

Oil Price Shocks and Nigeria's Macroeconomy: Disentangling the Dynamics of Crude Oil Market Shocks

Global Business Review

16(6) 920-935

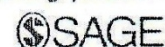
© 2015 IMI

SAGE Publications

sagepub.in/home.nav

DOI: 10.1177/0972150915597594

http://gbr.sagepub.com



Christopher N. Ekong¹
Ekpeno L. Effiong¹

Abstract

Previous empirical literature on the oil price shocks-macroeconomy relationship was hinged on the implicit premise that oil price shocks originated exclusively from exogenous supply shock to the crude oil market. Recent research by Kilian (2009) shows that oil price shocks are endogenous outcomes of the underlying demand and supply shocks in the crude oil market. Based on a two-stage approach, this article investigates the effects of demand and supply shocks in the crude oil market on Nigeria's macroeconomy for the period 1986-2011. Using a structural vector autoregressive (SVAR) model, oil price shocks are disentangle into three components: oil supply shocks, aggregate demand shocks and oil-specific demand shocks. The three shocks are recovered in the first analysis and conditioned on selected macroeconomic variables within a VAR framework in the second stage. The impulse response analysis shows that the macroeconomic aggregates are associated with different response pattern to each type of oil price shocks. However, their relative importance shows marginal effects.

Keywords

Oil price shocks, macroeconomy, Nigeria

Introduction

Over the past decade, oil prices have shown a wide volatility prompting deeper investigation into the dynamics of the crude oil market, the nature and impact of oil price shocks on the macroeconomy among economists. Recent development in the crude oil market especially the increased demand for oil from emerging economies, such as, China and India, has led researchers, such as, Hamilton (2009a, 2009b) and Kilian (2009), to suggest that unexpected oil price hikes may not necessarily be due to exogenous political events which affects the supply side of the market but could also be demand driven. The surge

¹ Department of Economics, University of Uyo, Akwalbom State, Nigeria.

Corresponding author:

Ekpeno L. Effiong, Department of Economics, University of Uyo, P.M.B. 1017, Uyo, Akwalbom State, Nigeria.
E-mails: ekpenoeffiong@uniuyo.edu.ng; ekpenol@gmail.com

in oil prices since early 2000 has been demonstrated to be driven primarily by shocks to the demand side of the crude oil market especially with limited increase in crude oil production and the declining importance of the Organization of the Petroleum Exporting Countries (OPEC) as a cartel within the international oil market.

Previous literature on the oil price shocks–macroeconomy relationship had concentrated on the linear and asymmetric models of oil price shocks which rested on the premise that oil price shocks originated exclusively from the exogenous supply side of the crude oil market. With the decline in the importance of Hamilton's (1983) linear impact model, Mork (1989), Lee, Ni and Ratti (1995) and Hamilton (1996) proposed alternative measures of oil price transformation that introduced asymmetries into the transmission models of oil price shocks. Unlike in standard models of oil price shock transmissions in which the response of macroeconomic aggregates would be identical for both negative and positive oil price changes, asymmetries tend to amplify and dampen the response of macroeconomic aggregates to oil price increase and decrease, respectively, due to the complementary mechanisms of discretionary income, uncertainty and reallocation effects (Kilian, 2010).

The low explanatory power of the asymmetric models coupled with the declining importance of oil price shocks since the late 1980s has led Kilian (2009) to criticize the implicit assumption of exogenous oil price shocks. This conventional approach fails to account for possible reverse causality from macroeconomic aggregates to oil prices and that oil price changes are deeper outcomes of both demand and supply conditions in the crude oil market. Kilian's (2009) analysis shows that the origin and impact of oil price shocks depend on the underlying source of oil-demand shock and oil-supply shock (OSS) in the crude oil market. Kilian (2009) accounts for these problems by developing a model of the global crude oil market using vector autoregression (VAR) model with three variables: the oil supply, the real oil price and an index of global economic activity to proxy for the global demand for industrial commodities, and further identifies based on a recursive structure, three types of oil price shocks, namely, OSS, aggregate demand shock (ADS) and oil-specific demand shock (OSDS). The distinction between oil-demand and OSSs provides a framework for analysing the endogenous character of oil price shocks which may have different implications for macroeconomic aggregates as shown by Kilian (2009) in his seminal work on the US economy.

This article pioneers the first analysis of the oil price shocks–macroeconomy relationship that accounts for the endogeneity of oil price shocks based on its underlying source of oil-demand shock and OSS within the global crude oil market on Nigeria, an oil-exporting country. Following Kilian (2009) and Kilian, Rebucci and Spatafora (2009), a two-stage approach is employed to disentangle the three types of oil price shocks and their effects conditioned on selected macroeconomic variables for the Nigeria economy during the period 1986–2011. Impulse response functions and variance decomposition analysis is used to trace the response pattern of the selected macroeconomic variables to each type of oil price shocks and their relative importance, respectively. Like Kilian (2009), our analysis hopes to offer insight into how oil price changes induced by its underlying source may have different effects on Nigeria's macroeconomy. The uniqueness of the Nigerian economy is because she doubles as both an oil exporter and importer. Oil generates more than 90 per cent of her earnings with the budgetary process conditioned on the prevailing oil price in the crude oil market. In addition, the country imports refined petroleum products to augment domestic production from four refineries which are in a dilapidated state. As such, her fiscal activities and economic management are subject to the vagaries of the crude oil market.

The rest of the article is organized as follows: The section 'Oil Price Shocks and the Macroeconomy: The Literature So Far' provides a review of the literature on the oil price shocks–macroeconomy relationship. The section 'Econometric Methodology and Data' describes the methodology and data employed for the analysis. The section 'Estimation Results' reports the estimation results and discussion and finally the section 'Conclusion'.

Oil Price Shocks and the Macroeconomy: The Literature So Far

Since the oil price shocks of 1970s, a preponderance of literature has investigated the impact of oil price shocks on the macroeconomy. Recent oil price hikes since 2000 have further deepen the discourse among economists from both theoretical and empirical angles on the relationship between oil prices and the macroeconomy. As a basic input in the production process, crude oil plays an important role in the world economy. However, changes in oil prices may exert considerable influence on the macroeconomy with a slowdown in economic growth and inflation as two inevitable outcomes. Theoretically, oil price shocks can influence macroeconomic activities through both the supply and demand transmission channels (see Brown & Yucel, 2002; Cologni & Manera, 2008; Tang, Wu & Zhang, 2010). On the supply side, oil price shocks increases the marginal cost of production leading to a reduction in capacity utilization and production. The increased production cost dampens investment expenditure via the uncertainty channel and consumption demand falls following an increase in the product prices. In addition, oil price shocks tend to worsen the terms of trade of oil-importing countries while transferring wealth in the form of oil receipts to oil-exporting countries, hence the reasoning that oil price shocks may have heterogeneous impact on the economies of oil-importing and oil-exporting countries (see Bjørnland, 2009).

Hamilton (1983) pioneered the first research work on the impact of oil price shocks on the macroeconomy in which he demonstrated that oil price shocks preceded all except one of the recessions experienced by the US economy. In the aftermath, the oil price shocks and macroeconomy literature have witnessed an exponential growth in researches for both oil-importing and oil-exporting countries.¹ So far, the core of empirical literature investigating the relationship between oil price shocks and the macroeconomy has focused on the linear and non-linear or symmetric and asymmetric effects of oil price shocks and the adoption of appropriate monetary policies in coping with the oil shocks (Tang et al., 2010). The maintained assumption in the literature has been to treat oil price shocks as an outcome of exogenous OSSs from the crude oil market triggered by political events or wars especially in the Middle East.

By the mid-1980s, Hamilton's (1983) linear negative oil price shocks and macroeconomy relationship had lost its significance. The decline in oil prices during this period had positive effects on macroeconomic activities in contrast to the predictions of the linear oil price shocks model. This meant a re-validation of the oil price shocks and macroeconomy relationship using alternative econometric specification. An extension of the linear oil price shock models was later introduced by Mork (1989). Lee et al. (1995) and Hamilton (1996) with emphasis on the non-linear transformation of oil prices. At first, Mork (1989) proposed the separation of oil prices into two separate variables capturing increases and decreases in oil prices for possible asymmetric responses of macroeconomic aggregates to oil price shocks. Lee et al. (1995) in their analysis took into account the volatility of oil prices by reflecting on both the unanticipated component of real oil price movement and the time-varying conditional variance of oil price forecasts using the generalized autoregressive heteroskedasticity (GARCH) model. Hamilton (1996) later proposed an alternative non-linear specification that considered the net increase in oil prices over the last year on the premise that observed oil price increases were corrections to initial declines.

Recent empirical literature is dominated by studies that attempt to model the asymmetries in the oil price shocks-macroeconomy relationship (see, e.g., Davis & Haltiwanger, 2001; Du, He & Wei, 2010; Hamilton, 2003; Lardic & Mignon, 2006; Lee et al., 1995). For instance, Lardic and Mignon (2006) studied the relationship between oil prices and economic activities in 12 European countries. They found the relationship to be asymmetric, that is, rising oil prices retard macroeconomic activities more than it is stimulated by falling oil prices. Du et al. (2010) investigated the linear and non-linear impact of oil price shocks on China's macroeconomy. They found a positive correlation between oil prices and China's

macroeconomic activities proxied by real output and consumer prices using the linear model, whereas the non-linear models showed that oil price shocks have an asymmetric impact of China's real output with the three non-linear oil price transformation having different magnitudes. The asymmetric impact of oil price shocks has also been investigated with particular reference to Nigeria (see, e.g., Akpan, 2009; Chuku, 2012; Iwayemi & Fowowe, 2011; Olomola & Adejumo, 2006). The main advantage of the asymmetric oil price shock models as argued by Kilian (2010) is that researchers need not take a stand on the mechanism generating the asymmetric response to oil price shocks, hence the paucity of an explicit theoretical justification for the asymmetric impact of oil price shocks. To wit, only the so-called *dispersion hypothesis* of Lilien (1982) provides an economic justification in the literature for the asymmetries in the oil price–macroeconomy relationship. The argument is hinged on the adjustment cost induced by sectoral reallocation of resources following a change in oil prices. For instance, an oil price increase (decrease) causes a contraction (expansion) in the aggregate output of sectors that utilizes oil in the production process and further generates an expansion (contraction) of energy-efficient sectors relative to energy-intensive sectors. The cost of sectoral reallocation of resources between energy-efficient and energy-intensive sectors leads to a reduction in aggregate output.

However, the asymmetric models of oil price shocks have not been spared from criticism. Kilian and Vigfusson (2009) show that the asymmetric models of oil price shocks transmission were misspecified resulting in spurious and inconsistent parameter estimates without statistical significance.³ The low explanatory power of the asymmetric models coupled with the declining importance of oil price shocks since the late 1980s has been linked to the implicit premise that oil price shocks are exogenous with respect to the global economy (Kilian, 2009, 2010). Existing studies (see, e.g., Barsky & Kilian, 2002, 2004; Hamilton, 2008; Kilian, 2008) argue that the same economic shocks that drive macroeconomic aggregates may likewise drive oil prices, thus making it impossible to separate reverse causality. The premise that oil price changes originate exclusively from exogenous supply shocks in the crude oil market provides a partial and incomplete treatment of the determination of oil price shocks. Studies by Hamilton (2009a, 2009b) and Kilian (2009) have shown that changes in oil prices originate not solely from the supply side of the crude oil market but also from the demand side. The emphasis on the demand-side conditions of the crude oil market underscores the relative importance of different oil-demand shocks which could be speculative in nature or traceable to fluctuations in the global business cycle (Kilian, 2009, 2010). Therefore, changes in oil prices are induced by a combination of oil-demand shock and OSS in the crude oil market with different effects on real oil prices and the macroeconomy. In other words, oil price shocks are better understood by tracing its source of origin based on the underlying economic conditions within the crude oil market.

In modelling the endogenous character of oil price determination, Kilian (2009) develops a model of the global crude oil market that accounts for the underlying source of oil-demand shock and OSS which allows one to assess the relative contribution of each type of oil price shocks to the variation in oil prices and macroeconomic aggregates. Kilian (2009) decomposes oil price shocks into three types, namely, OSSs which are driven by disruptions in global oil production, ADSs induced by global expansion in economic activities, such as, increased demand for industrialized commodities and crude oil, and oil-specific (precautionary) demand shocks which represents an expectation-driven shock induced by uncertainty over the future availability of crude oil supplies. Using this methodological framework, Kilian (2009) has shown that depending on the underlying source of oil price shocks, the effects of demand and supply shocks in the crude oil market are qualitatively and quantitatively different on US macroeconomic aggregates. Extensions of this model and similar frameworks that distinguish between oil-demand and supply shocks can be found in Kilian et al. (2009), Kilian and Park (2009), Aspergis and Miller (2009), Lippi and Nobili (2009), Peersman and von Robays (2009, 2012) and Baumeister and

Peersman (2009) for developed economies and Effiong (2014) for a developing economy, such as, Nigeria, within the context of oil price shocks and stock market relationship.

With the shift in focus in the current literature from the linear and asymmetric models which rested on the exogeneity assumption of oil price shocks to an endogenous framework for oil price shocks determination associated with the underlying source of oil-supply and demand shocks in the crude oil market, this article investigates the dynamic effects of each type of oil price shocks on Nigeria's macroeconomy in the same spirit as Kilian (2009).

Econometric Methodology and Data

Following Kilian (2009) and Kilian et al. (2009), a two-stage approach is adopted to disentangle the effects of the demand and supply components of the oil price shocks on Nigeria's macroeconomy. First, the oil-demand and supply shocks are identified using a recursive (Cholesky) identification scheme. Once the oil market shocks are recovered from the first stage, it is then conditioned on selected macroeconomic variables within a VAR framework to assess their response pattern and the relative importance of each oil price shocks (including their cumulative effects) in explaining the fluctuations in the macroeconomic aggregates over time. In the second stage, the structural oil market shocks are treated as predetermined.

The starting point of the analysis is the estimation of a structural VAR model using monthly data for the vector of time series y_t consisting of global oil production, detrended measure of global real economic activity and the real price of crude oil. The structural VAR model representation is given as:

$$Ay_t = c + \sum_{i=1}^p A_i y_{t-i} + \varepsilon_t \quad (1)$$

where ε_t denotes the vector of serially and mutually uncorrelated structural shocks and $y_t = [\text{oilprod}_t, \text{gea}_t, \text{roilp}_t]$ is a vector of endogenous variables. The structural shocks, ε_t , is derived by imposing an exclusion restrictions on A_0^{-1} such that $\varepsilon_t = A_0^{-1} \varepsilon_t$. This gives a recursively identified model as follows:

$$e_t \equiv \begin{pmatrix} e_{1t}^{\text{oilprod}} \\ e_{2t}^{\text{gea}} \\ e_{3t}^{\text{roilp}} \end{pmatrix} = \begin{pmatrix} a_{11} & 0 & 0 \\ a_{21} & a_{22} & 0 \\ a_{31} & a_{23} & a_{33} \end{pmatrix} \begin{pmatrix} \varepsilon_{1t}^{\text{oil supply shock}} \\ \varepsilon_{2t}^{\text{aggregate demand shock}} \\ \varepsilon_{3t}^{\text{oil-specific demand shock}} \end{pmatrix} \quad (2)$$

From (2), Kilian (2009) decomposes oil price fluctuations into three structural shocks: 'OSSs' to capture global supply of crude oil; 'ADSs' capturing innovations to global economic activity due to increased global demand for all industrial commodities; and 'OSDSs' to capture precautionary demand for crude oil that reflects concern about future shortfalls in oil supply. The error decomposition structure in (2) is based on three assumptions of exclusion restrictions (see Kilian, 2009). First, OSSs are exogenously determined and therefore do not respond to the other shocks—ADSs and OSDSs. Such shocks are driven by oil production disruptions caused by military and political conflicts or adjustment in the production quota as determined by OPEC's monopoly of the crude oil markets. Therefore, oil-producing countries will respond with a lag to demand shocks given the high cost of oil production adjustment and uncertainty in the crude oil market. Second, the global real economic activity responds immediately to OSSs while it reacts sluggishly (more than a month) to other oil-specific shocks. Disruptions in crude oil supply have significant impacts on global economic activity (see, e.g., Hamilton, 1983; Kilian, 2009).

whereas it lags behind to oil price changes as discussed by Kilian (2009). Lastly, shocks to oil prices (oil-specific shocks) that are not driven by oil supply and ADSs are explained by the precautionary motives for oil demand which is induced by uncertainty in the availability of future supply of crude oil.

The resulting crude oil market shocks are captured in the vector $X_t = [\varepsilon_t^{OSS}, \varepsilon_t^{ADS}, \varepsilon_t^{OSDS}]$, where $\varepsilon_t^{OSS}, \varepsilon_t^{ADS}, \varepsilon_t^{OSDS}$ denote OSSs, ADSs and OSDs, respectively, and are mutually correlated. Since our selected macroeconomic variables are available in quarterly frequency, the monthly structural oil market shocks are converted to quarterly series by averaging them. By temporal aggregation, the crude oil markets shocks need not be orthogonal or serially correlated. Therefore, the X_t vector can, for practical analysis, be composed of structural crude oil market shocks. In the second stage, the dynamic effects of the three crude oil market shocks are conditioned on selected macroeconomic variables within a VAR model framework which has the following general representation.

$$\begin{bmatrix} X_t \\ Y_t \end{bmatrix} = c + A(L) \begin{bmatrix} X_{t-1} \\ Y_{t-1} \end{bmatrix} + B \begin{bmatrix} \mu_t^X \\ \mu_t^Y \end{bmatrix} \quad (3)$$

where X_t denotes a vector of the structural oil market shocks while Y_t contains selected macroeconomic variables, such as, real gross domestic product (GDP) (*rgdp*), consumer price index (*cpi*) and real exchange rate (*rer*). c and $A(L)$ are matrices of constants and polynomial in the lag operator L , respectively, while B is the contemporaneous matrix of the vector of error terms μ_t^X and μ_t^Y .

For the purpose of analysis, this study uses a combination of monthly and quarterly data collected during the period 1986–2011. The choice of the sample period is hinge on data availability of selected series in the required frequency, and the observation of a structural break in the oil market dynamics in the mid-1980s following the collapse of the OPEC cartel and the start of the Great Moderation (Peersman & van Robays, 2012). In the first stage of the analysis, oil-demand and supply shocks are disentangled using monthly data on global oil production in levels, the global real economic activity and real oil prices. OSSs capture unpredictable innovations in global oil production levels. Global oil production data over the period of 1986:1–1993:12 are taken from Hamilton (2009b),³ and the remaining updated from the US Energy Information Agency (EIA) database which defines global oil supply as crude oil including lease condensate.

Recent hike in oil prices has been linked to a strong and an increasing global demand for crude oil particularly from emerging market economies, such as, China and India. Following Kilian (2009), the effects of global demand on oil price shocks are accounted for by including an index of global real economic activity as a proxy for global demand for industrial commodities. The index is based on dry cargo single voyage ocean freight rates of different commodities: grain, oilseeds, coal, iron ore, fertilizer and scrap metal. It captures the shifts in the demand for global industrial commodities in the world market. The index is deflated by the US consumer price index and is linearly detrended to remove the effects of technological advances in ship-building and other long-term trends in the demand for sea transport. Therefore, the detrended index captures the cyclical variations in ocean freight rates. Kilian (2009) provides a detailed discussion on the construction of the index, which is also available for download from his homepage.⁴

Oil prices are measured in dollars per barrel using the spot prices for the Nigerian bonny light crude oil as a proxy for world oil prices. Oil prices are deflated by the US consumer price index to reflect real oil prices. The selected macroeconomic variables include the real gross domestic output, consumer price index and real exchange rate.⁵ All variables are transformed into their logarithm form.

The data on the Nigerian bonny light crude oil spot prices are available from the 2012 OPEC Annual Statistical Bulletin. The US and Nigeria consumer price indices were obtained from the IMF (International Monetary Fund) International Financial Statistics database. The real GDP and nominal

exchange rate (naira-dollar rates) are available from the Christian Broadcasting Network (CBN) Statistical Bulletin. Figure 1 shows the plots of the selected variables in their logarithm form: global oil production (*oilprod*), index of real global economic activity (*gea*), Nigerian bonny light crude oil prices (*oilp*), Nigerian consumer price index (*cpi*), real naira-dollar exchange rate (*rer*) and the real GDP (*rgdp*).

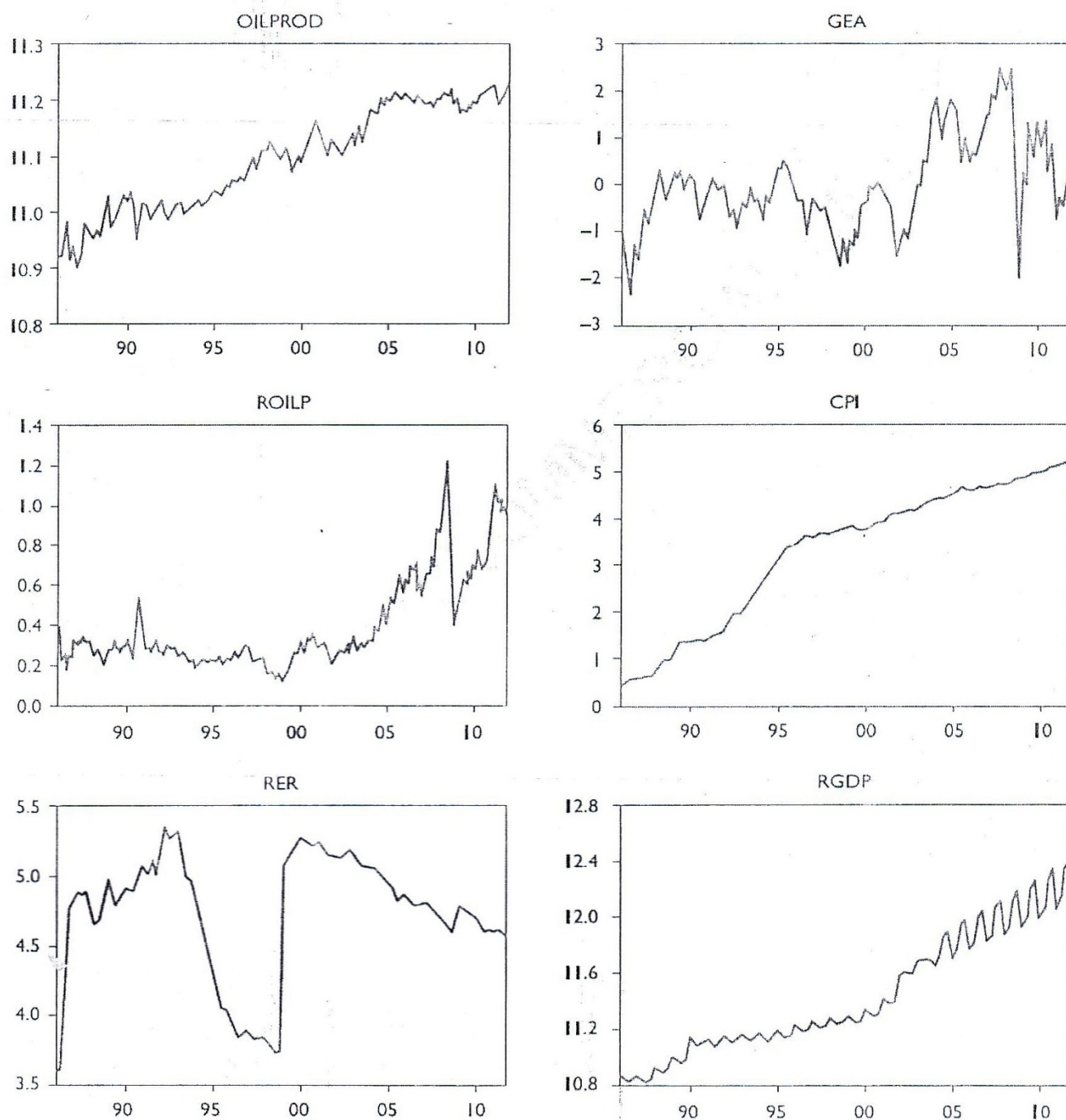


Figure 1. Plots of Selected Macroeconomic Variables (in logs)

Source: Authors' computation.

Estimation Results

Unit Roots and Cointegration Test

The first step in the empirical analysis is to confirm the stationarity properties of the selected time series through unit roots test. For this purpose, the null hypothesis of non-stationary variables is tested against the alternative hypothesis of stationary variables using the augmented Dickey–Fuller (ADF) test (Dickey & Fuller, 1979) and Phillips–Perron (PP) test (Phillips & Perron, 1988) with the inclusion of a constant and time trend in the regression. Table 1 presents a summary of the unit roots results for each variable.

For the variables that characterize the crude_oil market—global oil production, index of real global economic activity and real oil prices—the null hypothesis of unit roots is rejected for the natural logarithm of global oil production (*oilprod*) and index global economic activity (*gea*) but cannot be rejected for the real oil prices (*roilp*) at conventional levels. By implication, estimating the structural VAR model in (2) using the crude_oil market variables at levels would mean incorporating variables with inconsistent time-series properties. To circumvent this problem, the cointegration methodology of Johansen and Juselius (1990) is employed to test for the presence of possible long-run relationship for the crude_oil market variables. The outcome of the cointegration test offers an insight in determining whether to estimate the structural VAR in levels with non-stationary variables, first differenced with stationary variables or in a VAR with an error-correction component. Table 2 reports the cointegration

Table 1. Unit Roots Test

Variables	Level		First Difference	
	ADF	PP	ADF	PP
<i>oilprod</i>	-4.5102***	-4.3322***	-6.0077***	-22.7233***
<i>gea</i>	-3.4020**	-3.2170*	-5.7943***	-11.3822***
<i>roilp</i>	-1.9480	-2.5241	-6.7271***	-11.6763***
<i>rgdp</i>	-1.2249	-4.5881***	-3.2383*	-15.7206***
<i>cpi</i>	-1.0118	-0.8058	-3.4147*	-6.4535***
<i>rer</i>	-2.7240	-3.0373	-8.3857***	-8.4128***
<i>e^{OS}</i>	-3.2444*	-12.4240***		
<i>e^{ADS}</i>	-4.9575***	-9.0402***		
<i>e^{OSDS}</i>	-8.6493***	-9.6949***		

Source: Authors' computation.

Notes: *, ** and *** denote significance at 10 per cent, 5 per cent and 1 per cent, respectively.

Table 2. Johansen Cointegration Test

Null Hypotheses	Eigen Value	λ_{trace}	Critical Value (5%)	λ_{max}	Critical Value (5%)
$r = 0$	0.045727	24.39308	29.79707	14.36941	21.13162
$r \leq 1$	0.027167	10.02367	15.49471	8.455581	14.26460
$r \leq 2$	0.005095	1.568093	3.841466	1.568093	3.841466

Source: Authors' computation.

Notes: r indicates the number of cointegrating vector. Critical values are from MacKinnon, Haug and Michelis (1999) p -values at 5 per cent significance level.

test with both trace and maximum-eigen value statistics indicating the absence of a long-run relationship among the variables in the crude_oil market. Given the absence of a cointegration relationship, the structural VAR model in (2) can be estimated by using the crude_oil market variables in their stationary form (i.e., first difference) for which the null hypothesis of unit roots is rejected for all variables (see Table 1). Hence, consistency in the time-series properties of the variables is achieved with correct specification of the three-variable structural VAR model in (2) for the crude_oil market.

Further, the structural VAR model is estimated with a lag length of four selected based on the Akaike Information Criterion and the resulting orthogonalized structural crude_oil market shocks recovered in the first stage of the analysis are converted from monthly to quarterly series by averaging. As mentioned earlier, the three crude_oil market shocks represents the underlying source of oil price shocks, namely, OSSs (ϵ^{OSS}), ADSs (ϵ^{ADS}) and OSDSs (ϵ^{OSDS}). The stationarity properties of each oil price shocks as contained in Table 1 indicate their stationarity at levels which means they are $I(0)$.

For the macroeconomic variables, except the real gross domestic output for which the null hypothesis of the PP test is rejected at levels, the null hypothesis of a unit roots cannot be rejected for consumer price index and real exchange rates. However, their first difference becomes stationary both with the real gross domestic output (see Table 1). To avoid inconsistent time-series properties in the second stage of the analysis between the crude oil market shocks and the macroeconomic variables, the latter are treated in their first differences which is actually the growth rate. In the following analysis, the macroeconomic variables are expressed in their growth rate.

Granger Causality Test

The Granger causality test offers insight into the causal relationships between variables particularly the **likelihood** of each variable forecasting the future values of other variables in a system. The Granger **causality** test is employed to investigate the causality of the three crude oil market shocks on the growth **rates of real gross domestic output**, consumer price index and real exchange rates. Table 3 reports the **results of the Granger causality test**.

To wit, the Granger causality test results show that for the growth rates of the real gross domestic **output and consumer prices**, none of either macroeconomic variable is Granger caused by the three **oil price shocks**. In other words, the null hypothesis of no causality from the crude_oil market shocks to the **each of the macroeconomic** variables cannot be rejected at conventional levels of testing. For the **real exchange rates**, Granger causality runs only from the ADSs and not the OSS and OSDS. Overall, the **findings suggest that oil price shocks** do not Granger-cause most of the macroeconomic variables in the Nigerian economy. Thus, irrespective of the origin of oil price shocks, the Nigerian macroeconomy is unlikely to be affected significantly. These results are consistent with previous studies using both

Table 3. Granger Causality Test

Variables	ϵ^{OSS}	ϵ^{ADS}	ϵ^{OSDS}
rgdp	1.0780 [0.3624]	0.5128 [0.6744]	0.8182 [0.4870]
cpi	2.0088 [0.1181]	1.7946 [0.1536]	0.1342 [0.9394]
rer	1.9162 [0.1323]	3.2854 [0.0242]**	0.7367 [0.5327]

Source: Authors' computation.

Notes: The values are chi-square (Wald) test statistics, while those in brackets are p-values. Lag length of two is used. The macroeconomic variables are in their growth rate (first difference) form. ** indicates significance at 5 per cent level.

linear and non-linear oil price specification measures to analyze the impact of oil price shocks on the Nigerian economy (see Chuku, 2012; Iwayemi & Fawowe, 2011).

The Granger causality test above does not show the sign relationship (or response pattern) of the macroeconomic variables and their relative variability to each of the oil price shocks. This information can only be provided by the impulse response and variance decomposition analysis, respectively. Hence, for the second stage of the analysis, the impact of the three oil market shocks on the Nigerian macroeconomic variables is investigated using impulse response functions and variance decomposition.

Impulse Response Analysis

In the second stage of the analysis, each of the macroeconomic variables is treated as the dependent variables. Although the VAR framework treats all variables as being endogenous in the system, the impulse response and variance decomposition analysis are sensitive to the ordering of the variables. Therefore, the three oil price shocks—OSS, ADS and OSDS—are placed first before each of the macroeconomic variables. The impulse response functions traces out the response of each of the macroeconomic variables to the underlying source of oil price shocks. Figure 2 reports the results of the impulse response analysis estimated from the VAR model in (3). An optimal lag of four is selected by the Akaike Information Criterion. The nomenclature for the macroeconomic variables remains the same but expressed in their growth rates (first difference), while OSS, ADS and OSDS denote the oil-supply shock, aggregate demand shock and oil-specific demand shock, respectively, in the crude oil market. As expected, each of the macroeconomic variables has different response pattern associated with the underlying demand and supply shocks in the crude oil market.

The response of real domestic output to a one-time OSS is negative in the first two quarters. This implies that an OSS originating from the supply side of the crude oil market causes a fall in output in the Nigerian economy. This is in contrast to the theory that suggests an expansion in economic activity for oil-exporting country following an oil price shock through the wealth transfer transmission channel. The subsequent response pattern takes a positive zigzag shape after the second quarter. An unanticipated ADS caused by global expansion in economic activity also precipitates a fall in the real output in the first three quarters, followed by an increase afterwards. However, the response pattern maintains a zigzag shape as in the case of the OSS but with a net negative effect on the real output. For the OSDS induced by uncertainty in the availability of future supply of crude oil, the real output shows an immediate positive but short-lived response within the first two quarters and thereafter declines with a net negative effect all through the time horizon. In terms of significance, the response of real output of each of the three oil price shocks is statistically insignificant which suggest that irrespective of the origin of oil price shocks, the real domestic output of the Nigerian economy remains unaffected. This result is largely unexpected especially for oil-exporting countries, such as, Nigeria, which depends on her oil sector as a major source of foreign exchange earnings. This finding is consistent with previous evidence by Iwayemi and Fowowe (2011) and Chuku (2012). However, an explanation could be that the positive effects of an oil price shocks may be considerably eliminated since the country also depends on the importation of refined oil products for domestic consumption.

Considering the consumer price level, an OSS causes a partially significant and gradual decline in price level all through the time horizon. Meanwhile, an ADS has an immediate positive though partially significant effect on the consumer price level vis-à-vis the inflation level in the economy. However, in the case of an OSDS, the consumer price level responds positively from the fourth quarter after an initial flat response. For the real exchange rate, an OSS causes a mild increase in real exchange within the first

two quarters. It declines afterwards to the fourth quarter before reversing upwards. The response pattern of the real exchange rate all through the time horizon is however not significantly different from zero. Meanwhile, an ADS to the real exchange rate precipitate has a partially significant negative effect on the real exchange rate with a gradual decline all through the time horizon, whereas the corresponding response of the real exchange rate to an OSDS is completely flat through the time horizon.

In all, the impulse response analysis results can be summarized as follows. First, both OSS and ADS cause temporary decline in real output while the oil-specific demand has a mild positive effect on real output with all three oil market shocks being insignificantly different from zero. This reaffirms the earlier Granger causality tests which suggest that crude oil market shocks do not cause or precede real output in the Nigerian economy. Second, the consumer price level responds negatively, positively and

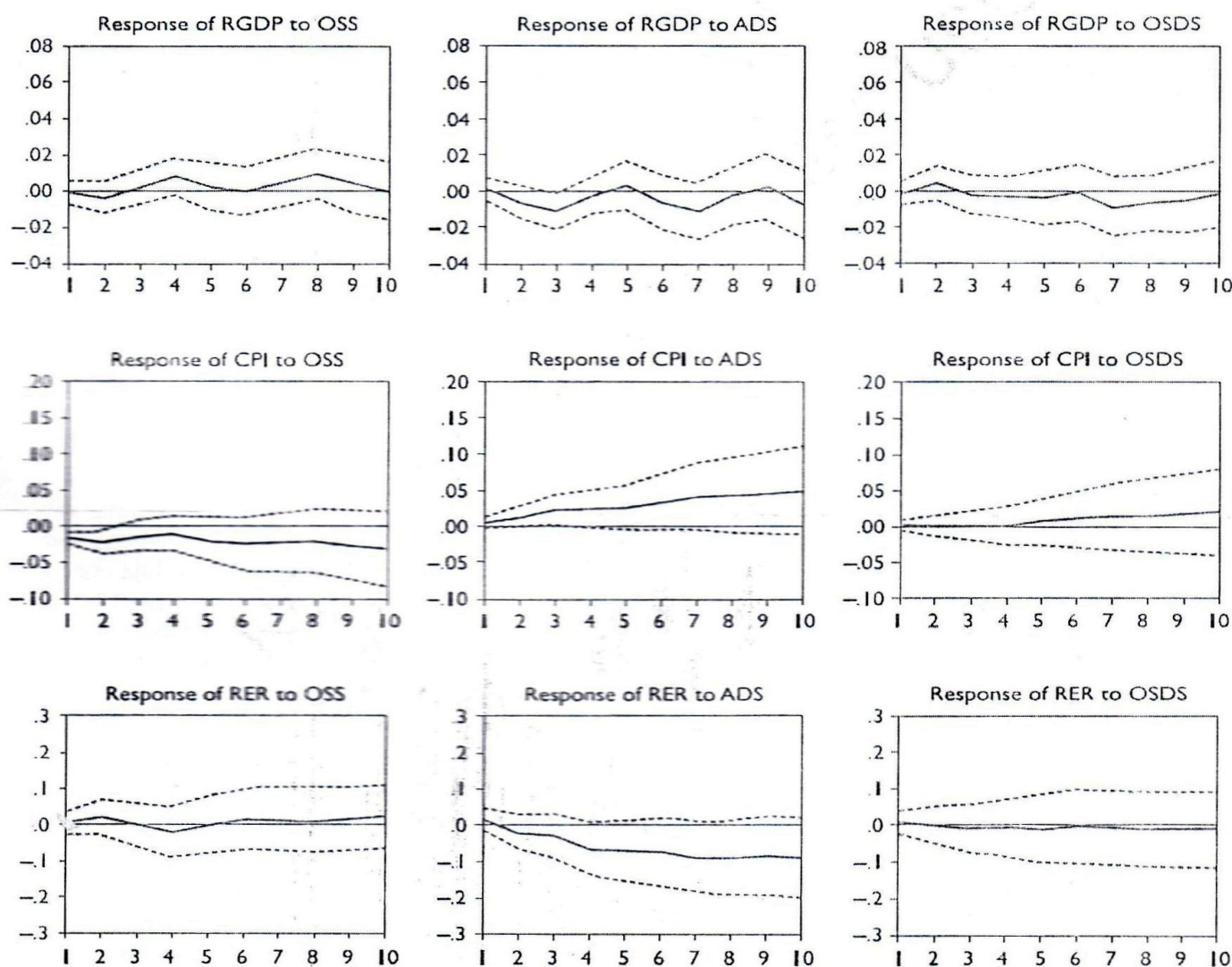


Figure 2. Accumulated Impulse Responses of Macroeconomic Variables to Crude Oil Market Shocks

Source: Authors' computation.

flat to the OSS, ADS and OSDS, respectively. Only, the aggregate demand stimulates an increase in inflation levels. This result seems puzzling considering the fact that the pricing mechanism of the refined petroleum products is regulated by government through heavy subsidization of imported petroleum products. Therefore, a transmission of higher oil prices to domestic petroleum prices is unlikely to exist (Iwayemi & Fowowe, 2011). Third, the real exchange rate is insignificantly different from zero in its response to both OSS and OSDS but declines with an ADS, thereby indicating a depreciation of the exchange rate in contradiction to a possible appreciation during an oil price hike. Lastly and very important is that each demand and supply shocks affects the macroeconomic variables differently in terms of their response pattern.

Variance Decomposition

The impulse responses in Figure 2 basically illustrate the impact of a one-time demand and supply shock on each of the macroeconomic variables under consideration. However, the relative importance of the each of the oil market shocks during the sample period in understanding the fluctuations in each of the macroeconomic variables in the Nigerian economy is captured using variance decomposition analysis. Table 4 summarizes the variance decomposition results for each of the macroeconomic variables in the Nigerian economy over selected time horizons (1, 5, 10, 15, 20, 25 quarters).

In cumulative terms, the variance decomposition results show that oil price shocks have a marginal contribution to the fluctuations of the real domestic output, consumer price level and real exchange rate over the sample period. Oil price shocks explain about 0.2 per cent, 9 per cent and 1 per cent of the variations in the real output levels, consumer price level and real exchange rate, respectively, within the first quarter. This suggests that oil price shocks are incompletely transmitted to the Nigerian economy with delayed response by her macroeconomic indicators due to stickiness and hysteresis. The petroleum products market in Nigeria is highly regulated by government and coupled with the presence of sunk costs (such as, marketing and distribution) compelled the adoption of ad hoc pricing policies. Such pricing behaviour precludes a pass-through to the consumer irrespective of the variation in oil prices at the international oil market. However, the contributions of oil price shocks tend to increase as the time horizon lengthens. In the long term (over 25 quarters), the variation in real output levels, consumer price levels and real exchange rate explained by oil price shocks are approximately 22 per cent, 20 per cent and 17 per cent, respectively. As a caveat, the cumulative contribution of oil price shocks should not be interpreted as the percentage for which it accounts for the fluctuations in the macroeconomic variables in the Nigerian economy. Rather, since oil price shocks are triggered by demand and supply shocks which are unlikely to occur simultaneously, it is expedient to shift focus to the relative importance of each of the crude oil market shocks on the Nigerian economy through the fluctuations in the real domestic output, consumer price level and real exchange rates.

Considering the relative importance of each of the crude oil market shocks, Table 4 shows that each oil shock contributes little to the fluctuations in the macroeconomic variables with some stability in the long term. For instance, OSS, ADS and OSDS on average explain approximately 6 per cent, 14 per cent and 4 per cent of the fluctuations in the real output, respectively. In the case of consumer price levels, 10 per cent, 9 per cent and 2 per cent on average of its fluctuations are explained by each of the three oil market shocks, while 6 per cent, 10 per cent and 2 per cent are explained for the real exchange rates fluctuation. Although each oil market shocks contribute marginally to the fluctuations in the macroeconomic variables, it can be observed that both OSS and ADS are dominant and relatively important more than the OSDS.

Table 4. Variance Decomposition of Crude_Oil Market Shocks

Quarters	ϵ^{OSS}	ϵ^{ADS}	ϵ^{OSDS}	Total
Decomposition of $rgdp$				
1	0.0012	0.0810	0.0849	0.1673
5	3.7325	7.0175	3.4988	14.2488
10	5.3451	11.7749	3.4988	20.6188
15	5.5412	12.3778	3.7863	21.7053
20	5.9497	13.8563	3.5088	23.3148
25	5.6875	13.2234	3.0603	21.9712
Decomposition of cpi				
1	7.4418	1.5546	0.0001	8.9965
5	8.8719	6.0241	1.0522	15.9482
10	9.1830	8.3908	1.5259	19.0997
15	9.1423	8.8706	1.5921	19.6050
20	9.1132	8.9470	1.6121	19.6723
25	9.1051	8.9651	1.6180	19.6882
Decomposition of rer				
1	0.1912	0.4675	0.2644	0.9231
5	5.4397	9.3304	0.8328	15.6029
10	5.9657	9.5772	1.1205	16.6634
15	5.9939	9.5773	1.1298	16.7010
20	5.9965	9.5773	1.1311	16.7049
25	5.9966	9.5774	1.1312	16.7052

Source: Authors' computation.

Conclusion

Existing literature on the effects of oil price shocks on macroeconomic activities has relied on the implicit assumption that oil price changes originate from the exogenous supply side of the crude oil market. However, Kilian (2009) documents that depending on the origin of oil price shocks, oil prices react in a different manner to oil-demand and supply shocks in ways that explains the declining importance of oil price shocks since the mid-1980s. Hence, oil price fluctuations depend on its underlying source of demand and supply shocks in the crude oil market which may have different implications for macroeconomic aggregates. Following Kilian's (2009) seminal work on disentangling the effects of demand and supply shocks in the crude oil market on the US economy, this article adopted the same methodological framework to provide the first examination of the oil price shocks-macroeconomy relationship in Nigeria with the focus on the origin of oil price shocks. A two-stage approach is employed in which three types of oil price shocks—OSS, ADS and OSDS—are identified within a recursive structure and their effects conditioned on selected macroeconomic variables in the Nigerian economy for the period 1986–2011.

The summary of findings is as follows: First, the Granger causality test shows that with the exception of the ADSs that Granger-cause the real exchange rate, the three types of oil price shocks do not Granger-cause real domestic output, consumer price level and real exchange rates in the Nigerian economy. Therefore, the Nigerian macroeconomy is unlikely to be significantly affected by the origin of oil price shocks. Second, the impulse response analysis shows as expected that the source of demand and supply shocks in the crude oil market is bound to have different implications on Nigeria's macroeconomic variables. An OSS causes a negative response from real domestic output and consumer price levels and a

positive response on the part of the real exchange rate within the first two quarters. For the ADS, real domestic output and real exchange rates experienced a net negative response, whereas consumer price levels show a gradual increase throughout the time horizons. An OSDS generates a short-lived increase in real domestic output but a flat response from consumer price levels and real exchange rates within the first two quarters although the consumer price levels later increased mildly from the fourth quarter. Lastly, the variance decomposition of the relative importance of each of the three types of oil price shocks to the variations in Nigeria's macroeconomic variables over the sample period is marginal with OSSs and ADSs being a more dominant source.

Overall, our empirical evidence suggests that irrespective of the origin of oil price shocks Nigeria's macroeconomic aggregates may not be substantially influenced. The small magnitude of the effects of the crude oil market shocks on the macroeconomic variables is a clear indication of the incomplete transmission of oil price shocks to the Nigerian economy. Moreover, it means that macroeconomic activities in Nigeria are likely to be determined by other factors (both economic and non-economic) peculiar to the economy. For once, the utilization of oil windfalls for the importation of refined petroleum and consumer durables products precludes the development of the productive capacity of the economy. Hence, the usual policy directive of efficient utilization of oil revenues for economic diversification is re-emphasized.

Acknowledgements

The authors are grateful to the anonymous referees of the journal for their extremely useful suggestions to improve the quality of the article. Usual disclaimers apply.

Notes

1. See Bjørnland (2009) for a review. Other research works include: Cologni and Manera (2008), Kilian (2008), Rafiq, Salim and Bloch (2009), Tang et al. (2010), Du et al. (2010).
2. Kilian and Vigfusson (2009) tested the asymmetric response to oil price shocks for the United States and found evidence of statistical insignificance.
3. The data can be downloaded from James Hamilton homepage: <http://weber.ucsd.edu/~jhamilto/>
4. <http://www.personal.manchester.ac.uk/~lkilian/>
5. The real exchange rate is computed by multiplying the naira-dollar nominal exchange rates by the ratio of the US and Nigeria consumer price indices.

References

- Alkon, E.O. (2009, March 22–24). Oil price shocks and Nigeria's macroeconomy. A paper presented at the Annual Conference of CSAE Conference, Economic Development in Africa, Oxford.
- Asperis, N., & Miller, S.M. (2009). Do structural oil-market shocks affect stock prices? *Energy Economics*, 31(4), 569–575.
- Barsky, R.B., & Kilian, L. (2002). Do we really know that oil caused the great stagflation? A monetary alternative. In *NBER Macroeconomics Annual 2001*, pp. 137–183.
- . (2004). Oil and the macroeconomy since the 1970s. *Journal of Economic Perspectives*, 18(4), 115–134.
- Baumester, C., & Peersman, G. (2009). Sources of the volatility puzzle in the crude oil market. *Mimeo*, Department of Economics, Ghent University.
- Bjørnland, C.H. (2009). Oil price shocks and stock market booms in an oil exporting country. *Scottish Journal of Political Economy*, 2(5), 232–254.
- Brown, S.P.A., & Yucel, M.K. (2002). Energy prices and aggregate economic activity: An interpretative survey. *The Quarterly Review of Economics and Finance*, 42(2), 193–208.
- Chinn, C.A. (2012). Linear and asymmetric impacts of oil price shocks in an oil-importing and -exporting economy: the case of Nigeria. *OPEC Energy Review*, 36(4), 413–443.

- Cologni, A., & Manera, M. (2008). Oil prices, inflation and interest rates in a structural cointegrated VAR model for the G-7 countries. *Energy Economics*, 30(3), 856–888.
- Davis, S.J., & Haltiwanger, J. (2001). Sectoral job creation and destruction responses to oil price changes. *Journal of Monetary Economics*, 48(3), 326–332.
- Dickey, D.A., & Fuller, W.A. (1979). Estimators for autoregressive time series with a unit problem. *Journal of the American Statistical Association*, 74(3), 427–431.
- Du, L., He, Y., & Wei, C. (2010). The relationship between oil price shocks and China's macro-economy: An empirical analysis. *Energy Policy*, 38(8), 4142–4151.
- Effiong, E.I. (2014). Oil price shocks and Nigeria's stock market: What have we learned from crude oil-market shocks? *OPEC Energy Review*, 38(1), 36–58.
- Hamilton, J.D. (1983). Oil and the macroeconomy since the World War II. *The Journal of Political Economy*, 91(2), 228–248.
- . (1996). This is what happened to oil price-macroeconomy relationship. *Journal of Monetary Economics*, 38(2), 215–230.
- . (2003). What is an oil shock? *Journal of Econometrics*, 113(2), 363–398.
- . (2008). Oil and the macroeconomy. In S. Durlauf & L. Blume (Eds), *The New Palgrave Dictionary of Economics* (2nd edn.). London: Macmillan. Retrieved March 2014, from <http://www.dictionaryofeconomics.com>
- . (2009a). Understanding crude oil prices. *Energy Journal*, 30(2), 179–206.
- . (2009b). Causes and consequences of the oil shock of 2007–08. *Brookings Papers on Economic Activity*, 218(Spring), 215–261.
- Iwayemi, A., & Fowore, B. (2011). Impact of oil price shocks on selected macroeconomic variables in Nigeria. *Energy Policy*, 39(2), 603–612.
- Johansen, S., & Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration-with an application to the demand for money. *Oxford Bulletin of Economics and Statistics*, 52(2), 169–210.
- Kilian, L. (2008). Exogenous oil supply shocks: How big they are and how much do they matter for the U.S. economy? *Review of Economics and Statistics*, 90(2), 216–240.
- . (2009). Not all oil price shocks are alike: Disentangling demand and supply shocks in the crude oil market. *American Economic Review*, 99(3), 1053–1069.
- . (2010). *Oil price volatility: Origins and effects*. Economic Research and Statistics Division (ERSD) (Working Paper No. 2). Geneva: World Trade Organization.
- Kilian, L., & Park, C. (2009). The impact of oil price shocks on the U.S. stock market. *International Economic Review*, 50(4), 1267–1287.
- Kilian, L., & Vigfusson, R. (2009). Pitfalls in estimating asymmetric effects of energy price shocks. Mimeo, Department of Economics, University of Michigan.
- Kilian, L., Rebucci, A., & Spatafora, N. (2009). Oil shocks and external balances. *Journal of International Economics*, 77(2), 181–194.
- Lardic, S., & Mignon, V. (2006). The impact of oil prices on GDP in European countries: An empirical investigation based on asymmetric cointegration. *Energy Policy*, 34(18), 3910–3915.
- Lee, K., Ni, S., & Rami, R.A. (1995). Oil shocks and the macroeconomy: The role of price variability. *Energy Journal*, 16(4), 39–56.
- Lilien, D.M. (1982). Sectoral shifts and cyclical unemployment. *Journal of Political Economy*, 90(4), 777–793.
- Lippi, F., & Nobili, A. (2009). Oil and the macroeconomy: A quantitative structural analysis. Economic Working Paper No. 704, Research Department, Bank of Italy.
- MacKinnon, J.G., Haug, A.A., & Michelis, L. (1999). Numerical distribution functions of likelihood ratio tests for cointegration. *Journal of Applied Econometrics*, 14(5), 563–577.
- Mork, K.A. (1989). Oil and the macroeconomy when prices go up and down: An extension of Hamilton's results. *Journal of Political Economy*, 97(3), 740–744.
- Olofinla, P.A., & Adejumo, A.W. (2006). Oil price shocks and macroeconomic activities in Nigeria. *International Research Journal of Finance and Economics*, 3, 28–34.

- Peersman, G., & van Robays, I. (2009). Oil and the euro area economy. *Energy Policy*, 24(60), 603–651.
- . (2012). Cross-country differences in the effects of oil shocks. *Energy Economics*, 34(5), 1532–1547.
- Phillips, P.C.B., & Perron, P. (1988). Testing for a unit root in time series regression. *Biometrika*, 75(2), 335–346.
- Rafiq, S., Salim, R., & Bloch, H. (2009). Impact of crude oil price volatility on economic activities: An empirical investigation in the Thai economy. *Resources Policy*, 34(3), 121–132.
- Tang, W., Wu, L., & Zhang, Z. (2010). Oil price shocks and their short- and long-term effects on the Chinese economy. *Energy Economics*, doi:10.1016/j.eneco.2010.01.002