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RESEARCH ARTICLE / ARAŞTIRMA MAKALESİ

Asymmetric behavior of oil price shocks and output performance in Africa

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Abstract

A comprehensive cross-country dataset is employed in this reseach to examine the impact of oil price shocks and its asymmetry on output in African oil exporting countries (AOECs). Using a panel-VAR model, the study accounted for impulse-response between output and oil price shocks. In addition, through the PVAR model, variance decomposition is performed to assess the importance of those effects and guidelines are offered for policy formation. The study revaled that oil price shocks create heterogeneously asymmetric effect on output. The study revealed the prevalence of Dutch Disease among the AOECs as apparent in the impact of negative oil price shocks on exchange rates and output. The study recommends that policies should be formulated to minimize the effect of oil price shocks on output, especially negative oil price shocks revealed to adversely affect oil revenue (policies aimed at strengthening economic activities through diversification, so as to enhance the export mix). This will reduce the AOECs' on-going reliance on large revenues from oil, arising from positive oil price shocks which the literature has argued to have a negative and hindering impact on economy, mainly because it impacts the non-oil sector.

Keywords: Asymmetric behavior, oil price shocks, Panel VAR, Africa's, Oil Exporting Countries

JEL codes: P28, P48, Q35, L72.

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1. INTRODUCTION

Several empirical works on the connection amid oil prices and output of the oil-exporting economies have assumed a homogeneous response (see Gachara, 2015). The study also assumes a linear association between macroeconomic variables and oil price shocks. Unfortunately, the study offers no insight into the dynamics of different categories of shocks (see Moshiri, 2015). Consequently, policy makers and scholars have argued that positive and negative oil price shocks impact the macroeconomy differently, and this may vary both in magnitude and signs across regions, hence causing economic imbalances (see Apergis *et al*., 2015; Narayan and Gupta, 2015). The few studies carried out on oil-exporting countries have used linear estimating techniques, focusing on positive oil price shocks, disregarding the likely consequences of negative oil price shocks (see Damechi, 2012; Gachara, 2015). According to Damechi (2012) and Gachara (2015), this may lead to faulty policy decision making which may be counterproductive and misleading. Furthermore, it may result to government's incapability to tackle prolonged effects of oil price shocks on output. Some of the linear techniques such as ordinary least square (OLS) and Fully Modified (FM)-OLS employed in the literature have been critiqued as unsuitable to evaluate the link between oil price behavior and output performance (see Gachara, 2015; Damechi, 2012). In addition, Damechi (2012) and Gachara (2015) argue that the SVARs estimating technique which has frequently been used in the literature to estimate the link between oil price behavior and ouput performance is inadequate and could only be suitable for positive oil price shocks and country specific studies. An asymmetric relationship occurring between output performance and oil price shocks may have vital consequences for policy responses and guidelines in the macroeconomic environment of oil-exporting countries (see Damechi, 2012; Gachara, 2015). Hence, the need for this study.

Considering the possible threat of the current decrease in oil prices and the vital role that variations in crude oil prices play in the behavior of monetary and fiscal policies in AOECs, it is crucial to investigate the asymmetric impacts of negative oil price shocks. This is a critical issue for policymakers in oil-dependent countries, as it will assist them in making decisions that may have serious implications for output growth and the behavior of other macroeconomic variables. While there is evidence on how industrialized countries, mainly developed net oil-importing nations react to positive oil price shocks, which are believed to hamper their economic growth (Hamilton, 2013; Aastveit, Bjornland and Thorsrud, 2015), we are not aware of such a study having been carried out to establish how negative oil price shocks impact the AOECs, where such shocks are similarly believed to hamper output growth. Therefore, this study explicitly estimates a measure of oil price shocks to determine the response of output performance within the context of the AOECs. In addition, while it is expected that oil prices would have various impacts on the output growth of the oil importing and exporting nations, there is a paucity of research on the asymmetric response of AOECs that captures the recent decline in oil prices compared with the differential effects of oil price shocks on exporting oil countries (see Wang, Zhu and Wu, 2017).

While the study deepens the understanding of how oil price shocks impact oil-exporting countries' output, it contributes to knowledge, empirically investigating the non-linear impacts of oil price shocks on the macroeconomy of AOECs, using PVAR.

The remainder of this paper is chronologically organized as beneath: section two discusses the literature review, materials & methods are discussed in section three, analysis of results are presented secion four. Section five and show the interpretation and discussions, and in section six, summary, conclusions and recommendations are presented.

2. LITERATURE REVIEW

A considerable body of empirical and theoretical evidences has been documented on oil price shocks and the reaction of the economy nexus around the world. However, the specific literature on the AOEC bloc appears inadequate. The belief of a nexus amid oil price shocks and output aligns with a few studies that assert that a proportional variation in oil price shocks is analogous to the proportion of variation in output (see Catik and Onder, 2013). However, some scholars have claimend that the proportion of oil price shocks may not necessarily account for the same proportional change in output. Although it is clear that oil price movement affects output, the asymmetric response of economic output to oil price shocks remains unclear (see Catik and Onder, 2013). While many studies on this issue have been carried out in developed oil-importing countries, the experience in oil-exporting economies remains equivocal, calling for an empirical study like the current one.

2.1. Empirical Review

There are various researches on the asymmetric impact of oil price shocks on the output of the importing oil countries (see Herrera, Hamilton, 2009; Lagalo and Wada, 2011). Their studies have generally revealed that upsurges in price of oil have adverse impacts, but the impacts of drops in oil prices on the economic activities of US and some developed oil-importing countries (e.g. the OECD) are not significant. Also, some studies have investigated the oil price shocks transmission mechanisms, seeking to identify the causes of non-linearity (Bernanke, Gertler, Watson, Sims and Friedman, 1997). The transmission mechanisms and the nature of the asymmetric impacts of oil price shocks in the oil-exporting nations may vary from the oil-importing nations. Oil price shocks accounts for demand-side impacts in the oil-exporting nations. A possible explanation for the non-linearity in demand-impacts in the oil-exporting nations may be the size of government and its extreme role in their economies.

The non-linear association amid oil prices and output performance is explained in various ways. For example, Davis (1987) and Loungani's (1986) studies, which are the leading works on this nexus, argue that oil price shocks could cause sectoral swings and expensive reallocation of resources. Mork (1989) reveals that, in separately estimating the coefficients on rises and falls in oil prices, the coefficients on falls are not statistically different from zero. Lee *et al.* (1995) show that a better prediction of GDP can be attained by fine-tuning the oil price rise using standard deviation of price instability. Taking this investigation further, Hamilton (2003) examines the non-linear relationship using an elastic parametric model and finds support for Lee *et al.*'s (1995) results. Various studies offer support for non-linear association between oil prices and output performance for OECD countries (see Mork, 1989; Cunado, Jo, & De Gracia, 2016).

A new strand of studies has come up with an alternative explanation to the identification of oil price shocks used by Lee *et al.* (1995) and Hamilton (2003). These include Kilian and Vigfusson (2011), and Kilian (2010), who point to potential endogeneity in the estimation of the impacts of oil price shocks on US economy and employ a measure of oil price shocks based on a structural near-VAR model of actual crude oil prices. In Kilian (2010), the methodology used to identify structural shocks to real prices of oil relies on delay restrictions that, according to Kilian (2010), are economically reasonable only at the monthly frequency. He develops a technique that permits the separation of innovations on oil prices to three fragments ("*specific oil supply, aggregate demand and oil demand shocks*"). Separating the source of oil price shocks in these three fragments, he concludes that, most of the shocks in the prices of oil are accountable for oil-specific demand shocks and aggregate demand shocks.

The asymmetric relationship amid oil prices and output performance in Nigeria has been investigated. For example, Aliyu (2009) employs a multivariate-VAR model to empirically examine ("non-linear and linear specifications") the impacts of oil price shocks on actual macroeconomic behavior in this country. Among other things, his findings supports the claim that oil price shocks have linear and non-linear effects on real-GDP. In the non-linear models, asymmetric oil price upsurges are revealed to positively impact real GDP growth of greater amount than asymmetric oil price declines' adverse effect on real GDP. Estimations from the non-linear shows significant improvement that is more than the linear estimation that Aliyu (2009) reported.

Asab (2017) examines the impacts of oil price shocks on the economic activities of Jordan, proxied with industrial production growth. The study accommodates non-linearity by using various measures for oil price shocks. His results show that positive oil shocks negatively and significantly impact growth, while a decrease in oil prices do not impact growth. These findings suggest that decreases in oil prices do not certainly trigger industrial growth of oil-importing economies. Consequently, the symmetric specifications of growth and oil price shocks are negatively correlated. Furthermore, he asserts that oil prices have direct relationship with production process and it may therefore significantly impact output, employment, and inflation in oil-importing nations. Variations in oil prices might affect an economy's interest rates and price level (see Cologni and Manera, 2008); exchange rates (see Chen and Chen, 2007); unemployment and stock prices (see Huang *et al.*, 2005; Asab, 2017). Another strand of the literature, consisting Lee *et al*. (1995), and Rafiq, Sgro, and Apergis (2016) examines the impact of uncertainties evolving from oil price shocks. They conclude that oil price shocks significantly affects aggregate macroeconomic indicators like unemployment, interest rates, exchange rates, GDP, investment and inflation. However, they find an asymmetric connection amid oil price variations and the economy, implying that negative impact of oil prices increases varies from positive effects of oil price drops. These studies were conducted in the situation of developed oil-importing nations in Europe and North America. A few academic endeavors have been undertaken to analyze the effect of oil price shocks on external balances (see Bodenstein, Guerrieri and Gust, 2013).

While prior studies have used time series estimating techniques, it is essential to categorize the linkage within a panel framework. This is needed to realize the oil exporting group dynamics evolving from the impact channels. More importantly, regional economic performance is attracting scholarly interest in order to advance appropriate policy guidelines for oil resources. This is the focus of this study. In addition, it adds to extant oil prices and output performance nexus literature. This is achieved by adopting a non-linear estimating technique that ascertains the asymmetric effect of oil price shocks in a panel of countries within the context of the AOECs.

2.2. Theoretical review

Several developing oil-exporters largely rely on proceeds from oil exports, causing their economic activities to oscillate with variations in oil prices (Aastveit, Bjornland, and Thorsrud, 2015). The literature reveals that most developing oil-exporting nations are lagging behind in their non-resource based contemporaries (see Subramanian and Sala-i-Martin, 2003). This is premised within the context of poor economic growth among the exporting economies, and by the contrary impacts of oil windfalls on government policies, institutions, and investment in human capital. It is contended that, comparatively, oil-endowed economies accrue less human capital compared with their oil-poor counterparts due to capital-intensive enclave characterizing it (Hjort, 2006). The oil-poor economy government has little encouragement to invest in skilled workers, and the returns on and quality of education are little (Birdsall, Pinckney and Sabot, 2001). This suggests that oil prices might asymmetrically impacting on the economies of developing oil-exporting nations. This suggests that the economies might not have suffered the conquence of low oil prices due to declining proceed from oil, but might also have been able to fully benefit from increases in upsurge in oil prices, that accounts for massive inflows in foreign reserves, as well as critical for economic growth.

According to Rafiq *et al.* (2016), asymmetric impacts of oil price variations on trade in the oil exporting economies may be classified into positive and negative effects. The impacts of positive oil price shocks have been relatively well accounted for in literature, specifically in relation to oil-importing countries (see Huang, Hwang and Peng, 2005). The studies argue in favour of oil price increase to positively impact the economy of net oil-exporting nations. This direct impact is referred to "*revenue effect*", asserting that oil prices rise may perhaps improve "*terms of trade*" in the net oil-exporting nations, which in turn, may enhance trade balance, cause revenue to increase, and a rise in both investment and consumption (see Korhonen and Ledyaeva, 2010). Such direct positive shocks could be refuted using diverse indirect effects (Lee and Chang, 2013). For instance, increases in oil prices might result to inflationary pressure in international markets, which may ultimately increase the prices of imports in the oil-exporting and oil-importing ceconomies. Therefore, for any country to curb inflationary pressure, the monetary authorities in the trading partners might react by increasing interest rates, which could lead to declining investment and consumption. Thus, reducing growth rate among the partner nations. In addition, this could lead to fall in demand for oil and ultimately leading to a decline in oil exports, affecting trade balance in oil-exporting countries. Conversely, a rise in oil prices might create negative supply shocks to the production processes of the importing countries, which in turn, may result in an economic go-slow in these countries, causing their imports to drop on the one hand and on the other, wielding a negative impact on the trade balances of oil-exporting economies. Overall, the gain from a rise in oil prices for an oil-exporting nation is entirely dependent on the degrees of three effects (supply , revenue and demand effects). In addition, even if the general impact is positive, Lee and Chang (2013) point out that, there are other worries, like the existence of volatility, Dutch Disease and the exhaustibility of the positive effect and dependence on trade partners.

3. METHODOLOGY

3.1. Panel-VAR (PVAR) Technique

Following several studies on natural resources, this study employed the PVAR estimating technique (see Canova and Ciccarelli, 2004; Cunado, Jo, & De Gracia, 2016; Andarov, 2019). The PSVAR generates impulse-response functions (IRFs) to analyze how oil price shocks impacts output of the AOECs. According to Canova and Ciccarelli (2012), the PVAR is built on the VAR framework. Apart from the fact that the PVAR is considered as an appropriate technique, focusing on the multivariate correlation among variables, it supports the creation of several lags because the impacts of oil price shocks might not be instantaneous. Nikolas *et al.* (2001) identify several benefits of using a panel VAR methodology compared with the methods (the OLS model) used previously to investigate the oil price shocks and macroeconomy nexus. Firstly, contrary to cross country methods, panel data techniques permit the control of unapparent time-invariant country features, and minimize concerns relating to omitted variable bias. Secondly, to explain any universal macroeconomic shocks which may impact all nations in similar manner, time fixed effects could be added. Thirdly, the addition of lags to the variables in a PVAR model assists to analyse the dynamic association between the various variables. The IRFs built on PVARs could explain the delayed impacts on the variables employed. This determines whether or not the impacts between the variables are short-lived. Fourthly, treating every variable as endogenous, PVARs overtly address the problem of endogeneity, which is common with empirical studies on oil prices. Fifthly, PVARs can be employed effectively with relatively short-time series as a result of the gained efficiency from cross-sectional measurement. Sixthly, PVAR pools data over time and across the section. This helps the study to overcome the problem of shortage of degrees of freedom which analysis with limited data using a country-specific or single VAR may compromise (see Andarov, 2019). In addition, Andarov (2019) and Gravier-Rymaszewska (2012) assert that, unlike the SVAR model, the PVAR model does not need imposition of a structural relationship. Though theory is considered in selecting the suitable normalisation, to interpret results. Furthermore, PVAR requires only a negligible set of assumptions in order to infer the effects of shocks on the variables of the PVAR system (Gravier-Rymaszewska, 2012).

3.2. Oil Price Change Derivation: *Decomposition*

To critically investigate the asymmetric effect, this study follows Mork (1989), Lee *et al*. (1999) and Hamilton (2003) to decompose the oil price. This procedure helps us to examine output responses within a short-run horizon. Furthermore, it allows us to expound the policy response and obtain policy direction on variations in global oil prices (increases and decreases) over time. An unprecedented variation in oil prices may have serious implications for economies that are reliant on oil, such as the AOECs. These asymmetric estimation techniques have been found suitable to measure movements in oil prices (see Kose and Baimaganbetov, 2015). As a result, this study employs three key non-linear transformations accounting for asymmetry of oil prices to examine the presence of an asymmetric relationship. These transformations have been widely used in related studies and are thus relevant to this study (see Herrera *et al*., 2011; Kose and Baimaganbetov, 2015). The specifications are the asymmetric specification, net specification and scaled specification (see Mork, 1989; Hamilton, 2003; Lee *et al.*, 1995).

Asymmetric specification propounded by Mork (1989) decomposes quarterly oil prices into and differentiates between a positive rate of variation (OP_t^+) and negative rate of variation (OP_t^-), which are expressed as:

$$OP_t^+ = \{OP_t if\ OP_t > 0, 0\ otherwise$$

$$OP_t^- = \{OP_t if\ OP_t < 0, 0\ otherwise$$

where OP_t represents the rate of change in oil prices. However, OP_t^+ quotes the net increase in oil prices and OP_t^- quotes the net fall in oil prices in a directly opposite way.

Mork (1989) proposes the censoring of the oil price series after the 1985-86 drop in the prices of oil.

Lee *et al*. (1995) propose the second of these transformation measures, PVAR:

$$OP_t^+ = 0\ if\ \frac{OP_t}{\sqrt{\delta_t}} > 0$$

$$OP_t^- = 0\ if\ \frac{OP_t}{\sqrt{\delta_t}} < 0$$

where, OP_t is a measure of changes (increase/decrease) in oil prices.

Hamilton (2003) proposes the third transformation procedure to evaluate the effect of oil price shocks. In addition, the transformation proposes the benchmark model given by:

$$Q_{i,t} = \delta_{\mathrm{i,t}} + \sum_{i=1}^{n} \beta_{t-i}\, Q_{t-i} + \sum_{i=1}^{n} \partial_{t-i}\, OP_{t-1}^{shocks} + \varepsilon_{\mathrm{i,t}}$$

where OP_{t-1}^{shocks} denotes an alternative measure of shocks (positive/negative); Q_t is output.

According to Hamilton (2003), considering the various available metrics of oil price shocks, the following test can help to determine the appropriate measure of such shocks. He further argues that although the measures of shocks could be non-linear functions of oil prices, they are linear functions of the parameter estimates of $Q_{i,t}$ above. Therefore, the benchmark model can be expressly reduced as follows:

$$Q_{i,t} = \delta_{\mathrm{i,t-j}} + \partial' \rho_{i,t-j} + \varepsilon_{\mathrm{i,t-j}}$$

Where $\rho_{i,t}$, is defined as $[Q_{t-1}, Q_{t-2}; OP_{t-1}^{shocks}, OP_{t-2}^{shocks}]$.

3.3. Model Specification and PVAR set up

This study employs data from five AOECs for the period 1980-2018. It uses the Hatemi-J (2012) PVAR methodological technique, which is similar to Hamilton (1989). The technique extends the traditional VAR model developed by Sims (1980), assuming that all variables, within the model, are endogenous. Therefore, the PVAR model, in the general form, is expressed as follows:

$$Q_{\mathrm{i,t}} = \delta_{\mathrm{i,t}} + \psi_{\mathrm{n,i,}} OP_{i,t-j}^{shocks} + \varepsilon_{\mathrm{i,t-j}} \quad (1.0)$$

where, Q is the output growth and OP is the oil prices expressed in USD; $i = 1, 2, \ldots, 5$ denoting the oil-exporting countries; $t = 1980, 1981, \ldots,$ 2018; $n = 1\ and\ 2$,showing movement in oil price or the cumulative amount of movement in the oil price, which could either be positive or negative and is the lag element.

Following Hatemi-J (2012), the study decomposes the prices of oil into their cumulative sums of (+) and (−) shocks. This is in response to Hooker (1996) who argues that the linear connection of oil price and output growth developed by Hamilton (1983) which was built on the oil price rise alone, is not dependable, especially given observed output growth performance realities. In addition, the decomposition of oil prices into negative and positive shocks in this study is a departure from what is common in the literature which considers only positive oil price shocks rather than the fluctuating movement in oil prices (see Huang, Hwang and Peng, 2005; Asab, 2017).

$$OP_{\mathrm{i,t}} = \psi_{\mathrm{i,t}} OP_{i,t}^+ + \vartheta_{\mathrm{i,t}} OP_{i,t}^- \quad (1)$$

Deviating from previous studies that employed Western Texas Intermediate, Brent Sweet Light Crude, Forties Crude and Oseberg Crude (see OPEC, 2016), this study investigates the effects of Brent Crude oil price shocks on AOECs, based on the asymmetric specification framework in equation (1) which is substituted into equation (1) to derive equation (2):

$$Q_{\mathrm{i,t}} = \delta_{\mathrm{i,t}} + \psi_{\mathrm{i,t}} OP^{+}_{i,t-j} + \vartheta_{\mathrm{i,t}} OP^{-}_{i,t-j} + \varepsilon_{\mathrm{i,t}} \quad (2)$$

As shown in equation (1), our benchmark specification is bivariate PVAR, containing output growth and oil prices. Nevertheless, the study extends the model to a quad-variate PVAR with the addition of two policy control variables, namely, inflation and exchange rates. Exchange rates (EXCH) measure the currency of each country which is expressed in the currency of another country. The study uses the USD exchange rate as a benchmark because it is widely acceptable and beign the most traded currency in foreign exchange market (see Rafiq *et al.,* 2016). Its inclusion follows Rafiq *et al*. (2016) to investigate how changes in the worth of the USD affect the variables selected in the AOECs. This also assesses the degree of interaction amid business cycles and the way that it stimulates output growth. Exchange rates assist in examining how changes in the worth of the USD affect oil prices and consequently output (Rafiq *et al.*, 2016). Furthermore, the inclusion of the inflation rate helps in assessing how the general price level may affect output growth when oil prices vary.

$$Q_{\mathrm{i,t}} = \delta_{\mathrm{i,t}} + \psi_{\mathrm{i,t}} OP^{+}_{i,t} + \vartheta_{\mathrm{i,t}} OP^{-}_{\mathrm{i},t} + \mu_{\mathrm{i,t}} \xi_{\mathrm{i,t}} + \omega_{\mathrm{i,t}} \zeta_{\mathrm{i,t}} + \varepsilon_{\mathrm{i,t}} \quad (3)$$

where Q is output growth; OP^{+} means positive oil price shocks; OP^{-}means negative oil price shocks; ξ is exchange rates. $\delta_{\mathrm{i,t}}, \psi_{\mathrm{i,t}}, \vartheta_{\mathrm{i,t}}, \mu_{\mathrm{i,t}}$ and $\omega_{\mathrm{i,t}}$ are parameters for intercept, positive oil price shocks, negative oil price shocks, exchange rates and inflation rate, respectively, $\varepsilon_{\mathrm{it}}$ is error term.

The oil price shocks decomposition procedure used in this study is a clear departure from previous studies that considered the oil price trend over time rather than oil price behavior (shocks). Ojo and Alege (2012) consider this approach a vital variable to determine output in oil-exporting countries. The exchange and inflation rate variables are considered here as policy variables to offer direction to policy makers.

Assumably, $OP_{\mathrm{t}}(\text{oil price at time } t)$ follows a random walk process given by:

$$OP_{\mathrm{t}} = OP_{\mathrm{t-1}} + \varepsilon_{\mathrm{i,t-1}} \quad (4)$$

Such that, the positive shocks from the white noise can be expressed as $\varepsilon^{+}_{1it} = m\,ax(\varepsilon_{1\mathrm{it}}, 0)$ and negative shocks as $\varepsilon^{-}_{1it} = min(\varepsilon_{1\mathrm{it}}, 0)$.. Hence, it is defined as $\varepsilon_{\mathrm{it}} = \sum_{t=1}^{1} \varepsilon^{+}_{it} + \sum_{t=1}^{1} \varepsilon^{-}_{it}$, such that,

$$OP_{\mathrm{t}} = OP_0 + \sum_{t=1}^{1} \varepsilon^{+}_{it} + \sum_{t=1}^{1} \varepsilon^{-}_{it} \quad (5)$$

where OP_0 is the early value of oil prices and $\varepsilon_{\mathrm{it}}$ is a white noise disturbance term.

Thus, this study uses a non-linear panel to establish the relationship amid oil price shocks and output performance. To carry out this estimation, it utilizes the current non-linear panel estimation technique of Kapetanios *et al*. (2014), allowing for cross-sectional dependence, and is appropriate for panel heterogeneity (see Rafiq *et al.*, 2016; Gravier-Rymaszewska, 2012).

The standard PVAR technique that captures the variables, output (Q_{t}), positive oil price shocks (OP^{+}_{t}), negative oil price shocks (OP^{-}_{t}), exchange rates (ζ_{t})), and inflation (ζ_{t})) employed in this study is made up of five system-equation given as equations (6) to (10).

$$Q_{i,t} = \delta_{1,t} + \sum_{i=1}^{n} \eta_i Q_{i,t-1} + \sum_{i=1}^{n} \psi_i OP^{0+}_{i,t-1} + \sum_{i=1}^{n} \vartheta_i OP^{-}_{i,t-1} + \sum_{i=1}^{n} \mu_{1,i} \xi_{i,t-1} + \sum_{i=1}^{n} \omega_i \zeta_{i,t-1} + \varepsilon_{1,t} \quad (6)$$

$$OP^{+}_{i,t} = \delta_{2,t} + \sum_{i=1}^{n} \eta_i Q_{i,t-1} + \sum_{i=1}^{n} \psi_i OP^{+}_{i,t-1} + \sum_{i=1}^{n} \vartheta_i OP^{-}_{i,t-1} + \sum_{i=1}^{n} \mu_i \xi_{i,t-1} + \sum_{i=1}^{n} \omega_i \zeta_{i,t-1} + \varepsilon_{2,t} \quad (7)$$

$$OP^{-}_{i,t} = \delta_{3,t} + \sum_{i=1}^{n} \eta_i Q_{i,t-1} + \sum_{i=1}^{n} \psi_i OP^{+}_{i,t-1} + \sum_{i=1}^{n} \vartheta_i OP^{-}_{i,t-1} + \sum_{i=1}^{n} \mu_i \xi_{i,t-1} + \sum_{i=1}^{n} \omega_t \zeta_{i,t-1} + \varepsilon_{3,t} \quad (8)$$

$$\xi_{i,t} = \delta_{4,t} + \sum_{i=1}^{n} \eta_i Q_{i,t-1} + \sum_{i=1}^{n} \psi_i OP^{+}_{i,t-1} + \sum_{i=1}^{n} \vartheta_i OP^{-}_{i,t-1} + \sum_{i=1}^{n} \mu_i \xi_{i,t-1} + \sum_{i=1}^{n} \omega_4 \zeta_{i,t-1} + \varepsilon_{4,t} \quad (9)$$

$$\zeta_{i,t} = \delta_{5,t} + \sum_{i=1}^{n} \eta_i Q_{i,t-1} + \sum_{i=1}^{n} \psi_i OP^{+}_{i,t-1} + \sum_{i=1}^{n} \vartheta_i OP^{-}_{i,t-1} + \sum_{i=1}^{n} \mu_i \xi_{i,t-1} + \sum_{i=1}^{n} \omega_5 \zeta_{i,t-1} + \varepsilon_{5,t} \quad (10)$$

The standard PVAR model made up of equations 6 to 10 can be concisely put in matrix notation. Therefore, the reduced form of a relationship between the endogenous variables (output, positive oil price shocks, negative oil price shocks, exchange and inflation rates) is given as:

$$Q_{\mathrm{i,t}} = A_0\beta_{i,t} + \alpha_1\phi_{\mathrm{i,t-1}} + \ldots + \alpha_{\mathrm{n}}\phi_{\mathrm{i,t-n}} + \nu_{\mathrm{i,t}} \quad (11)$$

where $Q_{\mathrm{i,t}}$ denotes a 5x1 vector of k system-variables (output, positive oil prices, negative oil prices, exchange rates, and inflation); A_0 is the associated parameter matrix; $\beta_{i,t}$ is vector of deterministic terms (trend and a constant); di is a cross-sectional identifier such that, $i = 1, \ldots, l$; $\alpha_{1,2,\ldots,n}$; represents a matrix of slope/coefficient estimates attached to those lagged variables $\phi_{\mathrm{i,t}}$; ν ; represents a 5x1 vector of system innovations or the stochastic error terms often called impulse innovations or shocks; and the optimal lag length (VAR order) is denoted by n for each variable selected in accordance with the SIC and AIC. The study adopts lag length two, which is found superior to others in terms of performance (see Table 6).

The reduced form PVAR in equation (11), permits implementation of dynamic simulations, one we estimate the unidentified parameters. The result takes the procedure of IRFs, their coefficient analysis, and "*forecast error variance decompositions*" which enable one to evaluate how oil price shocks impact other variables in the PVAR system.

The error process $\nu_{\mathrm{t}} = \gamma_{\mathrm{i}} + u_{\mathrm{t}} + e_{\mathrm{i,t}}$ (12)

where γ_{i} is the country's definite effect, u_{t} captures the annual effect, and $e_{\mathrm{i,t}}$ is the white noice. Zero mean is assumed for the error term ν_{t}, i.e., $E(\nu_{\mathrm{t}}) = 0$. The ν_{t}s and time invariant covariance matrix are independent.

Following Canova and Ciccarelli (2004), this study imposes two restrictions on the specifications in equation (11) and (12). Firstly, common slope coefficients is assumed, and it does't permit interdependences across units. With this restriction, the estimated (matrices) are construed as average dynamics. The interpretation is in reaction to shocks. Secondly, given the standard VAR model, the study assumes that variables rely on past behaviour of variables in the PVAR system, with the key variance being the presence of every nation's specific term, γ_{i}.

3.4. Data

Quarterly data spanning 1980Q1 to 2018Q4 is employed in this study. The commencement date captures the period of major oil price shocks that are assumed to cause an imbalance in the global economy and the exchange rates of oil-exporting nations. Data paucity dictates the cut-off date. It should be noted that the cut-off date accounts for the period of continuous decline in oil prices. The study sourced data from the OPEC and Federal Reserve Economic Database (FRED), over the period 1980:1 to 2018:4 on three variables. These variables are oil price (OP), output (Q) and exchange rates (EXR). The choice of Brent Blend follows the literature that notes that Brent Blend is the principal oil export in the AOECs among many major classifications (OPEC, 2016). The cutoff date is also informed by the belief that the period coincides with a time of continuous variations in global crude oil prices, with these prices lately showing a more sustained drop than in any other period.

Following Rafiq *et al*. (2016), Le and Youngho (2013), and Korhonen and Ledyaeva (2010), this study considers the terms of trade as a measure of output growth performance. It should be noted that the terms of trade reflect these countries' openness which is predominantly influenced by oil; and that oil accounts significantly for their foreign exchange earnings. In 2018, for instance, oil accounted for about 87 percent of earnings from foreign exchange in Nigeria and approximately 95 percent in Libya. It made up around 80 percent of earnings from foreign exchange in Gabon from 2010 to 2016 (WDI, 2021). Similarly, the terms of trade capture economic activity that may perhaps be affected directly by oil prices and uncertainty about such prices (see Rafiq *et al*., 2016). Theory and empirical works dictate the choice of these variables (see Rafiq *et al*., 2016) that are modeled into a PVAR estimating technique. Due to the requirement for using the panel VAR estimating technique, the variables employed here are subject to the stationarity test before proceeding to estimate the panel VAR model.

3.5. Brief Description of Variables

3.5.1. Output (Q)

The term of trade *(TOT)* proxy for output and it expresses the relationship between import prices and export prices. The TOT ranges from 0-100 percent. The higher the magnitude, the better the economy. Following Rafiq *et al*. (2016), this study uses the TOT to analyse the asymmetric link amid oil price shocks behavior and output performance in AOECs. TOT has been selected due to the understanding that the crude oil exports of these countries account significantly for their revenue and more importantly that, variations in the prices of crude exports affect their exchange rates.

3.5.2. Oil prices (OP)

The oil price means the sum that oil is sold daily on the world market (see Rafiq *et al.*, 2016; Hamilton, 2013; Rotimi and Ngalawa, 2017). It is usually invoiced in dollars. This study uses the prices of Brent Blend being the key oil exported in the AOECs among several key groupings of oil consisting of Brent Sweet Light Crude, Brent Crude, Forties Crude and Oseberg Crude (OPEC, 2016).

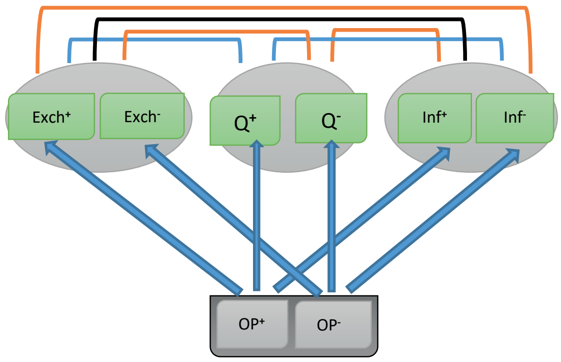
3.5.3. Exchange rates (EXCH)

Exchange rates express each nation's currency in another nation's currency. In this study, USD exchange rates are selected as a benchmark due to their wide acceptability and the most traded currency at the foreign exchange market (Kia, 2013). The choice of nominal exchange rates in this study is premised on various studies like Korhonen and Ledyaeva (2010), and Rafiq *et al.* (2016).

3.5.4. Inflation rate (INF)

Inflation measures the general rise in prices and a fall in purchasing power of money over time. It is measured using a quarter by quarter national composite consumer price index with 2010 as base year. Inflation is a fundamental monetary policy variable and it reacts when oil price shocks occur (see Hamilton, 2013). Therefore, it is introduced into the PVAR model as a monetary policy variable to serve as a control variable with a link to monetary policy decisions, especially exchange rates.

Figure 1. Macroeconomic-Oil Price Shocks Behaviour Model



Source: Authors' compilation (2022).

Figure 1 presents a model showing the relationship among the various macroeconomic variables considered in this study. More specifically, the model shows how the decomposed oil price shocks interact with output, inflation, and exchange rates. For the AOECs, positive oil price shocks lead to exchange rates to appreciate as a result of higher demand for their currencies. However, positive oil price shocks may cause an increase in inflation because the AOECs rely on importation of refined oil and other refined petroleum products due to their low refinery capacity. Inversely, production factors' prices may fall following negative oil price shocks. Output, which is the focus of this study, may respond negatively to oil price shocks and this may lead to a fall in revenue. Furthermore, a fall in oil prices may hamper economic growth and consequently lead to an unfavourable trade balance.

3.6. Estimating technique

3.6.1. Panel unit root tests

Various studies have emphasized the concept of unit root tests (see Moon, Perron, and Phillips, 2007, Im *et al.*, 2003). According to these studies, unit root is necessary to ascertain the because if the variables are non-stationary as well as non-cointegrated so as to avoid wrong specification of the model and hence, spurious results (see Shabri, 2017). Therefore, this study implements tests of Levin *et al*. (2002) and Im *et al*. (2003) to examine whether the variables follow a stationarity procedure, using both the Akaike and Schwarz Information criteria. The choice of the various criteria is informed by the need to confirm the validity and reliability of our results as well as their consistency (see Moon and Perron, 2004; Frimpong and Oteng-Abayie, 2006).

To test whether a series, say , is integrated or equivalent to testing for the significance of a series, the study employs the regression equation. This procedure follows the Augmented Dickey-Fuller technique which suggests that the Dickey-Fuller test creates an autocorrelation problem. An Augmented Dickey-Fuller test is suggested to tackle this problem (see Frimpong and Oteng-Abayie 2006).

$$\Delta\psi_t = \phi_0 + \beta\psi_{1t-1} + \alpha_{1i} + \varepsilon_{1t} \quad (13)$$

$$\Delta\psi 2_t = \phi_0 + \phi_{1t} + \beta\psi_{2t-1} + \alpha_{2i} + \varepsilon_{2t} \quad (14)$$

Regression equations and , respectively represent ADF with intercept only and ADF with trend and intercept. The hypotheses are specified below:

Null Hypothesis

$(\mathrm{H}_0: \mathit{Variables\ are\ not\ stationary\ or\ have\ unit\ roots})$

Alternative Hypothesis

$(\mathrm{H}_1: \mathit{Variables\ are\ stationary\ or\ have\ no\ unit\ roots})$

3.6.2. Panel lag length

Lag length shows the number of times between which output action responds to oil price shock. It refers to number of times back down the Autoregressive (AR) process one examines for serial correlation. According to Lutkepohl (2006), the information criteria for ideal lag length is contingent on the number of observations. Since the series for this study are quarterly, it tests for several orders of lag selection conditions that allows for modifications in the model, and consequently the attainment of good residuals.

3.7. Interpretation of Empirical Results

3.7.1. Panel unit root results

Table 1. Levin *et al.* Im *et al***.** and Fisher-ADF unit root tests: Individual Intercept

Var	Levin *et al.* (Individual Intercept)			Im *et al.* (Individual Intercept)			ADF- Fisher-Chi Square (Individual Intercept)		
	Integ Order	t-stat (t*)	Prob Value	Integ Order	t-stat (t*)	Prob Value	Integ Order	t-stat (t*)	Prob Value
Q	I(1)	-3.43894	0.0001***	I(1)	-3.3199	0.0000***	I(1)	8.19228	0.0001***
OP(-)	I(1)	-11.9081	0.0000***	I(1)	-12.9788	0.0000***	I(1)	11.2142	0.0000***
OP(+)	I(1)	-13.2155	0.0040***	I(1)	-10.6106	0.0000***	I(1)	14.2063	0.0020***
EXCH	I(1)	-9.12571	0.0023***	I(1)	-5.18969	0.0000***	I(1)	71.1402	0.0000***
INF	I(1)	-5.32421	0.0011***	I(1)	-5.24554	0.0000***	I(1)	25.1480	0.0100***

"***", "**" and "*" respectively represent statistical significance at 1%, 5% and 10%.

Source: Authors' computation (2022).

Table 2. Levin *et al.* Im *et al***.** and Fisher-ADF unit root tests: Individual Intercept and trend

Variа	Levin *et al.* (Individual Intercept and trend)			I'm *et al.* (Individual Intercept and trend)			Fisher-ADF (Individual Intercept and trend)		
	Integ Order	t-stat (t*)	Prob Value	Integ Order	t-stat (t*)	Prob Value	Integ Order	t-stat (t*)	Prob Value
Q	I(1)	-2.31527	0.0054***	I(1)	-2.11106	0.0410***	I(1)	22.2875	0.0009***
OP(-)	I(1)	-9.41454	0.0000***	I(1)	-11.3011	0.0010***	I(1)	120.147	0.0000***
OP(+)	I(1)	-16.6126	0.0000***	I(1)	-14.1268	0.0000***	I(1)	172.767	0.0000***
EXCH	I(1)	-13.0597	0.0000***	I(1)	-8.14352	0.0050***	I(1)	69.7551	0.0000***
INF	I(1)	-6.24174	0.0104***	I(1)	-4.24306	0.0000***	I(1)	39.7626	0.0000***

"***", "**" and "*" respectively represent statistical significance at 1%, 5% and 10%.

Source: Authors' computation (2022).

This study first diagonised the chataeristics of the series. The results presented in Tables 1and 2 reveal that output and negative oil price shocks under all the criteria considered are stationary in their first difference and no variable is found to be stationary following the second differences I(2).

3.8. Summary Statistics of variables

Table 3. Summary statistic of variables

	Q	OP^-	OP^+	EXCH	INF
Mean	141.182	-2.09665	2.27453	1.65118	1.16620
Median	134.270	0.00000	0.41500	1.83875	0.94750
Maximum	357.580	1.87726	25.5946	2.41000	2.87000
Minimum	43.8800	-59.8256	0.00000	-0.36000	-0.55000
Std. Dev.	56.8541	5.94569	3.91672	0.54988	1.13503
Skewness	0.94326	-6.68888	2.69320	-1.67347	0.01060
Kurtosis	4.22001	59.8756	12.2250	5.56951	1.49701
Jarque-Bera	164.040	110948	3708.74	578.646	73.4307
Prob	0.00000	0.00000	0.000000	0.00000	0.00000
Sum	110122.2	-1635.39	1774.139	1287.92	909.636
Sum Sq. Dev.	2518037.	27538.6	11950.40	235.549	1003.59
Obs	780	780	780	780	780

Sources: Authors' computation (2022).

Table 3 shows the statistics for the series employed in this study for the period under consideration, namely, output, positive and negative oil price shocks, exchange rates and inflation rates. The study focuses on decomposed oil prices and output because they are variables of interest, as the aim is to establish if oil prices have an asymmetric relationship with output. The maximum and minimum values of output are 357.58 and 43.88, respectively. The mean value of output is 141.18, suggesting that the mean falls at the lower side of the distribution. The range of the series and its mean distribution are relatively close to the minimum output, suggesting that oil prices might not have been significantly impactful on output but rather are considered low. This further suggests that the various positive oil price shocks experienced during the period under review may not have significantly impacted output, or the negative shocks could have retarded the economies of the oil-exporting nations. -2.09 and 2.27 are respectively the means of the negative and positive values of oil price shocks. The minimum negative oil price shocks and maximum positive oil price shocks are -59.8 and 25.59, respectively. The standard deviation for output stands at 56.85.

3.9. Panel Correlation Matrix

Table 4. Panel Correlation Matrix

Variables	Q	OP^-	OP^+	EXCH	INF
Q	1.00000	-0.07660	0.20413	0.25328	0.21776
OP^-	-0.07660	1.00000	0.20441	-0.06246	-0.12042
OP^+	0.20413	0.20441	1.00000	0.13902	0.23533
EXCH	0.25328	-0.06246	0.13902	1.00000	0.40015
INF	0.21776	-0.12042	0.23533	0.40015	1.00000

Sources: Authors' computation (2022).

To ascertain that the multi-collinearity problem is averted in the estimation of this study, this section presents the extent of the relationship among the series under consideration. These include output, oil price (positive and negative), exchange rates and inflation rates. Table 5.4 presents the association of these series.

A close look at the correlation matrix shows that the sign of connecting coefficients is consistent. For instance, the connecting coefficient of Q and OP^- is negative while that of Q and OP^+ is positive, indicating an improvement in output and fall in output. Nonetheless, the positive shocks coefficient (0.02) does not suggest an asymmetric relationship with negative shocks (-0.07). Similarly, negative oil price shocks reveal a weak association between oil prices and output, and positive oil price shocks reveal a relatively strong link amid oil prices and output. These findings validate the *"oil revenue effect"* on the oil-exporting economies. The association between negative oil price shocks and output presents an inverse relationship, while positive oil price shocks show otherwise. This validates our earlier results that positive oil price shocks are good news for oil-exporting nations (see Rafiq *et al.,* 2016; Catik and Onder, 2013; Hamilton, 2009).

This study also considers the association between monetary variables and the many oil price shocks. In particular, it considers the association between inflation and oil price shock. The positive sign between inflation and negative oil price reveals that a decline in oil prices reduces inflation but a rise in oil prices has the tendency to heighten inflation.

Apart from output and exchange rates that record a slightly weak coefficient with oil price shocks, other variables record strong correlations with such shocks. Nevertheless, the overall correlation among the various paired variables presents a negative and positive mix.

3.10. Panel Cointegration

Table 5a. Panel Cointegration- Individual Intercept

Criteria	Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic	-1.448872	0.9263	-1.540788	0.9383
Panel rho-Statistic	1.531916	0.9372	1.613725	0.9467
Panel PP-Statistic	1.336873	0.9094	1.424279	0.9228
Panel ADF-Statistic	1.914493	0.9722	2.086855	0.9815

Sources: Authors' computation (2022).

Table 5b. Panel Cointegration- Individual Intercept and Trend

Criteria	Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic	-2.199932	0.9861	-2.163561	0.9848
Panel rho-Statistic	2.775702	0.9972	2.748835	0.9970
Panel PP-Statistic	3.219331	0.9994	3.215085	0.9993
Panel ADF-Statistic	3.238242	0.9994	3.269647	0.9995

Sources: Authors' computation (2022).

After the variables have been tested and found stationary, a panel cointegration test is conducted using the Pedroni-Engle-Granger based procedure (1999). This is conducted to establish if there is a cointegrations relationship among the variables. Tables 5a and 5b show that there is no cointegrations relationship. The presence of a cointegrations relationship among variables may call for SVAR analysis of long-run effects (see Baltagi and Kao, 2001).

3.11. Panel Optimal Lag Selection

Table 6. The Panel ARDL Optimum Lag Selection Criteria

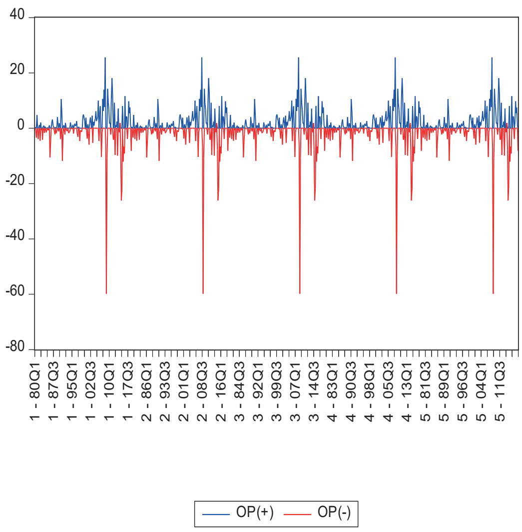
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-649.9163	290.9888	6.06e-06	2.175449	3.140356	2.547482*
1	-626.0697	78.65847	6.08e-06	2.178567	3.299103	2.610604
2	-584.4336	45.37297*	5.81e-06*	2.133604*	3.109771*	2.625647
3	-564.5175	101.9111	6.16e-05	2.223020	3.321037	3.015037
4	-450.1018	99.3375	9.09e-06	2.281356	3.235003	2.833378
5	-401.7723	93.26296	8.54e-06	2.218303	3.327580	2.830330

Source: Authors' Computation (2022).

The lag length result is presented in Table 6. It reveals that lag length 2 is the optimal lag length.

3.12. Panel VAR Estimation Results

Figure 2. Oil Price Shocks (Positive and Negative)



Sources: Authors' computation (2022).

The panel data procedure employed in this study follows Holtz-Eakin *et al.*'s (1988) claim that PVAR addresses unobserved heterogeneity in a model. To explain the cause-effect association amidst the explained and explanatory variables, two perspectives of oil prices are considered, via the OP_t^+ and OP_t^- to investigate the impact of oil price behavior on the output of the AOECs. These perspectives are showed in figure 2, showing the graphical demonstration of various oil price shocks' behavior. In this distinction, positive oil price shocks are referred to as a rise in oil prices as shown above line zero (0) in Figure 2 and negative oil prices are referred to as a fall in oil prices as shown below line zero (0).

The following section shows the findings of the PVAR model. The study focuses on the link amid output and various oil price shocks. Therefore, it tracks the dynamic paths of oil prices and how they impact on output over time. The study relies on the IRFs obtained from the VAR technique, since it endogenously treats the variables. Sims (1980) introduced impulse response function analysis in the VAR estimating technique. The technique highlights futre economic system state, if variation occurs in any of its components. This procedure provides an answer to the question of the way the economic system would be affected by variation in one of its variables. The impulse response technique helps to trace the time pathway reaction of the contemporary and future values of every variable to a one-unit rise in the present value of one of the innovations of VAR (see Stock and Watson, 2001). Bernanke and Mihov (1998) confirm that the IRF provides quantifiable measure of the response of every variable to shocks in the differential equations of the system. In addition, the impulse response generates the anticipated future path of variables subsequent to particular shocks. It is also exciting to establish how vital are particular shocks to explain instabilities of variables employed into the PVAR system, that is realized using VD. Following this background, this study relied on an atheoretical PVAR model, instead of a regression reliant panel data procedure that was perhaps more based in theory but will come at the cost of its failure to track the dynamics of output over time, following oil price shocks. We distinguish between negative and positive oil price shocks that are respectively captured by the negative and positive values of oil price variations.

To order the variables used in our model, the study follows Demary (2010). A study that addresses the wealth effect in time-series built VAR models for specific nations. According to the study, the VAR model is principally an atheoretical one, and accordingly, proper identification of the structural shocks is a field of on-going study in time-series econometrics. Therefore, the probable shocks in the system are recognized based on slow "(ordered before)" and fast-moving "(ordered after)" variables in relation to specific shocks.

3.13. Impulse Response Functions Analyses

Sims (1980) pioneered the application of the impulse response function technique (IRFT) in VAR modeling, to demonstrate the future position of an economic system when a variation occurs in a component of the system. The IRFT answers the question: How is the future of a system affected by a change in one of its variables? It thus shows the extent to which variables of the VAR system react to one another at a time.

Given that the impulse response function accounts for the extent to which the endogenous (dependent) variables react to one another as variations occur over time, the study constructs impulse responses for all the variables considered in the model. This allows us to recognize the economic reaction to various oil price shocks. For suitable analysis to be achieved, the IRFs analyses are divided into a thirty-period horizon, as presented on the horizontal axis (see figures 3 and 4). This is done to highlight the economy's reaction to various oil price shocks. Since stability of the VAR framework has been achieved, this study examines the economic system of the AOECs' impulse reaction to various oil price shocks (i.e., negative and positive oil price shocks) via exchange rates, output, and inflation rate. In the impulse responses depicted in figures 3 and 4, the x-axis represents the periods that the analysis covers. Generally, the unit root results of these macroeconomic variables reveal that the variables are stationary (see Tables 2a and 2b for details).

3.13.1. Impulse responses of output and other selected macroeconomic variables to negative oil price shocks

The vital focus of this study is to analyze how various oil price shocks impact output, with the aim of establishing whether or not there is an asymmetric relationship. The reaction of each variable to negative oil price shocks is analyzed. Figure 3a to 3c respectively depict the impulse responses of output, exchange rates, and inflation to a one percent standard deviation in negative oil price shocks, as dictated by the international oil market, covering thirty periods. Output is negative and significantly explain the impact of negative oil price shocks. One standard deviation in negative oil price shocks leads to a negative response in output. Following the negative oil price shocks' behavior, it is evident that output continuously declines from the beginning through period five to nine and bottoms at period ten. As it proceeds into future periods, it begins to rise until period thirty. This suggests recovery or improved output among the AOECs and also implies that negative oil price shocks may not necessarily dictate a continuous fall in output over time.

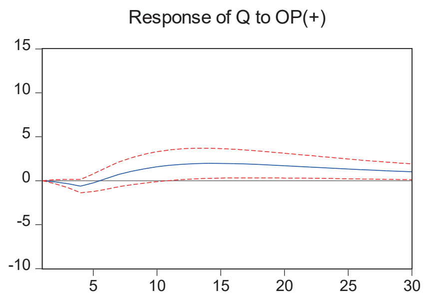
The attendant impact of a one percent variation in negative oil price shocks is also shown in a positive and significant reaction in exchange rates from periods fifteen to thirty. Prior to this, the exchange rates trend is positive but not significant, suggesting that the effect of negative oil price shocks is not felt instantaneously in exchange rates variations. Furthermore, the response shows that unanticipated negative oil price shocks from the external environment reduce the value of the domestic currency, as more units of domestic currency exchange for fewer units of dollars and this situation may relatively persist in the future period. This finding is in line with Kose and Baimaganbetov (2015) and Rafiq *et al*. (2016), who claim that the influence of oil price shocks on the currency of oil-exporting nations leads to currency appreciation or depreciation if the shocks are respectively positive or negative. Figure 3c shows a slight, significant decline in inflation over a relatively long period, specifically from the eighth to the thirtieth period, consequent to a one percent standard deviation in negative oil price shocks. More precisely, inflation rises sharply within periods one and two, peaks in period three and begins to decline continuously from period four as it moves towards period five, bottoming at period ten. It stabilizes steadily and flattens at period ten and continues up until period thirty with a negligible increase. These findings align with our expectations that, negative oil price shocks reduce output and cause a decline in oil revenue (revenue effects). However, external shocks have a spill-over impact on economic output. For example, negative oil price shocks could lead to a fall in production arising from a rise in the prices of production factor inputs. Following Di Giovanni and Shambaugh (2008) who assert that various economies are affected by external conditions, this is reflected in inflation that initially trends upward within the first three periods and later declines significantly until period thirty.

3.13.2. Impulse responses of output and other selected macroeconomic variables to positive oil price shocks

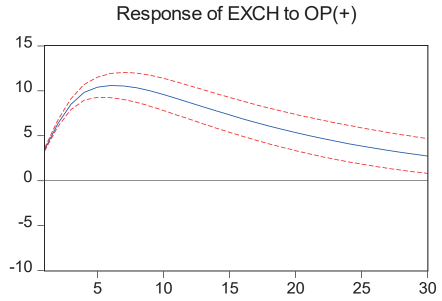
Figure 3a-3c presents the impulse responses of output and other macroeconomic variables to a one percent standard deviation in positive oil price shocks. More specifically, figure 3(a) shows that positive oil price shocks reduce output in periods one and three, bottoming out in period four. Thereafter, they become positive and significant, rising over a relatively long period and peaking at about period fifteen. Output responds positively to one standard deviation in positive oil price shocks. This may result in a rise in oil proceeds accruing to domestic oil-exporting economies and may consequently lead to domestic currency appreciation. This finding is in line with theory and also supports the findings of Rafiq *et al*. (2016) who report a positive nexus between output and one standard deviation in positive oil price shocks. Despite this observed similarity, there is a slight difference in output behavior in reaction to positive oil price shocks. For instance, this study finds a positive and significantly prolonged rise in output among the AOECs.

Figure 3

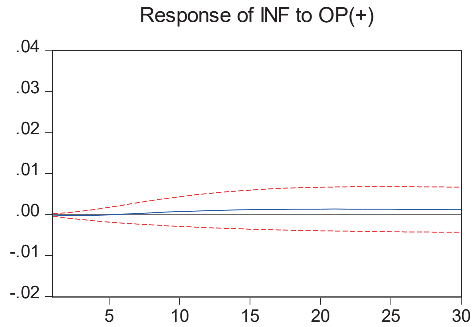
(a)



(b)



(c)



The impulse responses of the exchange rates to a one percent standard deviation in positive oil price shocks are presented in Figure 3(b) that shows that exchange rates rise, peaking in the fourth period and begin to decline significantly and continuously as it moves to period thirty. This suggests appreciation in the domestic currency of the AOECs, as less of their domestic currency will be required in exchange for foreign currencies. This is in line with the literature and the standard theory of exchange rate determination, suggesting that, positive oil price shocks lead to currency appreciation in an oil-exporting country and vice versa. Demand for its currency leads to a rise in the foreign exchange market, and this causes the value of domestic currency to appreciates. In contrast to negative oil price shocks, the inflation rate depicted in figure 3(c) does not significantly respond to one standard deviation in positive oil price shocks. This suggests that positive oil price shocks may not necessarily trigger inflation in the AOECs.

3.14. Variance Decomposition (VD)

VD shows the proportion of shocks to a exact variable that relates to either self innovations or innovation from other endogenous variables over a specified or forecasted time frame in a given model (see Rotimi and Ngalawa, 2017). Furthermore, variance decomposition accounts for the information on the percentage of movements in an order of a given variable due to self shocks or shocks arising from other variables (see Adarov, 2019). It analyses the relative significance of shocks in explaining changes among the variables in a given model. In this study, VD is employed to evaluate the relative fraction of shocks to variables in our model; basically, to assess how various oil price shocks impact output of the AOEC.

In order to determine the comparative significance of each structural innovation in explaining variabilities and shocks of the variables in our model, Tables 7-9 present variance decompositions for the variables output, exchange rates, and inflation for period thirty. The analyses thus cover a six-year forecast horizon.

Table 7. Variance Decomposition of Output

Period	S.E.	Q	OP^{-}	OP^{+}	EXCH	INF
1	3.47149	100.000	0.00000	0.00000	0.00000	0.00000
6	21.7749	93.1920	6.64621	0.13117	0.01787	0.01273
12	34.0327	87.2754	11.3884	1.14459	0.18155	0.01002
18	39.6121	84.0331	13.2026	2.26750	0.42680	0.06981
24	42.1613	82.3279	13.9000	2.86442	0.67838	0.22927
30	43.3597	81.3124	14.1614	3.14582	0.91651	0.46375

Source: Authors' Computation (2022).

Table 7 shows that the difference in the number of variations in output specifically ascribed to positive and negative oil price is relatively pronounced compared to inflation and exchange rates. Negative oil price shocks account for more than five times the proportion of the fluctuations in output that positive oil price shocks account for during the periods under examination. The degree of fluctuations associated with negative oil price shocks rose consistently over the period. It is zero percent within the first period, jumps to 6.6 percent, rises steadily through period twenty and peaks at 14.1 percent in period thirty. Similarly, positive oil price shocks gently appreciate within these periods. For example, it starts at 0.31 percent in the sixth period, jumps to 2.2 percent, more than quadruples in period eighteen and peaks at 3.1 percent in period thirty.

Table 7 reveals that exchange rates are relatively more influential in accounting for fluctuations in output than inflation.

Comparatively, the study reveals that negative oil price shocks and exchange rates, respectively account for more fluctuations in output than positive oil prices shocks and inflation rates. On the whole, the fluctuations in output ascribed to positive oil price shocks are more than those arising from either exchange rates or inflation rates. Similarly, the fluctuations in output that are ascribed to negative oil price shocks exceed those arising from positive oil price shocks, exchange rates and inflation rates. The result reveals that negative oil price shocks, that measure a net fall in oil prices is most influential on output behavior. The inference is that, of the two decomposed oil price shocks used to measure the attendant impacts of shocks on output, OP^{-} is higher than OP^{+} . Similarly, the outcome shows that negative and negative oil price shocks are disproportionate, suggesting the existence of asymmetry.

In addition, the finding reveals that negative oil price shocks explain the largest share of the fluctuations in output from the beginning to the end of the period. This clearly suggests that caution should be exercised, and appropriate policy measures should be applied to cushion the impact of negative oil price shocks.

Table 8. Variance Decomposition of Exchange Rates

Period	S.E.	Q	OP^{-}	OP^{+}	EXCH	INF
1	0.01415	0.87393	0.02748	0.00883	99.0897	0.00000
6	0.09032	2.30454	0.35920	0.06099	97.1222	0.15301
12	0.16700	3.53055	0.82375	0.02506	94.9738	0.64674
18	0.22648	4.69953	1.24902	0.02669	92.6775	1.34717
24	0.27530	5.72800	1.62358	0.05477	90.4438	2.14976
30	0.31731	6.57603	1.94015	0.09340	88.3885	3.00182

Source: Authors' Computation (2022).

Table 8 presents the variance decomposition of exchange rates, showing the different contributions of each innovation to exchange rates fluctuations. Exchange rates have been noticed to have large effect on output. As Table 8 shows, inflation rate has a marginal impact on exchange rates.

This account for less than 0.1 percent of fluctuations in exchange rates in period six, increasing to 1.3 percent in period eighteen and peaking at 3 percent in period thirty. Negative oil price shock has a somewhat larger effect on exchange rates fluctuations than positive oil price shocks. Furthermore, the result shows that negative oil price shock accounts for 0.02 percent of the instabilities in exchange rates in the first period. It jumps to 0.82 percent, and rises to 1.24 percent, 1.62 percent, and 1.94 percent by the end of the third, fourth, fifth and sixth periods, respectively. Consequently, the effect of negative oil price shocks is more pronounced than positive oil price shocks that stand at 0.0600 percent, 0.0200 percent, 0.0500 percent, and 0.0900 percent at the end of periods six, eighteen and thirty, respectively.

The results show that, during the period under examination, output increasingly accounts for fluctuations in exchange rates. This aligns with the exchange rates theory that posits that increases in output cause exchange rates to appreciate. It suggests that governments should focus on output enhancing policy to stabilize exchange rates. Table 8 also shows that output has significant impact on exchange rates fluctuations compared with negative and positive oil price shocks, and inflation rates. Furthermore, positive oil price shocks, is directly proportionate to output. Therefore, output increases during positive oil price shocks and vice versa.

Table 9. Variance Decomposition of Inflation Rates

Period	S.E.	Q	OP^{-}	OP^{+}	EXCH	INF
1	0.00428	0.00125	0.00714	0.07021	0.23065	99.6907
6	0.03210	0.01316	0.07021	0.01771	0.39965	99.4992
12	0.06670	0.11635	0.12135	0.06554	0.58570	99.1110
18	0.09603	0.29767	0.11851	0.12558	0.73311	98.7251
24	0.11965	0.52049	0.09905	0.15475	0.85010	98.3756
30	0.13846	0.75802	0.07971	0.16350	0.94773	98.0510

Source: Authors' Computation (2022).

Table 9 shows the VD, indicating that positive oil price shock accounts for marginal impact of 0.07 percent on the inflation rate. It rises progressively to 0.06 percent by the end of the twelfth period and at the end of periods eighteen, twenty-four and thirty, positive oil price shocks account for 0.1200 percent, 0.1500 percent and 0.1600 percent of the instabilities in inflation, respectively.

Contrarily, negative oil price shocks' affect inflation rate changes in the first ten periods, peaks at the end of period twelve and continuously declines to 0.07 percent at period thirty. The implication is that negative oil price shocks might result in an unstable inflation rate in AOECs. Shocks to exchange rates largely account for fluctuations in inflation from period one through to period thirty. For example, exchange rates account for 0.23 percent of the fluctuations in inflation in the first period. They account for 0.03 percent of fluctuations in inflation after six periods and 0.58 percent after twelve periods, peaking at 0.94 percent in period thirteen. Output shocks account for a negligible 0.01 percent of the fluctuations in inflation after the sixth period, 0.11 percent after twelve periods and progressively rise to 0.75 percent after period thirty.

4. DISCUSSIONS AND INFERENCES

This study primarily established the existence of asymmetry in oil price shocks in the various AOECs. Its findings may lead to vital conclusions in the debate concerning oil price asymmetry.

Firstly, the study finds evidence to support Rafiq *et al.*'s (2016) conclusion that the relationship amid oil price shocks and output is asymmetric, implying that output performance is different when positive oil price shocks are used, compared with when negative oil price shocks are employed. This is also evident from the impulse response analyses results (see Figures 3a and 4a). As indicated, positive oil price shocks clearly present a disproportionate pattern from negative oil price shocks. Consequently, output performance reacts to various oil price shocks in a disproportionate way. In addition, the study presents evidence that increased uncertainty with regard to variations in oil prices is connected with lower output. The generalized impulse response function shows an asymmetric effects of negative and positive oil price shocks on output. The IRFs reveal that the impact of positive oil price shocks on output over time differs in size and persistence from that of negative oil price shocks (bad news). This further assists to explain the asymmetric reaction of output to oil price.

Secondly, findings from the study offer a contrary opinion to the earlier claim that positive oil price shocks might trigger inflation (see figure 3b). This submits that positive oil price shocks might not account for inflation, but changes in other factors may lead to inflation.

5. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This study employs a comprehensive cross-country dataset to examine the impact of oil price shocks and its asymmetry on output performance in AOECs. Previous researches on oil price shocks and the macroeconomy nexus focused on how oil price uncertainty affected output in developed oil-importing countries but neglected the asymmetric relationship amid oil price shocks and economic activities, which may offer better policy options. This study specifically examines this relationship using output and decomposed oil price in the AOECs. It relies on a panel VAR model to study this relationship which allows us to account for impulse-response analysis to examine the impacts of oil price on output. In addition, through the panel VAR model, variance decomposition is performed to assess the importance of those effects and guidelines are offered for policy formation. The study, argue that negative and positive oil price shocks create asymmetric and heterogeneous impacts on output in the AOECs.

Furthermore, the study finds that, on average, positive oil price shocks positively impact output and this effect remains significant for more than fifteen periods. The reverse is observed with regard to negative oil price shock. Negative oil price shocks result in a fall in output. This implies that revenue from output will also fall. In terms of magnitude, the study finds that negative oil price shocks impact output greater than positive oil price shocks. For instance, fourteen percent of the fluctuations in output are associated with a change in negative oil price shocks, while only a three percent change in output is explained by a change in positive oil price shocks. The finding validates the claim that oil price shocks and output nexus is asymmetric. In addition, the results offer additional support for the institutional view of output performance that, with lower negative oil price shocks, output could be enhanced. Similar to output, fluctuations in exchange rates arising from negative oil price shocks are higher than those ascribed to positive oil price shocks. This suggests that negative oil price shocks affect AOECs more than positive oil price shocks. The net effect of positive and negative oil price shocks on output in the AOECs may therefore be unfavorable. Since this study established that the AOECs rely on proceeds from oil, and that, many of these countries rely on importation of refined oil due to their weak refinery capacity to meet local consumption, they need to mitigate against negative oil price shocks which may have serious consequences for their economies, and cause a decrease in oil revenue. The findings reveal the prevalence of Dutch Disease among the AOECs that is apparent in the impacts of negative oil price shocks on both exchange rates and output. The attendant effect of this phenomenon on the AOECs' tradable sectors is that it impacts domestic factors' prices. It squeezes out the tradable sector which my consequently portend further negative impacts for their macroeconomic behaviour. Previous studies concur that increase oil prices brings in extensive capital which may result in greater investment into human and physical capital in oil-exporting economies. In another way, a windfall from oil could cause exchange rates appreciation and deindustrialization that are detrimental to economic growth.

There is policy need to minimize the effect of oil price shocks on output, especially negative oil price shocks which have been found to adversely affect oil revenue (e.g., policies aimed at strengthening economic activities through diversification, so as to enhance the export mix). This will reduce the AOECs' on-going reliance on large revenues from oil arising from positive oil price shocks which the literature argues has had a negative and retarding impact on the economy, mainly because it affects the non-oil sector. Therefore, it is recommended that governments should provide public goods to support diversification.

It would also be beneficial for the AOECs to adopt economic stabilization policies that could reduce the level of risk attached to oil price shocks. This could include a more flexible exchange rates policy, which, to a reasonable degree, would raise the degree that the economy could make essential modifications without impeding output growth in the long run. In addition, a counter-cyclical fiscal policy is recommended. This aims to lessen spending and raise taxes during boom, and raise expenditure and lessen taxes during recession, to improve output and exchange rates. It could also mitigate oil price shocks effects on the AOECs' economies, through active and prudent management of the government estimate over the business cycles. This approach will demand that funds are reserved and a mechanism instituted through which assets may accumulate during oil booms and drawn during busts. This serves as a cushion fund that government can rely on without having to secure external borrowing to finance domestic investment. While it is noted that developed oil-importing and oil-exporting nations have some type of oil reserve fund and other internal mechanisms to stabilize their economies during unfavorable oil price shocks or in case of any uncertainties, reverse is the case in most developing oil-exporting countries. This scenario is still somewhat new to them, and they confront challenges like corruption, accountability, governance, transparency, insecurity, inequality, and high mortality rates.

It is also recommended that oil proceeds, windfalls and excess crude oil revenue are transformed into physical amenities and capital instead of being redistributed to municipal and regional governments that may not use it prudently to finance productive ventures. Funding business support projects will go a long way in encouraging production of additional tradable goods for export, and will empower the industrial base of the economy, and increase output. In addition, since oil resources are characterized as a generational resource, it is recommended that tax policy is introduced to transform today's oil revenue into social infrastructure and physical capital that will benefit future generations.

In conclusion and for the purpose of further research, the optimal size and management of oil proceeds within the oil-exporting regions are vital and this may be an motivating area for future research. On the whole, governance of the AOECs should always be proactive and provide public goods without having to rely on revenue from oil.

While our data sample for the countries under consideration is assumed adequate, a larger sample size, and more high-frequency variables, especially for the estimation of the panel VAR model, would be more appropriate. This is due to the fact that the assumption underlying the VAR model identification, where the data is on a quarterly or annual basis, could be too strong, because variables don't contemporaneously respond (within one year) to variations in other variables. Hence, data on monthly or daily frequency might offer more reliable results. Unfortunately, monthly and weekly data on national income accounts are unavailable for the nations included in our sample. The Mixed Data Sampling (MIDAS) estimating technique is recommended to handle this problem in further research.

Finally, it is recommended that future studies focus on oil revenue shocks instead of oil price shocks which could confuse demand and supply shocks. This will offer opportunities to discern the nature of oil price shocks which could be an interesting subject for investigation.

End Nots

[1] Demand effect.

[2] Supply effect.

[3] Dutch Disease is a situation where a rise in oil revenue does not result in increased domestic growth.

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