IMPACT OF NIGERIAN PETROLEUM OIL PRODUCTION ON NIGERIAN ECONOMY USINGCOINTEGRATION AND ERROR CORRECTION MODEL

ABSTRACT

In this study titled, "impact of Nigerian petroleum oil production on Nigeria economy using co-integration and error correction technique" was carried out to investigate the impact of Nigerian petroleum oil production on Nigerian economy. The concept of Johansen's co-integration is employed on thirty-three years (1981-2013) data on annual Gross domestic product, petroleum oil production and petroleum oil export. Unit root test of Dickey-fuller (ADF) was conducted in the level and first difference of each series. ADF test indicated the presence of unit root at the level but at first difference the series were stationary. The trace and eigenvalues of Johansen co-integration indicated one co-integrating equation in the system, hence existence of long-run relationship between the variable. However, since the series are co-integrated, vector error correction model was applied to estimate the long-run coefficient. Crude oil production has a negative coefficient and significant, while crude oil exported is significant in predicting changes in GDP on the long-run. Contrary to the long-run result there was no short-run causation between Gross Domestic Product, crude oil production and crude oil exportation in Nigeria. Based on the findings of this study, it was recommended that export of the product should be give 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

The major source of energy in Nigeria and world in general is oil. Oil play a major role in shaping the economic and political destiny of the country. Although Nigerian oil industry was established at the inception of the century, it was not until the end of the Nigerian civil war (1967-

1970) that the oil industry began to play important role in economic life of the country.

Nigerian can be classified as a country that is basically rural, which depends on primary product exports (especially oil products) since the realization of independence in 1960 it has experienced ethnic, religious and regional tensions, enlarged by the significance disparities in economic, educational and environmental development in the North and the South. These could be partially accredited to great discovery of oil in the country which affects and is affected by economic and social units. Crude oil discovery has had certain impacts on the Nigerian economy both positively and adversely on the negative side, this can be considered with respect to the surrounding communities within which the oil is exploited. Some of these communities still suffer environmental degradation which leads to deprivation of means of live hood and other economic and social factors. Although large proceeds are obtained from the domestic sales and export of petroleum products has effect on the growth of the Nigerian economy as regards to returns and productivity is still questionable. Hence the need to assess the relative impact of crude oil on the economy. In the light of this study the main objective is to assess the impact of petroleum oil production on Nigerian economy. Given the fact that the sector is a very important sector in Nigerian economy there is serious need for an appropriate and useful production and export policy for the sector. In Nigeria, though crude oil has contributed largely used in considering the fact that excess revenue made from oil sector can be invested in them to diversify and also increased the total GDP of the economy. The first attempt to explore oil began in the decade, this started with exploration activities by German Bitumen co-operation. They were licensed and were responsible for exploring Bitumen found in some parts of the country. The pre-independence era between 1914 to 1960 was identified by colonial entrepreneurship for legitimate commercial activities which were meant to replace the oppression and early period of nineteen centuries.

However, the post-independence era saw different exploration activities in petroleum exploration. On securing her independence, the oil market in Nigeria was wide open to accommodate countries other than Britain and United States of America to participate in petroleum exploration activities with the emergence of about nine International companies operating in Nigeria. These are Shell BP which was granted licenses in 1973. 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 successful explorers. This is because these have been studied on developing oil-exporting countries”.

Moreover, studies on OPEC countries also abound, these studies due to their significance to this research work in Nigeria, will therefore need to be considered. Doing so will bring forth the time position of the impact to petroleum Industry on the Nigerian economy as it has been highlighted by various researchers either generally or relating specifically to Nigeria.

2. Material 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 quantitative method used to determine patterns in data collected over time. It is used to detect patterns of change in statistical information overregular intervals of time. These patterns are used to arrive at estimates for the future.
Thus, time series analysis helps to cope with uncertainty about the future.

2.2 DEFINATION OF TERMS

Dependence: in time series, dependence refers to the correlation of two observations of the same variable, at prior time points.

Stationarity: in time series analysis, stationarity shows the mean value of the series remains constant over a time period.

Differencing: in time series analysis, differencing is used to make the series stationary, to De-trend, and to control the autocorrelations.

Specification: in time series analysis, specification may involve the testing of the linear or non-linear relationships of dependent variables by using models such as ARIMA,ARCH.GARCH,VAR, Co-integration, etc.

Assumptions in Time Series Analysis:

Stationary: in time series analysis, the first assumption is that the series are stationary.This means that the series are normally distributed and the mean and variance are constant over a long time period.

Uncorrelated random error: in time series analysis, we assume that the error term is randomly distributed and the mean and variance are constant over a time period. TheDurbin Watson test is the standard test for correlated errors.

No outliers: in time series analysis, we assume that there is no outlier in the series.Outliers may affect conclusions strongly and can be misleading.

Random shocks: if shocks are present in the time series analysis, they are assumed to be randomly distributed with a mean of 0 and a constant variance.

2.3 Jarque-Bera (JB) Test of Normality

The JB test of normality is an asymptotic or large-sample test. It is also based on the ordinary least square residuals. This test computes the skewness and kurtosis measures of the ordinary least square residuals and uses the following statistic:

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

Where n=sample size
S=Skewness coefficient and
K=Kurtosis coefficient.

For a normally distributed variables, S=0 and K=3. Therefore, the JB test of normality is atest of the jointly hypothesis that S and K are 0 and 3 respectively. In that case the value of the JB statistic is expected to be 0.

Under the null hypothesis that the residuals are normally distributed, Jarque and Bera showed that asymptotically (i.e in large samples) 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 do not reject the normality assumption.

2.4 Tests for Stationary

In time series analysis, the first assumption is that the series are stationary. This means that the series are normally distributed and the mean and variance are constant over a long time period. Before a fitted time, series model could be used for forecasting and control purpose, it is necessary we check its adequacy in diverse ways. The most popular diagnostic methods are based on analysis of the residual. In this sense, the residuals must be a white noise process if the model is adequate. This sometime can be studied from the graph of the residual. in this study project we considered the unit root test because of the importance attached to it.

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

As the error term is unlikely to be white noise, Dickey and Fuller extended their test procedure suggesting an augmented version of the test which includes extra lagged terms of the dependent variable in order to eliminate autocorrelation. The lag length onthese extra terms is 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 ADF test are given by the following equations:

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

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

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

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

2.6 Johansen Cointegration Test

The multivariate maximum likelihood co-integration testing procedure was developed by Johansen (1998) and Stock and Watson (1988) and Johansen and Juselius (1990).

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 oforder p:

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

Where Y_t is a k — vector of non — stationary I(1) variables; X_t is a d-vector of deterministic variables; and e_t is a vector of innovations. One can rewrite this VAR asfollows:

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

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 βis 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.

2.7 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-integrationusing 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:

$$y_{2,t} = \beta y_{1,t} \tag{8}$$

The corresponding VEC model is:

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

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

In this simple model, the only right-hand side variable is the error correction term. In longrun 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.

2.8 Granger Causality Test

If a time series is stationary, the test is performed 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. The number of lags to be included is usually chosen using an information criterion, such as the Akaike information criterion or the Schwarz information criterion. Any particular lagged value of one of the variables is retained in the regression if (1) it is significant according to a t-test, and (2), the other lagged values of the variable jointly add explanatory power to the model according to an F-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.

In practice it may be found that neither variable Granger-causes the other, or that each ofthe two variables Granger-causes the other.

A method for Granger causality has been developed that is not sensitive to deviations from the assumption that the error term is normally distributed (Hacker R.S, and Hatemi-J A. 2006). This method is especially useful in financial economics since many financial variables are non-normally distributed (Mandelbrot, Benoit, 1963). Recently, asymmetric causality testing has been suggested in the literature in order to separate the causal impact of positive changes from the negative ones (Hatemi-J A. 2012)

2.9 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 finds the proper lagged values of y to include in a univariate auto regression of y:

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

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

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

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 (whose null hypothesis is no explanatory power jointly added by the x's). 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. STATISTICAL ANALYSIS

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)

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

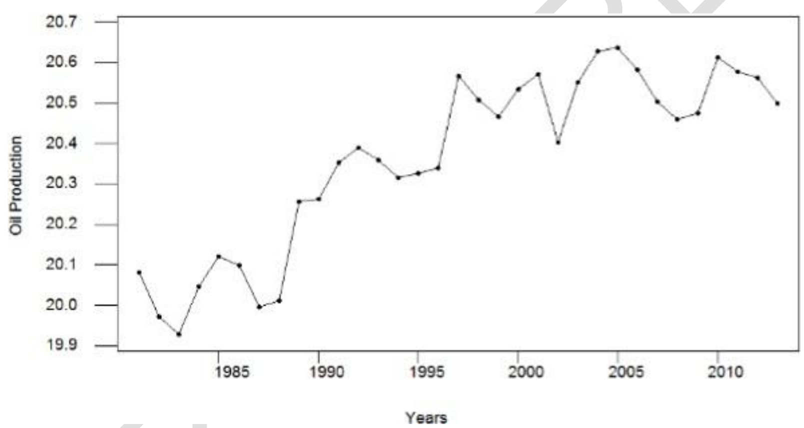

Figure 2: Time plot of total oil production at level for Nigeria from 1981 to 2013

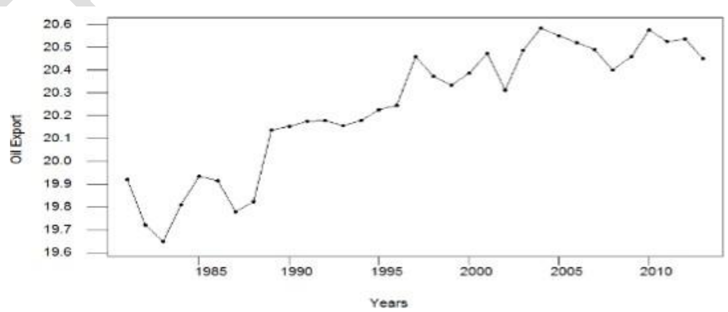

Figure 3: Time plot of total oil export at level for Nigeria from 1981 to 2013

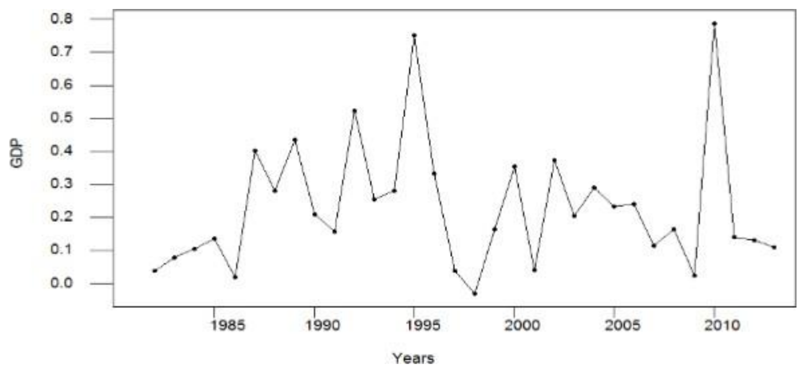

Figure 4: Time plot of Gross Domestic Product (GDP) at first difference for Nigeriafrom 1981 to 2013

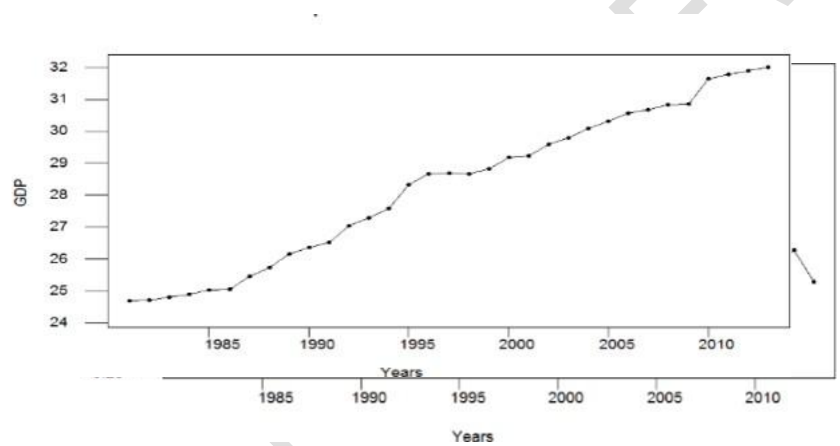

Figure 5: Time plot of total oil production at level for Nigeria from 1981 to 2013

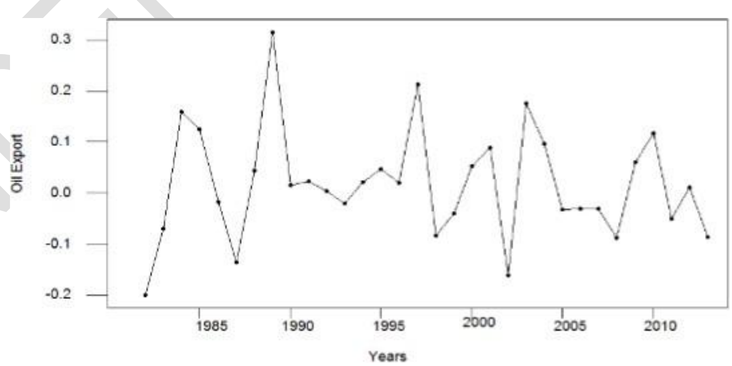

Figure 6: Time plot of total oil export at first difference for Nigeria from 1981 to 2013

From figures 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, figure 4, 5 and 6 indicate a pattern that canbe fitted; hence the series are stationary at first difference.

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:
H_0: JB=0 (normally distributed)
H_1: 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 < α value of 0.05 p-value< α valueof 0.1

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-Bera	2.375465	3.270079	3.110330
Probability	0.304912	0.194945	0.211155

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 observedthat the Jarque-Bera test indicated the retention of Ho, hence the time series observations are normally distributed at 5% level of significance.

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 unitroot hypothesis supports stationarity.

The hypothesis to be tested is:

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

$\alpha = 0.05$

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

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% Mickinno ncritical 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

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.

3.3 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 VECMmodel before performing the Johansen co-integration test.

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

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, Johansenco-integration test can be perform using lag of 1.

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 Y_t.

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.

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

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

3.4: 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

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

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

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)

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.

3.4.1 Granger Causality test

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

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 result of short-run granger causality of the vector error correction model indicatenone 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 assess 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 donot 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 longrun of relationship between them.

4.1 RECOMENDATION

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.

1. The Nigeria national petroleum corporation (NNPC) should diversity its export through downstream production this will enhance the refined petroleum for exports.

2. The government should encourage more company participation so that better equipped refineries can be built.

3. Security should be boosted on the high sea where crude oil products are being smuggled.

4. Government should give attention to non-oil sector to boost the economy.

5. 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.

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