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A Panel Analysis of Brent Oil Price Dynamics on Macroeconomic Effects: The Case of Some Selected Oil-Producing Countries

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About Article

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ABSTRACT

The study investigates the macroeconomic effects of Brent oil price dynamics on the economies of ten major oil-producing countries, representing over 65% of global crude production across four economic regions, namely, Sub-Saharan Africa, MENA, OECD, and BRICS. The study focuses on the transmission of Brent oil price shocks through macroeconomic variables - real GDP, fiscal deficit, oil rent, external debt, and trade balance from 1981 to 2021. Using a Panel Vector Autoregressive (PVAR) model, the study effectively captures the dynamic relationships between these regions while tackling issues like endogeneity and unobserved heterogeneity. The findings reveal region-specific channels through which oil price shocks are transmitted: fiscal deficits in Sub-Saharan Africa, trade balances in MENA, real GDP in OECD countries, and external debt in BRICS. Impulse response functions and variance decomposition reveal varying sensitivities to oil price changes across these economies. Focusing on Nigeria, the study suggests robust fiscal rules and a sovereign wealth fund management strategy to boost fiscal stability and long-term sustainability. This research contributes to the policy discussions on managing oil wealth and addressing economic vulnerabilities in resource-dependent countries, emphasizing the importance of contextualized fiscal frameworks to mitigate the negative impacts of oil price fluctuations.

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1. INTRODUCTION

The focus of this study is a comparative analysis of the dynamic effects of Brent oil price on external debt, trade balance, real GDP, and fiscal deficit (a measure of fiscal stance) in selected oil-producing economies across four economic regions, namely, Sub-Saharan Africa, MENA, OECD, and BRICS, respectively. From a Nigeria perspective, our study seeks to assess observed fiscal policy stances, macroeconomic performance, and then develop new fiscal rules that would guarantee long-term fiscal sustainability and intergenerational wealth. Sturm *et al.* (2009) assert that in the case of oil-centred economies, fiscal policy is susceptible to macroeconomic challenges stemming mainly from the ever-uncertain oil revenue, representing a large share of the government's total revenue. Hence, robust fiscal policy instruments are encouraged by governments as a deliberate strategy for rapid economic development.

Oil-producing countries, particularly those in Sub-Saharan Africa and the MENA regions, remain susceptible to fluctuations in Brent oil prices. These price shocks often lead to significant macroeconomic issues, manifesting through fiscal deficits, increasing external debt, trade imbalances, and output shocks. Despite efforts to build fiscal resilience, many oil-producing nations treat oil booms as permanent instead of a transitory phase, which only exacerbates vulnerabilities when the oil price plummets. Additionally, the absence of a robust fiscal framework and effective sovereign wealth fund (SWF) management leaves economies like Nigeria exposed to procyclical fiscal policies and unsustainable debt levels. While prior studies have addressed oil price dynamics within specific national contexts, there is a noticeable dearth of comparative, multi-regional analyses that connect fiscal performance and propose robust fiscal policy rules.

The sensitivity of global oil economies to the incidence of Brent oil price dynamics is not unexpected, given the critical role that crude oil plays in shaping government finances (Abubakar *et al.*, 2023). In recent times, oil price variations have been recognized in the macroeconomic literature as a significant determinant of real shocks on macro-variables, Akinsola and Odhiambo (2020); Chukwu *et al.* (2024). Therefore, oil price shocks can have significant macroeconomic consequences in developed and developing oil-producing economies (Mehrara & Mohaghegh, 2011). Consequently, volatile oil prices, poor fiscal planning, and heavy dependence on external financing explain the persistent fiscal deficit in oil-producing economies (Borozan & Cipcic, 2022). In this context, studies reveal that many oil-producing countries employ fiscal deficits by essentially raising their spending since these countries treat the oil price boom as a permanent shock (Mehrara & Mohaghegh, 2011).

Thus, this is supported by Eregha *et al.* (2022), who indicate that increased susceptibility to oil price changes can result in fiscal deficit for many African oil-producing economies. Most studies in the literature that have analysed the impact of oil price dynamics on macroeconomic variables have mainly focused on developed oil-importing and oil-producing economies. However, few studies that exist for oil-producing countries are single-country specific. Our study aims to bridge this gap by focusing on a multi-country analysis. In light of this debate, the objectives of our study are as follows: (i) to assess the transmission channels of Brent oil price dynamics on macroeconomic variables in ten oil-producing economies using the PVAR methodology; (ii) to assess fiscal stabilization funds, that is, sovereign wealth funds (SWFs), in Nigeria, drawing insights from the experiences of Norway and Azerbaijan; and finally (iii) formulate new fiscal rules that merge long-term sustainability considerations with the short-term goal of mitigating budget fluctuations and the external debt crisis, explicitly focusing on Nigeria.

Prior studies tend to focus on either oil-importing nations or focus solely on individual oil-exporting countries, Bouri (2015); Salisu and Isah (2017); Akinsola and Odhiambo (2020); Odhiambo (2020); Akinsola and Odhiambo (2022); Akinlo (2024). There's a noticeable dearth of comparative studies that cover multiple countries across economic regions like SSA, MENA, OECD, and BRICS. While the PVAR model is effective for exploring dynamic relationships, it is underutilized in the literature on oil price-macroeconomy literature, particularly when it comes to oil-producing countries. Further, there is a dearth in the literature that analyses the structural framework of sovereign wealth funds or proposes a tripartite administrative model as a mechanism for insulating countries from oil price fluctuations.

The study is timely and policy-relevant for several reasons. (i) The adoption of the PVAR model allows the study to capture both short-run and long-run dynamics in the selected regions. (ii) The study goes beyond diagnostics as it suggests specific fiscal rules and sovereign wealth fund management strategies, especially for Nigeria, drawing inspiration from successful examples in countries like Norway and Azerbaijan. (iii) Given the incessant volatility in global oil markets, the study provides policymakers with the tools to design fiscal rules that can insulate economies from future oil shocks, finally, (iv) the findings underscore the need for long-term fiscal sustainability and economic diversification in oil-dependent nations, particularly in the context of global energy transition and climate-related fiscal challenges.

To examine how Brent oil price fluctuation impacts the selected economies and the magnitude of its effects, a panel vector autoregressive (PVAR) model is constructed. A significant advantage of the model is that it offers a flexible framework that merges the conventional VAR method with panel data, thus enhancing its efficiency and analytical power. This approach captures both temporal and contemporaneous relationships among variables. The rest of the study is structured into four sections. Section two reviews the related literature on the subject matter. Section three documents the model, data sources, empirical analysis, and results, and policy implications and conclusions are reported in section four.

2. LITERATURE REVIEW

Fiscal policies governed by well-defined fiscal rules are becoming increasingly recognized as vital tools for improving budgetary discipline and promoting macroeconomic stability, especially in oil-rich countries. These countries often face revenue volatility due to changing oil prices, which can cause economic instability. Apeti *et al.* (2023) asserts that having a rule-based budget framework can help enforce discipline in public spending, thus mitigating the risks associated with the boom-and-bust cycles seen in the resource-dependent economies. Chang and Lebdioui (2020) further stress how crucial these policies are for transitioning from short-term fiscal stabilization to long-term economic diversification by promoting responsible resource management.

Nonetheless, implementing rule-based fiscal policies comes with its own set of challenges. Khezri (2024) highlights that the linkage between oil resource wealth and tax revenues can exacerbate the execution of fiscal policies, especially in developing oil-producing countries, where institutional development often lags. Similarly, Eddassi (2020) stresses the need for a robust tax regime that can adapt to the pressures of globalization, arguing that excessively strict fiscal rules might limit the needed flexibility to adjust to shifting economic landscapes.

Bauer (2014) discusses strategies for designing fiscal rules for oil funds, thus advocating for flexible approaches that can adapt to changing economic conditions. In line with this, (Kamar & Soto, 2015) emphasize the connection between monetary policy and overall economic performance, suggesting that a robust policy framework that includes fiscal rules can lead to better macroeconomic results. While Muhamad (2023b) acknowledges the advantages of fiscal rules, the path toward reducing reliance on oil resources remains complex. It requires a balanced approach that considers the risks associated with rigid fiscal constraints (Muhamad, 2023a; Ertimi *et al.*, 2021).

It is widely accepted that oil price dynamics and the macroeconomy have a strong relationship, as several studies have shown (Berument *et al.*, 2010; Hamilton, 2012; Ftiti *et al.*, 2016; Mohaddes & Pesaran, 2017; Bilal, 2021). These studies have developed and tested structural macroeconomic models for open economies to explain how fluctuations in oil prices impact macroeconomic variables. However, the extent of their interdependence remains uncertain (Vatsa & Basnet, 2020), and the correlation between these variables tends to morph over time and varies across different countries and economic regions.

The literature on oil price dynamics and macroeconomic variables performance is extensive; however, gaps can still be explored. Exploring the role of crude oil prices on macroeconomic dynamics came to the forefront of research in the 1980s with the seminal work of (Hamilton, 1983). His research suggested that seven out of eight economic recessions in the US after World War 2 were preceded by crude oil price hikes, thus arguing that oil price shocks lead to a higher inflation rate and lower output level in the US economy. Corroborating the empirical findings of Hamilton (1983), Burbidge and Harrison (1984) study further investigated the influence of oil price fluctuations on macroeconomic variables in Canada, Japan, Germany, and the United States using the vector autoregressive (VAR) models.

Their results conclude that the oil price crisis between 1973 and 1974 explains part of the macroeconomic performance of industrial production in each country reviewed. Analysing oil price dynamics in two different countries (the US and Brazil) from other economic regions, (Cavalcanti & Jalles, 2013) evaluate the effects of crude oil price fluctuations on macroeconomic variables like inflation rate and GDP for two different periods: 1975–1984 and 1985–2008. Their results suggest a reduction in the fluctuation of the US macroeconomic activities. For the Brazilian economy, oil price dynamics have a vague effect on macroeconomic activities and a low impact on the inflation rate and fluctuations of the growth rate.

In the case of Venezuela, Vaez-Zadeh (1989) assessed the effect of crude oil dynamics by modelling and estimating a macroeconomic model for an open economy from 1965 to 1981. The overall conclusions from the study reveal that a rise in crude oil prices initially has a positive impact on inflation, which eventually fades to stabilize below its historical level. Additionally, it leads to an increase in the demand for accurate balances. In the case of Kuwait, Iran, Indonesia, and Saudi Arabia, (Mehrara & Oskoui, 2007) explored the sources of macroeconomic variations using a structural VAR approach. Based on variance decomposition and impulse response analysis, their study suggests that oil price shocks are the primary source of output variations in Iran and Saudi Arabia, while in Indonesia and Kuwait, output fluctuations were mainly found due to aggregate supply shocks. Likewise, their findings reveal that oil price dynamics in Saudi Arabia steadily expand prices.

Investigating the impact of crude oil price dynamics on the macroeconomic variables data spanning 2005 to 2019 and using the vector error correction method (VECM) in Azerbaijan, Mukhtarov (2020) confirms three main results: (i) the presence of a long-run relationship among the macro-variables; (ii) a positive and statistically significant impact of crude oil price on macro-variables such as inflation, economic growth, and export; finally (iii) crude oil price negatively impacts on exchange rate.

Since the introduction of the PVAR model developed by Holtz-Eakin *et al.* (1988), there have been numerous applications of the PVAR approach in academic literature. Beaming a searchlight on the MENA region, Berument *et al.* (2010) investigated the effect of oil prices on output (real GDP) growth. Their results found that crude oil price increases triggered a statistically significant positive effect on the outputs. In contrast, using the vector auto-regressive (VAR) model in selected OPEC and OECD countries from 1970 to 2008, (Jahadi & Elmi, 2011) results reveal that the economies studied are impacted by crude oil price shocks in different aspects.

Examining the impact of oil price dynamics on selected oil-exporting economies in Africa and the PVAR model, (Omojolaibi & Egwaikhide, 2013) examined the nexus between crude oil price dynamics and macroeconomic variables. Their findings suggested that crude oil price fluctuation had a considerable impact on gross investment rather than on real GDP, fiscal deficit, and money supply. Omojolaibi *et al.* (2015) investigated the dynamic effects of crude oil prices on macroeconomic variables of five selected oil-exporting African countries from 1985 to 2013. Their study explores IRFs and FEVDs in a system that includes time series variables like real GDP, price index, exchange rate, crude oil price, and money supply. Their findings reveal that an increase in crude oil price is not necessarily inflationary, domestic shocks have a sizeable effect on crude oil price fluctuations, and money is the leading cause of macroeconomic fluctuations.

Investigating the oil price dynamics on macroeconomic variables, (Omolade *et al.*, 2019) used a PVAR modelling approach on eight selected net oil-producing economies in Africa from 1980 to 2016. Their findings show that the reaction of real GDP to crude oil price dynamics differs by country. Further, structural inflation accompanies a severe plummet in oil prices more than monetary inflation, since real GDP and investment decline significantly. While there has been extensive research documenting the economic impacts of oil price dynamics in individual economies where the oil sector plays a substantial role, there needs to be more research regarding exploring oil price dynamics on macroeconomic variables across multiple oil-dependent regions.

Considering the importance of this phenomenon and the lack of investigation within the context of the oil-producing economies (both developing and developed) under review, there is a need for empirical research to address this gap. Our study seeks to bridge this lacuna in the existing literature. To gain deeper insights into the dynamics surrounding Brent oil prices and their transmission channels in the macroeconomy, we develop a PVAR model for the selected oil-producing economies, categorized by four economic regions. This model aims to offer new insights into whether Brent oil price shocks impact the macroeconomic activities of these countries and, if so, how these effects are transmitted and the magnitude of the impact.

3. METHODOLOGY

3.1. The Model

To analyse the dynamic effects of changes in Brent oil prices on macroeconomic variables, a structural model for a panel of open oil-producing economies can be grouped into the following system of equations:

$OILP_{it} = \delta_{i0} + \delta_1 OILP_{it-1} + \alpha_{xt}{}^* - \alpha_t{}^* + \varepsilon_{OILPit}$ ....(1)

$RGDP_{it} = \beta_{i0} + \beta_1 RGDP_{it-1} + \beta_2 OILP_{it} + \varepsilon_{RGDPit}$ ....(2)

$FD_{it} = \gamma_{i0} + \gamma_1 OILP_{it} + {}_{\gamma 2} FD_{it-1} + \gamma_3 RGDP_{it} + \varepsilon_{FDit}$ ....(3)

$OILR_{it} = \omega_{i0} + \omega_1 OILP_{it} + \omega_2 RGDP_{it} + \omega_3 OILR_{it-1} + \omega_4 FD_{it} + \varepsilon_{OILRit}$ ....(4)

$EXTD_{it} = \theta_{i0} + \theta_1 OILP_{it} + \theta_2 RGDP_{it} + \theta_3 EXTD_{it-1} + \theta_4 FD_{it} + \theta_5 OILR_{it} + \varepsilon_{OILRit}$ ....(5)

$TB_{it} = \mu_{i0} + \mu_1 OILP_{it} + \mu_2 RGDP_{it} + \mu_3 TB_{it-1} + \mu_4 FD_{it} + \mu_5 OILR_{it} + \mu_6 EXTD_{it} + \varepsilon_{TBit}$ ....(6)

Where,

$OILP_{it}$, $RGDP_{it}$, FD_{it},$OILR_{it}$,$EXTD_{it}$,TB_{it} means Brent oil price, real GDP, fiscal deficit, oil rent, external debt, and trade balance, while δ,β,γ,ω,θ,and μ are the structural parameters. The panel vector autoregressive (PVAR) model integrates the traditional VAR methodology, which treats all systems of variables as endogenous, with the panel data approach, which allows for unobserved individual heterogeneity (Omojolaibi *et al.*, 2015). Equation (1) accounts for the external influence of crude oil prices on other macroeconomic variables under review. Thus, rearranging the model equations (1 to 6) by putting all the endogenous variables to the left and differentiating between the lagged variables, the interactions of the variables in all four economic regions, the following matrix equation is obtained:

$MZ_{it} = X_i + NZ_{it-1} + PX_{T^*} + \varepsilon_{it}$ ....(7)

Where:

$$M = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ -\beta_2 & 1 & 0 & 0 & 0 & 0 \\ -\gamma_1 & -\gamma_3 & 1 & 0 & 0 & 0 \\ -\omega_1 & -\omega_2 & -\omega_4 & 1 & 0 & 0 \\ -\theta_1 & -\theta_2 & -\theta_4 & -\theta_5 & 1 & 0 \\ -\mu_1 & -\mu_2 & -\mu_4 & -\mu_5 & -\mu_6 & 1 \end{bmatrix} \qquad N = \begin{bmatrix} \delta_1 & 0 & 0 & 0 & 0 & 0 \\ 0 & \beta_1 & 0 & 0 & 0 & 0 \\ 0 & 0 & \gamma_2 & 0 & 0 & 0 \\ 0 & 0 & 0 & \omega_3 & 0 & 0 \\ 0 & 0 & 0 & 0 & \theta_3 & 0 \\ 0 & 0 & 0 & 0 & 0 & \mu_3 \end{bmatrix}$$

$$P = \begin{bmatrix} 0 & 0 & 1 & -1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

Where,

M is the matrix of lagged interactions, Z_{it} is the vector of endogenous variables (a six-variable vector of Brent oil price, real GDP, fiscal deficit, oil rent (a proxy for oil revenue), external debt, and trade balance). Furthermore, P is the matrix of external time interactions, X_i is the vector of constant for each economic region, X_{t^*} is the vector of exogenous variables from the rest of the world at time t and ε_{it} is the vector of structural disturbances that are normally distributed with zero mean, constant variance, and serially uncorrelated. As an initial step, consider a Panel VAR whereby each equation contains lagged values of all variables for all economic regions under review. The Panel VAR model aims to identify unanticipated shocks to the endogenous variables. i is employed to index each economic region, while t is used to index periods.

The vector of variables, Z_{it}, is given below:

$Z_{it} = (OILP_{it}, RGDP_{it}, FD_{it}, OILR_{it}, EXTD_{it}, TB_{it})'$ ....(8)

The VAR model is written as follows:

$$Z_{it} = \rho_i + \sum_{K-1}^{K} P_k x_{it} + \varphi_{it} \qquad \text{....(9)}$$

Where,

φ_{it} denotes a vector of constants capturing economic region fixed impacts, while P_k are the appropriately defined matrices. The choice of the lag length relies on the Schwarz-Bayesian information criterion (BIC). In the spirit of (Blanchard & Perotti, 2002), I identify oil shocks by assuming that the oil price is predetermined relative to the other macro-variables in the VAR model. Furthermore, the PVAR specification in its structural form is represented thus:

$M_0 Z_{it} = M(L)Z_{it} + e_{it}$ ....(10)

Where,

Z_{it} is the (m×1) vector of endogenous variables, M_0 is an (m×m) matrix with 1's on the diagonal, e_{it} is the vector with the structural shocks, while M(L) is the lag operator. For the baseline model, Z_{it} is given as in equation (8) above, and e_{it} is given as:

$e_{it} = (e_{it}^{OILP}, e_{it}^{RGDP}, e_{it}^{FD}, e_{it}^{OILR}, e_{it}^{EXTD}, e_{it}^{TB})'$ ....(11)

The structural equation (10) is transformed into reduced form equations, which can be estimated. To achieve this, we pre-multiply equation (10) by M_0^{-1}, to obtain a reduced-form equation:

$Z_{it} = N(L)Z_{it} + \rho_{it}$ ....(12)

Where, $N(L) = M_0^{-1}\,M(L)$ and $\rho_{it} = M_0^{-1} e_{it}$ is the reduced-form residual vector which is assumed to be white noise. Therefore, I can write out $M_0\,\rho_{it} = e_{it}$ as:

$$\underbrace{\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ G_{21} & 1 & 0 & 0 & 0 & 0 \\ G_{31} & G_{32} & 1 & 0 & 0 & 0 \\ G_{41} & G_{42} & G_{43} & 1 & 0 & 0 \\ G_{51} & G_{52} & G_{53} & G_{54} & 1 & 0 \\ G_{61} & G_{62} & G_{63} & G_{64} & G_{65} & 1 \end{bmatrix}}_{M_0} \underbrace{\begin{bmatrix} \rho_{it}^{OILP} \\ \rho_{it}^{RGDP} \\ \rho_{it}^{FD} \\ \rho_{it}^{OILR} \\ \rho_{it}^{EXTD} \\ \rho_{it}^{TB} \end{bmatrix}}_{\rho_{it}} = \underbrace{\begin{bmatrix} \varepsilon_{it}^{OILP} \\ \varepsilon_{it}^{RGDP} \\ \varepsilon_{it}^{FD} \\ \varepsilon_{it}^{OILR} \\ \varepsilon_{it}^{EXTD} \\ \varepsilon_{it}^{TB} \end{bmatrix}}_{e_{it}} \quad ....(13)$$

Where,
ρ_{it}^{OILP}, ρ_{it}^{RGDP}, ρ_{it}^{FD}, ρ_{it}^{FD}, ρ_{it}^{EXTD}, and ρ_{it}^{TB} are the reduced-form residuals. The zeros in the first row of M reflect the identification assumption, while the remaining zeros are a convenient normalization. The restrictions entail that the crude oil price does not react to contemporaneous fluctuations in other variables since it is determined exogenously. On the contrary, all other macro-variables in the system are contemporaneously impacted by fluctuations in crude oil price.

3.2. Data sources

The data for this section are annualized and cover the period 1981 to 2021, with empirical analysis focusing on ten oil-producing economies across four economic regions – Nigeria, Angola, Saudi Arabia, Kuwait, Iraq, Canada, US, UK, Russia, and Brazil. The sample countries were selected based on data availability on relevant macro-variables. To contribute to the gap in the literature, the model incorporates six multi-country-specific macro-variables: real gross domestic product (RGDP), fiscal deficit (FD), oil rent (OILR), external debt (EXTD), trade balance (TB), and Brent oil price (OILP). Data on all variables were obtained from the World Development Indicators (WDI). Data on Brent oil price was collected from the World Bank Commodity Price Data, while data on external debt for the MENA and OECD regions were collected from the Federal Reserve Bank of St. Louis (FRED).

3.3. Empirical analysis

We begin my empirical analysis by conducting a panel unit root test on the time series. The (Levin *et al.*, 2002) test and the (Im *et al.*, 2003) are used widely in panel studies to determine the order of integration of the variables. If the variables exhibit I(1), then, we proceed to conduct the co-integration tests to examine the long-run relationship between the variables. The panel cointegration approach developed by Pedroni (2004) will be employed to determine the existence of cointegration among these series. The approach starts with the following regression equation:

$$OILP_t = \alpha_i + \delta_i t + \beta_{1i} InRGDP_{it} + \beta_{2i} InFD_{it} + \beta_{3i} InOILR_{it} + \beta_{4i} InEXTD_{it} + \beta_5 InTB_{it} + \varepsilon_{it} \quad ....(14)$$

$$\text{And, } \varepsilon_{it} = \gamma_i\, \varepsilon_{i,t-1} + u_{it} \quad ....(15)$$

Where,
t = 1, ... T time periods, i = 1, ..., N members of the panel; α_i is the region-specific intercept, and δ_i t is the deterministic trend specific to individual economic regions in the panel. The slope coefficients β_{1i}, β_{2i}, β_{3i}, β_{4i} and β_{5i} can vary, thus allowing the cointegrating vectors to be heterogeneous across economic regions. Additionally, the analysis in the section relies on Impulse Response Functions (IRFs) and forecasted variance decompositions. The IRFs are employed to track the adjustment path of the response of each endogenous variable to a one standard deviation shock to another variable within the system, while the variance decomposition analysis is employed to assess the relative importance of each of the structural innovations in the fluctuations of the variables at different time horizons. This approach is supported by (Iwayemi & Fowowe, 2011; Mehrara & Mohaghegh, 2011).

4. RESULTS AND DISCUSSION

The data series provides fundamental statistical insights, such as mean, minimum, and maximum values, standard deviation, and sample distribution captured by Skewness and Kurtosis, as shown in Table 1, below. Therefore, it is imperative to know how skewed the variables are, the magnitude of standard deviation values, and the kurtosis values, among other aspects. Hence, the descriptive statistics for the Sub-Saharan, MENA, OECD, and BRICS economic regions are presented in Table 1.

Table 1. Summary of descriptive statistics

Panel A: Summary of descriptive statistics for sub-saharan economic region						
	OILP	**RGDP**	**FD**	**OILR**	**EXTD**	**TB**
Mean	44.183	11.438	-2.602	1.547	10.636	-3.601
Minimum	12.717	11.14	-8.887	0.753	10.059	-1.301
Maximum	111.966	11.777	8.716	1.901	11.157	1.914
Std. Dev	30.016	0.231	3.846	0.058	0.2636	1.234
Skewness	0.962	0.284	1.264	-1.174	-0.004	-0.876
Kurtosis	2.751	1.464	4.548	4.366	2.939	3.218
Panel B: summary of descriptive statistics for the MENA economic region						
Mean	44.183	11.725	-23.736	2.016	1.082	6.624
Minimum	12.717	11.373	-75.967	1.635	0.000	-2.013
Maximum	111.966	12.011	-10.481	2.224	2.924	3.021

Std. Dev	30.016	0.199	12.622	0.14	1.044	8.81
Skewness	0.962	-0.122	-2.494	-0.484	0.187	1.252
Kurtosis	2.751	1.822	10.293	2.774	1.249	3.578
Panel C: Summary of descriptive statistics for OECD economic region						
Mean	44.183	13.087	-1.679	0.873	3.814	-1.241
Minimum	12.717	12.608	-5.5	0.094	3.017	-3.001
Maximum	111.966	13.454	1.356	2.476	4.455	2.219
Std. Dev	30.016	0.253	1.584	0.526	0.392	9.581
Skewness	0.962	0.371	-0.333	1.496	-0.956	-0.114
Kurtosis	2.751	1.913	2.619	4.864	2.155	1.443
Panel D: Summary of descriptive statistics for BRICS economic region						
Mean	44.183	12.105	-4.871	4.154	5.131	5.991
Minimum	12.717	11.275	-20.928	0.435	1.152	-1.411
Maximum	111.966	12.678	2.91	8.384	8.191	1.859
Std. Dev	30.016	0.428	4.868	2.25	3.761	5.684
Skewness	0.962	-0.456	-1.319	0.004	0.479	0.566
Kurtosis	2.751	2.231	6.261	1.859	1.707	2.125

Note: OILP, RGDP, FD, OILR, EXTD, and TB represent Brent oil price, real GDP, fiscal deficit, oil rent, external debt, and trade balance, respectively.
Source: Authors' Computation.

Table 1 shows the summary descriptive statistics of the Brent oil price (OILP), real GDP (RGDP), fiscal deficit (FD), oil rent (OILR), external debt (EXTD), and trade balance (TB) employed for all economic regions. Thus, the variables were analysed at their levels to provide detailed information on the original behaviour of the time series. Table 1 reveals that all the time series display a high level of consistency as their means have values within the maximum and minimum values for each economic region. Likewise, the summary statistics detailed relatively low standard deviations for most of the series, thus indicating that the dispersions of the actual data from their means are very small. We conducted a panel unit root test on all variables employed in the study to mitigate the risk of spurious regression results. Both the panel unit root tests proposed by Levin *et al.* (2002) and Im *et al.* (2003) specifications were used to test for the presence of a unit root with the panel data.
The outcomes of these tests are depicted in Tables 2, 3, 4, and 5 below, capturing the panel unit root results for the four economic regions. The LLC and IPS test results reveal that all variables are non-stationary at their respective levels. However, it is observed that all the variables were stationary at first difference, that is, the variables are I (1) series using the Levin, Lin and Chu, and Im, Pesaran and Shin panel unit root test, respectively.

Table 2. Panel unit root test result for sub-saharan economic region

Variables	**Levin-Lin-Chu (LLC)**		**Im-Pesaran-Shin (IPS)**		**Decision**
	Level	**First Diff**	**Level**	**First Diff.**	
OILP	-0.2604	-3.2007	-1.4075	-5.7792	I(1)
	(0.3973)	(0.0007)*	(0.5369)	(0.0002)*	
RGDP	0.3257	-2.3985	0.8619	3.8196	I(1)
	(0.6277)	(0.0082)*	(0.9982)	(0.0116)**	
FD	-1.2191	-3.1481	-3.1447	-8.1099	I(1)
	(0.1114)	(0.0008)*	(0.0583)	(0.0000)*	
OILR	-2.8637	-3.5516	-2.8666	-8.2538	I(1)
	(0.0621)	(0.0002)*	(0.0721)	(0.0000)*	

EXTD	-0.4647	-3.0784	-1.1290	-4.7922	I(1)
	(-0.3211)	(0.0010)*	(0.6642)	(0.0016)*	
TB	-0.2019	-2.4381	-2.7411	-6.4799	I(1)
	(0.4200)	(0.0074)*	(0.0900)	(0.0001)*	

Note 1: OILP, RGDP, FD, OILR, EXTD, and TB represent Brent oil price, real Gross Domestic Product, fiscal deficit, oil rent, external debt, and trade budget, respectively.
Note 2: The values in the square bracket [ ] are the probability values; (**) indicates significance at 5% level and (*) indicates significance at 1%.
Source: Authors' Computation

Table 3. Panel unit root test result for MENA economic region

Variables	Levin-Lin-Chu (LLC)		Im-Pesaran-Shin (IPS)		Decision
	Level	First Diff	Level	First Diff.	
OILP	-0.2604	-3.2007	-1.4075	-5.7792	I(1)
	(0.3973)	(0.0007)*	(0.5369)	(0.0002)*	
RGDP	0.3494	-2.8744	0.1973	-6.0398	I(1)
	(0.6366)	(0.0020)*	(0.9812)	(0.0002)*	
FD	-1.1495	-4.3846	-2.3402	-5.1956	I(1)
	(0.1252)	(0.0000)*	(0.1742)	(0.0012)*	
OILR	-0.1443	-3.7571	-2.4891	-7.2738	I(1)
	(0.4426)	(0.0001)*	(0.1375)	(0.0000)*	
EXTD	-0.0974	-3.1679	-1.0717	-6.6561	I(1)
	(0.4612)	(0.0008)*	(0.6890)	(0.0001)*	
TB	-1.4416	-4.0508	-2.3022	-5.7727	I(1)
	(0.0747)	(0.0000)*	(0.1840)	(0.0003)*	

Note 1: OILP, RGDP, FD, OILR, EXTD, and TB represent Brent oil price, real Gross Domestic Product, fiscal deficit, oil rent, external debt, and trade budget, respectively.
Note 2: The values in the square bracket [ ] are the probability values; (**) indicates significance at 5% level and (*) indicates significance at 1%.
Source: Authors' Computation

Table 4. Panel unit root test result for OECD economic region

Variables	Levin-Lin-Chu (LLC)		Im-Pesaran-Shin (IPS)		Decision
	Level	First Diff	Level	First Diff.	
OILP	-0.2604	-3.2007	-1.4075	-5.7792	I(1)
	(-0.3973)	(0.0007)*	(0.5369)	(0.0002)*	
RGDP	-1.2622	-2.8349	-2.7456	-4.3130	I(1)
	(0.1034)	(0.0022)*	(0.0893)	(0.0043)*	
FD	-1.8276	-2.8526	-2.0087	-4.3077	I(1)
	(0.0568)	(0.0022)*	(0.2778)	(0.0047)*	
OILR	-2.6254	-2.3134	-3.7650	-8.6843	I(1)
	(0.2697)	(0.0103)*	(0.0626)	(0.0006)*	
EXTD	-1.2716	-1.3942	-2.8017	-3.1113	I(1)
	(0.1081)	(0.0496)**	(0.0810)	(0.0463)**	

TB	-0.4342	-0.2760	-0.3541	-5.2935	I(1)
	(0.7094)	(0.0391)**	(0.9165)	(0.0006)*	

Note 1:OILP, RGDP, FD, OILR, EXTD, and TB represent Brent oil price, real Gross Domestic Product, fiscal deficit, oil rent, external debt, and trade budget, respectively.
Note 2: The values in the square bracket [ ] are the probability values; (**) indicates significance at 5% level and (*) indicates significance at 1%.
Source: Authors' Computation

Table 5. Panel unit root test result for BRICS economic region

Variables	**Levin-Lin-Chu (LLC)**		**Im-Pesaran-Shin (IPS)**		**Decision**
	Level	**First Diff**	**Level**	**First Diff.**	
OILP	-0.2604	-3.2007	-1.4075	-5.7792	I(1)
	(-0.3973)	(0.0007)*	(0.5369)	(0.0002)*	
RGDP	-0.8463	-2.3718	-1.3044	-5.2241	I(1)
	(0.1987)	(0.0088)*	(0.5849)	(0.0007)*	
FD	-1.2606	-4.5176	-2.6735	-6.2611	I(1)
	(0.1037)	(0.0000)*	(0.1018)	(0.0001)*	
OILR	-1.5144	-5.1771	-2.4667	-6.4206	I(1)
	(0.0650)	(0.0000)*	(0.1425)	(0.0001)*	
EXTD	0.4720	-2.5868	0.1784	-4.4166	I(1)
	(0.6815)	(0.0048)*	(0.9801)	(0.0035)*	
TB	-0.1583	-4.2941	-1.4061	6.3217	I(1)
	(0.4371)	(0.0000)*	(0.5376)	(0.0001)*	

Note 1: OILP, RGDP, FD, OILR, EXTD, and TB represent Brent oil price, real Gross Domestic Product, fiscal deficit, oil rent, external debt, and trade budget, respectively.
Note 2: The values in the square bracket [ ] are the probability values; (**) indicates significance at 5% level and (*) indicates significance at 1%.
Source: Authors' Computation

4.1. lag length selection criteria

Estimating the appropriate lag length of an autoregressive (AR) process for a time series is a crucial econometric application in most economic studies (Liew, 2004). This necessitates determining the suitable optimal lag length before the cointegration test to avoid the loss of degree of freedom and misspecification. One of the interesting findings of the section is that the lag length selection is based on the Akaike Information Criterion (AIC), as it is superior to other criteria under this section. The lower the value of AIC, the better the model. Table 6 below reveals the test statistics and the criteria for selecting the order of the PVAR model for all four economic regions. Table 6 shows the various test statistics used to determine the optimal lag length for the PVAR model for the Sub-Saharan Africa, MENA, OECD, and BRICS economic regions. The table shows that the criterion with the least value is the lag length. Hence, the Akaike Information Criterion (AIC) has the lowest value of all test statistics. Drawing from the justification for AIC, our study chooses the lag length of four for the independent variables as indicated by the AIC, which is used to estimate the PVAR model.

Table 6. PVAR lag order selection criteria

Panel A: PVAR lag order selection criteria for sub-saharan economic region						
Lag	**LogL**	**LR**	**FPE**	**AIC**	**HQIC**	**SBIC**
0	-1066.05		1.6e+19	61.2601	61.3521	61.5267
1	-892.159	347.78	6.3e+15	53.3805	54.0248	55.2469*
2	-849.645	85.028	5.3e+15	53.0083	54.2048	56.4745
3	-806.756	85.778	6.3e+15	52.6146	54.3634	57.6806

4	-727.062	159.39*	2.1e+15*	50.1178*	52.4189*	56.7836

Panel B: PVAR Lag order selection criteria for MENA economic region

Lag	LogL	LR	FPE	AIC	HQIC	SBIC
0	-1017.85		2.0e+21	66.0551	66.1456	66.3326
1	-880.701	274.3	3.0e+18	59.5291	60.1624	61.4719
2	-832.896	95.611	1.9e+18	58.7675	59.9436	62.3756
3	-787.556	90.681	2.5e+18	58.1649	59.8839	63.4382
4	-628.311	318.49*	1.1e+16*	50.2136*	52.4754*	57.1522*

Panel C: PVAR Lag order selection criteria for OECD economic region

Lag	LogL	LR	FPE	AIC	HQIC	SBIC
0	-1049.82		6.4e+18	60.3323	60.4243	60.5989
1	-781.996	535.64	1.2e+13	47.0855	47.7297	48.9519*
2	-746.969	70.053	1.5e+13	47.1411	48.3376	50.6072
3	-705.8	82.339	2.0e+13	46.8457	48.5945	51.9117
4	-597.295	217.01*	1.3e+12*	42.7026*	45.0036*	49.3684

Panel D: PVAR Lag Order selection criteria for BRICS economic region

Lag	LogL	LR	FPE	AIC	HQIC	SBIC
0	-2163.78		2.8e+46	123.987	124.079	124.254
1	-2014.72	298.12	4.6e+43	117.527	118.171	119.393*
2	-1974.19	81.058	4.3e+43	117.268	118.465	120.734
3	-1926.88	94.632	3.9e+43	116.621	118.37	121.687
4	-1864.29	125.17*	3.5e+43*	115.403*	117.403*	121.768

*Note: * indicates lag order selected by the criterion; LR, FPE, AIC, HQIC, and SBIC indicate sequential modified LR test statistic, Final Prediction Error, Akaike Information Criterion, Hannan-Quinn Information Criterion, and Schwarz-Bayesian Information Criterion, respectively.*
Source: Authors' computation

4.2. Stability conditions

A stability test is conducted to determine whether the model is stable. When the roots of the characteristic AR polynomial have a modulus of less than one and lie inside the unit circle, then the estimated PVAR is stable and satisfies the stability conditions. From the result of the stability test below, all the Eigenvalues lie inside the unit circle, and the PVAR satisfies the conditions of the model as seen in Table 7, panels a, b, c, and d. That is, the PVAR model has a modulus of less than one; thus, the sufficient condition of the model, as stated, is satisfied and stable.

Table 7. Stability test

Panel A: Stability test for the Sub-Saharan economic region

	Root	Modulus
1	0.7482+0.07i	0.5741
2	0.5981-0.26i	0.4809
3	0.4105	0.4408
4	0.4091	0.4099

Panel B: Stability test for the MENA economic region

	Root	Modulus
1	0.8027+0.73i	0.8930
2	0.5303-0.94i	0.6749
3	0.5182	0.5629
4	0.4409	0.5206

Panel C: Stability test for OECD economic region

	Root	Modulus
1	0.5379+0.62i	0.7409
2	0.4902-0.63i	0.6846
3	0.4389	0.6109
4	0.4006	0.6099

Panel D: Stability test for BRICS economic region

	Root	Modulus
1	0.6490+0.38i	0.5492

2	0.4991-0.67i	0.4899
3	0.3938	0.4309
4	0.3107	0.3647

Source: Authors' Computation.

4.3. Impulse response function (IRF) analysis

A selection of key impulse response functions of the variables (one standard deviation) shocks is reviewed in this section. Further, the magnitude of the shocks is measured by the standard deviations of the corresponding orthogonal errors obtained from the PVAR model. Figures 1 to 4 below reveal the responses of real GDP, fiscal deficit, oil rent, external debt, and trade balance to a one standard deviation shock of Brent oil price for the four economic regions. Additionally, the impulse response functions (IRFs) are derived and used to analyse the dynamic response of the macro-variables to Brent oil price shocks within the PVAR system. Each IRF shows the dynamic response of the variables of each country to a unit standard deviation shock of up to 20 periods, while figures 1 to 4 show the estimates of the IRFs and their associated 95 percent confidence intervals. The response of the macro-variables to a one standard deviation shock of Brent oil price for the Sub-Saharan region is depicted in Figure 1.

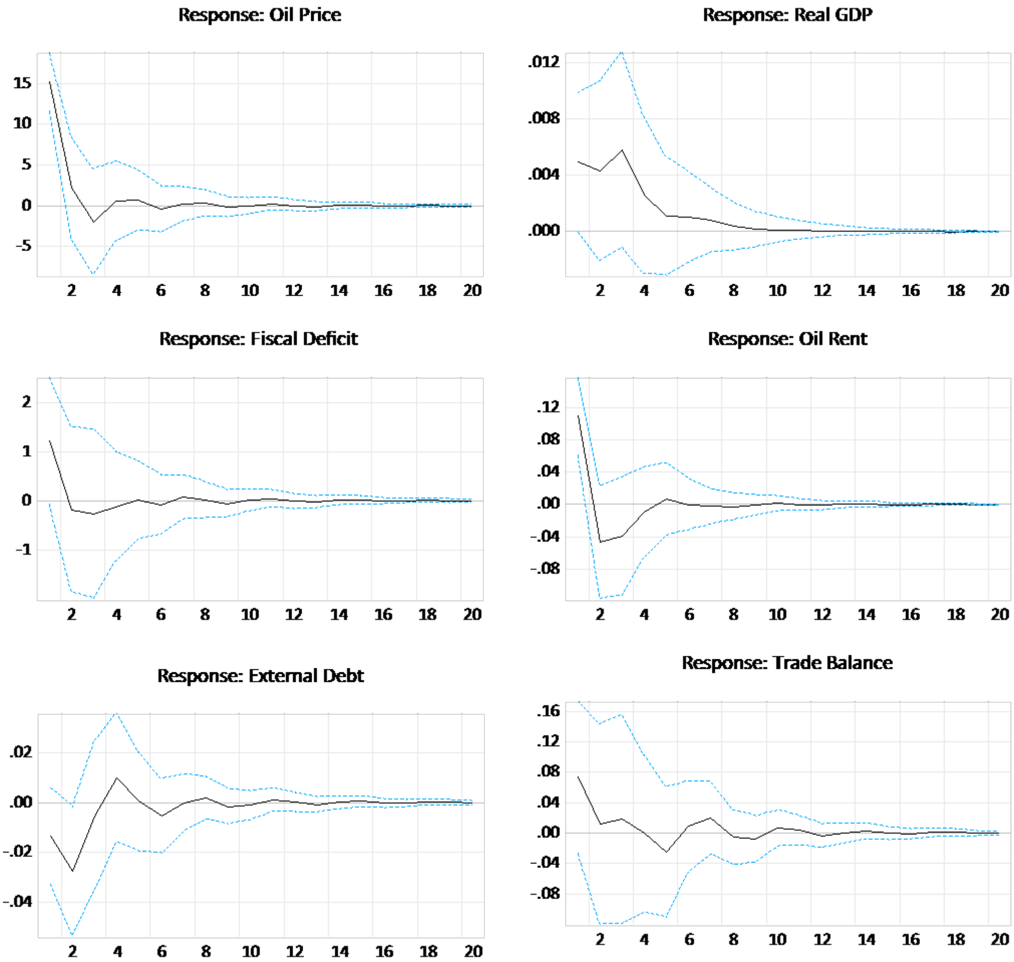

Figure 1. PVAR Impulse response functions: response of endogenous variables to volatility from brent oil price for the sub-saharan region.
Source: Authors' Computations

A one standard deviation shock in Brent oil price shows a gradual negative effect on real GDP up to period two, then experienced a positive effect between periods two and three. Real GDP takes a significant plunge, reaching a minimum variation of 0.001 percent around period eight, and then reaches the steady state level around period eleven. Unlike real GDP, fiscal deficit reaches the steady state level around period nine.

A one standard deviation shock in Brent oil price shows a significant plunge in fiscal deficit and oil rent between periods one and two. However, one standard deviation shock shows that oil rent fell to a minimum variation of 0.04 percent before rising to a maximum above the steady state and reaching the steady state level around period seven. Consequently, external debt plunges to a minimum variation of 0.025 percent between periods one and two due to a one standard deviation shock in the Brent oil price. Then external debt rises from period two to a maximum height of 0.01 above the steady state level, drops below the steady state level, and then reaches the steady state level in period thirteen. Finally, a one standard deviation shock of Brent oil price reveals a significant adverse effect on the trade balance up to period five below the steady-state level. Then, the trade balance from period five increased slightly above the steady state level and then reached the steady state level in period fourteen.

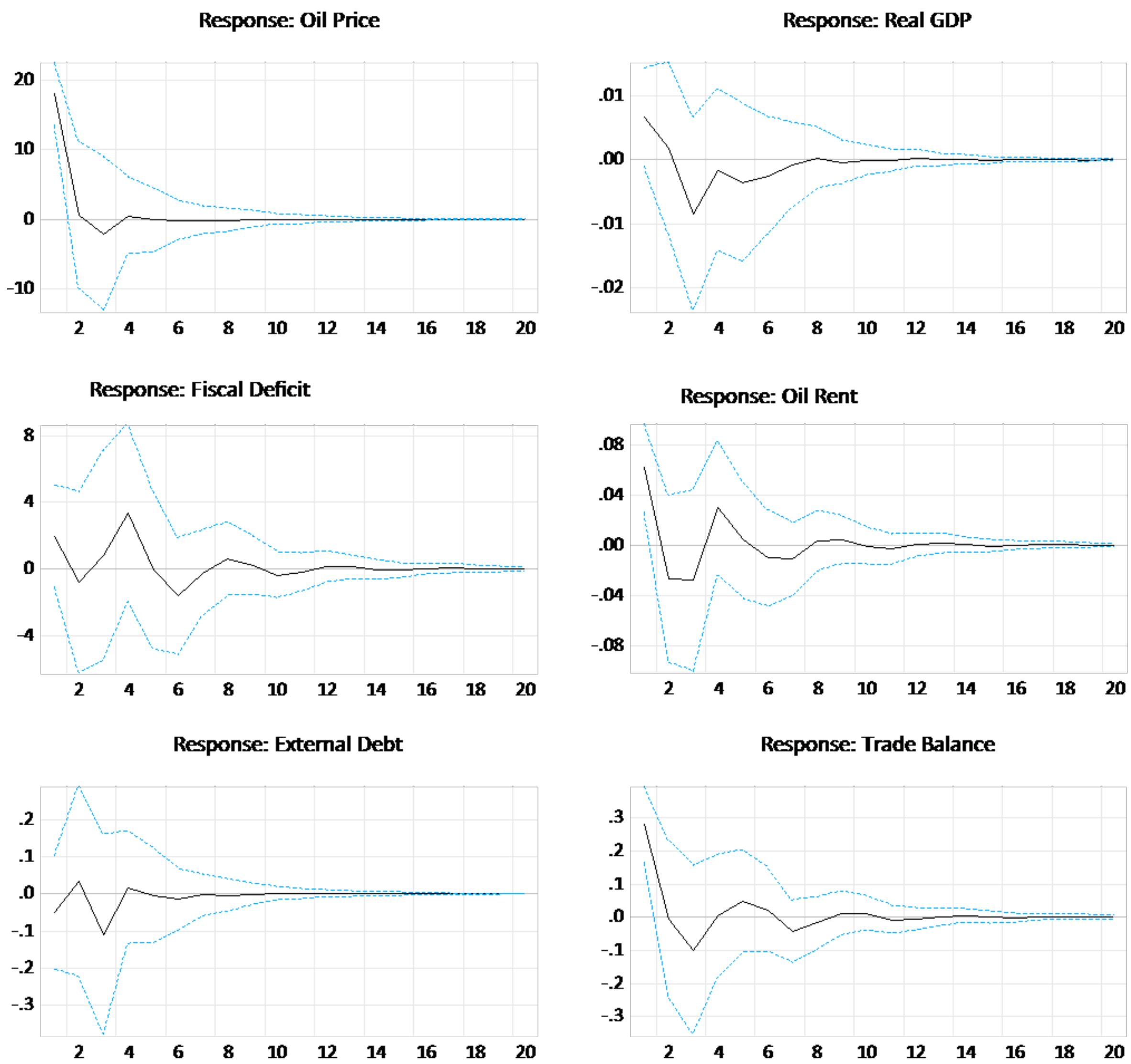

Figure 2. PVAR Impulse response functions: response of endogenous variables to volatility from brent oil price for the MENA region.
Source: Authors' Computations.

Some puzzling results are found in the IRFs for the MENA region depicted in Figure 2 above. For instance, a one standard deviation shock of Brent oil price causes a significant plummet in all macro-variables except for external debt, which increases slightly between periods one and two below the steady-state level. From period two, external debt fell to a minimum variation of 0.1 percent before taking an upward swing to a maximum variation of 0.2 percent and then reaching the steady state level in period five. The response of a standard deviation shock of Brent oil price on real GDP and oil rent is significantly downwards to minimum variations of 0.008 and 0.03 percent, respectively. These results show that Brent oil price dynamics play a significant role in fiscal policy for the MENA region, as the impact of the shock spreads into period three. A steady state level is attained at periods thirteen, twelve, and eleven for fiscal deficit, oil rent, and real GDP, respectively.

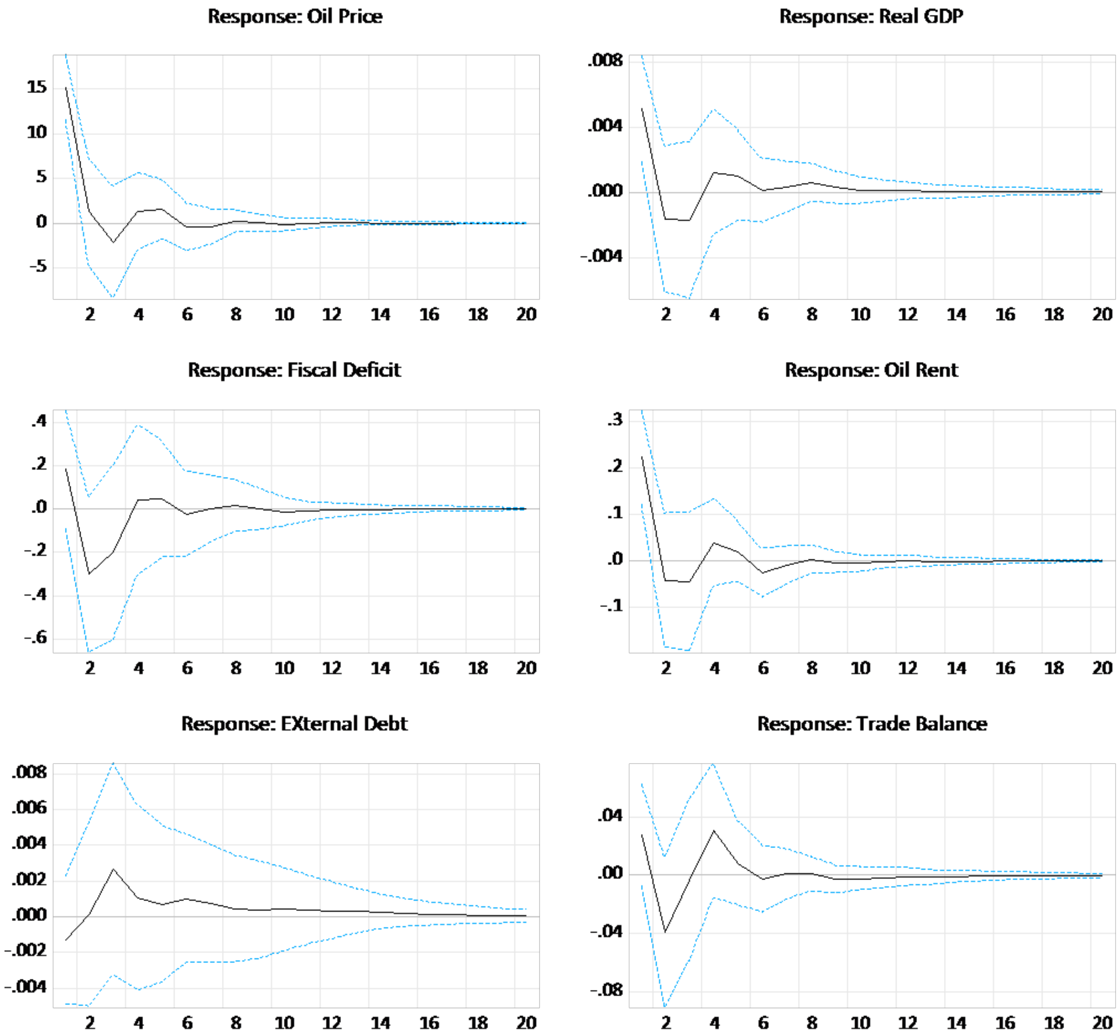

Figure 3. PVAR impulse response functions: response of endogenous variables to volatility from brent oil price for the OECD region.
Source: Authors' Computations.

Furthermore, a one standard deviation shock of Brent oil price saw a significant plunge in trade balance from period one to three below the steady state level at a minimum variation of 0.1 percent. However, there was a rise above the steady state level from period three to almost period six before a downward movement. A steady-state level was reached for the trade balance in period thirteen. Unlike the Sub-Saharan economic region, a one standard deviation shock of Brent oil price causes external debt to increase to a maximum variation above 0.002 percent from period one to almost period four in the OECD region below.
However, external debt reaches its steady state level from period sixteen. Furthermore, a one standard deviation shock of Brent oil price causes a major plunge below the steady state level for fiscal deficit, oil rent, and real GDP, respectively. For fiscal deficit, there was a recovery between periods two to five at a maximum variation above the steady state, and then reached the steady state level at period ten. Furthermore, oil rent plummeted significantly below the steady state level to a minimum variation of 0.05 percent, peaked above the steady state level in period four, and then reached the steady state in period nine. Additionally, a one standard deviation shock of Brent oil price shows a negative effect on real GDP to a minimum variation of 0.002 percent, then a maximum variation of 0.001 percent at period four, smooths out, and reaches the steady state level in period thirteen.
Finally, a one standard deviation shock of Brent oil price resulted in a sharp downward minimum variation of 0.04 percent for the trade balance. However, the trade balance rose from period two and peaked at a maximum variation of 0.03 percent in period four. Then, it experienced another fall slightly below the steady state level and reached its steady state level at period twelve. In the BRICS economic region, the IRFs reveal that a one standard deviation shock of Brent oil price has a sharp negative effect on all macro-variables. For instance, starting with real GDP, a one standard deviation shock of Brent oil price shows a negative effect with a minimum variation of 0.02 percent below the steady state level, then peaks at period five above the steady state level, and then smooths out and reaches the steady state level at period eight.

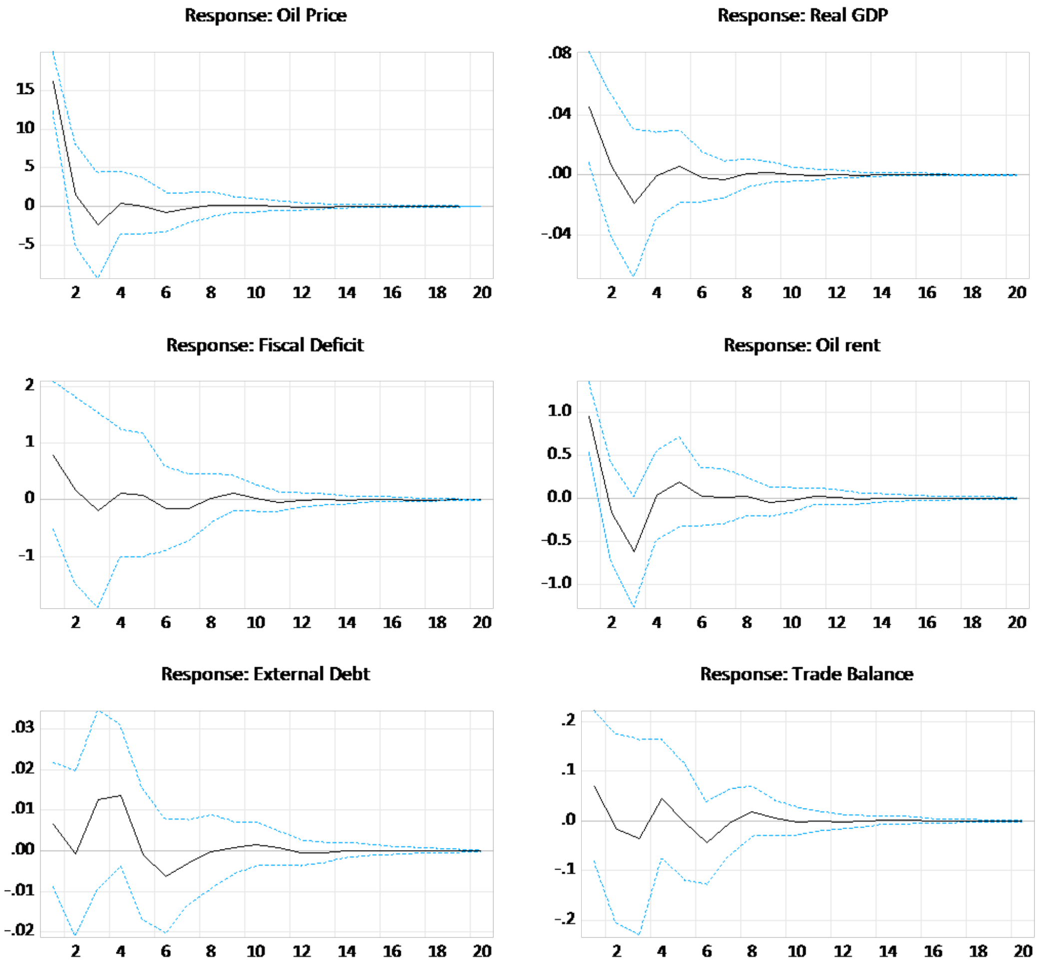

Figure 4. PVAR impulse response functions: response of endogenous variables to volatility from brent oil price for the BRICS region.
Source: Authors' Computations.

Consequently, external debt experienced a slight fall up to period two due to a one standard deviation shock in the Brent oil price. However, it peaked above the steady-state level at a maximum variation of 0.015 percent in period four before attaining a steady-state level in period twelve. Oil rent experienced the most significant adverse effect of a one standard deviation of Brent oil price shock. Between periods one to three, the minimum variation of oil rent stood at 0.4 percent below the steady state level. Then, it peaked at 0.1 percent above the steady state level in period five. The steady-state level for oil rent was reached in period eleven. Again, the fiscal deficit fell below the steady state level in period three due to a one standard deviation shock in the Brent oil price. Only a little significant variation occurred in the fiscal deficit after period three, but the steady-state level was attained in period ten. Finally, one standard deviation of Brent oil price caused the trade balance in the BRICS region to fall until almost period four, before peaking at 0.5 percent above the steady state level, then falling from period four to period six, and then reaching a steady state level at period ten.

4.4 Variance decomposition (VDC) results

Figures 5 to 8 present the summary of the variance decomposition results for the four economic regions. Thus, the VDC displays how much of the variability in the dependent variable is explained by its shocks compared to the shocks in the other variables in the system. Figure 5 depicts the variance decomposition (VDC) of Brent oil price and its effect on real GDP, fiscal deficit, oil rent, external debt, and trade balance in the Sub-Saharan region. In period one, all the variables had no contemporaneous effect on Brent oil price.

Consequently, in period two, variations in Brent oil price are mainly due to itself, while fiscal real GDP, fiscal deficit, oil rent, external debt, and trade balance explain 0.01 percent, 7.5 percent, oil rent 0.9 percent, external debt 0.5 percent, and trade balance 0.4 percent variations on Brent oil price shocks respectively. Over time, as the time series transverse through the periods, their effects increase while the effects of Brent oil price wane out to 80.1 percent even in period twenty. Fiscal deficit shows the highest effects at 11.9 percent compared to other variables in the region. It can be interpreted that the channel through which Brent oil price shock transmits to the oil-producing economies in the Sub-Saharan region is through fiscal deficit. This result aligns with the results of Omojolaibi and Egwaikhide (2013).

Figure 6 shows the variance decomposition (VDC) of Brent oil price and its effects on all variables captured in the system for the MENA region. Like the first period in the Sub-Saharan region, all the variables had no contemporaneous effect on Brent oil prices. However, in the second period, there were variations in all the variables examined. For instance, in period two, 97.6 percent variation in Brent oil price is mainly due to itself, while real GDP, fiscal deficit, oil rent, external debt, and trade balance explain 0.21 percent, 0.002 percent, 0.67 percent, 0.02 percent, and 1.5 percent variations on Brent oil price, respectively. As one transverse through the period, the effects of all variables increase, but that of Brent oil price wanes out to 97 percent. Furthermore, the trade balance shows the highest effect of 1.51 percent compared to other variables in the MENA region. This can be interpreted to mean that the trade balance is the channel through which Brent oil price shocks are transmitted to the MENA region. This result aligns with (Berument *et al.*, 2010; Nasir *et al.*, 2019).

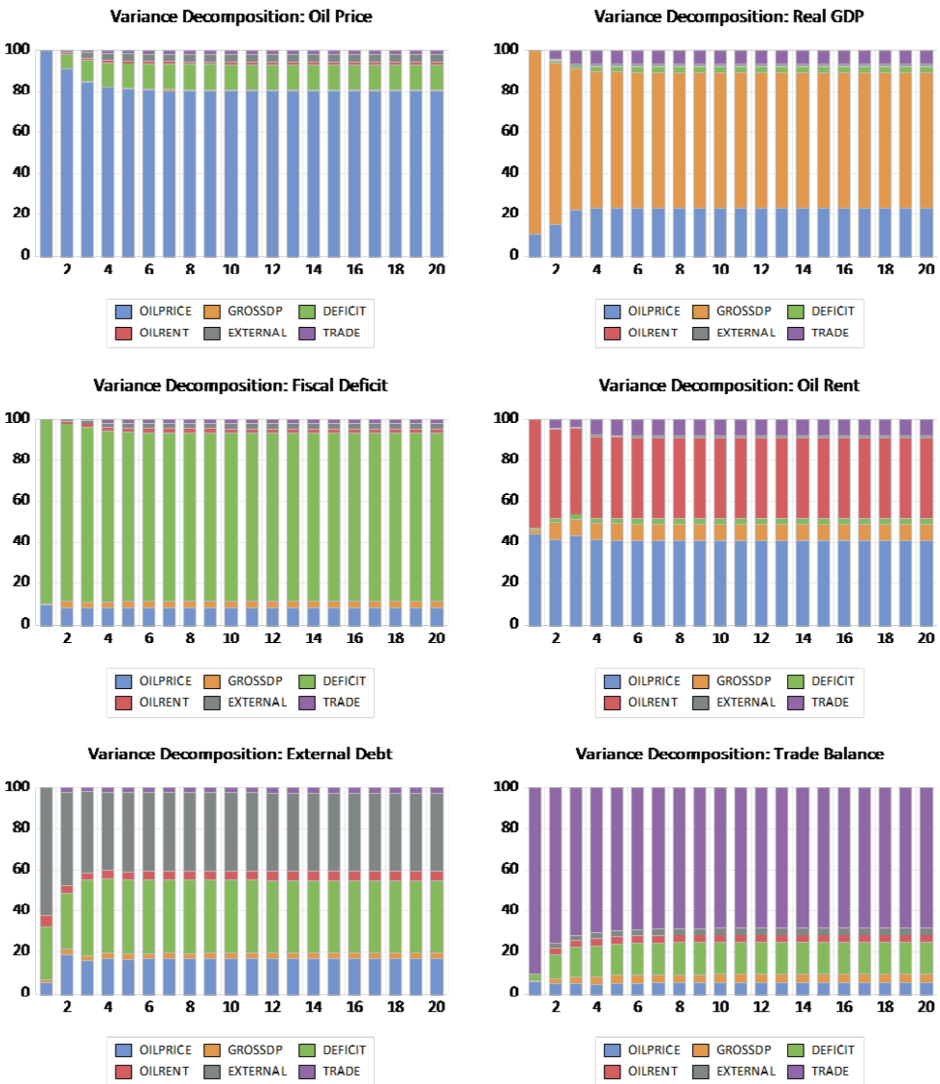

Figure 5. Summary of variance decomposition (VDC) results for the sub-saharan region.
Source: Authors' Computations

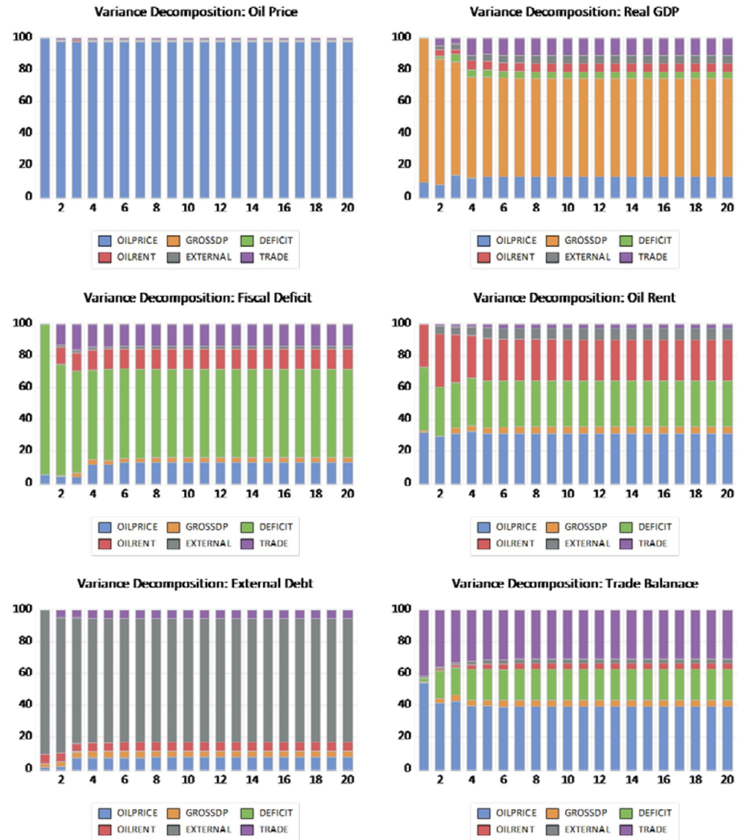

Figure 6. Summary of variance decomposition (VDC) results for the MENA region
Source: Authors' Computations

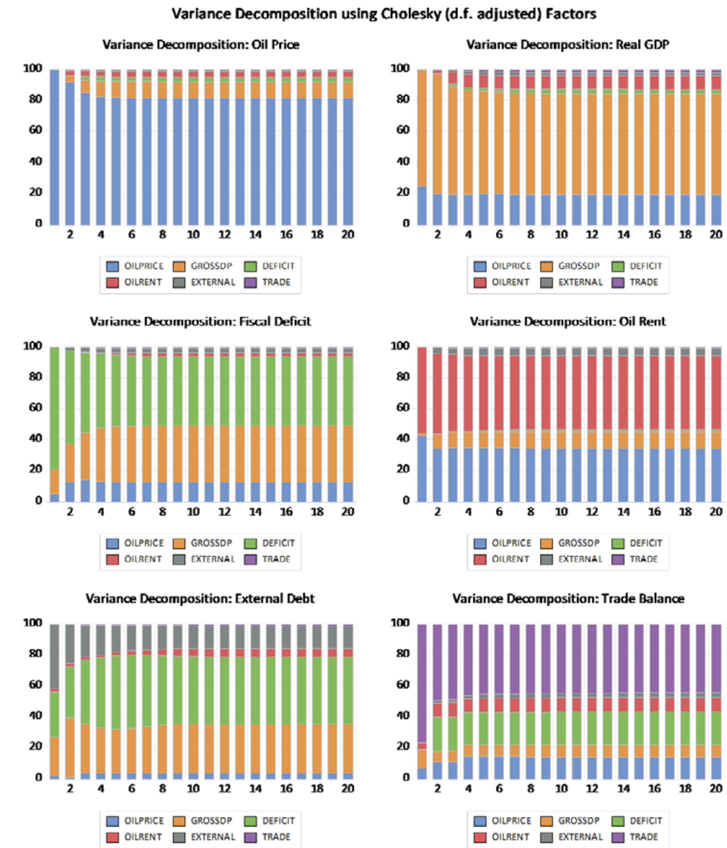

Figure 7. Summary of variance decomposition (VDC) results for the OECD region
Source: Authors' Computations

Similarly, Figure 8 captures the variance decomposition (VDC) of Brent oil price and its effects on all variables captured in the system for the OECD region. Like the first period in the MENA region, all the time series variables had no contemporaneous effect on Brent oil prices. However, in the second period, there were variations in all the macro-variables examined. For example, in period two, 91.5 percent variation in Brent oil price is mainly due to itself, while real GDP, fiscal deficit, oil rent, external debt, and trade balance explain 4.3 percent, 0.08 percent, 3.0 percent, 1.1 percent, and 0.001 percent variations on Brent oil price.

However, as one transverse through the periods, the effect on all variables increases, but that of Brent oil price wanes out to 81.1 percent. Furthermore, real GDP records the highest effect of 10.7 percent compared to fiscal deficit, oil rent, external debt, and trade balance in the OECD region. This can be interpreted to mean that the trade balance is the channel through which Brent oil price shocks are transmitted to the OECD region. Similarly, Figure 12 below captures the variance decomposition (VDC) of Brent oil price and its effects on all variables captured in the system for the BRICS region. Like period one in the OECD region, all the time series variables had no contemporaneous effect on Brent oil prices. However, in the second period, there were variations in all the macro-variables examined. For instance, in period two, 93.9 percent variation in Brent oil price is mainly due to itself, while real GDP, fiscal deficit, oil rent, external debt, and trade balance explain 1.0 percent, 0.01 percent, 2.3 percent, 2.8 percent, and 0.01 percent variations on Brent oil price, respectively. However, as one transverse through the periods, the effect on all variables increases, but that of Brent oil price wanes to 89.9 percent. Furthermore, external debt had the highest effect of 3.4 percent compared to real GDP, fiscal deficit, oil rent, and trade balance in the BRICS region. This can be interpreted to mean that external debt is the channel through which Brent oil price shocks are transmitted to the BRICS economic region. Table 8 in the provides a summary of the transmission channels of Brent oil price shocks for the four economic regions.

Table 8. Transmission channels of Brent oil price shock for the four economic regions

Economic Regions	Channels	Percentages
Sub-Saharan Africa	Fiscal Deficits (FD)	11.9
MENA	Trade Balance (TB)	1.51
OECD	Real GDP	10.7
BRICS	External Debt	3.4

Source: Authors' Computation.

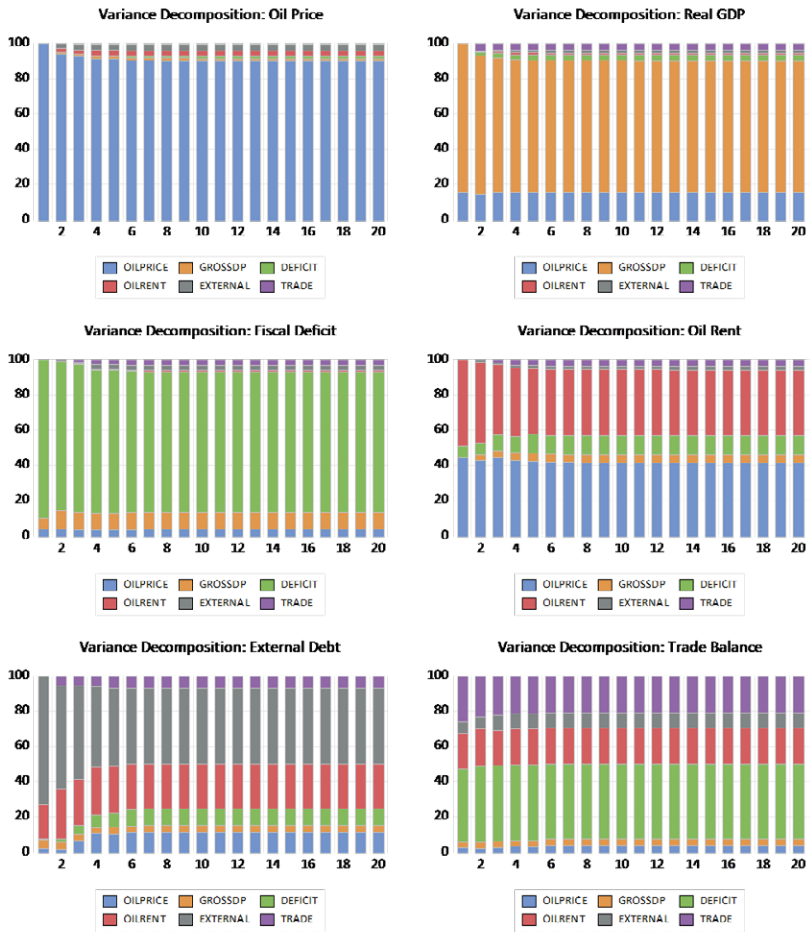

Figure 8. Summary of variance decomposition (VDC) results for the BRICS region
Source: Authors' Computations.

4.5. Policy implications

The findings have several policy implications for the countries and regions under review, but with a greater focus on the Nigerian economy, seeking to reduce its susceptibility to future global exogenous shocks. An additional policy implication entails building a robust and resilient fiscal framework to help ensure appropriate buffers are built to manage exogenous oil price shocks. Further, the fiscal framework would also play a significant role in mitigating the risk of overspending associated with periods of crude oil price plummet, supporting the long-term sustainability and intergenerational equity goals, as such a framework needs to rely on long-term fiscal anchors and include sound fiscal rules. Furthermore, the study recommends that a more robust fiscal framework be supported by dedicated oil funds, which should be governed by clear and transparent rules and fully integrated with the budget using the Norwegian oil fund template. However, while the appropriate rules and fiscal reforms may vary across economic regions, the MENA and Sub-Saharan regions should continue strengthening their fiscal framework to help better align desirable policies.

Hence, in minimizing its impact on the economy, our study presents two specific fiscal rules to consider: (i) a debt rule targeting a 15 percent debt-to-GDP ratio; (ii) an oil price-based rule targeting a balanced budget at a $45 per barrel reference price. Under the first rule, the federal government can only borrow (externally or internally) for investment purposes and not finance consumption or deficit budget, as is the usual practice, while under the second rule, the Nigerian budget would be benchmarked and executed based on the proposed reference oil price. The two fiscal rules can be presented more formally. Firstly, the oil price-based rule would require that the budget is balanced at the estimated oil revenue streams, Rev^{oilrev}, calculated using the oil reference price. Thus, this leads to the following fiscal rule:

$$Rev^{oilrev} + Rev^{nonoil} - e = 0 \qquad \text{....(16)}$$

Where,

Rev^{nonoil} is revenue from the non-oil sector in Nigeria, e is government expenditure (both recurrent and capital). Furthermore, the difference between the actual oil revenue and the estimated oil revenue calculated at the budget reference price will determine the extent to which the NSWF (financial assets), that is, oil revenue, is saved.

$$Rev - Rev^{oilrev} = fw \qquad \text{....(17)}$$

Where,

Rev is the actual oil revenue, Δfw is the financial assets.

Secondly, the debt rule will target reducing the debt-to-GDP ratio from 20.2 percent to 15 percent. More than anything else, the federal government should only borrow to fund public investment with high return rates and not finance the budget deficit. Thus, as the non-oil revenue is relatively stable compared to oil revenue, the budget deficit should be financed through oil revenue and financial assets (oil funds saved in NSWF).

$$\bar{d} = Rev^{oilrev} + fw \qquad \text{....(18)}$$

The reason for pegging the permanent oil price at $45 per barrel is justifiable. This is because the average oil price in the last four decades has been about $47 per barrel, which at first glance would provide some intuition for maintaining this as a forward-looking price target. However, because the government relies heavily on oil revenues, the permanent price rule will help insulate the economy (budget) from oil price swings, in contrast. Should there be a large non-price-related shock (a global pandemic), this can be accommodated by re-parameterizing the price-based fiscal price rule.

Again, as shown in Figure 9, our study proposes a tripartite fiscal rule for a robust fiscal rule based on a transparent sovereign wealth fund for Nigeria. By tripartite fiscal rule, we propose that the administration of the Nigerian Sovereign Wealth Fund (NSWF), which is being managed by the Nigerian Sovereign Investment Authority (NSIA), be divided among the three government entities: namely, the Central Bank of Nigeria (CBN), Federal Ministry of Finance and a government-appointed council. However, this proposal is to provide an accountable and transparent sovereign wealth fund for Nigeria.

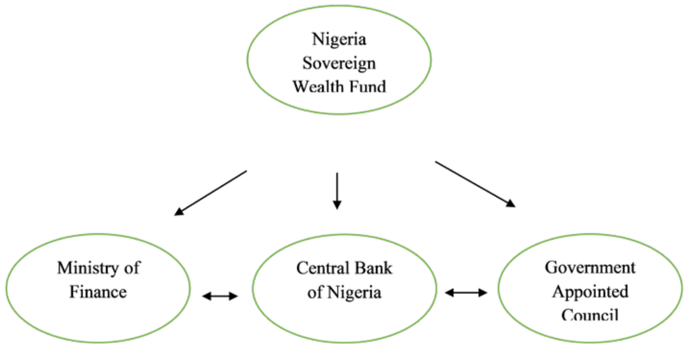

Figure 9. Proposed tripartite fiscal rule for Nigeria
Source: Authors' Computation.

The government-appointed council will provide ethical guidelines primarily in terms of investment decisions. At the same time, the Central Bank of Nigeria (CBN) will support the NSIA in terms of operational control and statutory regulation of the monetary systems, and the Federal Ministry of Finance will be saddled with the responsibility of developing sound fiscal policies for the NSIA. Furthermore, the Nigerian Sovereign Investment Authority will manage the Nigerian Sovereign Wealth Fund (NSWF).

5. CONCLUSION

A Panel Vector Autoregressive (PVAR) technique was used to estimate the effects of Brent oil price shocks on real GDP, fiscal deficit (a measure of fiscal stance), oil rent, external debt, and trade balance using annualized data covering the period 1981 to 2021. These shocks have dire economic consequences in developed, emerging, and developing countries. From a Nigeria standpoint, these challenges are not exclusive to Nigeria alone, but instead, they represent broader macroeconomic issues faced by oil-producing countries in different economic regions. A significant highlight of the study revolves around a panel of oil-producing economies across four regions: Sub-Saharan Africa, MENA, OECD, and BRICS.

The choice of the PVAR model stems from the dynamic shifts witnessed in the macroeconomics landscape over recent years. Given these rapid transformations, the utilization of the panel data methodology is notably advantageous. The model allows for the incorporation of a broad spectrum of countries within the study to avoid the small sample bias in the estimation process. As a result, the PVAR model enhances the precision of the analysis vis-à-vis the effects of Brent oil price on the macroeconomic indicators under review.

The outcome of the study supports four broad conclusions: (i) The impulse response function (IRF) of the PVAR analysis shows that the channel through which Brent oil price shock transmits to the Sub-Saharan region is the fiscal deficit. (ii) The channel through which Brent oil price dynamics are transmitted to the MENA region is the trade balance. (iii) Again, the channel through which Brent oil price volatility transmits to the OECD region is real gross domestic product (GDP); and (iv) The channel through which the Brent oil price shock transmits to the BRICS region is external debt. To avoid spurious regressions and to ensure the reliability of results, the study employed a panel unit root test and stability condition test to deeply analyse the effects of a Brent oil price shock on macroeconomic indicators in ten oil-producing countries across four economic regions.

The panel unit root test was applied using two methods, namely, the Im, Pesaran, Shin (IPS) test and the Levin, Lin, and Chu (LLC) test. The results show that all variables were stationary at first difference I (1) across the four economic regions. At the same time, the stability test reveals that all the eigenvalues lie inside the unit circle, and the PVAR satisfies the conditions of the model. From a policy perspective, Nigeria faces key economic issues to reduce procyclical fiscal policy and macroeconomic fluctuations. Thus, the design of fiscal rules and building a robust sovereign wealth fund (SWF) in this study is motivated by concerns for macroeconomic stability in the short term, escalating external debt management, the use of fiscal deficit to finance government consumption, and fiscal sustainability in the long term.

Conclusively, a defining ambition for the sovereign wealth fund (SWF) management mechanism and the proposed fiscal policy rule is to ensure a complete separation between the accumulation of oil revenues and the government expenditures of resource-related revenues. This can be achieved by recommending a tripartite transparent sovereign wealth fund (SWF) for Nigeria. Specifically, the administration of the Nigerian Sovereign Wealth Fund (NSWF), which is being managed by the Nigerian Sovereign Investment Authority (NSIA), should be divided among three government entities: namely, the Central Bank of Nigeria (CBN), Federal Ministry of Finance, and a non-partisan/independent fiscal council.

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