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Impact of Nigerian Petroleum Oil Production on Nigerian Economy: Cointegration and Error Correction Model Analysis

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This study was done to investigate the effect of Nigerian crude oil production against Nigerian economy.Johansen's co-integration concept is employed on thirty-three years (1981-2013) data about annual Gross national income, petroleum production along with petroleum oil exchange. Augumented Dickey-fuller (ADF) test was carried out in level as well as first difference of every sequence. ADF test indicated existence of unit root at the level otherwise at first difference the series were stationary. The trace and eigenvalues of Johansen co-integration indicated single co-integrating equation in the system, hence presence of long-term relationship between the variable. However, since the series are co-integrated, vector-error-correction-model was applied to estimate

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the long-term coefficient.Crude oil production has a negative coefficient and significant, while crude oil export is significant in predicting difference in Gross national income on the long-term. Contrary to the long-term result there was no short-run causation between Gross national income, petroleum oil production and crude oil exportation in Nigeria.The revealed result of the study attracted recommendation that export of the product should be given keen attention and proper management, that will bring development of other sectors through the income from crude oil exportation which will bring about great growth in economy.

Keywords: Economy; petroleum; production; co-integration; gross domestic product (GDP); export unit root test; stationary; trace; eigen values.

1. INTRODUCTION

Oil is the main source of power in Nigeria and the globe at large. Oil play major role in determining the commercial as well as political fate of Nigeria. Notwithstanding, Nigerian crude oill industry was established from inception of the century, it was inactive till the completion of Nigerian insurrection (1967-1970) before the oil industry commence to take important function in commercial life of Nigeria [1,2].

Nigeria may be classified as nation which is basically provincial that rely upon main production exports (particularly crude oil produce) after the realization of freedom by 1960 it had background of tribal, religious as well as aboregional pressure, enlarged by the significance difference by economic, educational as well as ecological evolution in the North and the South. These can be partially accredited into great exploration of crude oil in the country which impacts and is impacted by economic along social units. Petroleum oil discovery contributed to the development of Nigerian economy both favourably and unfavorably, on the unfavorable part, it can be weighed in terms of degradation of host community, where oil is exploited.Most of these communities bear ecological degradation that lead to reduction of ways of live hood as well as other economic and social factors. Though, broad earnings are garnered from the national and international sales of crude oil products has consequence on the improvement of the Nigerian economy in respects to gains and productivity is still a question to answer. Hence, the demand to analyze the similar impact of petroleum oil on the economy. The major objective of this study is to analyze the significance of petroleum oil production against Nigerian economy. Given the reality that the sector is highly important area in Nigerian economy there is serious demand for a proper and useful production as well as export strategy for the sector. Although, crude oil has contributed immensely used in cognizance of the fact that surplus earning made out of the oil sector can be invested in them to multiply and also improved the overall Gross domestic product of the economy.The initial trial to explore oil started in the decade, this began with exploration activities under German Bitumen co-operation. They were certified and were liable for exploring Bitumen discovered in some parts of the country.The period before Independence from 1914 to 1960 was identified by colonial entrepreneurship for lawful economic activities which were implied to replace the oppression and earlier era of nineteen centuries [3-5].

Notwithstanding, after independence period witness various exploration activities in crude oil exploration. On securing her independence, the oil market in Nigeria was wide open to accomodate countries other than Britain and United States of America (USA) to take in crude oil exploration activities with the emergence of about nine International companies running in Nigeria. These are Shell BP which was granted licensesin1973.Texaco/Mobil/Tennessee Nigeria incorporated (TENNECO), Gulf oil, SAFRAB (ELF) Nigeria Agip oil company (NAOC), Philips petroleum and Esso exploration. Other companies like Japan petroleum, Union oil American occidental were satisfactory explorers. This is due to the fact that these have been studied on developing oil-exporting countries" [6-9].

Furthermore, research on organization of petroleum exporting countries also constrained, these study due to their important to this research work in Nigeria, will consquently need to be examined. Doing so will bring forth the time position of the impact to petroleum Industry on the Nigerian economy as it has been identified by different researchers either generally or relating specifically to Nigeria.

2. MATERIALS AND METHODS

This study is limited to the period of 1981 – 2013 of the annual data collected from Nigeria

National Petroleum Cooperation (NNPC) and Central Bank of Nigeria (CBN).

2.1 Time Series Analysis

Time series analysis is a numerical methodology used to evaluate behavioral ways in data gathered over time. It is used to ascertain nature of change in statistical information over periodic intervals of time. These patterns are used to arrive at prediction for the future.

Thus, time series analysis assists to confront doubts about the future.

2.2 Jarque-Bera (JB) Test of Normality

Jarque-Bera test of normality is an approximation and exact test or large-sample test. It is principally based on OLS residuals. The test evaluate the measure of asymmetry and measures of taildness of the distribution of ordinary least square residuals. The following statistic is applicable:

$$JB = n\left(\frac{S^2}{6} + \frac{(k-3)}{24}\right) \quad (1)$$

Where n=size of the sample

S= Coefficient of skewness and
K=Kurtosis coefficient.

Under normally distributed variables, S=0 and K=3. Hence, the JB test of normality is a test of the jointly hypothesis that S and K are zero (0) and three (3) in that order. In this situation the value of the JB statistic is expected to be zero (0).

Under the null hypothesis that the residuals are normally distributed, Jarque-Bera showed that asymptotically (i.e when the samples large) the JB statistic follows the chi-square distribution with 2 degree of freedom. If the computed p-value of the JB statistic in an application is sufficiently low, which will happen, if the value of the statistic is very different from 0, one can reject the hypothesis that the residuals are normally distributed. But, if the p-value is reasonably high, which will happen if the value of the statistic is close to zero, we don't reject the normality assumption.

2.3 Tests for Stationary

In time series analysis, it is first assume that the series are stationary. When stationary exist in time series it implies that the series are normally distributed with it's mean and variance been constant over a long time period. Before appropriate time series model can be used for forecasting and control measure, it is essential to check its suitability in different ways. The ultimate famous distinct methods are based on analysis of the residual. In this case, the residuals should be a white noise process if the model is sufficient. A times this can be analyzed from the graph of the residual. In this study we measured the unit root test due to the significance devoted to it.

2.4 The Augmented Dickey-Fuller (ADF) Test for Unit Root

As the error term may not be white noise, Dickey and Fuller expand their test procedure intimating an augmented form of the test which involves additional lagged terms of the dependent variable to enable elimination of autocorrelation. The lag length on these additional terms can either determined by the Akaike Information Criterion (AIC) or Schwart Information Criterion (SIC), or more usefully by the lag length necessary to whiten the residuals.

The three possible forms of the Augumented Dickey-Fuller test are given by the following equations:

$$\Delta y_t = \alpha y_{t-1} + \sum_{i-1}^{p} \beta_i \Delta y_{t-i} + u_t \quad (2)$$

$$\Delta y_t = \alpha_0 + \alpha y_{t-1} + \sum_{i-1}^{p} \beta_i \Delta y_{t-i} + u_t \quad (3)$$

$$\Delta y_t = \alpha_0 + \alpha y_{t-1} + a_2 t + \sum_{i-1}^{p} \beta_i \Delta y_{t-i} + u_t \quad (4)$$

The difference between the three regressions concerns the presence of the deterministic elements α_0 and $a_2 t$.

2.5 Johansen Co-integration Test

The multivariate maximum likelihood co-integration testing procedure was developed by Johansen and Stock and Watson (1988) and Johansen and Juselius.

There are two basic test statistics involved in Johansen and Juseliuss maximum likelihood test. The first test statistic is the trace test while the second is the maximal eigenvalue test. The Johansen co-integration test is full information maximum likelihood approach; it is based on the following vector autoregressive (VAR) model of order p:

$$Y_t = A_1 Y_{t-1} + --- + A_p Y_{t-p} + BX_{t+e_t} \quad (5)$$

Where Yt is a k — vector of non — stationary I(1) variables; Xt is a d-vector of deterministic variables; and et is a vector of innovations. One can rewrite this VAR as follows:

$$\Delta Y_t = \Pi Y_{t-1} + \sum_{i-1}^{p-1} \Gamma_t \Delta Y_{t-i} + BX_t + e_t \quad (6)$$

Where: $\Pi = \sum_{i-1}^{p} A_i - I, \Gamma_i = -\sum_{j=i+1}^{p} A_j$ (7)

The Grangers representation theorem asserts that if the coefficient matrix Π has reduced rank r<k, then there exists $k \times r$ matrices α and β, each with rank r such that $\Pi = \alpha\beta'$ and $\beta' Y_t$ is I(0); r is the number of co-integrating relations (i.e the rank) and each column β
is the co-integrating vector. The elements of α are known as the adjustment parameters in the vector error correction model. The Johansen's approach is to estimate the Π matrix from an unrestricted VAR and to test whether we can reject the restrictions implied by the reduced rank of Π.

2.6 Vector Error Correction Model

A vector error correction (VEC) model is a restricted VAR designed for use with non-stationary series that are known to be co-integrated. One may test for co-integration using an estimated VAR object, Equation object estimated using non-stationary regression methods, or using a Group.

The VEC has co-integration relations built into the specification so that it restricts the long-run behavior of the endogenous variables to converge to their co-integrating relationships while allowing for short-run adjustment dynamics. The co-integration term is known as the error correction term since the deviation from long-run equilibrium is corrected gradually through a series of partial short-run adjustments.
To take the simplest possible example, consider a two variable system with one co-integrating equation and no lagged difference terms. The co-integrating equation is:

$$y_{2,t} = \beta y_{1,t} \quad (8)$$

The corresponding VEC model is:

$$\Delta y_{1,t} = \alpha_1 (y_{2,t-1} - \beta y_{1,t-1}) + \varepsilon_{1,t} \quad (9)$$

$$\Delta y_{2,t} = \alpha_2 (y_{2,t-1} - \beta y_{1,t-1}) + \varepsilon_{2,t} \quad (10)$$

In this simple model, the only right-hand side variable is the error correction term. In long run equilibrium, this term is zero. However, if y_1 and y_2 deviate from the long run equilibrium, the error correction term will be nonzero and each variable adjusts to partially restore the equilibrium relation. The coefficient α_i measures the speed of adjustment of the i-th endogenous variable towards the equilibrium.

2.7 Granger Causality Test

When time series is stationary, the test is carried out using the level values of two or more variables. If the variables are non-stationary, then the test is done using first (or higher) differences. Information criterion usually adopted for when chosen number of lags, such as the Akaike information criterion or the Schwarz information criterion. Any peculiar lagged value of one of the variables is withhold in the regression if (1) it is significant accordance with t-test, and (2), the other lagged values of the variable collectively add explanatory power to the model according to an Fisher exact test. Then the null hypothesis of no Granger causality is not rejected if and only if no lagged values of an explanatory variable have been retained in the regression.

2.8 Mathematical Statement of Granger Causality

Let Y and X be stationary time series. To test the null hypothesis that x does not Granger-cause Y, one first find the proper lagged values of Y to include in a univariate auto regression of Y:

$$y_t = a_0 + a_1 y_{t-1} + a_1 y_{t-2} + \dots\dots + a_m y_{t-m} + \varepsilon_t \quad (11)$$

Next, the auto regression is augmented by including lagged values of x:

$$y_t = a_o + a_1 y_{t-1} + a_2 y_{t-2} + \dots + a_m y_{t-m} + b_1 x_{t-1} + \dots + b_q x_{t-q} + \varepsilon_t \quad (12)$$

One retains in this regression all lagged values of x that are individually significant according to their t-statistics, provided that collectively they add explanatory power to the regression according to an F-test. In the notation of the above augmented regression, p is the shortest, and q is the longest, lag length for which the lagged value of x is significant.

The null hypothesis that x does not Granger-cause y is accepted if and only if no lagged values of x are retained in the regression.

3. RESULTS AND DISCUSSION

This chapter is centered on the analysis of data. The time plots, descriptive statistics, test of normality and all other analysis used in this work were done with computer using Eviews 7.2 Econometric package.

3.1 Time Plot

The time plot at level and for the first difference from 1981-2013 (i.e. 33 years)

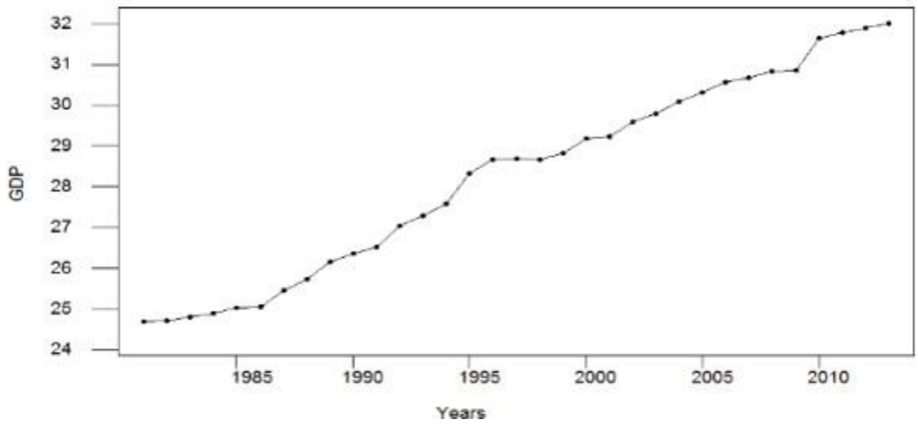

Fig. 1. Time plot of Gross Domestic Product (GDP) at level for Nigeria from 1981 to 2013

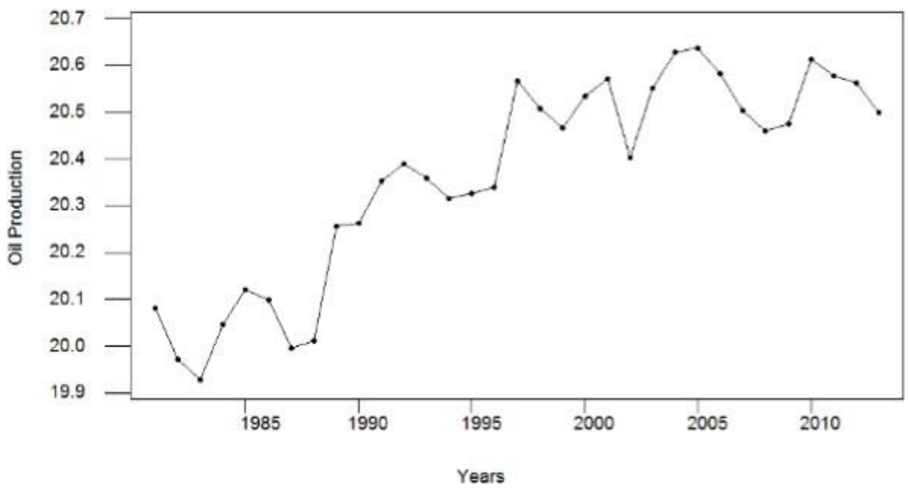

Fig. 2. Time plot of total oil production at level for Nigeria from 1981 to 2013

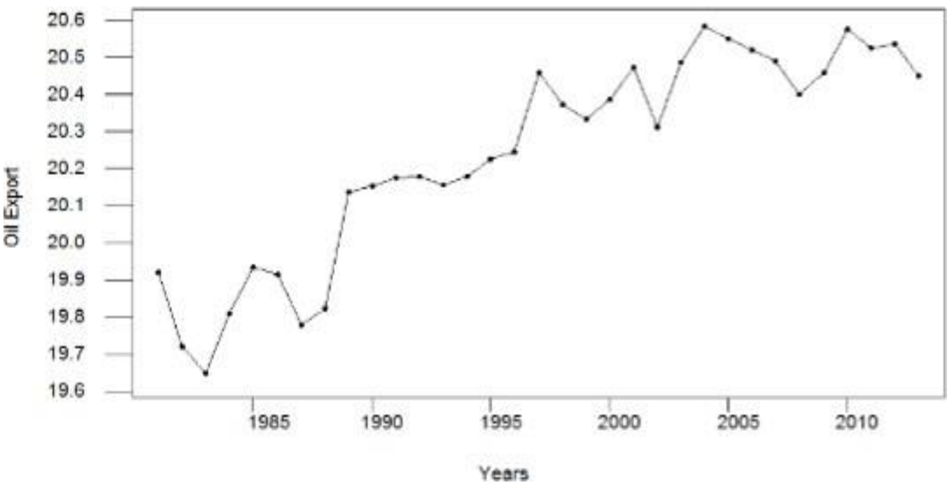

Fig. 3. Time plot of total oil export at level for Nigeria from 1981 to 2013

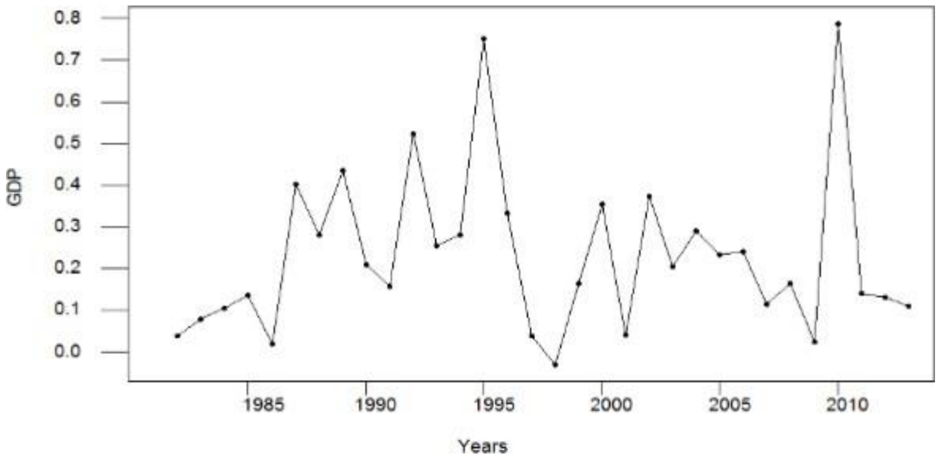

Fig. 4. Time plot of gross domestic product (GDP) at first difference for Nigeria from 1981 to 2013

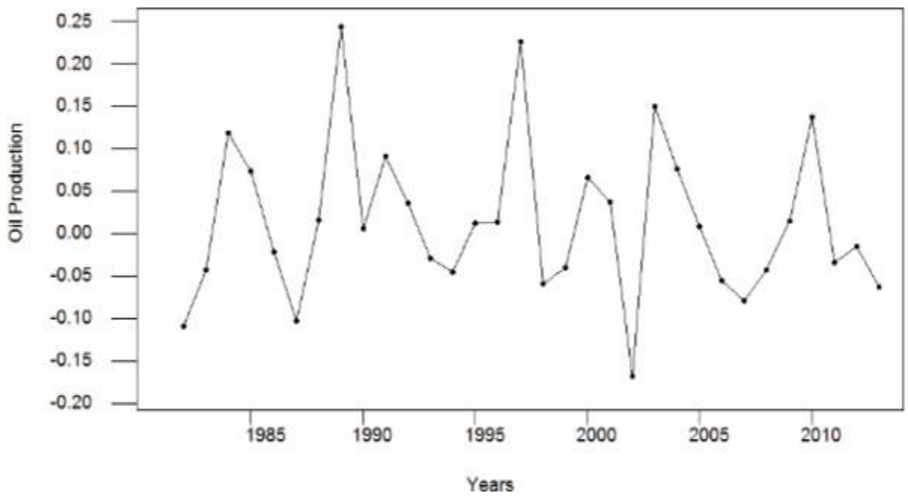

Fig. 5. Time plot of total oil production at level for Nigeria from 1981 to 2013

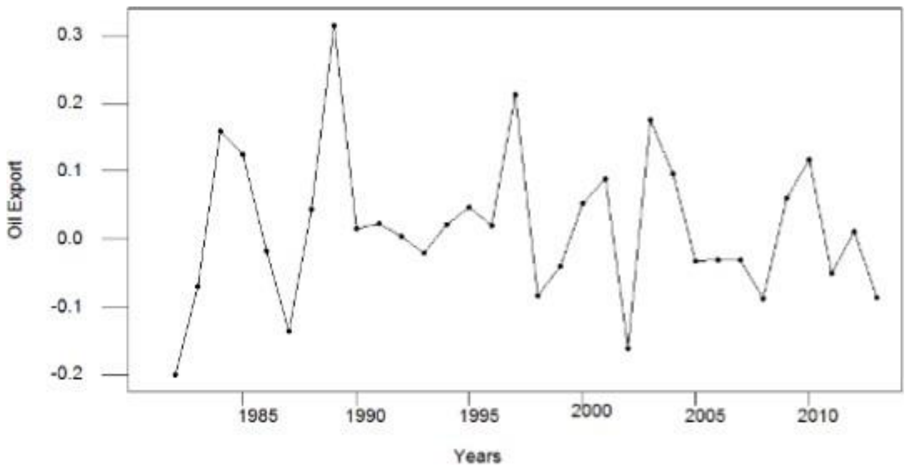

Fig. 6. Time plot of total oil export at first difference for Nigeria from 1981 to 2013

From Figs. 1, 2, and 3, it can be observed from their time plot that the series are trended indicating no stationarity at level of Gross Domestic Product (GDP), oil export and oil production in Nigeria. However, Figs. 4, 5 and 6 indicate a pattern that can be fitted; hence the series are stationary at first difference [10-12].

3.2 Descriptive Statistics and Test of Normality

In testing for normality, Jarque—Bera test for the time series data is employed.

The hypothesis to be tested is: Ho: JB=0 (normally distributed)
H1: JB $\neq 0$ (not normally distributed)

$\alpha = 0.05$

Test statistic=JB where JB is Jarque-Bera test
Critical region: Reject H0 if p-value $< \alpha$ value of 0.05 p-value$< \alpha$ valueof 0.1

The descriptive statistics reveal that during the period under study, the Gross domestic product had the highest mean and standard deviation; this implies that GDP is the most erratic among the variables under study. In the case of normality test, It can be observed that the Jarque-Bera test indicated the retention of Ho, hence the time series observations are normally distributed at 5% level of significance [13,14].

3.3 Unit Root Test Results

In order to perform Johansen co-integration test, the series have to be tested for stationarity. To investigate whether a series is stationary or not, unit root test of Augmented Dickey-Fuller (ADF) is conducted with levels and first differences of each series on the condition that the null hypothesis is non-stationary, so rejection of the unit root hypothesis supports stationarity [15-17].

The hypothesis to be tested is:

Ho: $\gamma = 0$ (unit root is not present) H1: $\gamma \neq 0$ (unit root is present)

Table 1. Results of descriptive statistic and test of normality

	GDP	PROD	EXPORT
Mean	28.27005	20.36380	20.24059
Median	28.66648	20.40287	20.31278
Maximum	32.02559	20.63877	20.58548
Minimum	24.66934	19.92692	19.64845
Std. Dev.	2.427058	0.218835	0.280427
Skewness	-0.086799	-0.618627	-0.624807
Kurtosis	1.697128	2.079433	2.163027
Jarque-Ber a	2.375465	3.270079	3.110330
Probability	0.304912	0.194945	0.211155

Table 2. Results of augmented dickey-fuller test at level and first difference

Observation	At Level	5% Mickinnon critical Value	P-Value	1st Difference	5% Mickinnon critical Value	P- Value
GDP	6.03E-05	-2.95711	0.9518	-5.513917	-2.96041	0.0001
Oil production	-1.266792	-2.95711	0.6326	-5.922493	-2.96041	0.0001
Oil export	-1.478413	-2.95711	0.5315	-5.787184	-2.96041	0.0001

Table 3. Optimum lag selection based on schwarz information criterion

Lag Length	GDP	Oil Production	Oil Export	System Equaton
1	-0.0472	-1.7143	-1.4405	-5.6612
2	0.1620	-1.4880	-1.3246	-5.3252
3	0.2827	-1.3211	-1.2205	-4.7752
4	0.5441	-0.9836	-0.9394	-3.9410
5	0.7154	-0.0577	-0.6052	-3.2442
6	0.6177	-0.4962	-0.5359	-3.6444

Table 4. Trace and max-eigen co-integration test for gross domestic product (GDP), oil production, and oil export (1981-2013)

Number of cointegrating vectors	Trace Test			Maximum Eigenvalue Test		
	Statistic	Critical-Value (5%)	P-Value	Statistic	Critical-Value (5%)	P-Value
R=0	63.61409	47.5613	0.0009	38.51065	27.58434	0.0014
R<=1	25.10344	29.79707	0.1578	17.90964	21.13162	0.1333
R<=2	7.193792	15.49471	0.5552	6.595283	14.26460	0.5381
R<=3	0.598509	3.847466	0.4391	0.598509	3.841466	0.4391

$\alpha = 0.05$

Test statistic= ADF test statistic

Critical region: Reject H0 if, ADF test statistic > Mickinnon critical value for rejection of hypothesis of a unit root at 5% significance level.

The result of Augmented Dickey-Fuller test of Table 2 indicates that at 5% significant level of Mickinnon critical test the variables considered are not stationary at level but they all become stationary after 1st difference.

3.4 Johansen Co-integration Test

After conforming that Gross Domestic Product (GDP), oil production and oil export observation were stationary at first order or I(1), then the next step is to estimate the Vector Error Correction Model (VECM). Firstly, we need to select an optimum lag of VECM model before performing the Johansen co-integration test.

Optimum lag selection based on the Schwarz Information Criterion on Table 3 above indicate lag 1 as lag length appropriate for the system of equations, therefore, Johansen co-integration test can be perform using lag of 1.

$$\Delta Y_t = \theta_1 (Y + \alpha_0 + \alpha_2 P + \alpha_3 X) + \alpha_4 \Delta Y)_{t-1} + \gamma(\Delta y + \Delta P + \Delta X + \varepsilon)_{t-1}$$

Table 5. Estimated long-run coefficient

Co-integrating Eq:	**Co-integrating Eq1**
GDP (-1)	1.000000
PROD (-1)	28.00619
	(4.89738)
	[5.71861]
EXPORT (-1)	-30.37707
	(3.81869)
	[-7.95483]
C	16.24712

$$Y_{t-1} = -16.24712 - 28.00619\ P_{t-1} + 30.37707\ X_{t-1}$$

S.E *(4.89738) (3.81869)*

t-statistic *(5.71861) (-7.95483)*

Table 6. Results of the VEC granger causality/block erogeneity wald tests

Dependent variable: D(GDP)			
Excluded	**Chi-sq**	**Df**	**Prob.**
D(PROD)	2.299066	1	0.1295
D(EXPORT)	1.623744	1	0.2026
All	2.471126	2	0.2907
Dependent variable: D(PROD)			
Excluded	**Chi-sq**	**Df**	**Prob.**
D(GDP)	0.543835	1	0.4608
D(EXPORT)	0.202968	1	0.6523
All	0.778629	2	0.6775
Dependent variable: D(EXPORT)			
Excluded	**Chi-sq**	**Df**	**Prob.**
D(GDP)	0.811143	1	0.3678
D(PROD)	1.583052	1	0.2083
All	2.352839	2	0.3084

The Johansen's co-integration test based on two tests, the first is the trace test, while the second is the maximal eigenvalue test. In determine the number of co-integrating vectors a segmental procedure is adopted.

1. First and foremost, test Ho (ro=o) against H_1(ro>o). If the null hypothesis is not rejected, then it is concluded that there are no co integrating vectors among the n variables in Yt.
2. If Ho (ro=o) is rejected, then it is concluded that there is at least one co integrating vector and proceed to test Ho(ro=1) against Hi (ro>1). If the null hypothesis is not rejected, then it's concluded that there is at least two co integrating vectors.

The co-integration test on the Table 4 indicates the rejection of none co-integration at 5% significant level for both trace and eigenvalue test but indicates a co-integrating equation.

3.5 Vector Error Correction Model

Having established that there is one co-integrating equation in the system, the vector error correction model and long-run coefficient can be estimated

Where Y_t = Gross Domestic product (GDP), P_t = crude oil production (PROD) and X_t = crude oil export (EXPORT) respectively.

The values of the long run result using vector error correction model indicated that crude oil production has negative coefficient and also significant at 5% on economic growth, while crude oil export is significant in predicting economic growth [18,19].

3.5.1 Granger causality test

The granger causality test approach used to estimate the coefficient of the short-run dynamic of the variable.

The result of short-run granger causality of the vector error correction model indicate none causation between the variables under considerations. As it can be observed, oil production and GDP are independent (that is, they cannot cause each other) likewise, export to GDP and finally production to export.

4. CONCLUSION

This study examined the impact of Nigeria petroleum oil production on Nigeria economy that covers a period from 1981 to 2013.To evaluate the impact of petroleum oil production on gross domestic product.

Jarque-Bera test for normality showed that the variables involved were normally distributed. Augmented Dickey Fuller test results shows that the time series variables incorporated in the study exhibit increasing consistent trend over the period, and they do not reject the null hypothesis of non-stationary in the levels. The null hypothesis at first difference is rejected and revealed that all the variables became stationary. Having confirmed the stationary status of the time series employed with the aim of determine level of integration by using the unit root test, the study proceeded by using Johansen's method of co integrating and the variables are co integrated and hence there exist a long run of relationship between them.

5. RECOMMENDATION

1. Based on the findings of this research work, it is inevitable to provide a set of policy recommendation that would be applicable to the Nigerian economy.
2. The Nigeria national petroleum corporation (NNPC) should diversity its export through downstream production this will enhance the refined petroleum for exports.
3. The government should encourage more company participation so that better equipped refineries can be built.
4. Security should be boosted on the high sea where crude oil products are being smuggled.
5. Government should give attention to non-oil sector to boost the economy.
6. Government should fight corruption by establishing institutions that will arrested prosecute public office holders. There is urgent need for Nigeria to diversity there export market especially the oil market.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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