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Effect of Crude Oil Revenue on the Oil and Non-oil Sectors in Nigeria

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Abstract. The debate for oil-rich economies to plough their oil windfalls into real economic activities to spur diversification has become intense due to the deficit fiscal crisis and poor socio-economic profile of resource-abundant nations. Therefore, we use secondary data from the period between 1981 and 2020 to assess the impact of crude oil revenue on the oil and non-oil sector output performance in Nigeria. The study adopts the ARDL (i.e. autoregressive distributed lag) and the augmented Granger causality techniques to analyse the data. The ARDL regressions show that crude oil positively impacts oil sector performance, but the impact is only substantial in the short run. Crude oil revenue exerts a positive and insignificant effect on the short-run non-oil sector output, whereas, over the long run, it has a negative but significant effect. To propel growth, the study recommends using the excess crude oil earnings to develop non-oil sectors such as agriculture, services, and manufacturing.

Keywords: natural resources, diversification, economic growth, economic output, revenue shock

JEL Classification: H27, Q35, O14, O47, N17

1. Introduction

Studies have demonstrated that countries with an abundance of natural resources can either experience significantly high growth rates or low economic growth, depending on how these natural resource rents are harnessed and put to use (Olayungbo and Adediran, 2017; Mesagan and Adenuga, 2020; Abdulaziz et al., 2021; Akinleye et al., 2021). For instance, Norway, Botswana, Malaysia, and Thailand are some economies that have stimulated development through natural resource abundance, thereby enjoying the blessings of nature (Iimi, 2007; Olayungbo and Adediran, 2017; Tabash et al., 2022). But, on the contrary, African countries such as Nigeria, Ghana, Sudan, Angola, and Gabon, with an abundance of resources, remain stagnated economically with glaring socio-economic problems such as poverty and massive joblessness (Gylfason and Zoega, 2006; Olayungbo, 2019; Mesagan et al., 2022a). These controversial issues have sparked debate in the literature on why resource-rich countries are not on the same pedestal of growth path. In this respect, crude oil is one of the dominant natural resources globally traded. According to the OEC Report (2020), oil is the world's third most valuable exported product in revenue and represents about 3.82 percent of global trade made up of crude oil trade.

Moreover, crude oil exploration, production, and export are a fundamental part of the Nigerian economy. Since the discovery of crude oil in 1956 and the beginning of commercial production, it has become the mainstay of the Nigerian economy (Isola and Mesagan, 2014; Olayungbo, 2019; Eregha and Mesagan, 2017, 2020). For instance, income from crude oil sales accounts for over 90% of gross foreign exchange earnings and 80% of budgetary income, and between 1981 and 2020 it contributed with an average of 11.64% to GDP growth in Nigeria (Mesagan, 2015; Olayungbo and Adediran, 2017; Global Edge Report, 2020; World Development Indicator (WDI), 2021). However, the massive foreign inflow of oil rent and royalties has prompted the government to shift its focus away from non-oil sectors such as agriculture and industry, which were the primary drivers of the economy prior to the discovery of oil towards the oil sector (Okotie, 2018; Oludimu and Alola, 2021). This has propelled investment flow from multinational and domestic companies into the oil sector, thereby enhancing oil sector productivity. According to BP Statistical Review of World Energy (2022), oil production in Nigeria has increased since 1965 from 274 thousand barrels per day (bpd) to about 1,798 thousand bpd in 2020, with the highest production of about 2,533 thousand bpd recorded in 2010. However, the performance of the oil sector has not translated to improve quality of life in Nigeria; rather, it has made the Nigerian economy vulnerable to crude oil revenue shocks (Babatunde, 2015; Omojolaibi et al., 2016a,b; Mesagan and Eregha, 2019).

With the reliance of the Nigerian economy on the oil sector, the non-oil sector has dwindled, and non-oil export production has seriously plummeted (Odularu, 2007; Hammayo, 2020). Before the discovery of oil, agriculture was the Nigerian economy's principal economic driver (Akinleye et al., 2021; Mesagan et al., 2023a,b). However, during the oil boom, agriculture's proportion to GDP declined from 62% in the 1960s to 47.9% in the 1970s (Olayungbo, 2019). The agriculture sector's contribution fell further down to 20% in the 1980s and stagnated till 2015, and it slightly increased to 24.1% by 2020 (World Development Indicator (WDI), 2021). In the same manner, the industrial sector suffers a similar challenge of neglect. The WDI (2021) report shows that during the 1980s oil boom, the manufacturing value contributed to the fact that GDP had started falling, declining from 20% in 1981 to around 13% in 2020. These demonstrate the poor performance of the non-oil sector since crude oil has become the government's main source of revenue and foreign exchange (FX) earnings. In the view of Aderounmu et al. (2021) and Abdulaziz et al. (2021), the bad performance of the real sector accounts for the high level of unemployment, poverty, and economic stagnation of the country.

However, it is believed that the oil boom can catalyse economic diversification in oil-rich nations (Miamo and Achuo, 2021). The economy can be diversified and made less susceptible to shocks from changes in oil prices by investing extra revenue from the oil sector in non-oil sectors, which raises the economy's overall GDP (Mesagan et al., 2023c). This indicates that earnings from crude oil sales can be ploughed into the economy to stimulate non-oil sector productivity. As the non-oil sector improves, it is expected that it will absorb the mass of unemployed citizens, thereby increasing productivity, per capita income, and total economic progress. Supporting this argument, Riman et al. (2013), Edo (2013), Hassan and Abdullah (2015), Lawrence and Victor (2016), Olayungbo (2019), Abdulaziz et al. (2021), Ammani and Hassan (2021), and Mesagan et al. (2021) show that crude oil rent affects specific sectors' performance such as agriculture, manufacturing, and the service sector. However, there is no consensus in the empirical findings, perhaps due to sample, method, and data series incongruence.

Therefore, it becomes pertinent to interrogate the effect of crude oil revenue on the oil sector and non-oil sector output performance. Unlike previous studies, we analyse the impact of crude oil revenue on oil sector's output performance. Also, the study assesses the effect of crude oil revenue on non-oil sector performance and, lastly, analyses the causal relationship between crude oil revenue, oil sector and non-oil sector output. This study is significant for the Nigerian economy at this time to accelerate the pace of economic diversification by taking advantage of oil windfalls from the upward trend in crude oil prices triggered by the Russia–Ukraine war. Also, the country's debt status and servicing give cause for concern; between 2019 and 2020, the debt servicing to revenue ratio increased from 54.66 to 72 percent. This calls for urgent diversification of revenue channels through non-oil sector investment stimulation, thus making this study important for Nigeria. Also, the study theoretically contributes to the literature by decomposing the output component of Solow's growth model into the oil and non-oil sectors to analyse the sectoral output performance of the Nigerian economy. This is the first time Solow's growth model has been altered, making it an interesting addition to the literature. Regarding the methodology, we use the autoregressive distributed lag model and the novel augmented Granger causality to analyse the secondary data from the period between 1981 and 2020. The analytical techniques are built on robust frameworks to generate sufficient estimates to enhance policy suggestions.

The remainder of this study has the following structure. Section 2 provides a literature review. Section 3 presents the methodology and models employed. Section 4 discusses the empirical analysis, while Section 5 concludes.

2. Literature Review

Numerous empirical pieces of evidence abound in the literature that has shed light on crude oil revenue and output performance. Most of these studies have focused on crude oil revenue and GDP performance. In contrast, some others concentrated on the sector-specific impact of crude oil revenue, i.e. crude oil revenue and agriculture, manufacturing and service sector performance. However, studies that take a closer look into the effect of crude oil earnings on oil and non-oil sector output performance are sparingly available in the literature. In this respect, Nweze and Edame (2016), Olayungbo and Adediran (2017), Tamba (2017), Olojede and Michael (2020), Ologunde et al. (2020), Mohammed et al. (2020), Akinleye et al. (2021), Oludimu and Alola (2021), and Miamo and Achuo (2021) have considered the nexus between crude oil revenue and GDP performance with several empirical outcomes. For example, Nweze and Edame (2016) adopted Johansen's cointegration and the ECM technique for Nigeria and showed the presence of a long-run association between crude oil rent and GDP moves together. Also, the ECM result indicated that in the short run, oil revenue enhanced GDP, while it retarded growth in the long run. Similarly, Olayungbo and Adediran (2017) found a long-run resource curse syndrome for Nigeria, as they revealed that oil rent engendered GDP growth in the short run and reduced GDP performance in the long run between 1984 and 2014, based on ARDL methodology. Tamba (2017) focused on Cameroon and found the absence of causality between crude oil revenue and economic growth between 1977 and 2010.

Again, using the OLS method, Olojede and Michael (2020) found that oil revenue impeded economic growth in Nigeria between 1981 and 2018. Ologunde et al. (2020) captured sustainable development with the human development index and indicated that crude oil revenue negatively affected sustainable development in oil-producing African economies between 1992 and 2017. Further, Mohammed et al. (2020) focused on 86 oil-producing nations and analysed the role of the financial sector on crude oil revenue and GDP nexus. They used the two-step system GMM based on panel data from the period between 1990 and 2015. The study showed that with banking development, crude oil affected GDP positively. However, the study revealed that private crude oil investment through banking development slowed GDP growth. For Nigeria, Akinleye et al. (2021) proxied crude oil revenue with petroleum profit tax between 1981 and 2018 and indicated that petroleum profit tax negatively affected the GDP performance of the nation. Also, Oludimu and Alola (2021) showed that crude oil revenue negatively impacted economic development in Nigeria, establishing a resource curse hypothesis for the nation. Similarly, Miamo and Achuo (2021) employed the ARDL technique and Toda–Yamamoto (T–D) causality to analyse Cameroon's situation between 1980 and 2018. The study showed that crude oil prices substantially increased real economic growth in both short and long periods. The T–D causality revealed evidence of a unidirectional causal effect that flowed from real GDP to crude oil prices in Cameroon.

For specific sectors, Riman et al. (2013) used the VAR methodology to study the nexus between crude oil rent, non-oil export, and industrial productivity in Nigeria. They established that crude oil revenue slowed industrial productivity and non-oil export output. In the same vein, Edo (2013) showed that crude oil revenue caused Nigeria's manufacturing and service sectors to stagnate, as suggested by time series data from the period between 1970 and 2009. Hassan and Abdullah (2015) studied the relationship between oil rent and service sector development in Sudan from 2000 to 2012. They used the OLS and Granger causality techniques to analyse the study, and the evidence suggested that crude oil rent promoted service sector output. The causality result showed a unidirectional causal effect from crude oil to service sector performance in Sudan. Applying a similar analytical method, Lawrence and Victor (2016) indicated that crude oil revenue did not substantially explain agricultural performance in Nigeria. Additionally, they found evidence of no causal effect among the variables.

Furthermore, Olayungbo (2019) assumed a connection between Nigeria's crude oil revenue and real sector productivity. The study captured the real sector with agricultural and manufacturing sector productivity and used secondary data from the period between 1970 and 2017. The NARDL method was employed, and results showed that crude oil revenue affected the real sectors negatively. Abdulaziz et al. (2021) concentrated on 25 minor and major oil-exporting economies and studied the mediating impact of exchange rates on crude oil revenue and agricultural sector performance between 1974 and 2014. Based on the panel ARDL, they showed that in both the short and long run, crude revenue inhibited agricultural sector growth. Again, they showed that the magnitude of impact is more severe in major oil-exporting nations than in minor exporters. More so, the effect of crude oil for both samples remained the same with mediating effect of exchange rate via the crude oil revenue and agricultural sector nexus. Again, the agricultural industry was broken down into subcomponents by Ammani and Hassan (2021), including animal output, forestry, fisheries, and crop production. They claimed that between 1981 and 2019, oil revenue decreased crop and livestock output in Nigeria while increasing forestry and fisheries productivity. However, concerning crude oil revenue, oil sector and non-oil sector output linkage, Omgba (2011) analysed the oil wealth and non-oil sector in Cameroon between 1980 and 2008. The study adopted the VAR estimation technique and showed that the deterioration in the non-oil industry that started before the oil boom was halted by oil money.

In conclusion, the review shows that most existing studies in the literature focus on the impact that oil revenue has on the aggregate economic output measured in GDP (see: Nweze and Edame, 2016; Olayungbo and Adediran, 2017; Tamba, 2017; Olojede and Michael, 2020; Ologunde et al., 2020; Mohammed et al., 2020; Akinleye et al., 2021; Oludimu and Alola, 2021; Miamo and Achuo, 2021). Also, other empirical examinations in this area have attempted to analyse crude oil revenue and specific sector performance such as: Riman et al. (2013), Edo (2013), Hassan and Abdullah (2015), Lawrence and Victor (2016), Olayungbo (2019), Abdulaziz et al. (2021), and Ammani and Hassan (2021). However, only Omgba (2011) attempted to study oil rent and non-oil sector output performance. As a result, such studies are scarce in the literature and rarely address Nigeria. This makes the present study imperative for Nigeria at this point of economic diversification and fiscal revenue challenge to suggest policy measures that can drive economic diversification through the oil sector and the non-oil sectors of the economy.

3. Methodology

3.1 Theoretical Framework and Model Specification

The model of this study relies on the Solow neoclassical growth theory suggested by Solow (1965). The theory emphasizes that exogenous factors are the stimulants of economic productivity. Also, the theory lists capital, labour, and technology as required components to promote economic expansion. Therefore, the original functional form of the Solow model is as follows:

$$Y = F(AKL)\,, \tag{1}$$

where Y is the economic output, A represents technology, while K and L capture capital and labour. Eq. (1) shows that the level of technological changes, capital accumulation, and labour productivity determines the size of economic output (Fanti and Manfredi, 2003). However, Cheng et al. (2021), Akinleye et al. (2021), and Mesagan et al. (2023d) pointed out that the technological progress (A) component of the Solow growth model represents exogenous variables that can drive productivity. Therefore, this study replaces the A component with crude oil revenue. This is because windfall from crude oil sales can be invested in the economy, impacting economic output (Mohammed et al., 2020). Also, we break down the output component (Y) into oil sector output (*OSEC*) and non-oil sector output (*NOSEC*). Therefore, the study augments the Solow growth model to capture the functional relationship between crude oil revenue, oil and non-oil sectors' relationship as follows:

$$Y^* = F(OILR, KP, LB)\,, \tag{2}$$

where Y* indicates the vector of dependent variables (oil sector and non-oil sector performance), crude oil revenue is represented by *OILR*, and *KP* and *LB* denotes capital and labour respectively. We present the econometric version of Eq. (2) in Eq. (3) by adding other possible covariates that can affect the dependent variables:

$$Y_t^* = \alpha_0 + \alpha_1 OILR_t + \alpha_2 KP_t + \alpha_3 LB_t + \alpha_4 FDI_t + \alpha_5 TD + \alpha_6 INF_t + \alpha_7 EXR_t + \varepsilon_t\,, \tag{3}$$

where α_0 is the regression intercept, and α_1–α_7 are the regression slopes of the explanatory variables. We include control variables in the model to account for possible model specification bias. These variables include foreign direct investment net inflows (*FDI*), trade openness (*FD*I), inflation rate (*INF*), and exchange rate (*EXR*). The parameter ε represents the stochastic disturbance, and t is the time variable.

3.2 Data and Analytical Technique

This study uses yearly time series data from the period between 1981 and 2020 to analyse the impact of crude oil revenue on Nigeria's oil and non-oil sectors. The dependent variables are oil sector output and non-oil sector output. The oil sector captures the performance of the oil and gas industry comprising upstream and downstream activities (Balza and Espinasa, 2015). However, Omgba (2011) posits that the oil sector is volatile to price shock in the international market, which translates into the domestic economy. On the other hand, the non-oil sector is the real productive industry of the economy, which entails the economy's manufacturing, agriculture, and tourism sector output. The oil and non-oil sectors are key components of the Nigerian economy. It is believed that changes in these sectors can affect the general output of the national economy. Also, crude oil revenue is the principal regressor in this study; it is the rent received from crude oil sales (Olayungbo and Adediran, 2017). It is a major source of government revenue to finance fiscal responsibilities. Crude oil revenue can be used to drive further investment in the oil and non-oil sectors to promote sustainable growth and development (Nweze and Edame, 2016; Ologunde et al., 2020).

The control variables are included based on the argument in the literature. For instance, capital and labour are included in the model following the argument of Solow's growth theory that the level of capital accumulation and labour productivity can affect output performance. Additionally, Efanga et al. (2020) noted that the level of foreign direct investment inflow into the oil and non-oil industries can stimulate the sector's performance. Additionally, trade with other countries can also affect the productivity of the oil and non-oil sectors (Nweze and Edame, 2016). For instance, if Nigeria exports oil and non-oil products, the productivity level of these sectors will rise because of its supply for domestic and international needs. Similarly, the exchange rate policy and the inflation level can impact the economy's output performance (Mohammed et al., 2020). Therefore, we present a summary of the variables, measurement units, and sources in a tabular format in *Table 1*.

Concerning the analytical technique, the study adopts the autoregressive distributed lag (ARDL) and the augmented Granger causality approaches proposed by Pesaran et al. (2001) and Toda and Yamamoto (1995) respectively. The ARDL approach presents several advantages over the traditional time series estimators, i.e. the ordinary least squares. The ARDL method avoids the endogeneity issue in a single-regression equation paradigm by distinguishing between endogenous variables and regressors (Pesaran et al., 2001; Mesagan and Nwachukwu, 2018; Dimnwobi et al., 2022). Secondly, unlike other time series econometrics, the ARDL allows for flexibility of order integration of variables between I(0) and I(1). Moreover, the estimate performs better even in a small sample (Pesaran et al., 2001). Most interestingly, the ARDL estimate yields both short- and long-run evidence that is crucial to guide short- and long-term policies. Despite the suitability of the ARDL method, it has been criticized in recent literature that the ARDL model is sensitive to model specification, including lag length selection and the inclusion or exclusion of key variables (Dimnwobi et al., 2022; Ibekilo and Emmanuel, 2022). The model's specification has a substantial impact on the findings, and improper specifications can lead to skewed and inconsistent estimations (Dimnwobi et al., 2022; Mesagan et al., 2022b). However, we specify the ARDL mathematical function as follows:

$$\Delta y_t = \alpha_0 + \sum_{i=1}^{n} \alpha_i \Delta y_{t-i} + \sum_{i=0}^{n} \alpha_i \Delta x_{t-i} + x_i y_{t-i} + \sum x_i y_{t-i} + \varepsilon_t \tag{4}$$

Eq (4) captures the ARDL short- and long-run model with an error correction term (ECT). In Eq (4), y_t and y_{t-1} represent the dependent and lag of the dependent variable, x_t and y_{t-1} indicate the independent and lag of independent variables, while α_i is the elasticity of the short-run model, and χ_1 indicates the slopes of the ARDL long-run regressors. Also, *n* indicates the lag length taking the values of $i = 0,1,2,\ldots,n$.

Further, the augmented Granger causality is the Toda–Yamamoto (T–D) causality, which augments the weakness of the conventional Granger causality proposed by Engel and Granger (1987). The T–D improves on Granger causality by offering a simple method that requires the estimate of an augmented VAR and ensures the asymptotic distribution of the MWald statistics even in the presence of cointegration (Toda and Yamamoto, 1995). Furthermore, the MWald statistics is consistent with the T–D causality whether a series is 1(0), 1(1), or 1(2), non-cointegrated, cointegrated, or cointegrated of any random order (Aziz et al., 2000). This makes the T–D causality novel by producing robust causality evidence.

Table 1. *Summary of variables*

Variable	Identity	Measurement	Source
OSEC	Oil sector output	The oil sector captures the performance of the oil and gas industry. It is measured with the value of oil output export in billions of Naira.	Central Bank of Nigeria, 2021
NOSEC	Non-oil sector output	Non-oil sector output is the real productive industry of the economy other than oil and gas. It is captured with the total real sector output export value in billions of Naira.	“
OILR	Crude oil revenue	This is the income received from the sale of crude oil. It is measured with oil rent in % GDP.	WDI, 2021
KP	Capital	This is the accumulation of capital, and it is captured with gross fixed capital formation % of GDP.	“
LB	Labour	Labour is the number of people with employment. This is measured with the growth rate of labour.	“
FDI	Foreign direct investment	It is captured with the net inflows of FDI in % of GDP	“
TD	Trade	This is trade openness, and it is measured with trade as a % of the GDP.	“
INF	Inflation rate	The inflation rate is the annual rate of the consumer price index. It is measured with consumer price annual %.	“
EXR	Exchange rate	This is the rate at which local and foreign currency exchange. It is measured with the official exchange rate per $.	“

Source: authors’ compilation

4. Empirical Analysis

4.1 Pre-estimation Analysis

The study conducts a unit root test on the time series to check the stationarity of the trends. This is essential since non-stationarity time series produce biased estimates and incorrect inferences. Therefore, we use the Augmented Dickey–Fuller (ADF) test suggested by Dickey and Fuller (1979) and the Philips–Perron (PP) test developed by Phillips and Perron (1988). We present the results in *Table 2*.

Table 2. *Unit root estimate*

Variable	ADF	PP	ADF	PP
	I(0)		I(1)	
OSEC	-1.161	-2.172	-4.550***	-5.914***
NOSEC	-2.336	-3.171	-4.917***	-6.635***
OILR	-1.813	-2.413	-4.478***	-5.731***
KP	-0.799	-0.946	-6.182***	-6.634***
LB	-2.415	-2.378	-7.218***	-8.756***
FDI	-1.339	-1.222	-5.924***	-5.331***
TD	-5.709***	-7.265***	-	-
INF	-4.257**	-3.251	-	-5.595***
EXR	-2.173	-3.648**	-5.733***	-
N	39	39	37	37

Note: ADF and PP represent the Augmented Dickey–Fuller and the Phillips–Perron unit root results, I(0) and I(1) denote the stationarity of the series at level or at first difference, N is the number of observations, ** and *** represent the significance of the ADF and PP statistics at 5% and 1% significant levels, respectively, and all the variables have been log-transformed.

Table 2 illustrates the ADF and PP unit root calculations. The evidence shows that trade openness (TD) is stationary for both ADF and PP at I(0) at a 1% significance level. However, ADF shows that inflation is stationary at I(0), while PP evidence suggests stationarity at I(1). On the contrary, PP reveals that the exchange rate (*EXR*) is stationary at I(0), whereas ADF confirms stationarity at I(1). In addition, the remaining variables are stationary for both tests at I(1) at a 1% significant level. Therefore, we conclude that all our variables are stationary with mixed order of integration. This necessitates estimating the bound cointegration test to determine whether there is a long-run association among the variables of interest.

Table 3. *Bound test*

Ho: Absence of cointegration		Oil sector model: ARDL (2, 1, 2, 1, 3, 3, 3, 3) Non-oil sector model ARDL (2, 1, 3, 3, 3, 3, 3, 3)	
F-statistic	**I(0) bound**	**I(1) bound**	**K**
5.322***	2.66	3.18	7
4.790***	2.59	3.09	

Note: I(0) and I(1) represent the lower and upper bound of the bound estimates, the number of observation (N) is 37, *** and ** show that the bound F-statistics are significant at 1% and 5% level of significance, ARDL (2, 1, 2, 1, 3, 3, 3, 3) and ARDL (2, 1, 3, 3, 3, 3, 3, 3) show the lag length selection of the model and are selected based on the Akaike Information Criteria (AIC), and K is the degree of freedom.

We show the bound test results in *Table 3* for the oil sector and non-oil sector models. The F-statistics for both models are significant at a 1% critical value, indicating the rejection of the null hypothesis of the absence of cointegration. Hence, at a 1% significance level, the study accepts the alternative hypothesis of the presence of cointegration among the interest variables. This implies that the variables exhibit a long-run association, showing that the variables move together in the long term. Since there is a cointegration association, the study proceeds further to determine the level of association between the variables to avoid having variables that can stand for each other due to a very strong degree of association. Hence, the study presents a correlation matrix to check the association among the variables in *Table 4*.

Table 4. *Correlation matrix*

	OSEC	***NOSEC***	***OILR***	***KP***	***LB***	***FDI***	***TD***	***INF***	***EXR***
OSEC	1.000								
NOSEC	0.567	1.000							
OILR	0.747	0.783	1.000						
KP	-0.729	-0.754	-0.718	1.000					
LB	0.648	0.768	0.641	-0.723	1.000				
FDI	0.346	-0.096	0.157	-0.145	0.017	1.000			
TD	0.771	0.309	0.653	-0.523	0.442	0.431	1.000		
INF	-0.226	-0.343	-0.276	0.203	-0.294	0.538	-0.052	1.000	
EXR	0.792	0.753	0.672	-0.626	0.742	0.202	0.631	-0.201	1.000

Note: The number of observations (N) is 39. *Source: authors' computation*

The correlation matrix in *Table 4* reveals a correlation among the series. However, the coefficients of correlations are not in excess of 0.80, which denotes a very high degree of association. This implies that the correlation among the variables is moderate; thus, the models' variables are not strongly associated. Hence, we conclude that there is no multicollinearity issue around our models. Therefore, all the pre-estimation checks conducted are satisfactory and suggest the estimation of the ARDL regression to guide inferences concerning the link between crude oil revenue impact on oil and on non-oil sector output performance.

4.2 ARDL parsimonious regression

The study presents the ARDL short- and long-run results in *tables 5* and *6*. In the same vein, we show the T–D causality evidence between crude oil revenue, oil sector and non-oil sector performance in *Table 7*. Further, *Table 8* presents the diagnostic results to validate the robustness of the regression estimates. Hence, *Table 5* shows that crude oil revenue positively and significantly impacts short-run oil sector performance. The evidence shows that oil sector output performance improves significantly by about 9% as crude oil revenue increases by at least 1%. This shows that crude oil revenue earnings increase the oil sector's productivity in the short run. However, for the non-oil sector, crude oil revenue exhibits a positive effect; such that a 1% rise in crude oil revenue increases short-run oil sector performance by about 7.2%. However the crude oil revenue impact on non-oil sector output is inconsequential. This shows that crude oil revenue can promote Nigeria's non-oil sector investment and development in the short run.

Table 5. *Parsimonious regression of the impact of crude oil revenue on oil and non-oil sector performance in Nigeria (in the short run)*

Explanatory var.	Model I: ARDL (2, 1, 2, 1, 3, 3, 3, 3) Model II: ARDL (2, 1, 3, 3, 3, 3, 3, 3)			
	Oil sector		**Non-oil sector**	
	Coefficients	**Probability**	**Coefficients**	**Probability**
ΔOSEC$_{-1}$	0.1832*** (0.0139)	0.0000	-	-
ΔNOSEC$_{-1}$	-	-	-0.5881*** (0.1115)	0.0008
ΔOILR	0.0908*** (0.0220)	0.0014	0.0727 (0.0881)	0.4331
ΔKP	0.0115*** (0.0020)	0.0001	0.0028*** (0.0008)	0.0093
ΔKP$_{-1}$	0.0035** (0.0015)	0.0406	0.0074*** (0.0009)	0.0000
ΔKP$_{-2}$	-	-	0.0033*** (0.0009)	0.0061
ΔLB	-0.0786 (0.0585)	0.1896	1.222** (0.3700)	0.0108
ΔLB$_{-1}$	-	-	3.8372*** (0.4171)	0.0000
ΔLB$_{-2}$	-	-	-3.0109*** (0.4657)	0.0002
ΔFDI	0.0049 (0.0081)	0.5536	-0.0119*** (0.0041)	0.0000
ΔFDI$_{-1}$	-0.0541*** (0.0125)	0.0010	-0.0345*** (0.0048)	0.0002
ΔFDI$_{-2}$	-0.0249*** (0.0072)	0.0048	-0.0072*** (0.0037)	0.0000
ΔTD	0.0008 (0.0009)	0.4075	0.0002 (0.0004)	0.1203
ΔTD$_{-1}$	-0.0002 (0.0010)	0.8136	0.0006*** (0.0002)	0.0001
ΔTD$_{-2}$	-0.0039*** (0.0010)	0.0015	0.0010** (0.0003)	0.0279
ΔINF	0.0004 (0.0006)	0.5434	-0.0012** (0.0003)	0.0199
ΔINF$_{-1}$	0.0046*** (0.0007)	0.0001	0.0064*** (0.0005)	0.0077
ΔINF$_{-2}$	0.0051*** (0.0009)	0.0002	0.0048*** (0.0004)	0.0020

Explanatory var.	Model I: ARDL (2, 1, 2, 1, 3, 3, 3, 3) Model II: ARDL (2, 1, 3, 3, 3, 3, 3, 3)			
	Oil sector		Non-oil sector	
	Coefficients	Probability	Coefficients	Probability
ΔEXR	-0.1733*** (0.0275)	0.0000	-0.1347*** (0.0153)	0.0059
ΔEXR$_{-1}$	-0.1910*** (0.0350)	0.0001	-0.1125*** (0.015)	0.0000
ΔEXR$_{-2}$	-0.0976*** (0.0287)	0.0053	-0.0683*** (0.0134)	0.0000
ECT$_{-1}$	-0.5672*** (0.0715)	0.0000	-0.2827*** (0.0213)	0.0000
N	37		37	

Note: Explanatory var. means explanatory variables, the values in parenthesis are the standard error of the regression coefficients, and ECT (-1) captures the short-run error correction model of the ARDL. *N* is the number of observations. Additionally, ** and *** indicate 5% and 1% significance, ARDL (2, 1, 2, 1, 3, 3, 3, 3) and ARDL (2, 1, 3, 3, 3, 3, 3, 3) show the lag length selection of the model and are selected based on the Akaike Information Criteria (AIC).

The long-run results in *Table 6* reveal that oil revenue positively impacts oil sector performance insignificantly. Results show that if all other variables remain fixed, a 1% change in crude oil revenue causes oil sector performance to rise by 1.4%. The estimates reveal that crude oil revenue weakly drives oil sector development in Nigeria. On the other hand, crude oil negatively but significantly impacts the non-oil sector; such that a 1% increase in oil revenue slows non-oil sector output performance by about 7.8%. The meaning is that in the long run, earnings of crude oil sales discourage non-oil sector performance in Nigeria.

The error correction term (ECT) for the oil sector and non-oil sector models are -0.5672 and -0.2827 respectively. The coefficients of the ECT are significant at a 1% level of significance. This indicates an extremely rapid convergence in the short-run and long-run discrepancies of the models. Moreover, ECT results support the bound test, which confirms the presence of cointegration in the model and thus shows that our ARDL model is robust for policy decisions.

Table 6. *Parsimonious regression of the impact of crude oil revenue on oil and non-oil sector performance in Nigeria (in the long run)*

	Oil sector		Non-oil sector	
Regressors	Coefficients	Probability	Coefficients	Probability
OILR	0.0149 (0.1366)	0.9148	-0.0784** (0.0120)	0.0108
KP	0.0100 (0.0101)	0.3435	-0.0301** (0.0120)	0.0365
LB	-0.4112 (0.6341)	0.5288	0.9589 (1.2561)	0.4671

	Oil sector		Non-oil sector	
Regressors	**Coefficients**	**Probability**	**Coefficients**	**Probability**
FDI	0.0916 (0.0949)	0.3537	0.1121 (0.0807)	0.2026
TD	0.0081*** (0.0002)	0.0000	-0.0025 (0.0046)	0.6025
INF	-0.0134 (0.0088)	0.1553	-0.0287** (0.0129)	0.0467
EXR	0.0939 (0.0086)	0.3002	-0.1181 (0.1289)	0.3865
Constant	15.4357 (10.8701)	0.1811	-3.0544 (22.7725)	0.8966
N	37		37	

*Note: ** and *** indicate 5% and 1% significance levels, respectively, and N is the number of observations.*

We present the causality report in *Table 7*. The augmented Granger causality indicates a one-way effect between crude oil revenue, oil sector output, and non-oil sector output, with the direction of association moving from oil revenue. This means that crude oil revenue influences the performance of the oil sector and non-oil sector. Also, results show a one-way causality between the oil and non-oil sectors. The causal effect moves from the oil sector to the non-oil sector. This result denotes that the oil sector influences the performance of the non-oil sector. This may be due to the fact that the non-oil sector depends on the oil sector for energy supplies (i.e. petroleum products) to power plants.

Table 7. *Augmented Granger causality*

	OILR	***OSEC***	***NOSEC***
OILR	-	5.127**	4.451*
OSEC	1.651	-	12.857***
NOSEC	0.869	2.266	-

Note: *, **, and *** indicate 1%, 5%, and 1% significance levels, respectively, and the number of observations (N) is 37.

4.3 Discussion of the Results

The study analyses the impact of crude oil revenue on oil sector and non-oil sector performance. First, the study shows that crude oil revenue positively impacts the oil sector in the short and the long run. However, the short-run effect is significant, whereas in the long run, the effect is weak in driving oil sector output performance. The assumption is that in the short run crude oil revenue substantially spurs investment in the oil industry in Nigeria, thereby engendering the sector's growth. The short-run findings point to the fact that after the discovery of oil in commercial production in Nigeria in the late 1950s, the government allowed several international oil companies (IOCs) to invest in the oil and gas industry (Steyn, 2009; Statista, 2022). Moreover, by the late 1980s, the federal government had had a huge direct investment in the oil industry to produce more output and earn excess revenue. According to Metz (1991), approximately 96% of the oil that Nigeria produced in 1988 came from firms where Nigeria National Petroleum Corporation (NNPC) owned at least 60% of the equity and where 75% of all investments in petroleum were made by the NNPC. These scenarios may account for the positive and significant impact of crude oil revenue on oil sector performance in the short run. However, in the long run, the impact is positive, but the effect is weak. This shows that over the long run, the earnings from oil sales were not able to drive the oil sector performance. This can be attributable to constant oil price shocks and supply control by OPEC and oil theft in the Niger Delta region. Hamilton (2011) shows that oil prices around 1990-1991 and 2007-2008 seriously affected oil net exporters. For instance, oil prices plummeted from a peak of $147 in July 2008 to a low of $32 in December 2008 (Gastautor, 2020). However, the oil market also witnessed a severe downtrend orchestrated by the COVID-19 pandemic in 2020. However, oil theft and oil and gas infrastructure vandalism in the Niger Delta region has substantially affected oil production and revenue, which has triggered a reduction in investment in the sector and the decommissioning of assets by the IOCs. For example, Olawoyin (2022) noted that Nigeria loses 470,000 bpd of crude oil worth $700 million each month to oil theft. These scenarios account for the possible implications of the long-run evidence causing the oil revenue to have an insignificant effect on the sector's performance.

For the non-sector model, in the short term, crude oil revenue has a positive but insignificant impact on the non-oil sector, whereas in the long term it exerts a negative but significant effect on the non-oil sector output. The short-run evidence indicates that crude oil revenue has the potential to promote non-sector investment in Nigeria. This means that if crude oil revenue is channelled towards the development of agriculture, manufacturing, and other productive sectors, it can expedite the increase in the economic output of the non-oil sector. However, the long-run evidence reveals the negligence of Nigeria's non-oil sector development. Since crude oil production is in commercial quantity, Nigeria has neglected non-oil sectors such as agriculture, manufacturing, and service, thereby making the nation a mono-economy (Olayungbo, 2019; Akinleye et al., 2021). This has affected the performance of the sector and the revenue the country generates from this sector. According to Dambatta (2022), less than 15% of Nigeria's foreign exchange revenues come from non-oil sector output exports. Hence, the evidence reflects the economic reality of the nation. Interestingly, the long-run finding is similar to Omgba's (2011) evidence for Cameroon. However, Olayungbo (2019) obtained similar results for Nigeria, focusing on real sector productivity.

Concerning the causal effect between crude oil revenue, oil, and non-oil sector output performance, crude oil revenue has a causal effect on the performance of the oil sector and non-oil sector performance. This denotes that oil revenue influences the oil sector and non-oil sector development. The unidirectional causal effect between crude oil revenue and the non-oil sector is similar to the evidence from Hassan and Abdullah (2015) that showed a one-way causal nexus between crude oil and service sector output for Sudan. Moreover, the study also reveals that the oil sector has a causal relationship with the non-oil sector. The reason is that the non-oil sector depends on the oil sector for the supply of energy resources to fire production. Hence, if the oil sector grows, it will affect the non-oil sector's performance.

4.4 Diagnostics

We conduct a series of diagnostic tests to check for the robustness of our models and the efficiency of our estimates to inform policy decisions. The diagnostic test results are presented in *Table 8*.

Table 8. *Diagnostic test results*

		Oil sector		
	Statistics	Probability	Null hypothesis	Decision
BG Serial correlation	2.695	0.237	No serial correlation	Do not reject
BPG Heteroscedasticity test	1.039	0.492	Homoscedasticity	Do not reject
JB Normality check	1.139	0.566	Model is normally distributed	Do not reject
F-stat	31.24***	0.000	Regressors are not significant	Reject
Functional form	4.362**	0.725	Model specification is bias	Reject
R-squared	0.895			
Adj. R-squared	0.815			
		Non-oil sector		
BG Serial correlation	2.540	0.263	No serial correlation	Do not reject
BPG Heteroscedasticity test	0.402	0.963	Homoscedasticity	Do not reject
JB Normality check	0.125	0.940	Model is normally distributed	Do not reject
F-stat	1341***	0.000	Regressors are not significant	Reject
Functional form	9.454***	0.663	Model bias	Reject
R-squared	0.953			
Adj. R-squared	0.898			

Note: BG Serial Correlation is the Breusch–Godfrey serial correlation, BPG Heteroscedasticity test means Breusch–Pagan–Godfrey heteroscedasticity test, JB Normality denotes the Jarque–Bera normality test, F-stat indicates F-test statistic, and Adj. R-squared is the adjusted R-squared. The number of observations (N) is 39. Also, ** and *** are significant at 5% and 1% critical region respectively.

Table 8 reveals that diagnostic reports are satisfactory. For instance, the BG Serial Correlation, BPG Heteroscedasticity, and JB Normality accept the hypothesis of no serial correlation, homoscedasticity, and normality of the model and result to draw inference and policy decisions. Further, the F-statistic and the functional form test reject the null hypothesis, which indicates that all the regressors are significant determinants of the dependent variables and that the model is well fitted. The R-squared and Adjusted R-squared for both models are above 80%, indicating a strong predictive power and the best fit of our model to guide policy formulation. Also, we present a stability test in *figures 1–3* based on the recursive cumulative sum (CUSUM) and recursive cumulative sum square (CUSUM-SQ) tests.

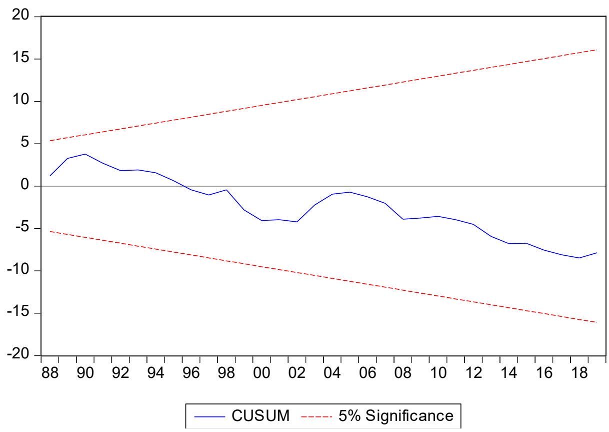

Figure 1. *CUSUM (oil sector)*

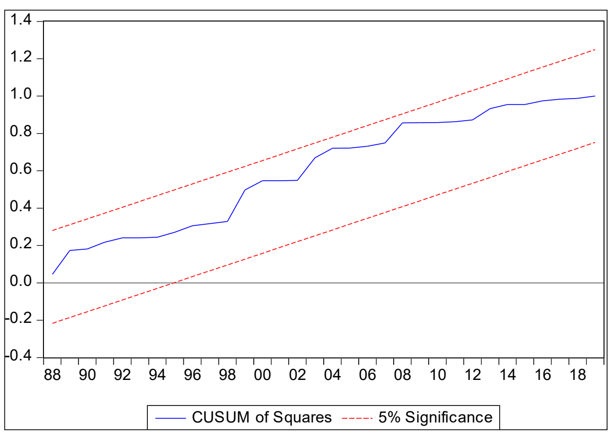

Figure 2. *CUSUM-SQ (oil sector)*

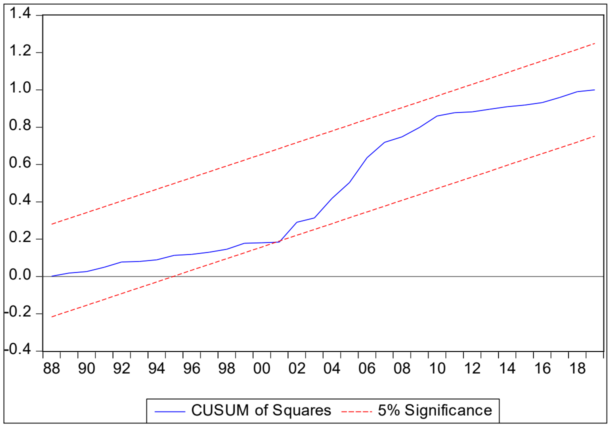

Figure 3. *CUSUM-SQ (non-oil sector)*

The CUSUM and CUSUM of square measurements in *figures 1–3* demonstrate the stability test of the estimates, which demonstrates the stability and dependability of the estimates. The diagnostic reports show that our results are solid and reliable for policy inferences.

5. Conclusions

This study assesses the impact of crude oil revenue on oil and non-oil sector performance. The study focused on Nigeria and collected periodic data for analysis from the period between 1981 and 2020. We use the ARDL and the Toda–Yamamoto causality techniques to perform analyses in the study. The study shows that crude oil revenue promotes oil sector performance in the short and long run. However, the long-run effect is insignificant. This means that in the short term, crude oil revenue substantially engenders output productivity in the oil sector, but the effect becomes weak over the long term. Furthermore, the study reveals that crude oil revenue has a positive effect on the non-oil sector. However, in the long run, the impact on the non-oil sector is negative. Although the short-run effect is insignificant, the long-term impact is significant. It denotes that crude oil revenue can promote non-oil productivity, but the effect on the sector in the long run is contractionary due to the neglect of the sector. Regarding the causal evidence, the evidence shows a unidirectional causal nexus moving from crude oil revenue towards the oil and non-oil sectors. This indicates that crude oil revenue influences these sectors' trends. Additionally, the study identifies a one-way causal relationship between oil sector performance and non-oil sector productivity. This means that the oil sector influences the non-oil sector.

The empirical findings provide insights for stimulating Nigeria's oil and non-oil sector development, as crude oil revenue significantly improves oil sector performance in the short run but insignificantly in the long run. The government should address the issue of oil theft and oil and gas infrastructural vandalism in the country's oil regions to improve oil production quantity, which will enhance earnings and further reinvestment in the sector in the long run. Also, since crude oil revenue has a short-run potential to drive non-oil sector performance, the government should take advantage of the oil rent to better the non-oil sector. For instance, when oil prices are high, the Nigerian government should make it a point to allocate or invest the extra funds into worthwhile projects and industries, fully aware that a period of low oil prices is unavoidable. However, aside from direct investment, oil revenue spending should be channelled towards capital overheads that encourage investments in agriculture, manufacturing, tourism, etc. This will not only promote the non-oil sector but also boost real economic growth, push government revenue above expenditures, and reduce the fiscal deficits of the nation. The policy implication is that as real investment rises as a result of reinvestment of excess crude oil earnings, real sector investment is expected to increase domestic production and absorb the unemployed population, which will translate into improved economic growth and overall welfare advancement. Also, the policy implications of sectoral diversification from the oil sector to the non-oil sector will enable the Nigerian domestic economy to be resilient against price shocks in the international oil market.

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