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OIL PRICE SHOCKS AND STOCK MARKET VOLATILITIES: EVIDENCE FROM SELECTED SUB-SAHARAN AFRICAN COUNTRIES

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Abstract

The paper examined the relationship between oil price shocks and stock market volatilities in Nigeria, Egypt, South Africa, Kenya, Ivory Coast, and Ghana using a structural Vector Autoregressive model. The data used for the study spanned from January 2000 to December 2019. Findings from the study showed homogeneity in the response of stock market volatility to oil shocks for both oil importing and oil exporting countries, with slight variances in the timing of pass-through and speed of adjustment. Supply shocks had no significant impact on stock market volatility in all countries considered. In making stock market-related decisions, investors and even policy makers should consider the source and pass-through mechanism of oil price shock in their specific countries.

Keywords: Oil price, Stock market volatility, Africa, economic shocks.

INTRODUCTION

Crude oil remains one of the major energy resources for both developed and developing countries, as well as a vital source of foreign exchange for large oil exporters. Therefore, any disruption to the global oil market and by extension to its price, poses severe consequences for most economies (Umar *et al*., 2021; Wu and Chen, 2019). Some of the major drivers of oil price changes include geo-political tension, trade disputes and natural occurrences. All these have varying effects on the financial markets, including the stock market depending on the underlying cause of the shock.

The oil price shocks of 1973-74 and 1979-80 have triggered intensive research interest on the interconnectedness between oil price shocks and macro-financial macroeconomic variables. It appears that the increasing research interest in this area arose largely from the recessionary impact of oil price shocks on the economies of both oil-importing and exporting countries. Within this subject area, most academics and policy practitioners have somewhat reached a consensus on the existence of a linkage between oil, stock market, and global economic activities (Degiannakis, Filis, and Arora, 2018). Of major research interest in the last two decades is the considerable volume of literature that widely investigated the nexus between stock market performance and macroeconomic and financial variables (see Bhuiyan and Chowdhury, 2020; Khan *et al*., 2023).

Oil price-stock market nexus has attracted a lot of interest, largely due to the volatile nature of oil price in recent decades, driven by varying disruptive occurrences in the market. However, while oil demand and supply shocks may impact on oil price and consequently markets, researchers have not been able to reach any clear consensus on the direction and severity of impact of oil price shocks on stock market volatilities. Our area of interest in this paper is the interaction between oil price dynamics and stock market volatilities in some selected sub-Saharan African countries.

The study builds on existing findings that oil prices are endogenous and driven by both demand and supply shocks (Hamilton, 2013; Bastianin, Conti and Manera, 2016). Even though, available body of literature have established a link between stock market volatility and macroeconomic variables including oil price shocks, the nature and severity of these shocks on the stock market remains unclear. The seminal work of Kilian (2009) indicated that an insight to the original cause of shocks to crude oil price is imperative to understanding its effects on macroeconomic and financial aggregates. In other words, the impact of oil price shocks on financial and macroeconomic variables is dependent on the underlying source of the shock. Oil price is largely driven by three distinct structural shocks which include shocks to the global crude oil supply, aggregate demand for all industrial use and oil-specific demand, also known as precautionary demand. However, out of these, the oil price shocks caused by aggregate demand have been identified as having significant influence on stock market volatilities. More so, the influence of aggregate demand driven oil price shocks, appears stronger in oil exporting countries compared to countries that import oil (Bastianin and Manera, 2018; Bastianin, Conti and Manera, 2016). On the other hand, the oil price shocks driven by supply and oil-specific demand do not significantly influence stock market volatilities (Algia, 2018; Bastianin and Manera, 2018).

It is well documented that a country's response to oil price shocks may vary, depending on the different characteristics of their economies (see Baumeister, Peersman and Van Robays, 2010). While some studies have established positive influence of oil price shocks on stock market volatilities (Anyalechi, 2019), other findings pointed to the contrary (see, Algia, 2018; Kelikume and Muritala, 2019; Liu, Umar, and Gao, 2023), or even indicated neutral effects (Liu, Xu and Ai, 2023). As indicated earlier, the direction of the impact of changes in oil price on a country's stock market is dependent on whether the country is an oil importer or oil exporter (Mokni, 2020). For instance, in an oil exporting country, an increase in oil price may trigger improvement in net export as well as the international asset position of the country, hence appreciation of exchange rate. While in the domestic economy, the increase could improve government revenue and consequently increase its expenditure. This might stimulate aggregate domestic demand and trigger corporate profit expectations leading to appreciation in stock market prices (Odionye, Ukeje and Odo, 2019).

In oil importing countries, where most firms depend on oil as productive input, an increase in oil price sends negative signal to the stock market. This may happen through an increase in the firms' or industrial cost of production leading to reduction in productivity of the factors of production, hence depressing the aggregate stock prices (Anyalechi, 2019).

The past four decades have recorded the emergence of many African countries into the league of oil producing countries both at regional and global levels. These include Angola, Nigeria, Algeria, Libya, Egypt, Gabon, DR Congo, Chad, Senegal, Ghana, Ivory Coast, and Chad. This demonstrates the significant role that Africa plays in the global crude oil market. Based on the foregoing, this study is motivated to examine the effects of oil price shocks on stock market volatilities within the Sub-Sahara African region. Understanding the relationship between oil price shocks and stock market volatilities may help to provide a guide for policy, in the design of appropriate investment plans and strategies for mitigating the impact of crude oil prices on stock market volatilities.

The point of departure for this paper relates to the use of recent data to analyze the impact of oil price shocks on major stock markets in Sub-Sahara Africa, a region scarcely covered by previous empirical work in this subject area.

The rest of the paper is organized as follows; Section Two reviewed the literature while Section Three discussed the methodology. Results and key findings of this study are discussed in Section Four while Section Five concludes the paper.

LITERATURE REVIEW

Theoretical Literature

Both theoretical and empirical research towards a better understanding of the interconnectedness between crude oil prices and stock markets performance have continued to grow. This development is a pointer to the critical role that crude oil plays in the global economy through its impact on industrial development and export earnings of most economies (Badeeb & Lean, 2018). One of the theories that attempts to explain the nexus between oil price shocks and stock market volatilities is the equity valuation theory. According to the theory, "stock price as the summation of all discounted values of different expected future cash flows at various investment horizons" depends largely on the behavior of macroeconomic indicators. Some of these indicators include inflation, interest rate, production cost, investors' confidence and aggregate demand and supply (Arouri *et al*, 2012; Badeeb & Lean, 2018). Crude oil price shocks are transmitted to the stock markets in both developed and emerging economies via the monetary policy instruments, consumer prices, corporate income, and other economic activities (Gourène & Mendy, 2018).

The theoretical nexus between crude oil prices and stock markets performance can also be anchored in the Arbitrage Pricing Theory (APT). Developed by Stephen Ross in 1976 as an alternative to the Capital Asset Pricing Model (CAPM), the theory describes the relationship between asset expected returns and macroeconomic factors that capture systematic risk. While CAPM considers market risk as a factor that determines pricing of security, APT considers multiple factors in determining the sensitivity of a security to macroeconomic risks. Some of the factors that determine prices of securities according to APT are unexpected changes in inflation, gross domestic product, exchange rate, market indices, commodity prices and oil price shocks.

Empirical Literature

The empirical literature space is replete with studies that examined the relationship between oil price shocks and stock market volatility, cutting across both oil-importing and exporting countries in developed, emerging, and developing economies. However, the number of empirical studies appears to be lopsided in favor of developed and emerging economies with few focusing on developing regions such as Africa (Kelikume & Muritala, 2019). Despite these efforts, no consensus has so far been reached on the nature and direction of the relationship, as economic dynamics differ from one country to another.

In the existing literature, some studies have shown that the impact of oil price changes on stock markets depend on whether the country is an oil exporter or importer. For an oil-importing country, some studies suggest a negative impact of high oil price on asset prices through inflation hikes, triggered by higher production costs and lower investors' earnings from the stock market (Managi *et al*. 2022; Akinsola, M.O. & Odhiambo, N.M. 2020). On the contrary, the impact of oil price shock on stock market performance of an oil importing economy was found to be positive (Okpezune, Seraj and Osdezer, 2023). Additionally, Shahrestani and Rafei (2019) investigate the effect of oil price shocks on the Tehran stock exchange index using the MS-VAR model. They conclude that the effects of oil price shocks are positive and negative in various regimes. However, for an oil-exporting country, increased oil price tends to have a rather positive impact through increased earnings and investment for the country (Sakaki, 2019). Youssef and Mokni (2019) examined the dynamic relationship between oil market shocks and stock markets of oil-exporting and importing countries. To assess the dynamic relationship between these markets, the study employed a DCC-FIGARCH model over the period 2000 and 2018. Results suggested that during a period of turbulence, stock market returns respond more to oil price changes for oil-importing countries than for oil exporting countries. Nonetheless, evidence from few studies suggested that stock market response to oil price shocks was not very significant (Apergis & Miller, 2009; Miller & Roland, 2009).

A strand of the literature focused on the response of stock market returns to the three oil-related shocks: aggregate demand, supply, and oil-specific related shocks. One of such studies interrogated the time-varying effects of oil price shocks on stock market returns, in both oil-importing and exporting countries (Mokni, 2020). The study employed a Structural Vector Autoregressive (SVAR) model based on a two-staged methodology with monthly data spanning 1999-2018. Findings indicated that almost all stock returns reacted positively to aggregate demand shocks, while the effect of supply shocks was generally limited and negative. Also, oil-specific demand shocks showed positive effects on stock returns of oil-exporting economies and negative effects on oil-importing countries, except for Chin by extending this further,

Ge (2023) decomposed oil price shocks into supply, demand, and risk shocks and examined the asymmetric impact on China's stock market using a quantile regression model. The study revealed that supply shocks positively influence the Chinese stock market when the market is in a bullish state and have no significant impact on the market when in a bearish state. Meanwhile, oil demand shock shows evidence of a more positive impact on the market when in a bullish state than in a bearish state. As for risk shocks, negative risk shocks are beneficial to the stock market moving away from a bearish state but have no significant impact on the bullish market, meanwhile, positive risk shock portends the inverse effect for the market is in a bullish state than in the bearish state.

Another related study investigated the effects of crude oil price shock, volatility spillovers, and global financial risk transmission mechanisms with evidence from the stock and foreign exchange markets (Chen & Zhang, 2023) using SVAR, DCC-GARCH, and asymmetric BEKK-GARCH models. The finding suggests that the risk spillovers of crude oil price shocks were time-variant, with demand shocks having the strongest spillover effects, while the effects of supply shocks are the weakest, the study also found that crude-oil importing countries are more exposed to the risk of spillover effects and that worsened the spread of global systemic financial risk. Also, Tian *et al*. (2021) examined the dynamic impact of oil volatility on the Chinese stock and exchange rate, using the TVP-VAR model, the evidence suggests that oil volatility index changes have a positive impact on the Chinese exchange rate volatility changes as well as the stock volatility index changes. However, the positive impact is sustained only in the short run but dies off in the long run. Similarly, Sreenu (2022) examined the effect of crude oil uncertainty on the aggregate and stock market returns in various economic sectors, specifically it tried to understand whether the 2012 reforms stimulated the oil price volatility index-stock market relationship using a quantile regression model. The study confirmed that oil price volatility exerts a significant negative effect on the aggregate and the various economic sectoral stock returns. Furthermore, the study found that the 2012 reform lowered the effects of positive crude oil price volatility index shocks on Indian market returns.

Lu *et al*., (2022) investigated the predictive ability of oil shocks for international stock market volatility, from the MIDAS result, the study suggests that in addition to established economic factors and uncertainty indices, several oil shock metrics provide useful information for predicting stock market volatility. Moreover, Chan and Qiao (2023) examine the link between oil and stock markets using the WTI oil price and 10 S&P 500 price subindices data from 1989 to 2021. The evidence from DSGE model estimation suggests that demand shocks to oil and stock markets create significant spillover effects in comparison to supply shocks. In addition, it was found that the role of demand and supply shocks differed largely across sectors. On the contrary, Zidet *et al* (2023) submitted that during periods of recession, the stock-bond relationship is adversely affected and statistically explained by oil supply shocks, while during periods of economic upturn, the relationship is positively affected. Further, this paper finds that demand shocks feature more where investor sentiment is negative; however, supply and risk shocks feature more when sentiment is positive. Meanwhile, using a quantile regression model, Umair and Gao (2023) observe that increased crude price volatility negatively affects stock returns under the caveat that the dual crude costs volatility and stock returns are minimal. They therefore conclude that increasing crude volatility leads to a growth in stock returns. Liu, Wang, Du, and Ma (2022) affirmed that oil price volatility has a negative effect on stock returns, and this effect increases with economic policy uncertainty. They observed varying responses across economies as oil-exporting countries tend to respond more strongly to oil price volatility than the oil-importing countries. More so, the stock returns of developing countries are much more prone to oil price volatility than those of developed countries.

However, within developing economies, Khan et al (2023) investigated the causal upshot of geopolitical oil price threat on stock returns and volatility under distinct market trends in the Pakistan stock market, using a non-parametric quantile causality approach, the study provide evidence that geopolitical oil price displacements have a causal effect on security returns only under normal market conditions, whereas they have a causal effect on volatility under all market conditions. More so, focusing on three oil-exporting countries Shahrestani and Rafei (2020) in Iran (an oil-exporting economy) investigated the effect of oil price shocks on the Tehran stock exchange index using a two-regime Markov Switching Vector Autoregressive (MS-VAR) model. Findings differed in both regimes based on their intercepts, coefficients, and variances.

The available literature on the subject matter suggested that only a few studies utilized data from the African continent. One of them focused on five major oil-producing countries in Africa using the dynamic panel analysis technique with quarterly data spanning 2010 to 2018 (Kelikume and Muritala, 2019). The variables for the model comprised stock returns, real GDP growth rate, exchange rate, and OPEC oil price. Results showed the adverse effect of oil price changes on African stock markets, largely traceable to the fragmented and underdeveloped nature of their capital markets. Tumala, Salisu, and Gambo (2023) contributed to the discussion by examining the effects of disentangled oil shocks on the volatility of the stock markets of Nigeria and South Africa using the Mixed Data Sampling variant of the Generalized Autoregressive Conditional Heteroskedasticity (GARCH-MIDAS) model, the study found that Nigerian and South African stock market volatility responds similarly to oil supply shocks and oil consumption demand shocks, but differently to economic activity shocks and oil inventory demand shocks. In the same vein, Adenekan, Hilili and Okereke (2020) also studied the nexus between oil price, exchange rate and stock market performance, using the VAR based technique and granger causality test. The result showed a unidirectional relationship running from crude oil price to shares, and shocks to crude oil market had positive impact on share prices.

Furthermore, Enwereuzoh *et al*. (2021) investigate the impact of crude oil shocks on selected African stock markets using a Structural Vector Autoregressive model and a two-state regime smooth transition regression framework. The study considers the stock markets of both oil-exporting and oil-importing countries in Africa, Results suggest that global demand shock has little effect on real stock returns in oil-importing nations; there is little evidence that oil supply shock affects real stock returns in both oil-exporting and oil-importing countries. Oil-specific shocks are significant in most nations studied; negative price shocks have a greater impact than positive price shocks.

Outside Nigeria, Ahmadi and Manera (2021) examined the impact of oil price shocks on 3 major net oil-exporting countries (Canada, Norway and Russia) using the threshold structural VAR. The study found little evidence of asymmetric response of output to asymmetric oil price shocks.

In another study, Hashmi *et al* (2022) showed that the impact of Brent crude oil prices on the Shanghai Composite Index and selected industries is significant. However, there are some variations in these relationships and the degree of influence on each differs during different sample periods.

Hashmi *et al*. (2022) showed in another study that the Shanghai Composite Index and a few selected industries are significantly impacted by Brent crude oil prices. However, the relationships do vary and the strength of each influence varies depending on the sample period.

Finally, an analysis of the effect of oil price and other macroeconomic variables on the Egyptian stock market returns showed a significant positive relationship between oil price and stock returns. However, the exchange rate indicated negative relationship while interest rate and inflation suggested no relationship with oil price.

Overview of the Stock Markets

Our study focused on the stock markets of six emerging Sub-Saharan African countries namely; Nigeria, Egypt, South Africa, Kenya, Ivory Coast, and Ghana, which are ranked among the largest stock markets in Africa. South Africa, Kenya, Ghana and Nigeria each operate a single fully functional stock and securities exchange in their respective countries, while Egypt has two operational stock exchanges. The stock market in Ivory Coast on the other hand operates under a regional stock exchange. The Johannesburg Stock Exchange (JSE) is the official stock exchange of South Africa. It is currently ranked as the largest in Africa and among the top 20 in the world by market capitalization. The JSE established in 1887 currently has over 350 listed companies and has contributed to economic growth and development over time (Osakwe *et al*., 2020).

The Kenyan stock exchange, popularly known as the Nairobi Securities Exchange (NSE) is also among the top three leading stock exchanges in the region. It was established in 1954 and currently has over 200 companies listed. The NSE has various international and intra-continental affiliations and contributes substantially to the development of the Kenyan capital market and the economy at large. Ivory Coast is one of the 8 West African countries trading under the regional stock exchange known as

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Bourse Regionale des Valeurs Mobilieres (BRVM). The BRVM is currently located in Abidjan and has about 45 listed companies. Prior to the establishment of BRVM in 1998, the main stock exchange in Ivory Coast was the Abidjan stock exchange known as Bourse des Valeurs d'Abidjan.

These stock markets have developed overtime with substantial contributions to the development of the respective economies and the region at large. They are also among the largest emerging capital markets and attract a considerable amount of foreign and domestic investments. According to available data, South Africa (342.5%) in 2019 had the highest market capitalization to nominal GDP ratio, the second highest was Kenya (26.1%), the third was Ivory Coast (18.3%), Egypt (16.7%) was the fourth, Nigeria was the fifth (9%) and Ghana [1] (7.8%) was the lowest.

Furthermore, among these countries, South Africa seems to have the highest number of listed companies, while the lowest is Ghana.

METHODOLOGY AND DATA

Theoretical Framework and Model Building

The Arbitrage Pricing Theory (APT) hypothesizes that asset returns are vulnerable to macroeconomic risks posed by inflation, output volatility and exchange rate volatility, oil price shocks among others. The relationship is represented below.

$$\gamma_i = \alpha_i + \beta_i \theta + \varepsilon_i \text{.............................} \quad (1)$$

where γ_i represents stock returns[2], α_i denotes the unconditional expected return, θ is a vector of different risks which affect stock returns,$\beta_i$is the coefficient that measures the impact of the risks on stock returns, while ε_i is the stochastic error term. However, Salisu and Isah (2017) argue that for an oil exporting country, which is reliant on oil revenue for economic activities, a sudden change in oil price will trigger these macroeconomic risks. This implies that macroeconomic risks, which influence asset prices are embedded in the oil price, and shocks to oil price directly affects the performance of asset prices. Hence, oil price is isolated among the other risks in equation 1 as follows;

$$\gamma_i = \alpha_i + \beta_i op + \varepsilon_i \text{ ....} \quad (2)$$

The present study aims to capture the impact of oil price on stock return volatility. Therefore, we employ a structural Vector Autoregressive (SVAR) model to determine the specific impacts of different oil price shocks on the stock market.

[1] Available data for Ghana ends in 2011.

[2] Stock returns is defined as $sr = 100 * \log\left(\frac{sp}{sp(-1)}\right)$

However, we begin with estimating a Generalized Autoregressive Conditional Heteroskedasticity (GARCH 1,1) model to derive the conditional volatility of stock returns. The Engle (1982) Autoregressive Conditional Heteroskedasticity ARCH (1,1) model is specified as follows;

$$\sigma_i^2 = \lambda_0 + \lambda_1 \varepsilon_{i-1}^2 \text{..................................} \quad (3)$$

where σ_t^2, the dependent variable is the squared residuals obtained from the estimation of equation (1), which captures the conditional variance, and $\lambda_1 \varepsilon_{i-1}^2$captures the ARCH effect. Equation (2) is then extended to the GARCH (1,1) model[3] which allows the conditional variance to be dependent upon its previous lags;

$$\sigma_t^2 = \lambda_0 + \lambda_1 \varepsilon_{i-1}^2 + \gamma_1 \sigma_{i-1}^2 \text{.............................} \quad (4)$$

where σ_t^2 denotes the conditional variance, $\lambda_1 \varepsilon_{i-1}^2$ captures the ARCH effect, and $\gamma_1 \sigma_{i-1}^2$ is the lagged dependent variable which captures the GARCH effect.

Structural Vector Autoregressive (SVAR) Model

Barsky and Kilian (2002) identified three determinants of global oil price including the shocks to the global supply of crude oil, changes in the global business cycle which affect the demand for crude oil and shocks originating from an increase in precautionary demand for crude oil[4]. Based on this, we rely on a structural Vector Autoregressive (SVAR) model to estimate the impact of the above oil price shocks on stock returns volatility for oil importing and exporting countries in Africa. The SVAR model linking the global oil price to the stock market volatility for each of the countries is specified below:

$$A_0 Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \alpha_2 Y_{t-2} + \cdots + \alpha_p Y_{t-p} + \mathcal{E}_t \ldots \quad (5)$$

where Y_t=[$g_t e_t$ p_t sv_t]is a 4×1 vector of dependent variables, where g_t represents global oil Production, e_t represents global economic activities, p_t represents oil price and sv_t represents conditional volatility of stock returns derived from the GARCH (1,1) model. A_0 is a 4×4 contemporaneous coefficient matrix, α_0 represents a 4×4 vector of constant terms and $\mathcal{E}_t$ is a 4×4 vector of structural shock with a zero mean and serially uncorrelated. P is the optimal lag determined by the Akaike Criterion (AIC) and Schwartz Information Criterion (SIC). The reduced form of the VAR model for estimation is given as;

$$Y_t = C(L) Y_t + e_t \text{.....................................} \quad (6)$$

which can be expanded to be;

[3] The standard GARCH (1, 1) model is an extension of the ARCH model, which captures the lag of the dependent variable in the ARCH model. The model is assumed to outperform the ARCH model with less parameters and more efficiency.
[4] This demand arises from expectation scarcity of crude oil in relation to demand.

$$C(L)Y_t = A_0^{-1}(\alpha_1 LY_{t-1} + \alpha_2 LY_{t-2} + \cdots + \alpha_p LY_{t-p}) + e_t = A_0^{-1}\mathcal{E}_t. \text{ ...... (7)}$$

where $A_0^{-1}\mathcal{E}_t$ is the reduced form VAR residuals.

In line with Kilian and Park (2009) and Bastianin *et al*. (2016), the identification of the model is given by imposing the following restrictions onA_0^{-1}:

$$e_t \equiv \begin{pmatrix} e_t^{g_t} \\ e_t^{e_t} \\ e_t^{p_t} \\ e_t^{sv_t} \end{pmatrix} = \begin{bmatrix} a_{11} & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} \end{bmatrix} \begin{pmatrix} \mathcal{E}_t \; Oil\ Supply\ Shock \\ \mathcal{E}_t \; Aggregate\ Demand\ Shock \\ \mathcal{E}_t \; Oil\ Demand\ Shock \\ \mathcal{E}_t \; Other\ Shocks\ to\ SV \end{pmatrix} \text{.... (8)}$$

The exclusion restrictions in the model above are motivated by the identifying assumptions specified by Kilian (2009) Kilian and Park (2009). The restrictions on the global oil market (i.e. global oil production, real global oil price and global real economic activity[5]) are based on the vertical short-run global oil supply curve and downward sloping oil demand curve. We assume that a shift in the crude oil demand and supply curves driven by unanticipated oil demand shock or aggregate demand shock and unanticipated oil supply shocks respectively will trigger an instantaneous change in the real price of oil.

It is instructive to note the following underlying assumptions for equation 8; i) oil production will not respond to demand shocks within the same month due to the high cost of adjusting oil production; ii) global economic activities are not affected by an increase in the real price of oil driven by oil specific demand shocks within the same period. However, aggregate demand shocks i.e. change in demand for oil as well as other commodities affect economic activities instantaneously iii) changes to the real oil price are motivated by oil supply shocks and aggregate demand shocks, as well as oil-specific demand shocks; iv) stock returns volatility are assumed to respond instantaneously to the three oil market shocks and other shocks to the stock market volatility. However, based on Kilian and Park (2009) it is assumed that stock market volatility does not affect the oil market instantly but with a lag of at least one month (Kilian and Park, 2009; Kilian and Vega, 2011; Bastianin and Manera, 2016; Bastianin *et al*., 2016).

[5] Global economic activities refer to aggregate demand, which encompasses the demand for all commodities including crude oil.

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DATA

The study uses monthly data ranging from January 2000 to December 2019 for two net oil exporters in Africa, Nigeria and Egypt and four oil-importing countries in Africa, Ivory Coast, Ghana[6], South Africa and Kenya. According to the World Factbook ranking, Nigeria and Egypt are ranked as the 1st and 7th largest oil exporters in Africa in terms of export volume, and the 6th and 29th respectively in the world. The stock price index of respective countries and WTI oil price were obtained from the Bloomberg terminal. The oil market data were obtained as follows; Global oil production and real oil price were obtained from the Baumeister & Hamilton (2019) database; and the index of global economic activities was obtained from the updated Kilian (2009) database. Stock returns volatility for each country was computed using the process described in equations 1-4.

RESULTS AND DISCUSSION

Preliminary Analysis

The table below shows the summary statistics of stock returns for Nigeria, Egypt, Ivory Coast, Ghana, South Africa and Kenya as well as the oil market indicators. Average stock returns are approximately 0.535 and positive for Nigeria, Egypt, Ghana, South Africa and Kenya while Ivory Coast is negative. Based on the minimum and maximum values, there seems to be evidence of variation in the stock returns of all countries. This is shown by the difference between the maximum and minimum values, which appears to be highest in Egypt (71.523) and lowest in Ghana (27.308). The standard deviation ranges from 4.648 in South Africa to 9.133 in Egypt. Stock returns are leptokurtic and negatively skewed in all countries except Ivory Coast and Ghana indicating that the stock markets tend to experience frequent small gains and few extreme loses. This also indicates the presence of volatility in the stock returns, thus justifying the study of stock market volatility. The mean of all oil price indicators is positive, positively skewed and plutocratic. Based on the standard deviation, the economic activity index appears to be most volatile, while the least volatile is the global oil production.

[6] Data for Ghana starts from January 2010 due to data limitation

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Table 1

Summary Statistics

Country	Mean	Std. Dev.	Min	Max	Skewness	Kurtosis
Stock Returns						
Nigeria	*0.644*	*6.848*	*-36.576*	*32.996*	*-0.427*	*8.262*
Egypt	*1.006*	*9.133*	*-40.331*	*31.192*	*-0.165*	*4.893*
Ivory Coast	*-0.050*	*4.998*	*-21.782*	*16.837*	*0.076*	*4.240*
Ghana	*0.754*	*4.783*	*-9.681*	*17.627*	*0.743*	*5.039*
South Africa	*0.800*	*4.648*	*-15.031*	*13.132*	*-0.242*	*3.599*
Kenya	*0.058*	*5.681*	*-25.667*	*16.019*	*-0.434*	*5.231*
Oil Market indicators						
Global Oil Prod.	*75.160*	*4.710*	*66.207*	*84.646*	*0.033*	*2.155*
Eco. Activities	*12.091*	*71.899*	*-159.644*	*190.729*	*0.472*	*2.641*
Real Oil Price	*28.277*	*10.954*	*10.896*	*61.587*	*0.530*	*2.435*

Figure 1. Shows that the stock market experiences periods of high variations followed by periods of relatively low variation. This further indicates the presence of volatility in the stock returns of all countries.

The Autoregressive Conditional Heteroskedasticity (ARCH-LM) test was conducted to test for the presence or otherwise of conditional volatility in the stock returns of respective countries. The ARCH tests were conducted for mean equation $sr_t = \alpha_t + \sum_{i=1}^{k} \delta_i sr_{t-i} + \varepsilon_t$........................ (9),

where i= 1,2,3…k and t=1,2,3…N. The results for the AR(1) model (table 2) indicates the presence of the ARCH effect in Nigeria, South Africa and Kenya at lag 2, 5 and 10 at 1 per cent significance level. Ivory Coast exhibits arch effect at lag 10, and no ARCH effect in Ghana and Egypt. The results for the AR (2) model shows the presence of ARCH effect at all lag lengths considered for Nigeria, South Africa and Kenya. Ghana exhibits ARCH effect at lag 2 and 5, Ivory Coast at lag 10, and Egypt at lag 2. The results also indicate that the stock market of Nigeria, South Africa and Kenya are more volatile than the other countries. The Ghanaian stock market is moderately volatile while volatility in Egypt and Ivory Coast are weaker than the rest. This may be as a result of the use of monthly data, rather than a higher frequency data (Salisu and Gupta, 2019). Notwithstanding, the ARCH LM test, and other preliminary analysis provide sufficient evidence of ARCH effects and provide justification for the study of volatility in the series.

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Table 2

ARCH-LM Test

		ARCH-LM TEST					
Mode	**Country**	***F-stat (2)***	**F-stat (5)**	**F-Stat (10)**	**Chi-Sq.(2)**	**Chi-Sq.(5)**	**Chi-Sq.(10)**
AR(1)	***Nigeria***	*8.542**	*10.349**	*6.804**	*23.466**	*43.255**	*54.423**
	Egypt	*0.397*	*0.641*	*0.758*	*1.205*	*3.245*	*7.698*
	Ivory Coast	*0.107*	*0.930*	*2.063***	*0.218*	*4.688*	*19.416***
	Ghana	*0.022*	*1.373*	*1.032*	*0.045*	*6.809*	*10.395*
	South Africa	*5.840**	*3.816**	*6.421**	*11.265**	*18.068**	*52.059**
	Kenya	*5.929**	*10.098**	*5.208**	*11.430**	*42.393**	*44.133**
AR(2)	**Nigeria**	*3.214***	*9.671**	*5.732**	*9.415***	*40.892**	*47.606**
	Egypt	*3.38****	*1.440*	*1.078*	*3.360****	*7.163*	*10.791*
	Ivory Coast	*0.239*	*1.833*	*1.738****	*0.485*	*8.983*	*16.686****
	Ghana	*2.516****	*1.901****	*1.124*	*4.936****	*9.187****	*11.209*
	South Africa	*6.108**	*4.130**	*6.693**	*11.755**	*19.422**	*53.704**
	Kenya	*2.820****	*11.621**	*6.239**	*5.577****	*47.450**	*50.873**

Note: *, **, *** denote 1%, 5% and 10% levels of significance respectively.

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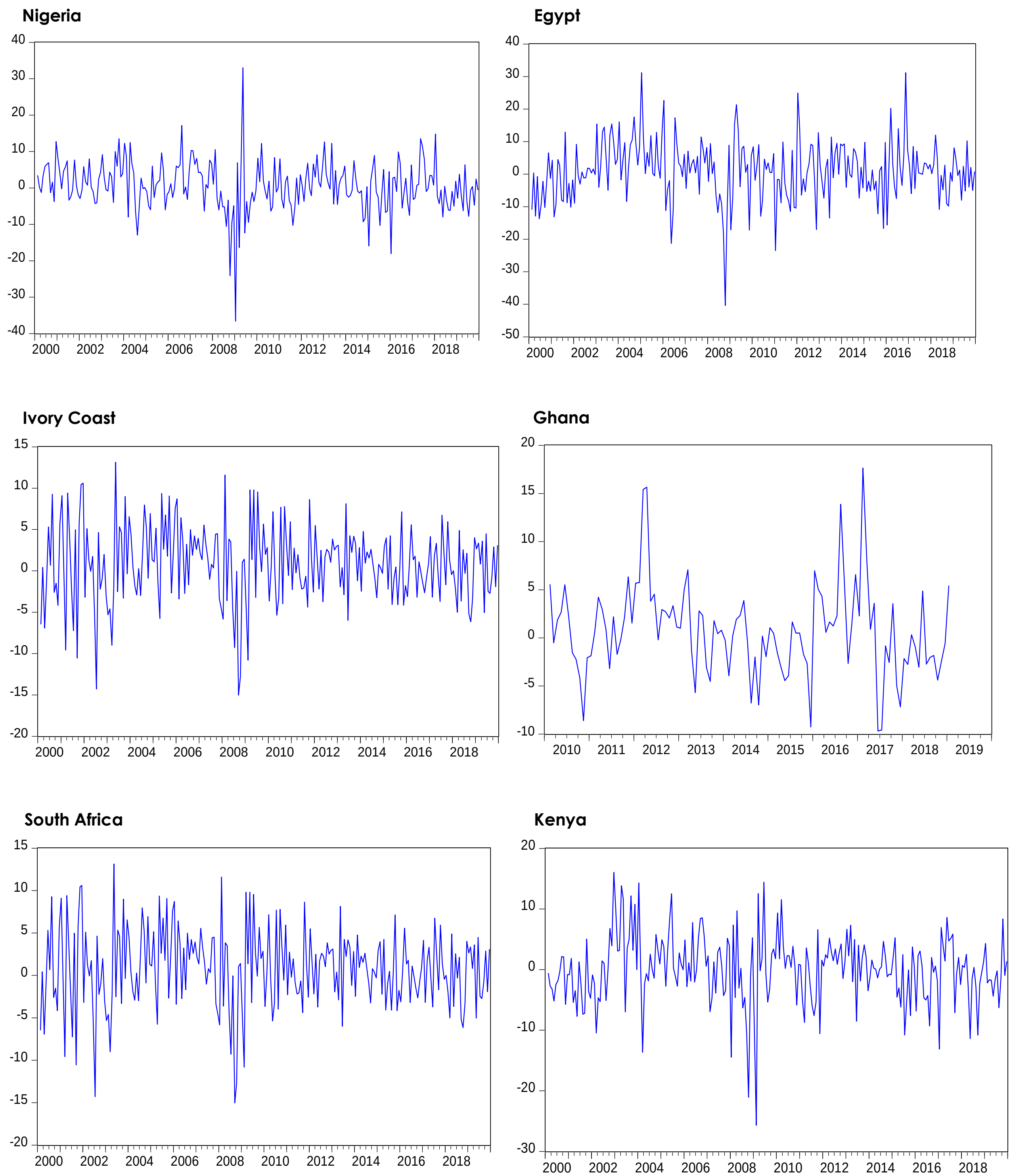
Figure 1: Monthly Stock Returns of Nigeria, Egypt, Ivory Coast, Ghana, South Africa and Kenya.



Impulse Response Function

The response of the stock market volatility to oil price shocks is shown in Figure 1 below. We report impulse response of stock market volatility to a two-standard deviation shock to global oil production, global economic activities and the real oil price. These shocks are interpreted as a negative oil supply shock, a positive shock to aggregate demand and a positive oil specific demand shock respectively, all of which trigger an increase in oil price.

Based on the figures, the response of stock market volatility to oil supply shocks is not statistically different from zero in all countries considered. This implies that an unanticipated cut in global oil production does not significantly affect the stock market of these countries. Furthermore, in line with findings of Bastianin *et al* (2016), we find no notable difference in the response of the stock markets of oil exporting countries and oil importing countries to oil supply shocks.

In the case of aggregate demand shocks, we observed that the response of stock market volatility to aggregate demand shocks is negative and significant. This implies that a positive aggregate demand shock reduces stock market volatility in all countries. A closer look at the graph for Nigeria revealed that the immediate response of the stock market is a rise in volatility, which is reversed after the 3rd month. The decline in volatility lasts up to the 11th month and there is a gradual rise in volatility in subsequent months. For Egypt, Ivory Coast, Ghana, and South Africa, the immediate response is a decline in volatility which lasts up to 7 months, 5 months, 9months and 11 months respectively after which the shocks fizzle out. In the case of Kenya, the initial decrease in volatility lasts for 3months, followed by a transitory rise in volatility until the 5th month, after which the shock fizzles out.

With regards to the oil-specific demand shocks (i.e. shocks to oil demand as a result in an increase in the real price of oil); we observed similar responses for all countries. In Nigeria and Egypt, oil-specific demand shocks tend to prompt a negative and significant response from stock market, however, the sign appears reverse around the 14th month for Nigeria and 7th month for Egypt. Kenya and South Africa exhibit a similar pattern and timing with Nigeria. The immediate impact is a decline in volatility which remains below zero for over a year and fizzles out after that. The reaction in Ghana is a short-lived decline in volatility which fizzles out after two months, while in Ivory Coast, the decline in volatility appears to last throughout the estimation period.

As expected the response of stock market volatility to other shocks to the stock market is positive and significant for all countries. This indicates that other shocks not related to the oil market tend to raise volatility in the stock market significantly.

Forecast Error Variance Decomposition

The forecast error variance decomposition shows the percentage of movement in stock market volatility that can be explained by the various oil market shocks. Based on the results in Table 3, the influence of the oil market shocks to stock market volatility in all the countries is negligible in the first month, while other shocks to the stock market contributes the highest proportion to stock volatility in all the countries. The contribution of oil supply shock was weak and insignificant for all countries, ranging from 0.0003 to 0.003 per cent in Egypt and South Africa respectively. Oil-specific demand shocks contribute more than other oil market shocks in Nigeria and Ivory Coast, while aggregate demand shocks contribute more in Egypt, Ghana and South Africa.

In the third month, the contribution of oil specific demand shocks was the highest in Nigeria, Ivory Coast and Kenya, with contribution above 2 per cent. Compared to other oil market shocks, aggregate demand shock contributes the highest in Egypt, Ghana and South Africa with contribution above 6 per cent. In the ninth month, the impact of oil specific demand shock rises to 33.76 per cent, 17.81 per cent and 13.31 per cent in Nigeria, Ivory Coast and Kenya respectively, while the contribution of other oil shocks was weak in these countries. In the case of Egypt and Ghana, the impact of aggregate demand shocks was the highest in comparison to other oil shocks.

Finally, in the eighteenth month, oil specific demand shocks had the highest impact in Nigeria, Ivory Coast and Kenya, compared to other oil market shocks. Aggregate demand shocks had the highest contribution in Egypt, Ghana, and South Africa. In the same period, the contribution of oil supply shocks remained low in all countries with the contribution ranging from 0.305 per cent in Nigeria to 3.617 per cent in Ivory Coast.

In summary, we observed that the impact of oil supply shocks is negligible in all the countries, with the highest being 3.61 per cent in Nigeria in the 18th month. This is in line with the findings of Kilian and Park (2009) and Bastianin *et al*., 2016 on the G7 countries. Furthermore, the results also show that aggregate demand shocks contribute less than 5 per cent to stock market volatility in Nigeria and South Africa. However, in the case of Egypt, it contributed more than other oil shocks in the all the periods. Finally, oil-specific demand shocks seem to contribute significantly to stock volatility in Nigeria, Ivory Coast and South Africa, although more in Nigeria. These differing responses may be attributed to the difference in the size of the economy and the level of oil production, as well as the market share of the different countries (Salisu and Gupta, 2019). Our results show that oil demand shocks contribute more to stock market volatility than oil supply shocks in oil importing and exporting countries. This corroborates the argument of various previous studies on this subject.

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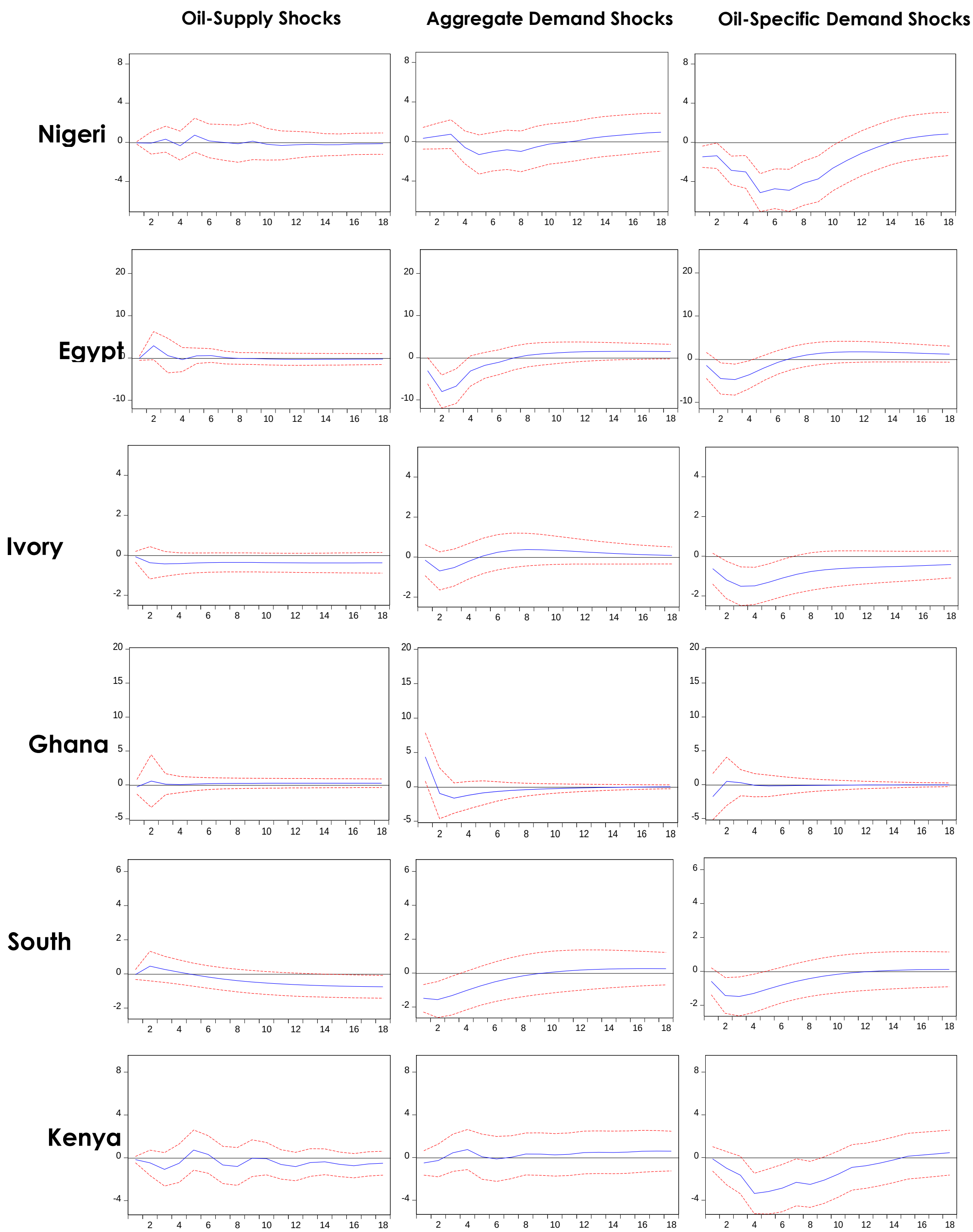
Table 3

Forecast Error Variance Decomposition

Period	**Shock**	**Nigeria**	**Egypt**	**Ivory Coast**	**Ghana**	**South Africa**	**Kenya**
t=1	Oil Supply	0.004	0.0003	0.020	0.025	0.003	0.039
	Aggregate Demand	0.147	1.687	0.093	5.612	5.532	0.344
	Oil-Specific Demand	3.092	0.444	1.581	0.924	0.860	0.022
	Stock Volatility	96.757	97.869	98.305	93.438	93.605	99.595
t=3	Oil Supply	0.088	0.857	0.674	0.117	0.286	0.812
	Aggregate Demand	0.764	11.426	1.517	6.439	6.589	0.304
	Oil-Specific Demand	9.989	4.391	8.452	0.979	4.684	2.138
	Stock Volatility	89.160	83.325	89.286	92.465	88.442	96.747
t=9	Oil Supply	0.221	0.797	1.866	0.171	0.527	0.911
	Aggregate Demand	1.661	11.015	2.034	7.394	5.634	0.354
	Oil-Specific Demand	33.768	7.274	17.811	0.998	5.774	13.310
	Stock Volatility	64.350	80.914	78.289	91.537	88.065	85.425
t=18	Oil Supply	0.305	0.812	3.617	0.319	3.002	1.514
	Aggregate Demand	2.227	11.913	2.487	7.321	5.442	0.829
	Oil-Specific Demand	33.667	9.600	20.144	1.002	5.364	12.975
	Stock Volatility	63.801	77.674	73.752	91.358	86.192	84.683

Note: Shock 1, 2, 3, and 4 refer to oil supply shocks, aggregate demand shocks, oil-specific demand shocks and other shocks to stock returns volatility respectively.

Figure 1: Response of Stock Returns Volatility to Oil Price Shocks



Note: The graphs show the estimated response of conditional volatility derived from the GARCH (1, 1) model for each country to a one-standard deviation shock to oil price.

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Robustness Tests

The proxy for volatility used in the initial analysis was the conditional volatility derived from a GARCH (1,1) model. However, to validate our findings we replaced conditional volatility in the SVAR model with an alternative measure of volatility. Based on the impulse response functions in figure 2 below, the estimated responses of log-conditional volatility to the different oil price shocks are similar to our earlier results, with slight differences in timing. For instance, in the initial analysis, the decline in volatility due to aggregate demand shocks reverses around the 11th month for Nigeria, while it remains below zero until the 16th months in the second model. Similarly, in the case of Kenya, the decline in volatility lasts until the 6th month in the second model, compared to the 3rd month in the first model. Overall, the responses in the second model do not differ significantly from those obtained using conditional volatility.

In addition, we test the robustness of our findings to changes in data frequency by estimating the initial model using quarterly data and observe similar responses to the other two models. Thus, our results are robust to changes in measures of volatility and sampling frequencies.

Figure 2: Response of Stock Returns Volatility to Oil Price Shocks

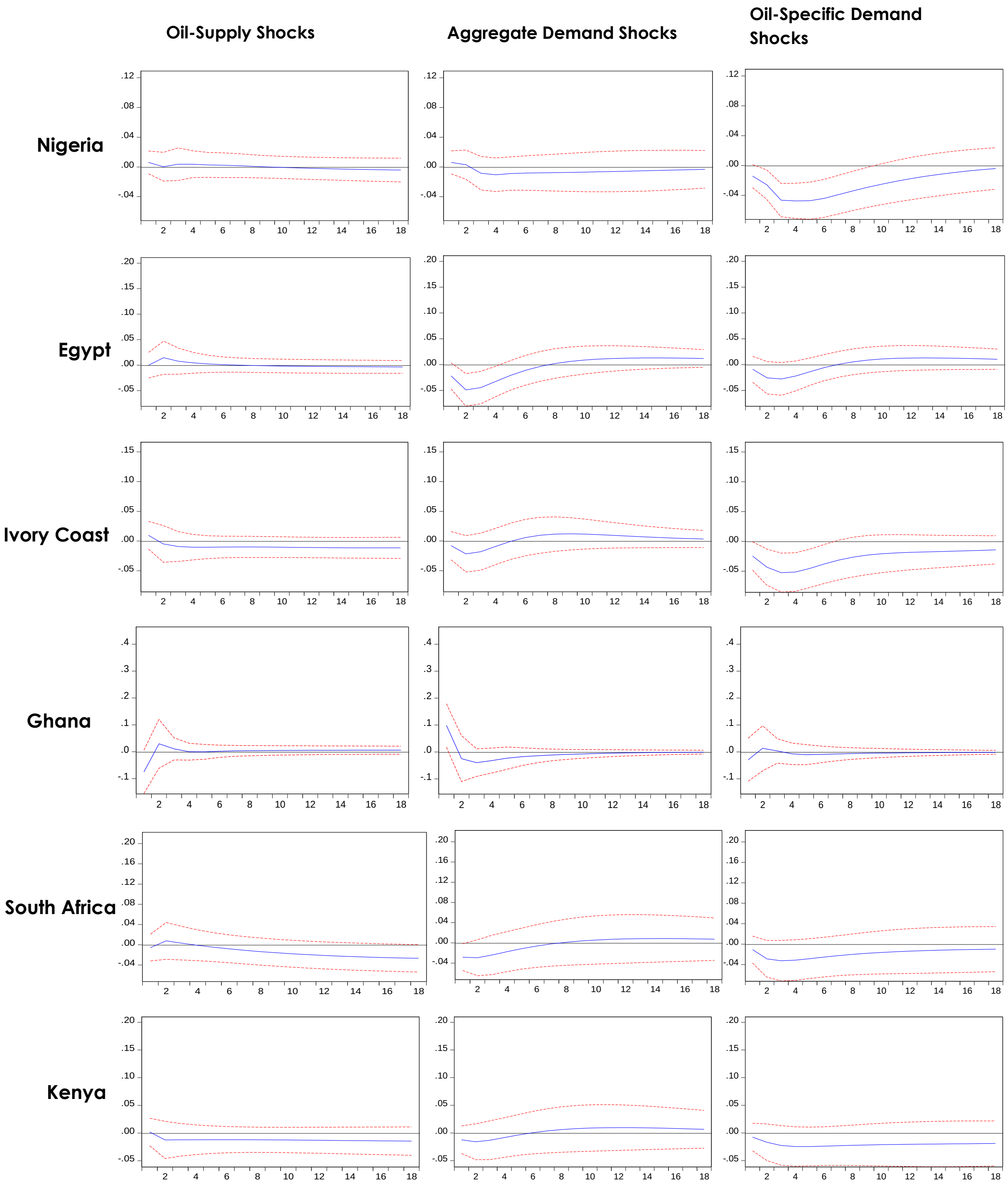

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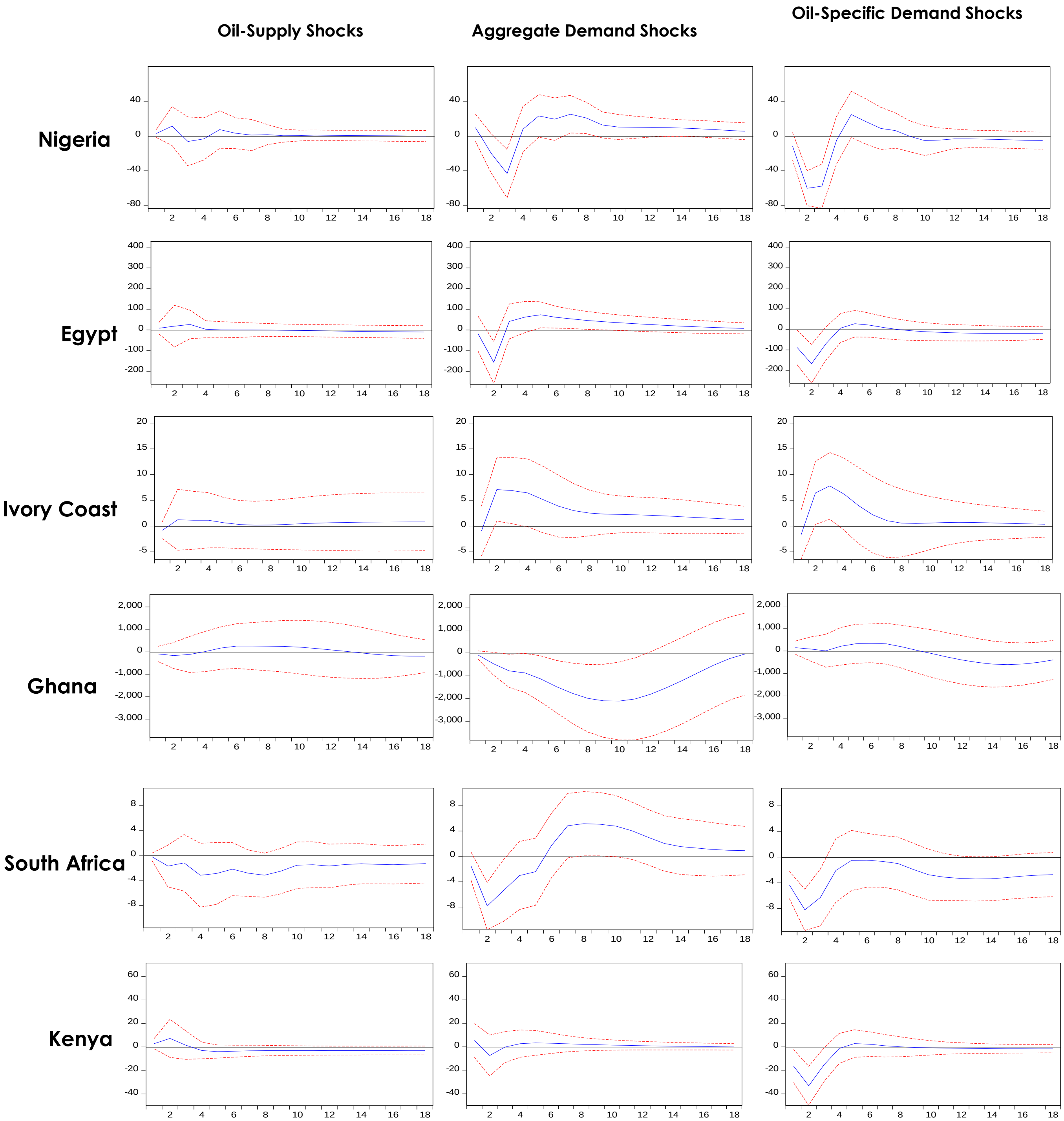
Figure 3: Response of Stock Returns Volatility to Oil Price Shocks



Note: Figure 3 shows the estimated response of quarterly conditional volatility to a one-standard deviation shock to oil price.

CONCLUSION AND POLICY IMPLICATIONS

In this paper, we revisited the oil price stock market nexus for selected sub-Saharan African countries, with emphasis on the impact of oil price shocks on stock market volatility. We employed a structural VAR model to estimate the response of stock markets to three measures of oil shocks proposed by Killian (2009), which captures demand and supply induced shocks. Specifically, we examined response of stock market volatility to global oil supply shocks, economic activity shocks and oil-specific demand shocks in two net oil exporters and four net oil importers in the region.

Our findings show homogeneity in the response of stock market volatility to oil shocks for both oil importing and oil exporting countries, with slight variances in the timing of pass-through and speed of adjustment. Decomposing the shocks into demand and supply shocks, we observed that supply shocks have no significant impact on stock market volatility in all countries considered. However, the response to aggregate demand shocks and oil-specific demand shocks is a decline in volatility in the short run and subsequent rise in volatility for all countries. To a large extent, the response of stock markets to oil-demand shocks is dependent on investors' behavior. For instance, if investors perceive a shock to be caused by a rise in aggregate demand or precautionary oil demand, there will be a decline in stock market volatility. However, when there are concerns about future cash flows and uncertainties about oil supply, there will be a rise in volatility. Overall, the findings are summarized as follows; the impact on stock market volatility is dependent on the source of the oil price shock; stock market volatility in oil exporting and oil importing countries seem have similar responses to oil price shocks; key drivers of stock volatility in Africa seem to be aggregate demand and oil specific demand shocks and not oil supply shocks. These findings have several policy implications. First, given that the contribution of oil supply shocks is negligible, it may be counterproductive for investors to base investment decisions on the impact of supply shocks on stock volatility. Second, the fall in volatility following an aggregate demand shock suggests that a rise in economic activities is interpreted as good news by investors. This implies that expansionary fiscal and monetary policies will increase investment activities in the short-run as these are indicative of increased future cash flows and investment profitability. Thirdly, our results indicate that the positive response to aggregate demand shocks reversed after 11, 7, 5, 9, 5 and 10 months in Nigeria, Egypt, Ghana, Ivory Coast, Kenya and South Africa respectively. Thus, policymakers in these countries need to take note of the timelines for reversal and implement timely policy responses to boost economic activities and retain investors' confidence. Furthermore, investors should take cognizance of the speed of pass-through of shocks for each country when making investment decisions to avoid losses. Finally, we observed that stock market volatility tends to fizzle out after some time in all countries. This is an indication of the developing nature of African stock markets. Therefore, analysis like this provides guidance for investors and risk managers in Africa and allows them to anticipate the various sources of stock volatility.

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