Bima Journal of Science and Technology, Vol. 9(1A) Mar, 2025 ISSN: 2536-6041

DOI: 10.56892/bima.v9i1A.1234

The Impact of Oil Revenue on Revenue Generation in Nigeria Using Vector Error Correction Model (VECM)

Kawu A. S.*, Obini Nweze, M. U. Adehi and Alilu Haruna

Department of Statistics, Nasarawa State University, Keffi, Nigeria

Corresponding Author: alhassanalhaji1010@mail.com

ABSTRACT

This study investigates the relationship between oil revenue, exports, and overall revenue generation in Nigeria using a time series approach. Stationarity tests was carried out using the Augmented Dickey-Fuller (ADF) approach, confirm that all variables are integrated of order one, I(1). Lag selection criteria suggest an optimal lag of one (1) for the Vector Error Correction Model (VECM), which highlights the existence of a cointegrating relationship. The results from the VECM indicate that oil revenue has a coefficient of -0.88845 and t-statistics value of [-30.2226] which indicated that oil revenue has a positive and significant long run effect on revenue in Nigeria. Eexports significantly influence revenue generation in the long run with the coefficient value of 0.60397 and t-statistic value of [4.39911], with adjustments occurring at a moderate speed of 40.36% annually when deviations from equilibrium arise. Diagnostic tests, including serial correlation and normality tests, suggest no significant serial correlation, although residuals are not fully normally distributed. The study therefore, recommend that the government should invest in data analytics and forecasting tools to monitor global market trends and proactively adjust policies to maximize revenue.

Keywords: Revenue, Oil Price, Export, Vector Error Correction Model.

INTRODUCTION

The economic development of any nation is closely tied to its ability to mobilize resources effectively. This explains why revenue generation is a key priority for any government. The primary goal of revenue generation is to meet the social and infrastructural needs of the population (Nakah, 2018). Before 1970, Nigeria's revenue largely came from the non-oil sector, including agriculture and mineral resources such as coal, iron ore, and tin. At that time, Nigeria earned foreign exchange through the export of cash crops like cocoa, coffee, palm oil, rubber, and groundnuts.

Unfortunately, with the discovery of oil in the early 1960s, there was a dramatic change in the structure of Nigerian economy. As a result, the non- oil sector started experiencing unprecedented neglect by successive governments. This culminated in a perceptible drop in the contributions of the non-oil sector to about 23% (Odularu 2008). By the year 2000, oil accounted for about 98% of total exports and about 83% of Federal Government Revenue (Odularu, 2008). It should be noted that after Nigeria shifted its focus from non-oil revenue to oil revenue, Nigeria's growth and development has continue to decline with little hope of recovery (Chima, 2017).

However, Ujunwa (2015) attributes the recent oil price fluctuation (a significant up and drop in oil prices) to various factors, including an unexpectedly high supply of oil, weakened global demand for oil due to advances in the technology used in the production processes such as shale production techniques in the United States, a continuous increase in oil production from non-OPEC economies, and the rapid way recovering from the stress that was confronting oil production in some OPEC producers (for example, Iran). Additionally, OPEC's decision in November 2014 to keep oil production levels constant despite the

DOI: 10.56892/bima.v9i1A.1234

substantial drop in prices suggests that this trend may persist in the foreseeable future.

Furthermore, particularly in a one- sided economy such as Nigeria, oil price uncertainty makes it difficult to ascertain the direction of the economy as a result of its perceived consequences of depleting the oil revenue coupled with the perceived improper allocation/mismanagement associated with the revenue in question. Argument abounds as to why an oil- producing economy like Nigeria should import refined petroleum instead of refining it locally for consumption in the domestic economy. Studies such as Akinleye and Ekpo (2013) posit the importation of refined petroleum plays a significant role in declining in revenue generation resulting from value addition, thus making the domestic oil price higher compared to the price that would have been set by the local market if the refine locally. This has caused the devaluation of the revenue of the affected Nation. In contrast, Budina and Van Wijnbergen (2008) are of the opinion that the challenges are associated with inappropriate management of the proceeds from oil achieved, viewing the role played by fiscal policy in an attempt to control the fluctuation of oil wealth and its perceived implications for debt and development of the nation.

The effect of the fall in oil price eventually distorted revenue generation which in turn affected the government budget, as a result the economy was engulfed with serious economic distress as evidently seen in capacity underutilization of local refineries, poor infrastructural facilities, high rate of poverty and unemployment coupled with a surge of instability in the political sphere and corruption, thereby undermining the overall performance of the national economy through the multiplier effect (Akinlo, 2012; Udoh, 2014 and Adugbo, 2016).

However, there are numerous studies of the time series analysis on the impact of oil revenue on the revenue in Nigeria. Like those of Ejinkonye *et, al* (2024) which assessed the effect of government revenue on economic growth in Nigeria. The study was anchored on the endogenous growth theory of Harrod-Domar. The ex-post facto research design was employed and data from 1981 to 2022 obtained from Central Bank of Nigeria statistical bulletin. But this data is limited to 2022 while the current study extends scope of the data 2023.

Again, Olusegun (2023) examined the impact of government revenue and expenditure on economic growth in Nigeria utilizing time series data spanning from 2000 to 2021. The specific objective was to evaluate the impact of capital expenditure, recurrent expenditure, and non-oil revenue on Nigeria's economic growth. They sourced secondary data from Central Bank of Nigeria statistical bulletin and analyzed. The results showed that there was no unit root. Also, non-oil revenue and capital expenditure were positively influencing economic growth in both short and long-run period but was not significant. Recurrent expenditure on the other hand had an insignificant negative effect on economic growth of Nigeria.

Adefolake and Omodero (2022) assessed the effects of tax revenue on economic growth in Nigeria utilizing time series data spanning from year 2000 to 2021. The specific objective is to evaluate the influence of hydrocarbon tax, corporation income tax and value added tax on Nigeria's economic growth.

In addition, Akinleye *et, al* (2021) examined the impact of oil revenue on economic growth in Nigeria (1981-2018). The secondary data collected on the economic variable used in the study were sourced from the Central Bank of Nigeria Statistical Bulletin and National Bureau of Statistic. An Augmented Dickey Fuller unit root test, autoregressive distributive lag (ARDL) method and ARDL bound test for co-integration with various other diagnostic techniques were employed for the study.

Furthermore, Rotimi et al (2021) examined the relationship between revenue generation and economic growth in Nigeria. It employed time series data sourced from the Central Bank of Nigeria and National Bureau of Statistics from 1981 to 2018. The multiple regression analytical tool was used. Findings revealed that domestic debts and non-oil revenue positively and significantly impact on economic growth, while external debts and oil revenue were otherwise.

The current study differs in timeframe, variables of the study and methodology as well. Based on the backdrop, the study utilized Vector Error Correction (VEC) model in analyzing the impact of oil revenue on the revenue generation in Nigeria.

MATERIALS AND METHODS

This research modeled and forecast oil revenue with some selected macroeconomic variables such as export and revenue using Vector Error Correction (VEC) model and finally examine their structural relationship from 1970 to 2023. Augmented Dickey Fuller (ADF) test was utilized to investigate the stationarity level of the variables. the data for the paper was obtained from NBS and CBN Bulletin. VECM (Vector Error Correction Model) is an extension of the VAR (Vector Autoregressive) model that is used to analyze and forecast non-stationary time series data while capturing the long-run equilibrium relationships between multiple variables. VECM is particularly suitable for handling variables that exhibit cointegration, which means they have a long-run relationship even though they may show short-term deviations from this relationship.

Model specifications

The general form of a VECM with k lags for a system of n variables is stated as follows:

$$\Delta X_t = \Pi X_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-1} + C + Dt + u_t \quad (1)$$

Where:

X_t is an (n× 1) vector of the endogenous variables

$\Delta X_t = X_t - X_{t-1}$ represent the first difference of X_t.

$\prod$ is an (n× n) matrix capturing the long run equilibrium relationship.

It can be decomposed as $\prod = \alpha\beta^!$, where α means coefficient of adjustment to deviation from long run equilibrium.

β means cointegration matrix, contains the cointegrating vectors.

Γ_i are (n× n) matrices that capture short-run dynamics

C is a vector of constant terms (intercepts)

Dt captures the deterministic trend (if present).

u_t is an (n× 1) of white noise error terms.

Test for Stationarity

$$\Delta y_t = \mu + at + \delta y_{t-1} + \sum_{i=1}^{n} \beta \Delta y_{t-1} + e_t \quad (2)$$

DOI: 10.56892/bima.v9i1A.1234

Where:

Δy_t is the first difference of y_t $i.e$ $y_t - y_{t-1}$

The stationarity test hypothesis is as follows:

H_o: $\delta = 0$ Unit Root (non-stationarity)

H_a: $\delta \neq 0$ There is no Unit Root (stationarity)

If the null hypothesis is accepted, we assume that there is a unit root and difference the data before running a regression. If the null hypothesis is rejected, the data are stationary and can be used without differencing (Dominick and Derrick, 2002)

The Philip Perron Test: This assumed that error terms μ_t are independently and identically distributed.

Johansen Cointegration Test

The most popular method for testing cointegration is the Johansen and Joselius cointegration test (i.e. Maximum Eigenvalue test and the trace test) (Johansen and Joselius, 1990). The maximum eigenvalue test and the trace test are used as procedures to determine the number of cointegration vectors.

The maximum eigenvalues statistic tests the null hypothesis of r cointegrating relations against the alternative of r+1 cointegrating relations for r=0,1, 2,…, n-1. This test statistic is computed as

$$\lambda_{max}\,(r, r+1) = -Tin(1 - \hat{\lambda}_{r+1}) \quad (3)$$

Where:

$\hat{\lambda}$ is the computed maximum eigenvalues

T is the sample size

$$\lambda_{trace}\,(r) = -T\sum_{i=r+1}^{n} In\,(1 - \hat{\lambda}_i) \quad (4)$$

The result of trace test should be chosen where trace and maximum eigenvalue statistic may yield different result in some cases (Habte, 2014)

Model Selection

Most recent approaches used as criteria for choosing the order of a model without going through hypothesis testing are:

Final Prediction Error (FPE). The FPE criterion for path order model is given by pth order model is given by $FPE_p = \sigma_p^2\left(1 + \frac{P}{N}\right)$ where σ_p^2 is the unbiased estimates of σ_p^2 after fitting the pth order model. That is. $\hat{\sigma}_p^2 = \frac{RSS_p}{N-p}$

RESULTS AND DISCUSSION

Table 1: Descriptive Statistics

Variables	REV	OIL_REV	EXPR
Mean	2750.054	2000.101887	18.2745
Std. Dev.	3568.3507	2624.783565	10.5576
Maximum	11116.85	8878.97	55.7994
Minimum	0.63	0.17	3.33503
Skewness	0.9705048	1.027348533	1.09062
Kurtosis	2.4876168	2.705382711	5.04994

DOI: 10.56892/bima.v9i1A.1234

The aggregate average of revenue earned during the observed period amounts to 2750.054 billion as captured in the table above. This depicts the general performance of revenue generation in Nigeria, which is greatly driven by oil and other associated income-generating activities. The 3,568.3507 standard deviations indicate a very high figure where revenue is said to vary. It implies that revenues have been very erratic at various times and this is possibly due to other factors such as fluctuation in export performance, government measures, economic conditions, or even oil price volatility. The highest earnings amounting to 11,116.85 units indicate that there are some years in which the performance was said to peak, probably due to increased export activities, increased production, or `favorable` prices of petroleum. The very little minimum revenue of 0.63 units could show times of severe economic distortions, such as periods of very high oil prices.

As per the extrapolation, oil revenue averages around 2000.101887 (two billion and one hundred one point nine), which reflects that oil revenue occupies a considerable proportion of Nigeria's total revenue generation. This portrays how extensively the country depends on the oil sector to provide major income. The standard deviation of the oil revenues shows a high value of 2,624.7836. This indicates that oil revenue has a very high instability or volatility that could be as a result of erratic changes in global oil prices, production levels, or global geopolitical or market factors affecting the oil industry. The highest oil revenue of about 8,878.97 units would thus be representing peak performance in oil income perhaps during periods of high oil prices or increased production and export activities. The minimum oil revenue received is 0.17 units, which is an extremely low figure likely to account for periods with oil price crashes, halted production, or economic crises (e.g., global oil crises or internal inefficiencies in oil sectors).

The average export value is 18.2745%, an indication of mean export activities in Nigeria during the period observed, which exhibits a moderate performance in exports and its rather broader contributions from oil and non-oil exports to the economy. The standard deviation of 10.5576 units also reveals a moderate level of variability regarding the values of exports over time. Such changes will likely influence export performance by global demand and prices, trade policies, or prevailing economic conditions. The highest value of export is 55.7994 units, depicting years of peak performance in exports due to positive global demand, increased oil prices, or very significant growth in non-oil exports. The lowest value of export is 3.33503 units, indicating minimum export periods that result from a country going through an economic slump, a country imposes or faces trade restrictions, or that production/export capacities are reduced.

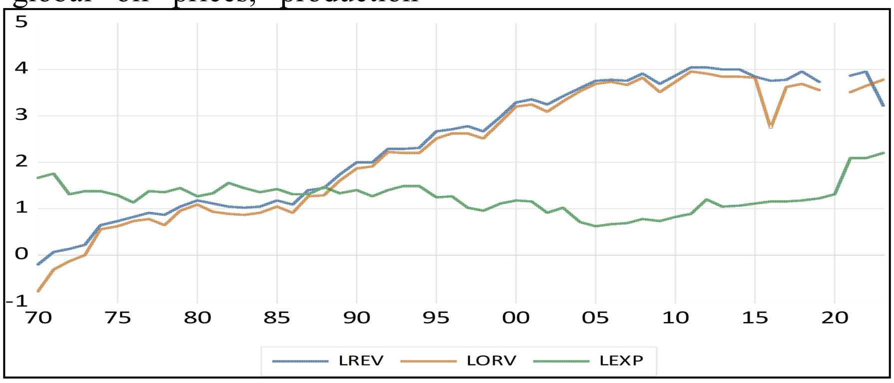

Figure 1: Plot of Revenue, Oil Revenue and Export rate

The figure 1 above is a graphical representation of the movement of the variables under observation during the study period.

Table 2: Augmented Dickey-Fuller Test

Variables	ADF -Statistic	Prob.	Order of integration
D(LREV)	-5.417789	0.0000	1(1)
D(LORV)	-9.08911	0.0000	1(1)
D(LEXP)	-7.94734	0.0000	1(1)

The Augmented Dickey-Fuller test was used to conduct a unit root test on each variable to check for stationarity. As illustrated in Table 2 above, the absolute values of ADF statistics are more than 5% higher than the absolute critical value. This is supported by the likelihood figures in table 2, where the majority of them are less than 5%. The results show that all of the three variables, Revenue, Oil Revenue, and Export, are non-stationary at level but they become stationary on first difference (I(1)).

Table 3: Lag selection criteria

VAR Lag Order Selection Criteria

Endogenous variables: LREV LORV LEXP

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-30.9913	NA	0.00088	1.477884	1.597143	1.522559
1	84.44721	210.8008*	8.61e-06*	-3.149879*	-2.672842*	-2.971178*
2	90.23633	9.816342	9.96E-06	-3.01028	-2.17546	-2.69755
3	92.63258	3.75065	1.35E-05	-2.72316	-1.53056	-2.2764
4	99.01766	9.161205	1.55E-05	-2.60946	-1.05909	-2.02869

* Indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

LREV= log of revenue, LORV= log of oil revenue and LEXP= log of export

Lag 1 is the best lag for the VAR model according to all criteria (LR, FPE, AIC, SC, and HQ), according to Table 3. This indicates that the optimal balance between predictive power and model simplicity is achieved by including one lag of each variable (LREV, LORV, and LEXP). The model will capture the dynamics between the variables without overfitting or adding needless complexity if lag 1 is used.

Table 4: Vector Error Correction Model

Vector Error Correction Estimates	
Cointegrating Eq:	CointEq1
LREV(-1)	1
LORV(-1)	-0.88845
	0.029397
	[-30.2226]
LEXP(-1)	0.60397

DOI: 10.56892/bima.v9i1A.1234

	0.137294		
	[4.39911]		
C	-1.13584		
Error Correction:	D(LREV)	D(LORV)	D(LEXP)
COINTEQ1	-0.40358	0.222608	-0.08921
	0.128081	0.185952	0.107199
	[-3.15101]	[1.19713]	[-0.83217]
D(LREV(-1))	0.00666	0.619004	-0.07203
	0.243408	0.353388	0.203723
	[0.02736]	[1.75163]	[-0.35355]
D(LORV(-1))	-0.07227	-0.42178	-0.07496
	0.1358	0.197159	0.113659
	[-0.53219]	[-2.13929]	[-0.65948]
D(LEXP(-1))	0.009602	-0.25235	-0.21386
	0.177387	0.257536	0.148466
	[0.05413]	[-0.97988]	[-1.44049]
C	0.066418	0.06428	0.002799
	0.02914	0.042307	0.024389
	[2.27926]	[1.51938]	[0.11477]

When cointegration is present, the Vector Error Correction Model (VECM) examines the short- and long-term correlations between the variables (Revenue (LREV), Oil Revenue (LORV), and Export (LEXP). The model distinguishes between short-term dynamics (Error Correction and differenced variables) and long-term equilibrium relationships (Cointegrating Equation). With matching t-Stats of -30.2226 and 4.39911, Table 4 above showed an oil income and export rate coefficient of 0.88845 and -0.60397, respectively. It suggests that negative multiplier effects extend from oil revenue to revenue generation over an extended period of time. The positive multiplier effects, on the other hand, extend from revenue generation to the exchange rate. Additionally, revenue generation increased by 88% for every 1% increase in oil prices. In contrast, a 1 unit increase in the export rate would result in a cause a decrease in revenue generations of 60 percent.

On the other hand, the table 4 reveals the adjustment parameter of -0.40358 with the t-statistic value of -3.15101. It implies two fundamental relationships: first, long-run causality or influence runs from oil revenue and export rate to revenue generation. Secondly, 40.35 percent of disequilibrium is being corrected within a year. It suggests that 40.35 percent of imbalance in economic development is fixed and adjusted when oil revenue and export rate jointly change by one percent. The coefficient of oil revenue at present value is negative and at lag 1. It affirms that both current and previous oil benefits have a negative short-run dynamic influence on revenue generation. It is arguably in conformity with the proposition that economic development does not improve as a result of abundant resources in the economy as specified by the theory of resource cause. Also, the result shows that the coefficients of the export rate at current value and lag 1 are negative. It confirms that the export rate at present value and previous value have positive but insignificantly effect on revenue generation.

Table 5: VEC Residual Serial Correlation LM Tests

VEC Residual Serial Correlation LM Tests						
Null hypothesis: No serial correlation at lag h						
Lag	LRE* stat	Df	Prob.	Rao F-stat	Df	Prob.
1	20.13203	9	0.217115	2.393591	(9, 95.1)	0.517226
2	14.68449	9	0.099975	1.696941	(9, 95.1)	0.100314
Null hypothesis: No serial correlation at lags 1 to h						
Lag	LRE* stat	Df	Prob.	Rao F-stat	Df	Prob.
1	20.13203	9	0.117115	2.393591	(9, 95.1)	0.117226
2	24.03055	18	0.154029	1.383431	(18, 102.3)	0.155929

The VEC Residual Serial Correlation LM Test checks whether there is serial correlation (autocorrelation) in the residuals of the Vector Error Correction Model (VECM). The null hypothesis of the test is "No serial correlation at lag *h*. At Lag 1. LRE Stat* 20.13203, with = 0.217115. The p-value is greater than 0.05, so we fail to reject the null hypothesis, meaning no significant serial correlation in the residuals at lag 1 Rao F-stat, 2.393591 2.393591, with = 0.517226 p=0.517226. Similarly, the p-value is greater than 0.05, confirming no evidence of serial correlation at lag 1 based on this alternative test.

Alternative Hypothesis (H_1): The residuals are not normally distributed.

The normality test checks whether the residuals of the model follow a normal distribution. Residuals for Component 1 and Component 3 are normally distributed, as indicated by their high p-values. Residuals for Component 2 are not normally distributed, as shown by the extremely low p-value. The joint test for all components shows that the residuals for the entire system are not normally distributed (p-value < 0.05).

Table 6: Normality Test

Component	Jarque-Bera	Df	Prob.
1	0.013559	2	0.993243
2	660.7992	2	3.23E-144
3	0.366774	2	0.832446
Joint	661.1796	6	1.47E-139

Null Hypothesis (H_0): The residuals are normally distributed.

CONCLUSION

The study analyzed the impact of oil revenues on revenue generation in Nigeria from 1970 to 2023. It applied the Augmented Dickey-Fuller unit root test, the Johansen Multivariate co-integration test, the Long Run Multiplier Effects, Short Run Dynamic Relationship, vector residual serial correlations, heteroscedasticity, and

Bima Journal of Science and Technology, Vol. 9(1A) Mar, 2025 ISSN: 2536-6041
DOI: 10.56892/bima.v9i1A.1234

normality in the correction model to evaluate for errors. The time-series data on the oil, export rates, and revenue generated were subjected to similar analytical processes. Dependence on oil revenues leads to increasing revenue in Nigeria. However, the export rate provides negative and statistically significant sign for revenue generation in Nigeria, which means that export rate does not significantly contribute to economic development in Nigeria during the study period. Given the significant role oil revenue in revenue generation, the study recommended that the government should invest in data analytics and forecasting tools to monitor global market trends and proactively adjust policies to maximize revenue.

REFERENCES

Adefolake, A. O., & Omodero, C. O. (2022). Tax revenue and economic growth in Nigeria. Cogent Business and Management, 9(1), 1-19.

Adugbo, D. (2016), Nigeria: Oil Price Fall - How the Mighty Are Crawling. Daily Trust. Available from: https://www.scirp.org/ reference/referencespapers?referenceid=3041688

Akinleye, S.O., Ekpo, S. (2013), Oil Price Shocks and Macroeconomic Performance in Nigeria. Economiamexicana, 2, 565-624.

Akinleye, S.O., Ekpo, S. (2013), Oil Price Shocks and Macroeconomic Performance in Nigeria. Economiamexicana, 2, 565-624.

Akinlo, A.E. (2012), How important is oil in Nigeria's economic growth? Journal of Sustainable Development, 5(4), 165-179.

Budina, N., Van Wijnbergen, S. (2008), Managing oil revenue volatility in Nigeria: The role of fiscal policy. In: Africa at a Turning Point? Growth, Aid and External Shocks. Washington, DC: World Bank. p427-459

Chima, O. (2017). Focus on Nigeria's Non-oil revenue potentials. Internet Retrieved, May 1, 2019.

Ejinkonye, R. C., Mazeli, E. N., Adiga, D. L., & Nwosu, S. N (2024). Effect of Federal Government Revenue on Economic Growth in Nigeria: 1981–2022.

Habte, Z. (2014). Market integration for oxen prices using vector error correction model (vecm) in Ethiopia. *International Journal of Technology Enhancements and Emerging Engineering Research*, *2*, 6-9.

Johansen, S., & Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration—with appucations to the demand for money. *Oxford Bulletin of Economics and statistics*, *52*(2), 169-210.

Nakah, M.B., Park, I., & Ogaba, L.J. (2018). The impact of non-oil revenue on economic growth on Nigeria: Internal Journal of Advance Research in Accounting, Economics and Business Perspectives, 2(1), 1-14.

Odularu, G. O. (2008). Crude oil and the Nigerian economic performance. World Trade Organization

Olusegun, J. O. (2023). Impact of government revenue and expenditure on economic growth in Nigeria. Researcg Gate, doi:10.13140/RG.2.2.34497.94565.

Rotimi, C. O., John, N., Rotimi, M. E., & Doorasamy, M. (2021). Assessment of the impact of government revenue mobilization on economic growth in Nigeria. Journal of Economics, Business and Accountancy Ventura, 24(2), 310-325. Doi:10.14414/jebav.v24i2.2716.

Udoh, M.D. (2014), The impact of foreign direct investment and oil exports on economic growth in Nigeria. Research on Humanities and Social Sciences, 4(24), 1-10.

Ujunwa, A. (2015), Macroeconomic Effects of Exogenous Oil Price Shock in Nigeria: Persistent or Transitory. Nigeria: Department Banking and Finance, University of Nigeria, Enugu Campus.