rational investor can formulate profitable trading rules. (Okafor, 1983), (Bodie, et al.,2008)

On the other hand, the Technical approach dismisses the quest to obtain knowledge of intrinsic value as irrelevant in the buy or sell decisions of investors in the capital market. The assumptions here are that the value of a security is determined by the forces of supply and demand and that prices of securities are observable, chartable and follow recurring patterns which can be used to formulate profitable trading rules in the market. For the Technicalists therefore, reliance on market prices and their patterns over time would provide signals for timing of market transactions to optimum advantage.(Francis, 1980).

The Efficient Market approach is anchored on the EMH which assumes that market prices of securities fully reflect all available and relevant information about such securities and changes in security prices are random and not systematic as propounded by the Technicalists. For the EMH approach therefore, there is no specific and recurring patterns in the behavior of stock prices which could provide the basis for formulating reliable and profitable trading rules. (Hirt and Block,1983) The culmination of the EMH is the single-factor CAPM according to which the expected return on an asset is postulated be an increasing function of the asset's beta coefficient. Although some authors like Roll (1977) are of the view that the CAPM is untestable on account of the difficulty in finding a perfect proxy for the market portfolio, the work by Ogbulu (2012) demonstrates the use of an All-Asset Market Portfolio to test the validity of the single-factor CAPM.

Expectedly, the discussions and controversies that have been generated over the years on the proper meaning of the term "all available information" have given rise to the characterization of the EMH into three levels of market efficiency namely- the weak form, the semi-strong form and the strong form (Bodie, Kane and Marcus, 2008; Ogbulu, 2009). The weak form asserts that current market prices of securities in the capital market fully reflect the information implied by the historical sequence of prices of the securities. Hence, the weak form efficiency implies that knowledge of past prices of a security cannot be used to predict future prices of that asset nor consistently secure abnormally high rates of return. The semi-strong form says that all public information about the securities including historical information is already fully reflected in the current prices of the securities hence an investor cannot use fundamental analysis of the securities to determine whether an asset is mis-priced or not in order to produce abnormal returns. On the other hand, the strong form states that all, not just publicly available information about a security is fully reflected in security prices such that even those with privileged or what may be considered as insider information can utilize such information to earn superior returns in the market.

The Arbitrage Pricing Theory (APT) in contrast to the EMH single-factor CAPM, postulates a multifactor APT which generalizes the single-factor model to incorporate several other sources of systematic risk beyond the beta coefficient. (Ross,1976); (Chen, Roll and Ross, 1986).

Notwithstanding the apparent contradictions inherent in these theories, it should be noted that each approach has its adherents and in practice many practitioners are wont to use a combination of these approaches to arrive at optimal decisions.

Resting on the tenets of the Fundamentalist approach therefore, it is apposite to contend that prices of financial assets quoted on any stock exchange are influenced not only by firm-specific and industry factors but also by macro-economic, socio-economic, political and even socio-cultural factors within and outside the domestic economy given the inter-connectedness of many Nations today. The focus of this paper therefore is to examine the nature and extent of the impact of Nigeria’s crude oil price and the Naira exchange rate on stock market prices in Nigeria as well as investigating the volatility spillover effect from crude oil price and exchange rates to the stock market prices.

2.1 Theoretical Background

The oil price-stock market price transmission path can be traced in two ways. First is the cash flow path and the second relates to the wealth effect The link between oil prices and stock returns can be explored by explaining the channels through which the changes in oil price can affect real stock market returns. In theory, there are several transmission mechanisms that clarify this relation. According to the financial economic science, there are two main channels. First, based on a microeconomic perspective, a logical way is the channel of expected cash flow. Oil is an important input in the production process; therefore, higher production costs due to higher oil prices will adversely affect margins, cash flows and hence stock prices. Second, according to the macroeconomic view, oil prices may impact stock returns via the discount rate. An oil price increase often results in inflationary pressures. The central bank may raise the interest rate to combat these pressures (Basher and Sadorsky, 2006). Since both the inflation rate and interest rate, which constitute the discount rate, are influenced by oil price, it follows that the rise in oil price raises the discount rate, and thus, reduces the stock returns.

In fact, the response of aggregate stock returns to oil price changes greatly depends on whether the country in question is an oil-importing or exporting country. For a net importer of oil, a rise in oil price puts a downward pressure on the country’s foreign exchange rate and upward pressure on domestic inflation rate. Because a higher expected inflation rate raises the discount rate, an increase in oil prices has a negative impact on stock returns (Huang et al. 1996). A positive impact is, however, expected on stock market in oil exporting countries as a reaction to a change in oil prices. The mechanism can be explained through income and wealth effects. A rise in oil prices raises government revenues, and public expenditure on infrastructure may increase. Furthermore, higher prices lead to an immediate transfer of wealth from net oil importers to net oil exporters. Government spending on purchasing domestic goods and services generates a higher level of economic activity and improves stock market returns in these countries (Bjornland, 2009).

2.2 Empirical Literature Review

In their paper, Lake and Katrakilidis (2009), explored the effects of oil price returns andoil price volatility on the Greek, the US, the UK and the German stock markets. More specifically, the authors’ research focused on the interactions among oil prices, its volatility, and the stock market returns as well as on the futures indices of each index. The volatility of the employed indices has been quantified by applying EGARCH models and the relationship between the variables has been examined by means of structural equation models (SEM). The findings from their analysis reveal that the Greek stock market index returns and the US stock market index returns are both sensitive to the oil price returns movements while the German and the UK stock market returns are not affected at all.

In addition, Ono (2011) investigated the impact of oil prices on real stock returns for Brazil, China, India and Russia, the BRIC countries, over the period 1999:1-2009:9 using the multivariate VAR models. The results suggest that whereas real stock returns positively respond to some of the oil price indicators with statistical significance for China, India and Russia, those of Brazil do not show any significant responses. In addition, the author found statistically significant asymmetric effects of oil price increases and decreases for India but in the cases of Brazil, China and Russia no asymmetric effects of oil prices were detected. The analysis of variance decomposition shows that the contribution of oil price shocks to volatility in real stock returns is relatively large and statistically significant for China and Russia.

The paper by Muhtaseb and Al-Assaf (2017) examined whether Amman stock market returns respond asymmetrically to oil price fluctuations for the quarterly period 2000-2015 by applying asymmetric co-integration. The authors employed both TAR and MTAR specification models and based on the asymmetric ECM, the results of their analysis provide evidence that stock returns in the Amman Stock market react to oil price variations in an asymmetric manner. Specifically, the findings indicate that rising oil prices have a larger impact on stock returns which implies that increases in oil prices have a significant effect on the behavior of stock market in Jordan. Hence the significant relationship between oil prices and stock returns strengthen their predictability power, so that appropriate strategies may be built on the basis of expected increases or decreases in oil prices.

In examining the impact of oil price fluctuations on economic growth in Nigeria, Yusuf (2015) undertook a study to investigate the impact of oil price shocks on the Nigerian economic growth using quarterly data from 1970:1-2011:4 while controlling for the effects of unrest in the international oil market, exchange rates and agricultural output. Employing the methodology of ADF unit root tests, Johansen-Joselius co-integration as well as the SVAR, IRF and VDC analyses, findings revealed that all the variables are integrated of order one. In addition, the results from the IRF and VDC analysis show that the response of oil price shocks and unrest to real GDP depicts both negative and positive impacts. Hence, the author concludes that oil price, exchange rates, agricultural output and unrest contained some useful information in predicting the future path of economic growth in Nigeria and recommended that the Nigerian government should diversify the economy away from oil to non-oil sectors as well as improving the security situation in the Niger Delta region to boost oil output and the economy in general.

Furthermore, the trio of Masih, Peters and De Mello (2011) explored the empirical relationship between oil price volatility and stock price fluctuations in South Korea using monthly data from May, 1988-January, 2005. The authors adopted the multivariate VEC model incorporating the variables- interest rates, economic activity, real stock returns, real oil prices and oil price volatility. The results of the analysis vividly show the dominance of oil price volatility on real stock returns and emphasized how this has increased over time thus underscoring the point that oil price volatility can have profound effect on the time horizon of investment and firms need to adjust their risk management procedures accordingly.

Zubair, Okorie and Sanusi (2013), in their study investigated the exchange rate pass-through to domestic prices in Nigeria by employing the impulse response from an estimated SVAR model of the inflation process using quarterly data for the period 1986-2010. The results suggest that the exchange rate pass-through is incomplete, low and fairly slow. In addition, the authors report that the elasticity of inflation to exchange rate changes is about 0.02, and that it takes about eight quarters to reach its full-impact of only 0.26. The authors further argue that given the large share of imports in Nigeria's consumption basket, this surprisingly low pass-through indicates that importers practice the so-called pricing-to-market strategy of price setting for the Nigerian market. The variance decomposition analysis suggests that money supply has contributed more to Nigeria's inflation process relative to the exchange rate. This suggests that policy makers must beep up efforts at achieving monetary stability.

Furthermore, Bastianin and Manera (2014) in their research paper explored the impact of oil price shocks on the US stock market volatility by deriving three different structural oil shock variables namely aggregate demand, oil-supply and oil-demand shocks which the authors related to stock market volatility using bivariate SVAR models, one for each oil price shock. Monthly data from February, 1973-December, 2013 were employed in the analysis. The findings of the study show that volatility responds significantly to oil price shocks caused by sudden changes in aggregate and oil-specific demand while the impact of supply-side shocks were negligible and insignificant.

Using cross-country analysis, Dhaoui and Khraief (2014) examined the empirical linkage between oil price shocks and stock market volatility in eight developed countries namely-USA, Switzerland, France, Canada, UK, Australia, Japan and Singapore. Using monthly data for the eight developed countries from January 1991 to September 2013 and employing the methodology of EGARCH with an ARCH-in-mean model (EGARCH-M), findings reveal that strong negative connections between oil price and stock market returns are found in seven of the selected countries. Oil price changes are without significant effect on the stock market of Singapore. Furthermore, the authors report that on the volatility of returns, the changes in oil prices are significant for six markets and they have not much effect on the others.

Berk and Aydogan (2012) in their paper investigated the impact of crude oil price variations on the Turkish stock market returns. The authors employed vector autoregression (VAR) model using daily observations of Brent crude oil prices and Istanbul Stock Exchange National Index (ISE-100) returns for the period between January 2, 1990 and November 1, 2011. In addition, they also tested the relationship between oil prices and stock market returns under global liquidity conditions by incorporating a liquidity proxy variable, Chicago Board of Exchange's (CBOE) S&P 500 market volatility index (VIX), into the model. According to the authors findings of the variance decomposition test suggest little empirical evidence that crude oil price shocks have been rationally evaluated in the Turkish stock market. Rather, it was global liquidity conditions that were found to account for the greatest amount of variation in stock market returns.

The work by Hamma, Jarboui and Ghorbel (2014) examined the links and interaction between oil and stock markets in Tunisian terms of volatility at the sector-level and secondly to determine the best hedging strategy for oil stock portfolio against the risk of negative variation in stock market prices. The authors investigated seven sectors namely-Automobile &Parts, Banks, Basic Materials, Utilities, Industrials, Consumer services and Financial services using weekly data from 2ndApril, 2005 to 12th July, 2012. The methodology adopted is the bivariate GARCH model to capture the effect in terms of volatility in the variation of oil price on the different sector index, and to use the conditional variances and conditional correlation to calculate the hedging ratio and then determine the best hedging strategy. The empirical results obtained indicate that the majority of relationships are unidirectional from the oil market to Tunisian stock market. In addition, the conditional variance of a stock sector returns is affected not only by the volatility surprises of the stock market, but also by those of oil market.

Further empirical research on sectoral impact of oil price volatility include the work by Caporale, Ali and Spagnolo (2015) in which the researchers investigated the time-varying impact of oil price uncertainty on stock prices in China using weekly data on ten sectoral indices over the period January 1997–February 2014. They estimated a bivariate VAR-GARCH-in-mean model and the results suggest that oil price volatility affects stock returns positively during periods characterized by demand-side shocks in all cases except the Consumer Services, Financials, and Oil and Gas sectors. The latter two sectors are found to exhibit a negative response to oil price uncertainty during periods with supply-side shocks instead. By contrast, the impact of oil price uncertainty appears to be insignificant during periods with precautionary demand shocks.

The paper by Kang, Ratti and Yoon (2015) examined the impact of structural oil price shocks on the covariance of U.S stock market return and stock market volatility. The authors constructed from daily data on return and volatility the covariance of return and volatility at monthly frequency. The measures of daily volatility are realized-volatility at high frequency (normalized squared return), conditional-volatility recovered from a stochastic volatility model, and implied-volatility deduced from options prices. Results indicate that positive shocks to aggregate demand and to oil-market specific demand are associated with negative effects on the covariance of return and volatility while oil supply disruptions are associated with positive effects on the covariance of return and volatility. In addition, the spillover index between the structural oil price shocks and covariance of stock return and volatility is large and highly statistically significant.

3. Methodology and Data

3.1. Methodology

The methodology adopted for this study is the econometric investigative enquiry which involves the application of regression analysis, unit root tests, Johansen Co-integration tests, the Error Correction mechanism (ECM), Granger causality tests and the ARCH-GARCH(1,1) model to test for volatility effect from changes in crude oil price and exchange rates to stock market prices. In addition, the paper employed the Variance Decomposition (VDC) analysis within an unrestricted VAR setting to examine the forecast error decomposition of the variables ten months into the future.

3.1.1Model Specification

The functional relationship describing the response of stock market prices to changes in the international crude oil prices and exchange rates can be stated as in equation (1) thus:

$$ASI = f(DPO, FXR) \qquad (1)$$

While the functional model is specified as

$$ASI = \beta_0 + \beta_1 DPO + \beta_2 FXR + \mu \qquad (2)$$

Where:

ASI= Nigerian Stock Exchange All-Share Index
DPO= Nigerian Crude Oil Price in the international market
FXR= Exchange rate of the Naira to the US Dollar

The apriori theoretical expectation about the signs of the parameter coefficients are given as $\beta_1 > 0$ and $\beta_2 < 0$ given that Nigeria is an oil-exporting Nation, increase in oil prices leads to increase in aggregate income and cash flows and hence a bullish stock market, all things being equal.

3.1.2 Unit Root Test

The Unit root test has become a popular test of the stationarity or otherwise of time series data in many econometric studies given the time-dependent nature of many economic variables. Some of the most popular tests for unit root are the Augmented Dickey-Fuller (ADF) test, the Phillips-Perron (P-P) test and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test The ADF unit root test is adopted in this study. The tests usually consist of estimating the regression:

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \sum_{i=1}^{n} \alpha_i \Delta Y_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots(3)$$

Where ε_t is a pure white noise error term and $\Delta Y_{t-1} = (Y_{t-1} - Y_{t-2})$, $\Delta Y_{t-2} = (Y_{t-2} - Y_{t-3})$, and so on with a number of lagged difference terms included so that the error term is serially uncorrelated to enable the researcher obtain an unbiased estimate of δ, the coefficient of lagged Y_{t-1} in equation (3) above (Gujarati and Porter, 2009). In testing for unit root, the null and alternative hypotheses are stated as Ho: $\eta = 1$ (unit root exists and series is non-stationary) as against H_1: $\eta = 0$ (No unit root, series is stationary).

3.1.3 The Granger Causality Test

The Granger causality test is used for testing the direction of causality between variables say Y and X (Granger,1969). The test is based on estimating the following bivariate regressions.

$$Y_t = \sum_{i=1}^{n} \alpha_i X_{t-i} + \sum_{j=1}^{n} \beta_j Y_{t-j} + u_{1t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

$$X_t = \sum_{i=1}^{n} \delta_i Y_{t-i} + \sum_{j=1}^{n} \lambda_j X_{t-j} + u_{2t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(5)$$

where Y_t and X_t are the variables of interest while u_{1t} and u_{2t} are the disturbance terms assumed to be uncorrelated. The present study employed the Granger causality test to estimate the degree of causality between stock market prices, crude oil prices and exchange rates (Brooks, 2008).

3.1.4 The ARCH-GARCH Test

The development of the Autoregressive Conditional Heteroscedasticity (ARCH) model is usually attributed to Engle (1982) who developed the ARCH model to capture the effect of serially correlation of volatility in time series data according to which the ARCH model expresses conditional variance as a distributed lag of past squared innovations. (Goudarzi, 2013). In developing the ARCH model, the conditional return must be modeled first by stating the return relationship as an autoregressive AR(p) process with lags up to (p) stated as follows say:

$$ASI_t = \alpha_o + \sum \alpha_t ASI_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(6)$$

Where ASIt is current stock market price in period t. Equation (8) above implies that ASIt depends not only on (ASI_{t-1}) but also on previous prices (ASI_{t-p}). Given that the ARCH model assumes that the residuals (ε's) have no constant variance, the conditional variance is modeled to incorporate the ARCH process of (ε^2) in the conditional variance with (q) lagged values of the residuals (ε^2) as stated in equation (7).

$$\sigma_t^2 = \alpha_o + \alpha_1 \varepsilon_{t-1}^2 + \ldots + \alpha_p \varepsilon_{t-p}^2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(7)$$

However, Bollerslev (1986) as well as Bollerslev, Chou and Kroner (1992) refined Engle (1982) linear ARCH (q) model as represented in equation (6) above to remove its long lag structure by including the lagged values of the conditional variance in his formulation which Bollerslev called the Generalized Conditional Heteroscedasticity (GARCH) model. That is, the GARCH (p,q) model specifies the conditional variance to be a linear combination of (q) lags of the squared residuals (ε^2_t) from the conditional return equation and (p) lags from the conditional variance (σ_{t-j}^2). The GARCH (p,q) model is then written as follows:

$$\sigma_t^2 = \alpha_o + \sum \alpha_i \varepsilon_{t-i}^2 + \sum \beta_j \sigma_{t-j}^2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(8)$$

where α_i, $\beta_j > 0$ and α_i, $\beta_j < 1$ to avoid the possibility of negative conditional variance.

From equation (8), it means that the current value of the conditional variance is a function of a constant and values of the squared residuals from the conditional return equation plus values of the previous conditional variance. (Goudarzi, 2013). Thus, given the standard GARCH (p,q) model, if both the ARCH and GARCH coefficients are significant then there is evidence of volatility in the squared series. In addition, the GARCH model can be utilized to model volatility clustering. If the coefficients of the ARCH and GARCH terms sum up to 1, then there is volatility clustering and confirms the presence of ARCH and GARCH effects in the variable (s) of interest.

3.2 Data

Data for the study are secondary data (monthly) sourced from the NSE official Daily Stock Market Price List of the NSE from January, 1985 to August, 2017. The data on Crude oil prices and Foreign Exchange Rates were extracted from the CBN Statistical Bulletin. The summary descriptive statistics for the data series on ASI, DPO and FXR are as presented in Table 1. The raw data are presented in the Appendixes.

Table 3.1 presents the summary statistics for the variables for the period under study. The mean of ASI is 15349.46 with a standard deviation of 15135.06. For DPO, the mean dollar price of crude oil is 38.88 US$ and standard deviation of 29.7US$. The mean of FXR is N90.5607 to $1 with a standard deviation of N76.3737 to$1. The J-B statistic for all the series show that they are all not normally distributed.

Table 1: Summary Statistics (1985:1-2017:8)

	ASI	DPO	FXR
Mean	15349.46	38.88087	90.56069
Median	9872.700	24.26500	111.6000
Maximum	65652.40	128.0800	309.7300
Minimum	111.3000	8.030000	0.820300
Std. Dev.	15135.06	29.70307	76.37374
Skewness	0.863020	1.024385	0.594463
Kurtosis	3.009841	2.789413	3.008463
Jarque-Bera	48.66207	69.28283	23.08907
Probability	0.000000	0.000000	0.000010
Sum	6016988.	15241.30	35499.79
Sum Sq. Dev.	8.96E+10	344968.6	2280683.
Observations	392	392	392

4. Results and Discussion

4.1 Unit Root Test Results

Table 2 shows a summary of the ADF Unit root test results obtained using the E-Views version 9.0 statistical package. The results indicate that all the variables are integrated of order one. That is, they all become stationary after the first differencing.

Table 2 ADF Unit Root Test Results

Variable	ADF test statistic at 1st diff	Order of integration
ASI	-8.153873	1(1)
DPO	-10.615780	1(1)
FXR	-14.243390	1(1)

Critical Values: 1% -3.447036; 5% -2.868790; 10% -2.570698

Source: Author's Computation

4.2 Co-integration Test Results

Having established that the series are integrated of the same order, it becomes plausible to apply the Johansen-Joseluis co-integration test to determine whether there is any long-run dynamic relationship among the variables. In table 3, the Johansen co-integration test results are presented. The results show that there is one long-run co-integration relationship between stock market prices, crude oil price and exchange rates for both the trace test and the maximum eigenvalue test. The test assumes a linear deterministic trend and was estimated with lag interval of 1 to 8.

Table 3: Johansen Co-integration Test Results

Sample (adjusted): 10 392
Included observations: 383 after adjustments
Trend assumption: Linear deterministic trend
Series: ASI DPO FXR

Lags interval (in first differences): 1 to 8

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.062490	34.88953	29.79707	0.0119
At most 1	0.023737	10.17525	15.49471	0.2675
At most 2	0.002540	0.974171	3.841466	0.3236

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.062490	24.71428	21.13162	0.0150
At most 1	0.023737	9.201075	14.26460	0.2698
At most 2	0.002540	0.974171	3.841466	0.3236

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values
Source: Author's computation

4.3 Error Correction Model

Having established that there exists long run relationship among the variables, the oil price-stock market price linkage under investigation is then specified in an ECM incorporating a four- period lagged residual. The ECM is employed to capture the short-run deviations of the parameters from the long-run equilibrium within the framework of an ARDL technique to obtain an over- parameterized ECM and then arriving at the parsimonious error correction result using the general - specific approach.

Table 4: Parsimonious ECM Result

Dependent Variable: D(ASI)
Method: Least Squares
Date: 09/03/17 Time: 22:25
Sample (adjusted): 6 392
Included observations: 387 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	92.45219	78.76416	1.173785	0.2412
D(ASI(-1))	0.056604	0.051333	1.102690	0.2709
D(ASI(-2))	0.170585	0.050269	3.393427	0.0008
D(ASI(-3))	0.210106	0.050362	4.171922	0.0000
D(ASI(-4))	-0.137790	0.052094	-2.645016	0.0085
D(DPO)	65.86481	17.39081	3.787335	0.0002
D(DPO(-1))	23.24333	17.79356	1.306278	0.1923
D(DPO(-4))	-28.88898	17.53848	-1.647177	0.1004
D(FXR)	-14.95351	15.42477	-0.969448	0.3329
D(FXR(-1))	-8.333265	15.43510	-0.539890	0.5896

D(FXR(-3))	-13.43361	14.72812	-0.912106	0.3623
ECM(-1)	-0.025511	0.010777	-2.367129	0.0184

R-squared	0.176671	Mean dependent var	93.15098
Adjusted R-squared	0.152520	S.D. dependent var	1628.564
S.E. of regression	1499.235	Akaike info criterion	17.49381
Sum squared resid	8.43E+08	Schwarz criterion	17.61656
Log likelihood	-3373.053	Hannan-Quinn criter.	17.54248
F-statistic	7.315248	Durbin-Watson stat	1.973917
Prob(F-statistic)	0.000000		

Source: Author's computation

Table 4 presents the results of the parsimonious ECM estimated using difference data of the variables. From the results, it is evident that changes in crude oil prices (DPO) have a significant and positive impact on stock market prices (ASI). Changes in foreign exchange rates are positive but not significant. The adjusted R^2 is approximately 15.25% while the D-W statistics of 1.97 shows the absence of autocorrelation in the residuals. The ECM coefficient value of -0.0256 approximately, is appropriately signed and significant and indicates that the speed of adjustment of the model back to the long-run equilibrium when disturbed by any short-run shock is 2.56% per month.

4.4 Granger Causality Test Results

As mentioned in 3.1.3, Granger causality test is employed to examine the direction of causality between two variables of interest. In Table 5 the results of the Granger causality tests are exhibited. The results report a bi-directional causality relationship between Crude oil price (DPO) and stock market prices (ASI) while the causality relationship between ASI and FXR is uni-directional running from foreign exchange rates (FXR) to ASI. There is no significant causality relationship between FXR and DPO.

Table 5: Granger Causality Test Results

Sample: 1 392
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
DPO does not Granger Cause ASI	390	4.64971	0.0101
ASI does not Granger Cause DPO		10.7126	3.E-05
FXR does not Granger Cause ASI	390	3.70910	0.0254
ASI does not Granger Cause FXR		0.14697	0.8634
FXR does not Granger Cause DPO	390	2.70202	0.0683
DPO does not Granger Cause FXR		1.16005	0.3146

Source: Author's computation

4.5 ARCH-GARCH Test Results for Volatility

The test for the presence of volatility and its transmission effect in the crude oil price-stock market price relationship is modeled using the ARCH-GARCH(1,1) technique. The first step in the volatility analysis is to establish whether the residuals in the crude oil price-stock market price model possess any ARCH effect. Table 6 presents the results of the heteroskedasticity test which indicates significant ARCH effect in our model. That is, the variances of the residuals are not constant from one period to another thus confirming the presence of high volatility in the series.

Table 6: Heteroskedasticity Test: ARCH

F-statistic	1714.830	Prob. F(1,389)	0.0000
Obs*R-squared	318.7038	Prob. Chi-Square(1)	0.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 09/03/17 Time: 22:33
Sample (adjusted): 2 392
Included observations: 391 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5100817.	3040211.	1.677784	0.0942
RESID^2(-1)	0.902918	0.021804	41.41051	0.0000

R-squared	0.815099	Mean dependent var	52913251
Adjusted R-squared	0.814624	S.D. dependent var	1.29E+08
S.E. of regression	55612294	Akaike info criterion	38.51081
Sum squared resid	1.20E+18	Schwarz criterion	38.53111
Log likelihood	-7526.863	Hannan-Quinn criter.	38.51886
F-statistic	1714.830	Durbin-Watson stat	2.342716
Prob(F-statistic)	0.000000		

The presence of volatility in the model can also be demonstrated graphically by observing the plot of the residuals. Fig.1 below is the plot of the residuals from equation (2).

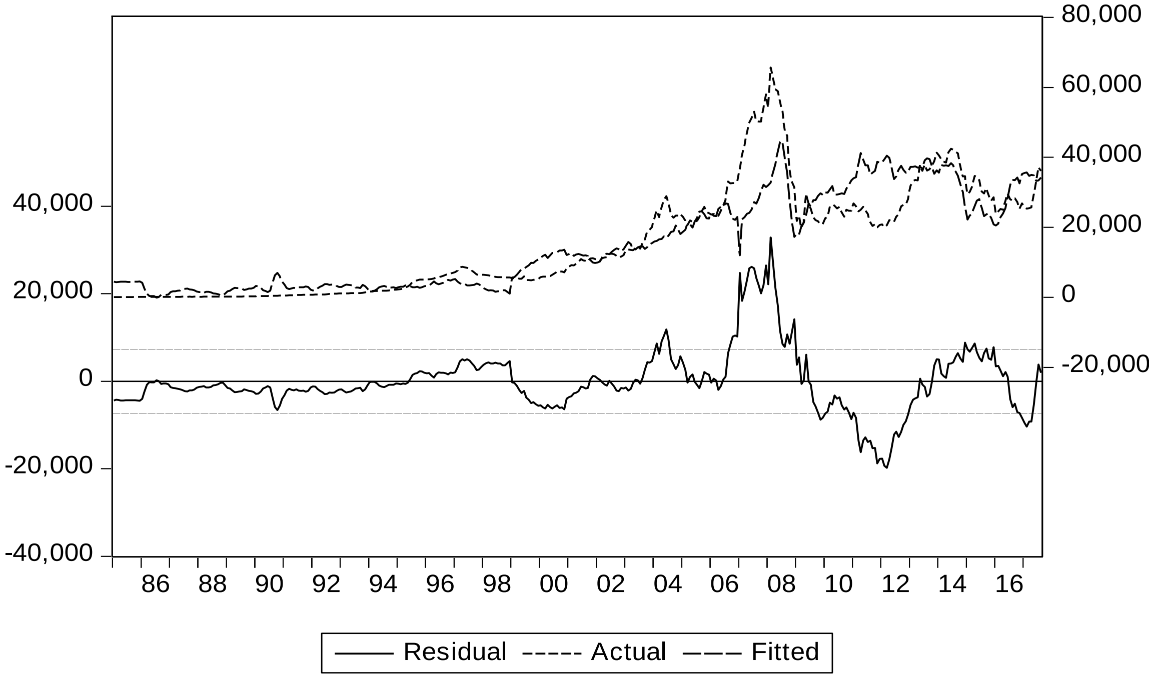

Fig 1: Plot of residuals of oil price-stock price model

From the graph above, we can deduce the presence of volatility in the model where small (large) changes are followed by large (small) changes especially during the period 2006 to 2010.

The next step involves the estimation of the ARCH-GARCH model to examine the nature and extent of the volatility relationship among the variables. In Table 7, we present the results of the estimated GARCH model using E-Views 9. The mean equation shows a significant and positive relationship between stock market prices (ASI) and crude oil prices (DPO) as well as between foreign exchange rates (FXR) and stock prices.

The variance equation indicates that both the ARCH and GARCH terms are positive and significant meaning that stock market prices in the Nigerian Stock market exhibit strong volatility. It is also evident from the results that changes in the international crude oil price (DPO) contribute significantly to the volatility in stock market prices in Nigeria just as changes in foreign exchange rates (FXR) do also contribute significantly to the volatility in stock market prices. In addition, there is evidence of volatility clustering in the model given that the sum of the ARCH and GARCH terms is one (1) approximately. This implies that shocks to the conditional variance are highly persistent.

Table 7: ARCH-GARCH Test Result

Dependent Variable: ASI
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)
Sample: 1985M01 2017M08
Included observations: 392
Failure to improve likelihood (non-zero gradients) after 70 iterations
Coefficient covariance computed using outer product of gradients
Presample variance: backcast (parameter = 0.7)
GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*GARCH(-1) + C(7)*DPO + C(8)*FXR

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-861.9789	49.69672	-17.34478	0.0000
DPO	36.40032	3.200040	11.37496	0.0000
FXR	100.1106	0.689781	145.1340	0.0000
		Variance Equation		
C	-38153.37	6898.508	-5.530670	0.0000
RESID(-1)^2	0.985343	0.192599	5.116042	0.0000
GARCH(-1)	0.125656	0.050631	2.481799	0.0131
DPO	2355.079	450.4689	5.228061	0.0000
FXR	580.9129	109.5096	5.304677	0.0000

R-squared	0.424575	Mean dependent var	15349.46
Adjusted R-squared	0.421616	S.D. dependent var	15135.06
S.E. of regression	11510.44	Akaike info criterion	18.20694
Sum squared resid	5.15E+10	Schwarz criterion	18.28799
Log likelihood	-3560.561	Hannan-Quinn criter.	18.23906
Durbin-Watson stat	0.022134		

Source: Authors computation

4.6 Variance Decomposition Analysis

To further our investigation, the variance decomposition analysis was undertaken to examine the response of stock market prices emanating from own shocks and also from shocks in crude oil prices and foreign exchange rates within an out of sample period of ten months. In Tables 8, we show the results of the VDC obtained from the unrestricted VAR estimation of the model.

The results in Table 8 indicate that own shocks from stock market prices (ASI) account for 100% of the forecast variance decomposition in the first month in the future and none is attributable to the other variables and steadily decreases to 98.68 % in the 10th month. In the 10th month for example, shocks emanating from DPO and FXR account for the remaining 1.32% in the variance decomposition of ASI.

The first panel in the graph in Fig 2 amplifies the variance decomposition of ASI due to shocks from ASI and the other variables.

Table 8: Variance Decomposition Test Results

Variance Decomposition of ASI:				
Period	S.E.	ASI	DPO	FXR
1	1582.229	100.0000	0.000000	0.000000
2	2372.300	98.97639	0.936641	0.086969
3	2982.137	98.48131	1.399620	0.119073
4	3475.070	98.33504	1.553430	0.111530
5	3887.317	98.35498	1.553003	0.092016
6	4241.111	98.44049	1.480838	0.078667
7	4550.743	98.53915	1.378907	0.081947
8	4825.831	98.62279	1.269258	0.107947
9	5073.153	98.67554	1.164028	0.160430
10	5297.680	98.68792	1.070191	0.241888

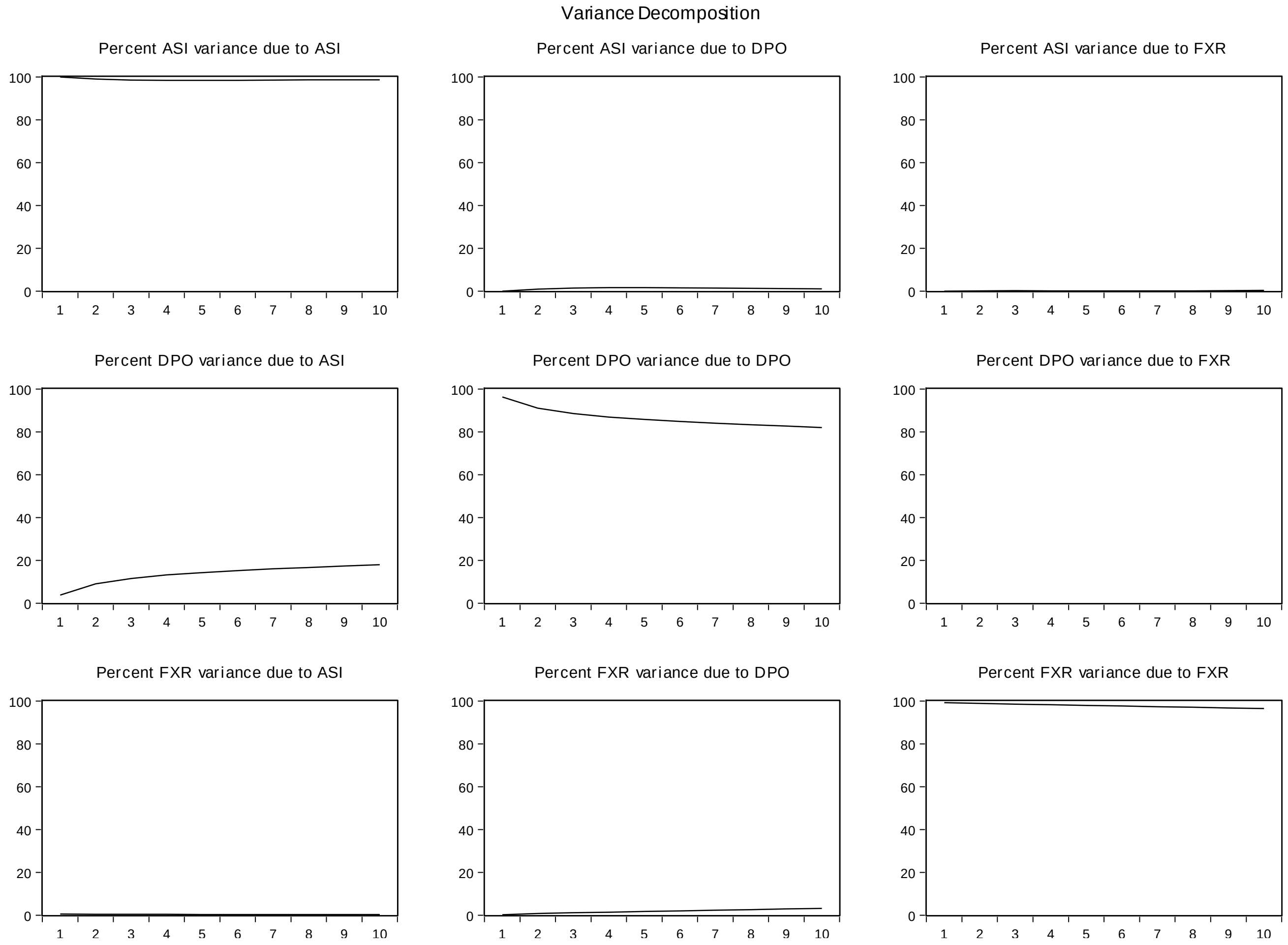

Fig 2: Graph of Variance Decomposition of ASI

4.7 Discussion of Findings

The results from the parsimonious ECM indicate that changes in crude oil prices (DPO) significantly and positively affect changes in stock market prices (ASI) in Nigeria. Foreign exchange rate movements are appropriately signed but not significant. The above ECM results when taken with the Granger causality results which show a bi-directional causality relationship between ASI and DPO underscores the fact that there is a strong and significant relationship between crude oil prices and stock market activities. The uni-directional causality from FXR to ASI suggests that activities in the foreign exchange market also influence prices in the stock market. These findings are in consonance with the results of the studies carried out by Kang, Ratti and Yoon (2015), Zubair, Okorie and Sanusi (2013) as well as an earlier work by Ogbulu and Torbira (2017).

Furthermore, the results of the volatility test using the GARCH (1,1) model vividly confirm the presence of ARCH effect in the ASI-DPO model. The mean equation shows that both DPO and FXR are positive and significant just as the variance equation depicts that both the ARCH and GARCH terms are significant and positive. The implication is that both the previous month's squared residual (volatility) and the previous month's residual (volatility) of stock market prices (ASI) significantly and positively influence the current month's volatility of the Nigerian stock market. In addition, both DPO and FXR contribute significantly to the volatility of stock market prices in the Nigerian context. The observed results also indicate the presence of volatility clustering in the market. The results of the forecast variance decomposition of ASI emanating from own innovations dominate those of DPO and FXR within the forecast period of 10 months. These results agree well with earlier results from the works of Basher, Alfred and Sadorsky (2010) and Berk and Aydogan (2012).

5. Conclusion and Recommendations

This paper set out to investigate in the main the nature and extent of the relationship between crude oil prices and stock market prices in Nigeria with foreign exchange rate movements as a control variable. In addition, the paper sought to explore the nature of the volatility relationship between crude oil prices and stock market prices in Nigeria using the GARCH (1,1) model. The findings of the paper vividly indicate that changes in crude oil prices in the international oil market significantly affect stock market prices in Nigeria. On volatility, it is evident that crude oil prices and foreign exchange rates contribute significantly to the volatility of the stock market in Nigeria.

In the light of the above results, it is recommended that investors in the Nigerian stock market should always incorporate information emanating from the international oil market and the Nigerian foreign exchange market in their investment-decision process. Given the observed significant relationships between crude oil prices and the stock market including the presence of volatility pass-through in the markets, it is apt for policy makers in Nigeria to design and sustain investment-friendly policies that would help in boosting oil production. The issue of security, infrastructure and energy are of paramount importance in achieving this goal.

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