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SHOCK AND VOLATILITY SPILLOVER BETWEEN OIL PRICES AND SECTORAL STOCKS IN NIGERIA

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Abstract

The study examined the stock and volatility spillover between oil prices and sector-specific stock prices in Nigeria with the objective of uncovering shock and volatility spillover effects. The study adopted the CCC-VARMA GARCH methodology of McAleer et al (2003, 2009), where findings indicate sufficient ARCH & GARCH effects between oil and the sectors. Additionally, the study observe short and long term volatility spillover effects between oil and most of the sectors. The study recommends among others for investors, fund managers, portfolio managers to factor into their decision making, immediate past shock and volatility of the series as this will help in portfolio allocation and management in the presence of oil price risk.

Keywords: Spillover, Shock, volatility, GARCH.

JEL Classification: C22, C32, G11, G12, G15.

1. Introduction

It is a common knowledge that the integration of financial markets have significantly helped in promoting economic development and growth. However, such developments are characterized by high level of uncertainty shock and volatility especially in less developed economies, such as ours. Consequent upon these, prices of securities and commodities have now become prone to different types and levels of shocks.

Oil price stocks and uncertainty has at different times been used to evaluate economic occurrences which include, but not limited to investment decision, unemployment relations, and demand for money and, stock market returns. However, the bulk of the evaluation has been devoted to oil price - stock return nexus (Abeng, 2017). This is due to the fact that oil, as a source of energy, plays a strategic role in the performance or otherwise of the global economy as it affects the consumption and investment decision of households and business firms at various times. An important discourse in the financial economics literature of recent is the understanding of the complex dynamics that explain the volatility of oil prices over time as it is critical for the growth and development of any economy. It is pertinent to note that almost all issues of production had to do with oil (Malik & Rashid. 2017). Oil is said to occupy an important place in the world economy since it is considered as the most important source of energy in the world, not just as fuel and source of energy for heating, but also as raw material in the production process (Al-Quduh. 2015). Any fluctuation in the price of oil has over bearing influence on other economic activities of a nation.

The stock market has been viewed worldwide as a market where elements that feed into the development of a nation's economy is said to operate. In both developed and underdeveloped economies, stock markets, which are part of the financial system plays a pivotal role in the development process. A well-functioning economy is one which is binged on a sound financial system of which the stock market is a major player. The Stock market is often seen as a place for accessing long term securities comprising both the primary and secondary market for the issue of new securities and trading of existing share respectively. Stock markets, as posited by Adenuga (2010) support resource allocation and spur growth by reducing transaction costs, affecting the average productivity of capital mobilizing savings and altering the rate of investment, promoting and improving resource allocation among others.

In Nigeria, the stock exchange is said to have recorded tremendous success over the years leading to its consideration as a frontier market (Kumeka, Adeniyi & Orekoya, 2017).An empirical in-depth examination of the return spillover intensity offers more insight into constructing forecasts of the return of both oil and stock markets in Nigeria. Individual investors, fund managers, portfolio advisors would come to the knowledge of the risk and value of their portfolio as a result of these spillover effects.

The link in the co-movements between crude oil and stock nexus hinges on the fact that oil is regarded as an important input in the production process over time Abdala (2013). Additionally, it influences the level, volume and magnitude in the returns across sectors Rashid and Malik (2017). The main goal of investors in the Nigerian Stock Market is to earn high returns on investment. However, this goal is not fully achieved due to the volatile nature of the market occasioned by the speed and nature at which information is transmitted to it from oil price shocks. There is need for portfolio managers to have adequate information for asset allocation and valuation, portfolio diversification, etc.

The objective of this paper therefore, is to examine the shock and volatility spillover effects between oil prices and the eleven industrial sectors listed of the Nigerian Exchange Limited (NGX). Following this introduction, is section two which is focused on literature, section three on methodology, section four on analysis and discussion of findings, while section five is the conclusion.

2. Literature Review

2.1 Conceptual Issues

Shock and Volatility Spillover

Spillover generally refers to an event producing an effect elsewhere with no obvious connection. It is the transmission of instability from one market to another and this occurs when volatile prices change in one market (oil) causes lagged impact or effect on another (stock) and vice-versa above the prevailing local effects.

According to Umm and Wenlong (2021) shocks and volatility spillover can cause either positive or negative outcomes, but negative outcomes seem to occur most often such as Covid-19 pandemic, Russia-Ukraine war etc. In this study, we refer to shocks as the short run effect of price disruptions and we take volatility to mean long term effects of price fluctuations.

Oil Price: The price of oil refers to the spot price of a barrel of oil (about 160 litres) benchmark crude, which is a reference price for buyers and sellers of crude oil such as West Texas International (WTI), Brent oil, OPEC basket, Tapis crude oil, Bonny light and several others. EIA (2020) oil price differentials are based on their gravity, sulfur content and location EIA 2020).

Sectoral Stocks: A sector is regarded as an area within the economy by which business activities share the similar and related activities, product or service. It represents a heterogenous grouping of firms with similar business activities that operate together within the same environment or institutional arrangement Umm and Wenglong (2020). For this study, we are concerned with the eleven industrial sectors such as Agriculture, Conglomerates, Construction/Real estate, Healthcare, Oil and gas, Services, ICT, Natural recourses, Industrial goods, Financial services, Consumer goods These together form part of the stock market and engages in trading in shares which are valued based on quoted prices on daily basis.

2.2 Theoretical Framework

The Arbitrate Pricing Theory (APT) propounded by Ross (1976) is used to validate the effect of shocks and other risk factors on stock market volatility. The theory assumes that returns can be describe by a factor model, there are no arbitrate opportunities, and that there are a large number of securities such that it is possible to form portfolios that diversify risk. The theory assumes that the asset (stock) returns are generated by the following equation as outlined in Salisu and Isah (2017).

$R_i = \lambda_i + \beta_i \psi + e_i$

Where;

R_i is the return on asset (stock) i

$\lambda$is the unconditional expected return

ψ is a vector of different risk factors

$\beta_i$is a vector measuring the influence that each risk factor has on return on asset i

e_i- is the error term for the residual effect of the returns series in question.

Therefore, for the purpose of this study, we isolate only the effect of oil price shocks among other risk factors. Therefore a 'reduced form' version of the APT presented above is rewritten as:

$$R_i = \lambda_i + \beta_i Op + e \qquad (1)$$

Where;

R_i and $\lambda_i$are as previously defined

Op = oil price

2.3 Empirical Review

Chen, Li and Jin (2018), examined the effect of return and volatility spillover between crude oil prices and stock price in China using daily data from 2010 to 2017. The paper employed the CCC MGARCH model where results indicate un-directional return spillover from crude oil to firms in the Chinese stock market. However, no formal pretests for model selection were conducted. The study ought to have conducted the Engle-Sheppards CCC test.

Abioglu (2021) examined the return and volatility correlation between oil prices and stock sectors in Turkey using weekly data from 2002 to 2020. Findings from the DCC model indicate significant return spillovers from oil to market to the 12 sectoral indices on the Turkish Exchange. The study did not disclose how the DCC model was chosen. Also, the study quoted oil price in the local currency instead of dollars.

Hongsakulvasa, Khewugandee and Liammukda (2020) investigated the effect of oil market risk and return on Thailands sectoral indices in the presence of Covid-19. Using daily data from 2016 – 2019, utilizing the DCC-GARCH-in-mean model, findings show significant return spillover from oil to services, constructions and property financial and products sectors. Notwithstanding, not all the industrial sectors were used. Stationarity properties of the variables were not done.

The nexus between oil prices and stock market in South Asia was also examined by Alamgir and Bin Amin (2021) using the NARDL model using data from 1997 – 2018. Results indicate significant positive effects of oil prices on the economies selected. Findings further show that high oil prices stimulate stock prices. The study ought to have used the Panel-non-linear autoregressive distributed large model as it covers more than one entity.

Umm and Wenlong (2020), investigated the dynamics of volatility spillover between oil prices and stock market returns at the sector level in Pakistan using data from January 2003 to December 2017, using the VARMA – GARCH framework, findings indicate negative return spillover effects from oil market to agriculture, energy, machinery sectors, while the return spillover effects from stock to oil market were not significant. The study captured adequately, the return and volatility services at daily frequency using all the sectors; however, it chose the CCC variant arbitrarily.

Fasanya, Oyewole and Agbatogun (2019) measured the return and volatility spillover among sectoral stocks in Nigeria using monthly data from 2007 – 2016. Results indicate evidence of interdependence among sectors. The study covered only 9 sectors, which does not give an accurate picture of the entire market.

Writing on oil price stocks and stock returns nexus for Malaysia, Al-Hajj, Al-Mulali, and Solarin (2018) sought to examine the asymmetric effect of oil prices on stock returns in Malaysia. Apart from oil prices, the study used other variables such as exchange rate, industrial production and inflations, possible such as exchange rate, industrial production and inflations, possibly as control variables form 2000 to 2016 about nine (9) economic sectors. The study utilized the non-linear autoregressive distributed lag model for analysis. Findings from the study implied that oil price stocks have an adverse impact on the stock market returns in most of the sectors in respective of whether oil price stocks are asymmetric or symmetric. However, the use of monthly data may not have yielded efficient result because of the volatile nature of financial series.

Ashamu, Adeniyi and Komeka (2017) examined the effects of oil price volatility on selected banking sector stock prices to Nigeria, using monthly data from 2000 January to 2015 December. Their main objective was to explore the relationship between oil prices fluctuation and banking sector stock prices using disaggregated data on oil prices and the banking sector stocks. Using the APT theory and the vector Autoregressive-generalized aid regressive conditional heterescadastiy (VAR-GACH) methodology, findings from the study reveals short run predictability on of bank stock prices and that crude oil prices had a significant effect on banking sector stocks. Results also show the existence of significant volatility transmission between oil and banking sector stocks in Nigeria.

Kumeka, Adenyi and Orekaya (2018) analyzed the effects of oil shocks-stock return relationships using selected sectors for Nigeria including banking and oil/gas sectors from January, 2000 to December, 2015. The study focused on oil prices, and individual. Stock returns on banking sector and oil and sector. It used the VAR-GACH methodology as a tool analysis. Results from the study indicate that returns on stock market are affected by their own past values. Past oil shocks drive volatility for the firms in the banking sector. The study nonetheless had limited focus as it only covered two (2) sectors.

Oyinlola and Oloko (2018) investigated the link between exchange rate dynamics and stock market performance in Nigeria. The main objective of the paper was to investigate asymmetry in the impact of exchange rate on the Nigeria stock market using non-linear ARDL framework. The study made use of exchange rate and stock prices as variables from 1985 to 2017 on monthly basis. The result from the study indicates the existence of long run, but not short run, asymmetry effect between exchange rate and the Nigeria stock market for the period of study. Inspite of this, the study used one variable to represent the overall stock market which may not be a reflection of the market.

Caporale, Ali and Spagrolo (2015) examined the impact of oil price uncertainty on sectoral stock returns for China using monthly data from January 1997 to December 2014. The variables used included oil prices and the specific sector returns on 10 sectors. The study utilized the VAR-GARCH-in-mean volatility model analysis. Result from the study suggest that oil price shocks affect stock return positively during periods characterized by demand-side shocks in all the sectors except the consumer series, oil and gas and financials while the other sectors were found to exhibit negative responses. The impact of oil price uncertainty appears to be insignificant during periods of precautionary demand shocks.

Modeling the impact of oil price shocks on energy sector stock returns in Nigeria was examined by Ebechidi and Nduka (2017). The study used oil prices and stock returns of energy related firms using monthly data from January 2000 to December 2015. Using the generalized autoregressive conditional heterescedastity (GARCH) modeling approach, the results indicate the existence of negative effect between oil prices shocks and energy sector stock returns by over 74%. Also, an increase in oil prices leads to a margin increase in stock return. The variance equation which measures volatility indicates that oil price shocks and energy stock returns are negatively related at least on the short run. The study used only one sector, also the asymmetric effect of shocks was ignored.

Modeling the impact of oil price fluctuations on the stock returns in an emerging market like Saudi-Arabia, Abdala (2013) made use of aggregate stock market index and oil prices in monthly frequency from January 2007 to December 2011. Using VAR GARCH methodology and maximum likelihood estimation, results from the work suggests that crude oil price fluctuations lead to increases in stock market returns volatility for the study period. The study however, used aggregate stock data which hides a lot of information about the stock market.

Malik and Rasid (2017) examined the return and volatility spillover between sectoral stock and oil price in Pakistan. The study used oil price and sectoral stock returns on eight different sectors on the Pakistan Stock exchange as variables of interest from January 2001 to December 31st 2015. Using the VAR-GARCH modeling technique, the results indicate no short run price transmission between world oil prices and stock sectors of the PSE. However, past shocks in world oil prices have significant effect on volatility individual sectors of the PSE.

Yaya et al (2017) examined the returns and volatility spillover from oil to FOREX markets in oil exporting countries using VARMA-GARCH models where results indicate significant bi-directional returns spillovers between oil and FOREX markets in OPEC countries. Though the methodology is relevant here, the focus in more on exchange rate dynamics.

Majority of the studies reviewed, indicate positive significant spillover effects from oil to stock markets. Also most of the studies used data on lower frequency than expected and none investigated the whole stock sectors. This study in contrast, used daily frequency with a large number of data sects covering the entire eleven industrial sectors on the stock exchange. Apart from this, adequate relevant pretests including sign and size biased test and Engle-Sheppard CCC test were done before the VARMA-GARCH model was selected.

3. Methodology

3.1 Sources of Data

The study covers the period 2011 – 2021. Oil data is sourced from the US energy information administration (EIA, 2021) while the sector based stock prices are obtained from the NGX on agriculture, conglomerates, construction, consumer goods, natural resources, financial services, oil and gas, ICT, industrial goods, healthcare and services

Where is the daily closing price of oil, and the 11 industrial sectors indices on the Nigerian Exchange Limited (ngx).

3.2 Model Specification

In other to realize set objective, and following Yaya et al 2017, Malik and Rashid 2017, Fasanya, Oyewole and Agbatogun 2019 and hinged on the (APT) theory, CC-VARMA GARCH model for the mean (return) and variance equation is specified as thus:-

3.2.1 Mean (Return equation)

$$\begin{matrix} \boldsymbol{Roil_t} \\ \boldsymbol{Rs_t} \end{matrix} = \begin{pmatrix} \boldsymbol{Yoil} \\ \boldsymbol{Ys} \end{pmatrix} + \begin{pmatrix} \boldsymbol{Qoil} & \cdots & \boldsymbol{Qoils} \\ \vdots & \ddots & \vdots \\ \boldsymbol{Qsoil} & \cdots & \boldsymbol{Qs} \end{pmatrix} + \begin{pmatrix} \boldsymbol{Roil_{t-1}} \\ \boldsymbol{Rs_{t-1}} \end{pmatrix} + \begin{pmatrix} \boldsymbol{\varepsilon oil_t} \\ \boldsymbol{\varepsilon_{st}} \end{pmatrix} \qquad \textbf{(2)}$$

Where

and are the daily return of sector specific stock index and oil prices respectively, and are the coefficients of own past lag effect of sector stock returns and oil price returns respectively. and both measure the return spillover effect of oil on the stock returns and stock on oil returns respectively.

3.2.2 The Conditional Variance Equation

The conditional variance equation for the oil stock series for objective three and four is specified as follows:

$$\begin{pmatrix} \delta^2{}_{oil,t} \\ \delta^2{}_{s,t} \end{pmatrix} = \begin{pmatrix} \omega_{oil} \\ \omega_s \end{pmatrix} + \begin{pmatrix} \lambda_{oil} & \lambda_{oil,s} \\ \lambda_{s,oil} & \lambda_s \end{pmatrix} \begin{pmatrix} \varepsilon^2{}_{oil\,t-1} \\ \varepsilon^2{}_{s\,t-1} \end{pmatrix} + \begin{pmatrix} \beta_{oil} & \beta_{oil,s} \\ \beta_{s,oil} & \beta_s \end{pmatrix} \begin{pmatrix} \delta^2{}_{oil,t-1} \\ \delta^2{}_{s,t-1} \end{pmatrix} \qquad \textbf{(3)}$$

Where:

and are the variance of the two series. and are the non-negative constants of the model, λ_{oil} and measure the short run persistence or ARCH effects of the past shocks of both oil and sector stock return respectively at time t – $_1$ on the present conditional variance series capturing the impact of direct transmitted shocks. Measures the long run persistence or GARCH effects of past shocks of oil and stock return at respectively, on the transmitted conditional volatility series capturing the direct impact of the effects of the transmitted conditional volatility series and measures the cross value of the error terms and on current conditional variance series for oil and sector stock respectively. Thus, these parameters and shock spillover or volatility spillovers coefficients that measure the effects of volatility shocks between oil and stock markets such that measure the impact of sector stock shocks (volatility) on oil market, whereas measure the impact of oil market volatility shocks on sector stock volatility.

In the same vein, volatility spillover between oil price and sector stock returns are measured by and , i.e measures the impact of volatility spillover from stock to oil market while measures the impact of volatility spillover from oil to sector stock market returns.

3.2.3 The conditional variance equation (VARMA-A GACH)

To accommodate the asymmetries in the model, McAleer, Hoti and Chan (2009) introduced the VARMA. AGARCH version. The authors adopted the GJR style of asymmetry to uncover the asymmetric impact of unconditional shocks on the conditional variances. This is specified as in Yaya, Luqman, Akinlana, Tumola and Ogbonna (2017) as follows:

Note that the only difference between the VARMA – GARCH and the VARMA – AGARCH model is the inclusion of the leverage effect parenthesis and which measure the asymetic impact of volatility of oil and stock markets respectively using the indicator variable and conditioned such that for and is otherwise, same as when .

4. Data Analysis

4.1 Descriptive statistics

The descriptive statistics for the study is presented below

Table 1: Descriptive Statistics (Return Series)

Variable	**Mean**	**Median**	**Max**	**Min.**	**Std. Dev.**	**Skewness**	**Kurtosis**	**JB**
Oil Price	-1.67R-2	0.000351	0.0828	-0.1214	0.0100	-0.971	23.665	48099.14
Agriculture	0.000341	0.00001	0.03974	-0.2257	0.008092	-7.8870	231.71	586889
Conglomerates	-0.000197	0.0000	0.064729	-0.07296	0.00764	-0.1490	10.552	6379.55
Constr. Real Estate	-8.50E-02	0.0000	0.04986	0.106934	0.00322	-120377	487.87	2631814
Consumer goods	0.00152	1.60E-05	0.03650	0.03949	0.005302	0.09624	141.173	13944.9
Financial Services	1.32E.05	-1.66E-05	0.088896	-0.08028	0.00326	2.0971	419.892	1940956
Health Care	8.91E-05	0.0000	0.04537	-0.08499	0.00606	1.31093	31.018	88431.28
ICT	0.000609	0.00011	0.8778	-0.0677	0.02039	36.2494	1448.64	2.34E^{0}8
Industrial Goods	0.000226	0.00010	0.063031	-0.04017	0.00534	1.85925	24.589	53591.8
Natural Resources	1.26E-05	0.0000	0.07185	0.07947	0.00374	088076	177.7732	3409703
Oil & Gas	0.000156	-4.57E^{0}2	0.28383	-0.05557	0.00824	15.28319	529.080	31009284
Services	7.52E-05	0.0000	0.062088	0.03127	0.003318	6.0850	118.590	1508526

From table 1, we can observe that the return mean on oil during the study period is 1.67E.0.5, while that of agriculture, consumer goods, financial services, industrial goods, Natural resources, oil and gas and ICT were all positive while that of the other remaining sectors reported negative values.

The highest returns for the series are that on financial services about 4.32E-05. The maximum return on investment in oil market is about 0.0828.Looking at the stock market, the highest return of investment is on ICT, followed by oil and gas sector. The standard deviation, which reveals the volatility of the series indicate that the volatility of oil return is 0.0100, which is far from the mean, indicating that oil returns are highly volatile. A look at the stock returns reveal that the ICT sector with a standard deviation of 0.020390 is the most volatile, while the construction sector seem to be the least volatile. The standard deviation values indicate the preference for GARCH model. The kurtosis of the returns are high, i.e they are leptokurtic for most series, while the Jarque Bera value indicate that all the variables are non-normal just like the price values thus, necessitating the use of our models. The non-normality of data and high value of kurtosis (peaked) provides justification for the use of GARCH models as evidenced by Tule *et al* (2018), Uzonwanne (2021).

4.1.2 Stationarity Tests:

Though the study uses return series, which are already stationary nonetheless, unit root tests are conducted on the price data just for confirmatory reasons. The result is presented as follows.

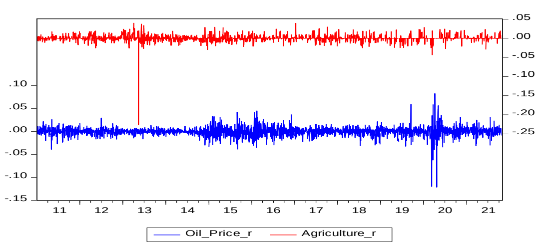
Table 2: Unit Root Test

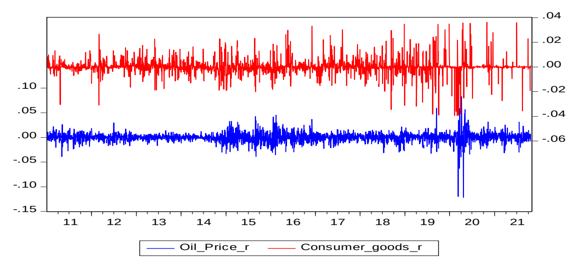
Variable	ADF Stat	Prob	Decision
Oil Price	63.59203	0.0001	1(1)
Agriculture	47.24475	0.0001	1(1)
Conglomerates	46.85522	0.0001	1(1)
Consumer goods	47.14081	0.0001	1(1)
Construction/Real Estate	50.17499	0.0001	1(1)
ICT	39.03502	0.0000	1(1)
Industrial Goods	-50.27804	0.0001	1(1)
Health care	-32.60718	0.0000	1(1)
Natural Resources	-33.31252	0.0000	1(1)
Oil and Gas	-48.36656	0.0001	1(1)
Financial Services	-45.98963	0.0001	1(1)
Services	-49.47295	0.0001	1(1)

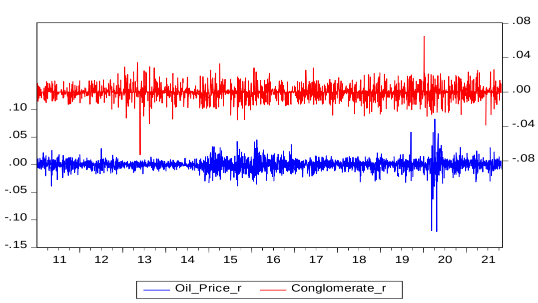
As we can see from the unit root test above, all the series are stationary after been differenced once. Consequently, the series are adequate for analysis using appropriate volatility models.

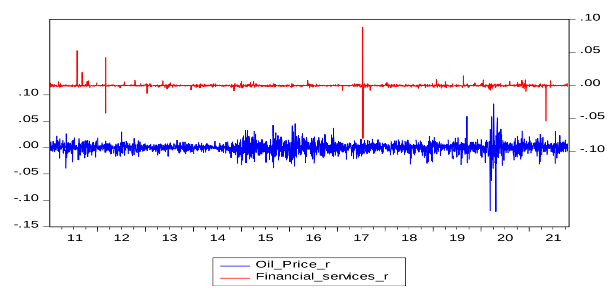
4.1.3 **Time Plots for Return Series**

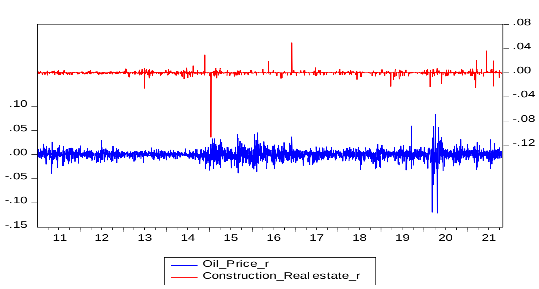
The time plots of the return series are presented on figure 1 as follows:

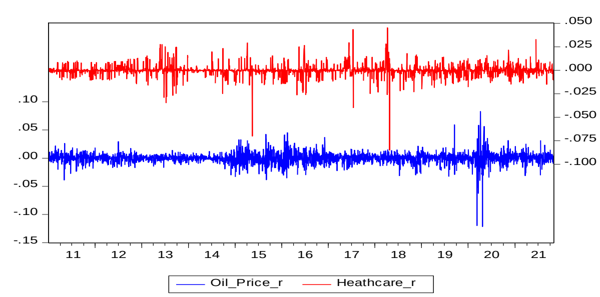












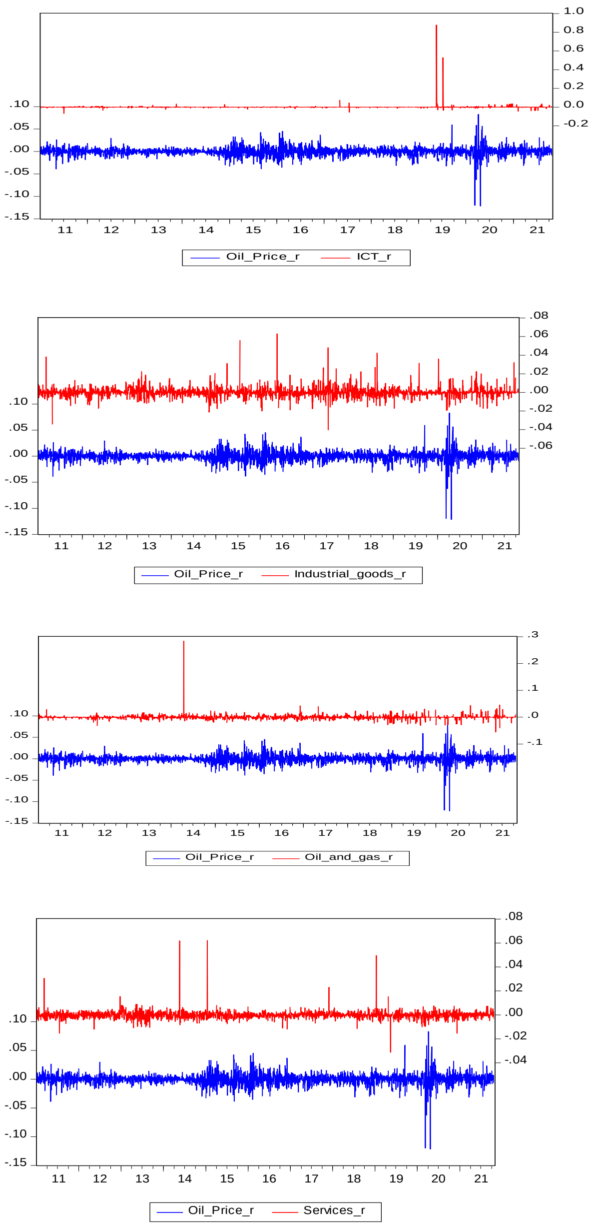


Figure 1: Time plot for return series

The time plots of oil and the eleven sectoral indices are as presented above. For the agriculture xxx we observe spikes in oil return around late 2012, while return on agriculture sector was stable between 2011 to 2014. However, as observed by 2020, there was a sharp spike in returns perhaps due to the COVID 19 Pandemic. We can also observe that all the return series exhibit volatility clustering given rise to excess kurtosis with very high values as evidence in the table 4.1 on descriptive statistics. Volatility clustering indicates that large positive changes in volatility are likely to be followed by negative changes in volatility. Thus scenario suggests the positivity of return and volatility spillover effects between the series which makes GARCH based models ideal for estimation Fracq and Zakoian (2010), cited by Abdala (2014).

4.1.4 ARCH and Serial Correlation Tests

Evidence from the unit root test, Jarque-Bera and Kurtasis support the adoption of GARCH model however, the ARCH test serial correlation test were conducted. The Engle (1982) ARCH tests were conducted where results reveal existence of ARCH effects and serial correlation in the series as follows.

Table 3: ARCH & Correlation Test.

Variable	ARCH LM	Jarque Bera
Oil Price	6.7606	38.873
Agriculture	3.646	49.495
Conglomerates	4.3863	30.820
Consumer goods	2.8613	7.5563
Construction/Real Estate	32.5634	47.084
ICT	590.3996	221.37
Industrial Goods	19.6183	63.979
Health care	2.7309	8.7091
Natural Resources	28.559	20.075

Oil and Gas	3.9690	67.689
Financial Services	6.0223	31.634
Services	2.4601	4.776

Significant figures in bold.

4.3.5 Asymmetry and Sign laws Test3: The results of the sign laws test and the Engle-Sheppard CCC X^2 test are presented below:-

Table 4

Variable	Sign Bias Test	-ve size bias test	+ve size bias test	Joint bias test	Engle-Sheppard CCC X^2 test
Agriculture	1.1869 (0.235368)	2.1448 (0.032060)	0.3301 (0.74133)	13.9861 (0.002924)	1.530652 (0.465182)
Conglomerates	0.08428 (0.9328)	0.58831 (0.5564)	1.36576 (0.1721)	3.52104 (0.3188)	1.453491 (0.48348)
Construction and Real Estate	1.699 (0.0596)	1.489 (0.36682)	2.659 (0.00688)	15.603 (0.00136)	2.293520 (0.029352)
Consumer Goods	1.70426 (0.08833)	0.76213 (0.44598)	1.25435 (0.20972)	7.58415 (0.07544)	0.87052 (0.64709)
Fin. Services	0.78937 (0.42989)	0.07919 (0.93668)	0.20487 (0.93608)	0.77341 (0.85582)	5.993539 (0.05990)
Health care	0.83198 (0.4055)	0.02822 (0.9775)	0.08515 (0.9321)	0.73317 (0.8654)	1.650715 (0.438078)
ICT	1.1863 (0.23568)	0.3833 (0.70152)	2.0564 (0.03984)	8.4404 (0.03773)	0.029403 (0.998648)
Industrial goods	0.835213 (0.4037)	0.003808 (0.9976)	0.087349 (0.9304)	0.758233 (0.8594)	0.037844 (0.981255)
Natural resources	0.4332 (6.649e-1)	2.3155 (2.066e-02)	4.5577 (5.405e-06)	26.4730 (7.592e-06)	0.22862 (0.891979)
Oil and Gas	0.69921 (0.4845)	0.07271 (0.9420)	0.19427 (0.8460)	0.57841 (0.9014)	0.088905 (0.956520)
Services	0.66369 (0.5069)	0.06218 (0.9504)	1.12457 (0.2609)	2.30726 (0.5111)	8.369742 (0.0582417)
Oil	1.1265 (0.2600)	0.4485 (0.6538)	0.3311 (0.7406)	1.3004 (6.7290)	

From the results of Asymetric and sign bias tests we observe that the null of constant conditional correlation (CCC) cannot be rejected as all the series show probability values greater than 0.05 as evidence in Yaya, *et al* (2016) Uzonwanne 2021 and Tule *et al* 2018. Turning to the bias tests, we observe that the null hypothesis of symmetry was not rejected for the series except, for agriculture, construction/real estate, ICT.

4.2 CCC VARMA (A) GARCH Results [1]

Based on the results of the Eagle-shaped and the sign and size based tests, the CCC- VARMA – A GARCH model is computed and estimated for oil-agriculture, oil-Construction and Real estate, and Oil-ICT Nexus, while the symmetric version, the CCC- VARMA –GARCH is estimated for the remaining pairs of oil-conglomerates, oil-consumer goods, oil-financial services, oil-health care, oil-industrial goods, oil-natural resources, oil-oil and gas and oil-services. The results are presented below.

Table 5: CCC-VARMA–(A) Garch Model Results Variance Equation

	Oil-Agriculture	*Oil Conglomerates*	*Oil Construction and Real Estate*	*Oil-Consumer Goods*	*Oil-Financial Services*	*Oil-Health care*
	0.0000011	0.0000010	0.000001	0.00000276	0.000001192	8.056E-07
	0.000034	0.0000236	0.000001	0.00001037	0.000007633	1.644E-006
	0.033173	0.1004599	0.014218	0.1101830	0.1084999	0.1074
	0.9114314	0.135495	0.217449	0.116421	0.1265462	0.0814
	0.029231	0.0330529	0.021595	-0.0070500	-0.0038594	-6.995E-03
	0.290577	0.0455949	0.108683	0.0026644	0.0107364	0.0201
	0.893898	0.8465595	0.898847	0.686077	0.8850205	0.8799
	0.0459119	0.3654655	0.406142	0.2214605	-0.0492202	0.8593
	0.064400	5.794942	0.700338	23.429217	-0.0985254	0.4535
	0.017646	5.1659749	1.356372	17.587475	0.019432	0.2560
Leverage Effects						
	0.456400	x x	0.127975	x x	x x	x x
	0.0738305	x x	0.849101	x x	x x	x x
Residual Diagnostics						
AIC	-13.733	44780.3	15.835	14.228	-15.730	-14.372
SBC	13.731	176770.4	15.833	14.225	-15.728	14.370
Ljung-Box (PV)	0.4068	0.5142	0.1890	0.6281	0.6034	0.4464
Mcleoid–Li (PV)	0.2713	0.1287	0.2143	0.4887	0.1272	0.0908

Note: The bivariate VARMA –GARCH Model is estimated for each pair of oil/stock rexus. The optimal lag order for the model is determined based on AIC/SBC. Significant VARMA-GARCH Parentheses are in bold.

	Oil-ICT	*Oil-Industrial Goods*	*Oil Natural resources*	*Oil-Oil and Gass*	*Oil-Services*
	1.1191E-06	-0.0000004	1.059E-06	0.000001	0.000002
	2.3789E-04	0.0000099	1.975E-06	0.000027	0.118994
	0.0349	0.1097733	0.1101	0.108316	0.003244
	1.6868E-03	0.297527	0.0419	1.329181	0.003244
	1.4127E-03	-0.0317534	-4.914E-03	-0.015056	-0.080308
	-0.0505	0.055259	-0.1271	-0.001024	-0.011940
	0.8997	0.8428424	0.8859	0.879422	0.869317
	0.4234	0.1790937	0.07431	0.008637	0.816047
	0.0380	14.0803850	-0.0105	0.127560	1.361774
	0.0120	18.372086	-0.0529	0.000638	0.036127
Leverage Effects					
	0.1063	x x	x x	x x	x x
	-0.0885	x x	x x	x x	x x
Residual Diagnostics					
AIC	11.761	-14.519	15.312	13.962	15.375
SBC	11.759	14.516	15.310	13.959	15.372
Ljung-Box (PV)	0.5382	0.2689	0.8051	0.4507	0.7351
Mcleoid–Li (PV)	0.2469	0.9397	0.1438	0.1268	0.0549

Note: The bivariate VARMA –GARCH Model is estimated for each pair of oil/stock rexus. The optimal lag order for the model is determined based on AIC/SBC. Significant VARMA-GARCH Parentheses are in bold.

[1] Given that the objective of this paper is to examine the shock and volatility spillover between oil prices and sectoral stocks in Nigeria, the result of the mean equation is suppressed but available.

4.3 Discussion of Findings

From the table 4.5, we observe that the estimated values of the ARCH and GACH coefficients (shock and volatility) are all significant for the brent oil in all the oil-stock pairs. This indicates that volatility of the oil market is driven by its own stock and volatility. Volatility persistence is very high for the oil market compared to the stock market. This suggests that future volatility in the oil market can be predicted from its past volatility up to about 0.98%. This is in line with Kalu (2015) Malik and Rashid (2017) Vnm and Zhang (2020). For the volatility of the stock sectors are fueled by their own stocks (ARCH) in all sectors with the highest been agriculture 0.91%, oil and gas over 1% industrial goods 0.29% etc. Also the sectors respond significantly to own volatility or (GARCH) effects, though with low GARCH estimates. Conversely, it can be seen that volatility of the stock market as represented by their sectors is influenced more by their own shocks than their long term volatility because the ARCH effects are far larger than the GARCH effects, This further suggests that investor, find managers, portfolio advisors takes into account, long term effects of stocks when making investment decisions rather than short term effects.

Turning to interdependence of shocks, we observe significant short term shock spillover from agriculture, oil and gas sector to oil market. This indicates that a shock originating from these two sectors have the ability to affect a shock in the oil market. However, the coefficients are very low at 0.2% for agriculture and less than 0.01% for oil and gas. This shock spillover from the other sectors to the oil market is however not significant. It means therefore that in the short run, the oil market has in place strategies to withstand any shock from the Nigerian stock market.

Conversely, the short term spillover from oil to the sectors is significant for 8 out of the 11 sectors of agriculture, construction/real estates, financial services, healthcare, ICT, natural resources, and services. A shock originating from oil market has the potential to cause a shock in these sectors. For example, a shock in oil price will cause the agriculture sector to move by about 0.29%.

However, we observe that the short term shock spillover from the oil market to the conglomerates, consumer goods, industrial goods and the oil and gas sectors is not statically significant. In other words, these four sectors in the short term are for shocks originating from the oil market. We therefore observe bidirectional shock spillovers between oil and agriculture sector, no shock spillover between oil and conglomerates sector, unidirectional spillover from oil to construction and real estate sector, no shock spillover between oil and consumer goods sector, uni-directional spillover from oil to financial services sector, oil and health care sector, oil and ICT sector, oil and natural resources sector, oil and services, unidirectional shock spillover from oil to oil and gas and no shock spillover between oil and industrial goods.

Turning our focus to long term spillovers, among the oil-stock nexus, we observe bi-directional spillover between oil and agriculture, oil and conglomerates, oil and construction, oil and consumer’s goods, oil and healthcare, oil and industrial goods, oil and natural resources and oil and gas and oil and oil and its services. Unidirectional volatility spillover is observed from oil to ICT, while there is a volatility spillover between oil and financial services.

The long term volatility spillover from conglomerates, consumer goods, industrial goods and services to oil indicates high significant values. This indicates high significant values. This indicates that volatility in the oil market is fueled by the volatility originating from the stock market in those sectors. For instance, 1% volatility in the stock market (conglomerates) causes the oil market to move by about 0.57%. This can be explained by the fact that a boom in the stock market will elicit demand for output, which will lead to increase demand for input (oil) will ultimately, put pressure on the demand for crude oil, thereby causing a shock in the market. Also considering the fact that Nigeria is one of the lead of oil producers in the world; this result is not surprising. Overall, the vol. spillover from the stock sector appears significantly across sectors.

Apart from the financial services sector the long term, volatility spillover from the oil market to the ten (10) sectors show significantly estimates with the most significant being conglomerates 0.51%, construction/real estate 1.35%, health care 0.25%, industrial goods 1.83% and services 3.6%. A 1% volatility in the oil market will cause the conglomerates sector to move in the same direction by 0.51%, construction sector by 0.135%, healthcare 0.28%, and industrial goods 18.3%. This is the suggestive of the fact that these sectors reliance on oil is high. This is in line with results from Lin et al Arouri et al (2012). This high figures are evidence of the fact that that as indicated in Arouri et al (2012) rising financial stock prices are often indicative of high oil consumption occasioned by increased productive activities.

These results are therefore indicative of the fact that individual investors, portfolios managers and investment analyst take into their account volatility spillovers in their decision making process as to mitigate risk and uncertainty involved in investing in financial assets.

The coefficient of asymmetry or the leverage effect is as reported on table 4.5. The parameters of oil are all stationery significant for the three oil-stock pairs for agriculture, construction and real estate and the ICT sectors.

This shows that negative news in the oil market tend to increase its volatility up to about 0.13% for agriculture, construction and the ICT sectors. In a similar vein for the stock factors, asymmetric coefficients are significant for three sectors. For instance, the leverage effect is very high for construction of real estate at 85% which indicate that negative unexpected shock has the ability to increase volatility of this sector by 0.85% as compares to a positive shock. This aligns with Malik and Rashid (2017).

The diagnostic tests on table 4.5 are for remaining ARCH effects and serial correction. Results of the Mcleod-Li test is used to test for the presence of ARCH effect we observe that going by the p values, there are no remaining ARCH effects of our Ljong-Box test show that is no more evidence of serial correction the returns series.

5. Conclusion and Recommendations

This paper investigated the shock and volatility spillover effects between oil prices and sectoral stocks in Nigeria from January 2011 to November 2021. Findings indicate significant ARCH and GARCH effects between oil and the eleven sectoral stocks. I employed the VARMA-GARCH Model of McAleer (2003, 2009) allowing for spillover effects in both return and variances. Overall, the results point to the existence of significant shock and volatility spillover effects from oil to stock sectors and insignificant effects from stock to oil market. Additionally, results also show that current volatility in both markets is fueled by their lag values. The study concludes that different sectors react differently to oil price shocks on the stock exchange depending on their individual exposure to such shocks.

From the findings and conclusion of this study, we recommend that:-

i. Investors, portfolio managers should factor into their decision making, own short term (ARCH) and long term (GARCH) effects to maximize returns.

ii. Because of the high value of volatility persistence, investors should construct optimal hedge ratios and portfolio weights to minimise losses without affecting gains.

iii. Policy makers should formulate effective policies for registered firms under different sectors that are highly dependent on oil to adopt greener technologies and other alternatives to mitigate their exposure to oil price risk.

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