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Performance Evaluation of the Nigerian Petroleum Industry: modular refinery plant alternative

O. J. Odejobi[1], P. O. Ayoola[2*], M. A. Abiodun[1] and M. A. Abioye[1]

[1]Department of Chemical Engineering, Obafemi Awolowo University, Ile-Ife, Nigeria
[2]African Institute for Science Policy and Innovation, Obafemi Awolowo University, Ile-Ife, Nigeria
*Corresponding author's email address: ayoolaphillip@gmail.com

ABSTRACT

This study monitored the trend and evaluated the performance of the Nigerian Petroleum Industry (NPI) over a period of ten (10) years and also examined oil revenue and its impact on economic growth over a period of twenty-six (26) years. Secondary data on Gross Domestic Product (GDP) was used as a benchmark for economic growth. Oil revenue (OREV) and government expenditure (GEXP) which represented the decision variables were sourced from CBN publications. Advanced econometric techniques such as Augmented Dickey-Fuller Unit Root Test, Johansen Co-integration Test, Vector Error Correction Mechanism (VECM) and the net present value (NPV) method were employed and the result revealed that the variables that were not integrated on the same order justifying co-integration and error correction mechanism test. The co-integration result indicated that there is a long-run relationship between the variables with three co-integrating equation(s) and the result obtained from the error correction mechanism test shows that all the variables except lag of government expenditure exerted a significant impact on economic growth in Nigeria. The study concluded that the revenue generated from petroleum should be invested in non-oil sectors to expand the revenue base of the economy. The economic viability of the Modular Refinery Plants Alternative (MRPA) is considered viable and recommended for adoption in Nigeria.

Keywords: NPI, Oil Revenue, Government expenditure, GDP, Co-integration, MRPA

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INTRODUCTION

The history of petroleum industry in Nigeria revealed that oil was first discovered in 1956 at Oloibiri in the Niger Delta. The discovery was made by Shell–BP and actual production and exportation started in 1958. Crude oil has been a primary source of revenue, energy and foreign exchange for the Nigerian economy (Titus and Muhammed, 2017), and petroleum has continued to play a predominant role by accounting for about 90 percent of Nigeria's gross earnings. Petroleum has emerged from being a supportive economic sector in the 1960s to be the predominant source of foreign exchange, development, finance and international investment opportunities till date. This dominant role has pushed other sectors especially agriculture that used to be the main-stay of the economy in the early 50's and 60's to the background (Shagari, 2007). The Oil sector provides 80 percent of the budgetary revenue, 95 percent of foreign exchange earnings and contributes over 14 percent to Gross Domestic Product. This indicates that Nigeria is now heavily dependent on crude oil for survival (Onyemaechi, 2012). The rise of oil prices from the oil boom of the 70's to its peak price in the 90's has made Nigeria one of the fastest growing countries in the world. The International Monetary Fund projected a growth of 9 percent in 2008 and 8.3 percent in 2009 (Anthony, 2012). It is unfortunate that though the government used the revenue derived from oil through tax and royalties to fund development in the country, little or nothing has been done to support the oil sector itself since its discovery (Gbadebo, 2008). Neglect and other corrupt practices have made the petroleum sector to become moribund and no longer support local demand for petroleum products. No significant effort has been made to empower the local investor in the oil sector, and the government–owned oil companies have not being receiving the needed empowerment to take the leading role in the industry (Hamisu, 2013). All the refineries built for the purpose of increasing the benefits of crude oil are all working at very low capacities. Local demand for fuel are being met through importation of refined products, thereby leaving its effect on the growth of the Nigerian economy as regards returns on investment and productivity questionable. This development therefore calls for evaluating the performance of the sectors to identify the needed improvement.

The main objective of this study is to evaluate the performance of the Nigerian petroleum industry over a period of twenty-six years as regards its impact on the economy, analyze the data obtained in other to propose performance enhancement models and to recommend policies for optimum performance of these sectors. The current situation in the sector suggests that there is a dire need to formulate appropriate and desirable production and operational policies for the sector. Considering the fact that there are different sectors of the economy, the excess revenue realized from the oil sector could have been invested in these sectors to diversify the economy thereby leading to increased aggregate GDP of the economy however, if this has ever been done, the effect is hitherto to be seen.

RESEARCH METHODOLOGY

This sector gives a detailed outline of the method adopted in the study to improve the performance of the Nigerian oil sector.

Analysis of the Impact of Crude Oil on the Nigerian Economy

The methodology for assessing the impact of crude oil on the development of the Nigerian economy followed a pattern similar to the work of Nweze (2016). The model is expressed in a multiple regression form and modified with the incorporation of the following exogenous factors: oil revenue (OREV) and government expenditure (GEXP). Government expenditure was incorporated in the model because revenue from oil exports constitutes government expenditure. This research was carried out over a period of 26 years i.e. 1990-2016. Therefore, the functional form of the model is expressed as:

$$GDP_t = F\left(OREV_t, GEXP_t, GDP_{t-1}\right) \quad (1)$$

The mathematical and econometric form of the model is given as:

$$\Delta GDP_t = \partial_o + \partial_1 GDP_{t-1} + \partial_2 OREV_t + \partial_3 GEXP_t + U_t \quad (2)$$

Where: ∂_o is parameter intercept; ∂_1, ∂_2, and ∂_3 are coefficients of parameter estimates; U_t is the error term (Musa, 2015).

Evaluation Procedure
The properties of the time series were examined using the Augmented Dickey-Fuller (ADF) unit root tests to determine their long-run convergence and stationary levels; also vector error correction mechanism was used to estimate the short run speed of adjustment from this equilibrium.

Modular Refinery Plant Alternative
The study assumes a project planning template incorporating capacity, time and cost as thus: The Modular Refining Plant (MRP) will have a 30,000-bpd production output of gasoline, LPG, diesel, kerosene and fuel oil. The facility is expected to be installed within 18 months. The budgeted cost of the facility is US$150 million**.** Hence, the model is setup to quantify the effect of modular refineries in the operation of petroleum sector and its effectiveness in solving the problem associated with immediate petroleum needs. To quantify the number of modular refineries required to achieve the petroleum energy demand over a projected five years period (i.e 2017-2021), Equation (3) below is used:

$$\text{Number of MRP} = \frac{\text{Petroleum Energy Demand as at 2021}}{\text{Petroleum Refining Output by MRP/year}} \qquad (3)$$

For adequate analysis and computation of the effect of the modular refinery plant alternative, the amount of petroleum product by percentage obtainable per barrel of crude oil as shown in Table 1 is used.

Table 1: Percentage of Petroleum Product Obtainable from a Barrel of Crude Oil

Product	**Percentage of Total Crude Oil (%)**
Gasoline	41.5
Diesel Fuel & Heating Oil	26.1
Other Products	15.7
Jet Fuel	9.1
Liquefied Petroleum	3.85
Asphalt	3.75

Source: US Department of Energy, Energy Information Agency EIA (2014)

Energy Planning and Strategic Foresight Analysis
Energy planning and Strategic foresight analysis was used to determine the national petroleum energy demand and crude oil production forecast from 2017 to 2021. For crude production forecast, the projection time frame is based on Nigeria's production target of 3 Million Barrels Per Day (Mbpd) in the next 5 years which agrees with the rule of thumb for futuristic projections. The foresight analysis was developed using the scenario building technique and Microsoft Excel "goal seek function" based on production data

obtained from 2007-2016. A 10.3% change was observed for policy reforms (optimistic scenario) and based on an average of crude oil production demand overtime, a 5.3% decrease is projected in the business as usual scenario, an exponential increase in petroleum energy demand was observed which gave the highest R^2 value of 0.9981 with the model equation:

$$y = 3E^{-74e^{0.0867x}} \qquad (4)$$

Where" y" is the petroleum energy demand at a particular period and "x" is that particular period. Hence, the exponential "growth function" shown below was used for the projection of petroleum energy demand over the next five years (2017-2021).

$$GROWTH(Known\_y_s, [Known\_x_s], [new\_x_s] \qquad (5)$$

Techno-Economic Viability of the Modular Refinery Plant

The engineering economy methodology adopted in calculating the economic viability of modular refineries is net present value (NPV). NPV can be described as the difference between the sums of discounted cash inflows and cash outflows. The NPV is estimated using Equation (6) (Investopedia, 2017).

$$NPV = \sum_{t=1}^{T} \frac{C_t}{(1+r)^r} - C_o \qquad (6)$$

Determination of discounting factor using 13% interest rate as provided by the Central Bank of Nigeria (CBN) is done using Equation (7):

$$Discounting\ Factor = \frac{1}{(1+\mathrm{r})^n} \qquad (7)$$

Where: C_t is the net cash inflow during the period, t; C_o is the total initial investment costs; r is the discount rate; and t is the number of time period.

RESULTS AND DISCUSSIONS

Impact of Oil on the Development of the Nigerian Economy

This section investigates the relationship between gross domestic product, oil revenue and government expenditure. Gross domestic product is used as an indicator for economic growth.

Unit Root Test Results

To properly examine the trend relationship and the nature of stationarity in this study, the researchers adopted the Augmented Dicks-Fuller test (ADF) at trend only to eliminate the possibility of obtaining a spurious result. The results are presented in Table 2.

Table 2: Augmented Dickey-Fuller Unit Root Test with Trend and Intercept

Variables	Level	1st Difference	2nd Difference	Critical Value (5%)	Order of integration	Remark
D(GDP)	-1.565756	-4.788782	-	-2.981038	I (1)	Stationary
D(GEXP)	-3.891471	-7.229593	-	-2.991878	I (1)	Stationary
D(OREV)	-1.927620	-4.661571	-	-2.986225	I (1)	Stationary

From Table 2 none of the variables were stationary at the level, since their critical value is less than 5% level of significance, but after differencing the variables by one, all became stationary.

This means that all the variables were stationary at first difference since their critical value is greater than 5% level of significance$(-4.788782, -7.229593, \text{and } -4.661571 > -2.986225)$. Hence, since all the variables are not stationary at level and are not integrated at the level, the co-integration analysis is justified. We then proceed to conduct the long run relationship of the variables and their short-term speed of adjustment to equilibrium.

Co-integration Test

This test is used to verify for the long-run relationship between the variables under consideration; it was carried out using the augmented eagle –Granger test on the residuals under the following hypothesis:
$H_{o:}$ $\partial = 0$ (Not Cointegrated)
$H_{1:}$ $\partial \neq 0$ (Cointegrated)

Decision Rule: Reject H_o if T*. Adf (trace Statistic) > T-Adf (Critical Value), Accept if otherwise. Where Adf refers to Augmented Dickey-Fuller. As shown in Table 3.

Table 3: Unrestricted Co-integration Test (Trace)
Series: GDP GEXP OREV
Unrestricted Co-integration Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.855861	77.03367	29.79707	0.0000
At most 1 *	0.609096	30.54625	15.49471	0.0001
At most 2 *	0.283565	8.003213	3.841466	0.0047

Trace test indicates 3 co-integrating eqn(s) at the 0.05 level
** denotes rejection of the hypothesis at the 0.05 level*
***MacKinnon-Haug-Michelis (1999) p-values*

From Table 3 it can be seen that the trace statistic (t*) is greater than the T-adf i.e. the critical value at 5%, or since the Eigenvalues are greater than 5% level of significance, we reject H_o and conclude that the variables are cointegrated. Put differently, there is a sustainable long-run relationship (i.e. steady-state path) between gross domestic product (GDP), Oil revenue (OREV), and Government expenditure (GEXP). The normalised co- integrating coefficients for one co-integrating equation given by the long-run relationship is:

$$\boldsymbol{GDP = 5050.589 + 2322171OREV - 18.27198GEX} \quad (8)$$

Where GDP is the dependent variable, the positive sign of oil revenue indicates a direct relationship between both variables. This implies that revenue generated from oil sales has had a potentially significant impact on Nigeria's economic growth through government expenditure in the long run; although there was an inverse relationship between OREV and GDP in the short term. This might be as a result of the fact that the policy makers have relied on oil revenue to the detriment of other promising sectors especially the agricultural sector, which if not corrected may have a serious effect on the economic growth of Nigeria in the long run.

Error Correction Mechanism

The existence of a long-run co-integrating equilibrium provides for short-term fluctuations. To strengthen out or absolve these fluctuations, an attempt was made to apply the Vector Error Correction Mechanism (VECM). As noted, the VECM is meant to tie the short-run dynamics of the co-integrating equations to their long-run static dispositions. Table 4 shows the error correction mechanism result.

Table 4: Vector Error Correction Mechanism Result
Sample (adjusted): 1993-2015; included observations: 23 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.	Remarks
C	1926.411	1181.920	1.62989	0.1100	Reject
D(GDP(-1))	0.519647	0.14522	3.57842	0.0008	Reject
D(OREV(-1))	-2.937369	0.54487	-5.39094	0.0000	Reject
D(GEXP(-1))	-6.540250	4.91761	-1.42417	0.2457	Accept
ECM(-1)	-0.478784	0.15695	-3.05063	0.0051	Reject

$R^2 = 0.8834, F^* = 16.23$

From the result, the coefficient of error correction term (ECM) is -0.4787. This showed that 47.87% of the errors in the short run are corrected each year. Thus, the coefficient captures the speed for adjustment at which the short-run of GDP ties with its long-run. The result is significant since the coefficient of multiple (R^2) (0.8834) determination is greater than zero and the error correction variable (ECM), is negative which shows that there is feedback from the previous year's disequilibrium. A mere observation of the individual parameters reveal that all the variables were significant since their p-value is greater than 5% level of significance, except government expenditure which was not significant given the level of significance at its P-value. The a priori expectation of oil revenue is expected to be positive, which means that the higher the level of revenue generated from oil the higher the economic growth. The regression result showed that the coefficient is negative, even though it has a positive relationship with economic growth in the long-run as revealed by the VECM result.

The result showed that the government expenditure has a negative (-6.5403) relationship with economic growth in both the short and long run. The sign of government expenditure is expected to be positive for economic growth to take place. This has to do mainly with the state and expenditure pattern of government. The expenditure of government through accelerator principle is supposed to spur every other sector of the economy. As postulated by Keynes, if an economy is experiencing recession, government can through her expenditure boost the economy; by increasing her expenditure thereby raising the aggregate demand of the economy depending on the multiplier. In Nigeria, oil revenue constitutes 80% of government revenue which goverment, in turn, spend to drive the economy. If government spending is done without adhering to certain guiding principles such as the principle of sanction, and the principle of the economy among others, it can lead to a negative relationship between government spending and economic growth in both short and long-run.

Table 5 shows Nigeria's projected petroleum energy demand in million barrels and petroleum products forecast in billion litres. Petroleum demand is projected to rise by 3.67 billion litres from 2017 to 2018; by 4.02 billion litres from 2018 to 2019; by 4.39 billion litres from 2019 to 2020 and by 4.80 billion litres from 2020 to 2021. Furthermore, total petroleum demand for the time frame is estimated to be 236.83 billion litres, total petrol production is 98.28 billion litres, total diesel production is 61.81 billion litres, other petroleum products is 37.18 billion litres, total jet fuel production is 21.55 billion litres, total liquefied petroleum production is 9.12 billion litres, and total asphalt production is 8.88 billion litres. These projections provide information for petroleum products production and marketing templates necessary to

Table 5: Projected Petroleum Energy Demand for Nigeria (billion litres)

Year	**Petroleum**	**Petrol**	**Diesel**	**Other Products**	**Jet Fuel**	**Liquefied Petroleum**	**Asphalt**
2017	39.30	16.31	10.26	6.17	3.58	1.51	1.47
2018	42.97	17.83	11.22	6.75	3.91	1.65	1.61
2019	46.99	19.50	12.26	7.38	4.28	1.81	1.76
2020	51.38	21.32	13.41	8.07	4.68	1.98	1.93
2021	56.18	23.32	14.66	8.82	5.11	2.16	2.11
Total	236.83	98.28	61.81	37.18	21.55	9.12	8.88

Table 6: Petroleum and Petroleum-Products Production from 30,000 BPD Modular Refinery Plants (MRP) over specified time periods

Petroleum (10^3b/d)	Petroleum (10^6L/d)	Petrol (10^6L/d)	Diesel (10^6L/d)	Other Products (10^6L/d)	Jet Fuel (10^6L/d)	Liquefied Petroleum (10^6L/d)	Asphalt (10^6L/d)
30	4.77	2.24	1.1	0.86	0.48	0.19	0.14
Petroleum (10^6b/y)	Petroleum (10^9L/d)	Petrol (10^9L/y)	Diesel (10^9L/y)	Other Products (10^9L/y)	Jet Fuel (10^9L/y)	Liquefied Petroleum (10^6L/y)	Asphalt (10^6L/y)
10.95	1.74	0.82	0.4	0.31	0.18	69.6	52.2

facilitate the establishment of refineries in the country as well as facilitate appropriate planning of petroleum products marketing in the country, ameliorating the identified domestic limited petroleum products marketing planning infrastructure. Using the 30,000 bpd MRPA model, Table 6 shows the production outputs expected in million liters per day and billion liters per year where applicable for the MRP.

A total number of 30,000bpd MRPs required to meet domestic petroleum energy demand in Nigeria is:

$$Number\ of\ MRPs = \frac{Petroleum\ Energy\ Demand\ as\ at\ 2021}{Petroleum\ Refining\ Output\ by\ MRP/year}$$

$$Number\ of\ MRPs = \frac{353.36 Million\ Barrels}{10.95\ Million\ Barrels/year} = 32.27$$

Where (1 Barrels of Oil to Litres = 158.9873)

Thus, a plan to construct thirty-five 30,000-bpd MRPs in Nigeria over the next five years should be adequate to meet the required domestic petroleum energy demand. Recently, President Muhammad Buhari approved licenses to 65 Nigerian private firms to construct private modular refineries in the country. The companies were reportedly selected from about 285 applications that were screened (Vanguard, 2016). The modular refining plant in this study have a 30,000-bpd production output producing PMS, Diesel, Jet Fuel and LPG, Asphalt and other products with a budget of about US$150 million which equals 55.20 billion naira at the exchange rate of 1dollar = ₦368.00k.

Economic Viability of the Modular Refining Plant Alternative (MRPA) in Nigeria

This section analyses the economic viability of the MRPA. The results are critical to strategic policy development in the Nigerian Downstream sector. Total Investment Costs of 30,000-bdp MRP for Required Domestic Petroleum Energy Demand is US$150million (₦55.20 Billion). Hence, the total investment cost for thirty-five 30,000-bpd MRP is expected to be US$5.25 Billion (₦1.932 Trillion) while the operating cost is expected to be US$2.625 Billion each year (₦0.966 Trillion) (an assumption of 50% of the investment cost), which is shown in Table 7.

Table 7: Investment and Operating Costs for MRPs.

	30,000 BPD MRP Cost	Number of MRPs	Total Costs
Investment Costs	US$ 150 Million (₦ 55.20 Billion)	35	US$ 5.25 Billion (₦ 1.932 Trillion)
Operation Costs/year	US$ 75 Million (₦ 27.60 Billion)	35	US$ 2.625 Billion (₦0.966 Trillion)

Exchange Rate: US$ = ₦368.00

Table 8 shows the estimated revenues accruable after the sale of the petroleum products in Nigeria is further obtained. This covers revenue per MRP as well as revenue for the 35 required MRPS.

Table 8: Estimated Revenue from Sale of Petroleum Products

	Petrol	Diesel	Other Products	Jet Fuel	Liquefied Petroleum	Asphalt	Total
Quantity/MRP (BL/year)	0.82	0.4	0.31	0.18	0.0696	0.0522	
Cost (₦/Litre)	145.0	177.0	N. A	200.0	216.22	110	
Revenue/MRP (₦ Billion)	118.90	70.8	N. A	36.0	15.05	5.74	246.49
Revenue from 35 MRPs (₦ Trillion)	4.161	2.478	N. A	1.260	0.527	0.201	8.627

Source: Product Prices obtained from Proshareng.com

Net cash flow per year = Revenue – Operating Costs

= ₦ 8.627 Trillion - ₦ 0.966 Trillion = ₦ 7.661 Trillion

Petrol and diesel sales are estimated to be the largest earners of revenue from the adoption of the MRP (₦ 4.161 Trillion and ₦ 2.478 Trillion respectively). Furthermore, total revenue is estimated to be ₦ 118.90 billion for one MRP or ₦ 8.627 Trillion for the thirty-five 30,000-bpd MRPs.

Table 9: Net Present Value (NPV) for the MRPA

Year	Cash Flow (₦ Trillion)	Discounting Factor	Present Value (₦ Trillion)
0	1.932	1	1.932
1	7.661	0.885	6.780
2	7.661	0.783	5.998
3	7.661	0.693	5.309
4	7.661	0.613	4.696
5	7.661	0.543	4.160
		NPV	25.011

Using Eq. 6 and Eq. 7 to obtain the Net Present Value (NPV) value and discounting factor respectively, the result is shown in Table 9.
The Modular Refining Plant Alternative (MRPA) in Nigeria has a Net Present Value of ₦ 25.011 Trillion; hence the option is considered viable and recommended for use in Nigeria.

Job Creation Opportunities for MRPA
Records from major petroleum refining countries in the world show job creation potentials of about 5,000 direct labour to 50,000 industry workers for every 10 million barrels of crude oil refined (Leffler, 1985; Colwell, 2009; Cenam, 2014). Using this statistic as template, Table 10 shows the number of jobs that can be created in the Nigerian refining industry using MRPs from 2017 to 2021.

Table 10: Job Creation Opportunities for MRPA in Nigeria, 2017-2021

Year	Petroleum (Million Barrels)	Jobs Potential (500/Mil barrels)	Jobs Potential (5,000/Mil Barrels)
2017	247.17	123,585	1,235,850
2018	270.27	135,135	1,351,350
2019	295.53	147,765	1,477,650
2020	323.16	161,580	1,615,800
2021	353.36	176,680	1,766,800

Collectively, the petroleum refining industry in Nigeria can create from 123,000 to 1.7 million jobs from 2017 to 2021. It is important to note that from the National Bureau of Statistics, in the third quarter of 2016, the rate of unemployment and underemployment in the country is 13.9% and 19.7% respectively. Workers are needed to design, build, and operate new refineries – especially modular refineries and the availability of skilled workers at all levels has been critical to the successful growth of the global petroleum refining industry (Colwell, 2009). Table 10 also shows that the Modular Refining Plant (MRP) is an eminent incentive for job creation which could contribute to the reduction of poverty in Nigeria.

CONCLUSION

Nigeria needs to improve on her trade with the rest of the world. The revenue generated from oil should be used judiciously to develop other sectors of the economy most especially the agricultural sector and the manufacturing sector at large. By virtue of performance, it is evident that the petroleum industry is performing below par. Due to the findings of this research, the Modular Refinery Plants Alternative is considered viable and recommended for adoption in Nigeria. From a policy perspective, increased oil activity could impact on the other non-oil sub sectors. However, to ensure that oil continues to foster better growth and development there is the need to focus on three major areas. These are sustenance of increased investment inflows to the oil sector, stimulation of local labour and capital and institution of appropriate reforms to enhance efficiency and transparency.

Recommendations

For the establishment of a modular refinery, there should be investment-friendly conditions. Government should ensure there are guaranteed ready off-takers for the refined products by the NNPC and Modular Refinery operators. The government should help in protecting their investment by addressing issues such as pipeline vandalism and oil theft by giving immediate attention to the indigenes of the region where crude oil is being extracted from. This will reduce the unrest in that region. The modular plants should be strategically located throughout the country to serve the needs of various regions of the country. Macroeconomic policies aimed at enhancing output in the oil sub-sector should be embarked upon by the government. This may include; reviewing and strengthening existing policies and incentives to support the growth of the non-oil sector; improving the current state of infrastructure since the operation of small and medium-sized enterprises (SMEs) which constitute the bulk of the non-oil sector of the economy rely on a steady supply of electricity; and allocating sufficient funds to R&D since innovation and competitiveness of the sector depends on it.

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