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# An Empirical Use of Multiple Regression Models on Oil Export and Non Oil Export in Nigeria

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***Abstract:*** *This work is focused on the modeling of oil exports and non-oil exports in Nigeria. The value of* $R^2$ *indicates that 73% is the proportion of variation in the observed values that is explained by the fitted model. The residuals of the model are uncorrelated. In the study only oil export is significant (P< 0.05) in the regression model. Hence, the fitted model is given as:* $Y = 201403.56 + 0.808x_1 + 0.083x_2$ *. It is the basis for forecasting of the series of the first independent variable (*$x_1$*), oil export and second independent variable (*$x_2$*), non- oil export. The value of* $x_2$ *which is 0.083 is statistically insignificant due to the neglect of the activities of non-oil sectors in Nigeria. Also, we observed a significant difference between the mean of oil export and non-oil export. (P< 0.05). Hence, we concluded that Nigerian Government should improve on non-oil commodities.*
***Keywords****: Multiple regression, oil export, non- oil export, Nigeria.*

## I. Introduction

Every country is encouraged to improve on its economic growth both in oil and non-oil exports. Any country that falls in any of these factors is bound to serious economic crisis. For instance, Nigeria economy has heavily dependent on oil. Agriculture which formed the bedrock of the economy has been relegated to the background. That is why Nigeria is facing serious economic crisis today. The forecasting and control of oil export and non-oil export could help in management and good governance.

It has been observed that multiple regression models are gaining popularity in statistical modeling. A few of such studies that utilizes multiple regression model are: banks of non-oil exports[2], marketing of non-oil agricultural product in Nigeria[3], crude oil production, price, export and foreign exchange rate[4], and Non-oil export product is a precondition accelerated real economic growth[5]. It is obvious that the multiple regression models are effective and reliable in explaining the variation in two or more independent variables.

However, several studies has been carried out in this area, but none has given detail insights in terms of gross domestic product (GDP) using multiple regression model. Hence, this study aimed to examine the relationship between oil export and non-oil export measured in terms of gross domestic product, and to model oil export and non-oil export in order to provide a model for possible forecasting of the series.

## II. Materials And Methods

***DataSource***
The study utilized data from the publication of the Central Bank of Nigeria statistical bulletin, 1980-2013.

***Multiple Regression Model***

The aim of this study is to build a model that relates dependent variable (GDP) to two independent variables (oil export and non-oil export). The general multiple linear regression models is given by

$$Y = \beta_0 + \sum_{i=1}^{k} \beta_i x_i + \mathcal{E} \qquad (1)$$

Where $Y$ is the dependent variable,$x_i$($i$ = 1,2, …k) represents $i$th independent variable, $\beta_i$ represents the $i$th regression coefficient,$\mathcal{E}$ represents the random error component which is normally and independently distributed with zero mean (μ = 0) and constant variance $\sigma^2$. The parameter $\beta_i$ is usually unknown but be estimated using n-uncorrelated observations.

Assuming $x_1$ and $x_2$ are independent variables then, $Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \mathcal{E}$. $\beta_1$,measures the expected change in $Y$ per unit change in $x_1$ when $x_2$ is held constant. Similarly $\beta_2$ measures the expected change in $Y$per unit change in $x_2$ when $x_1$ is held constant. $\beta_0$is the intercept of the plane on general perspective from model (1). The model describes the hyperplane in k-dimensional space of the independent variables $x_1, x_2, \ldots, x_k$ . The parameter $\beta_j$ represents the expected change in $Y$ per unit change in$x_j$. When $x_i (i \neq j)$ are held constant for values of $x_1, x_2, \ldots, x_k$ , the expected values of dependent variable, $E(Y) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_k x_k$ . The model parameters can be estimated using the method of least square.

***Estimating the parameters of the multiple regression***

Let $y_1, y_2, \ldots, y_n$ be the observations with each observation $y_i$ been associated with observation in each regressorvariables $x_1, x_2, \ldots, x_k$, and let n be the number of uncorrelated observations such that n>k.

Recall: $\hat{Y} = \widehat{\beta_0} + \widehat{\beta_1} x_{1j} + \widehat{\beta_2} x_{2j}$. The estimates will be obtained by minimizing the sum of squares residuals.

$\sum_{i=1}^{n} e^2 = \sum_i^n (y_i - \widehat{y_i})^2 = \sum_i^n (y_i - \widehat{\beta_0} - \widehat{\beta_1} x_{1j} - \widehat{\beta_2} x_{2j})$.

A necessary condition for this expression to assume a minimum value is that its partial derivatives with respect to $\widehat{\beta_0}, \widehat{\beta_1}$ and $\widehat{\beta_2}$ be equal to zero,

$$\frac{\partial \sum (y_i - \widehat{\beta_0} - \widehat{\beta_1} x_{1j} - \widehat{\beta_2} x_{2j})^2}{\partial \widehat{\beta_0}} = 0 \qquad (2)$$

$$\frac{\partial \sum (y_i - \widehat{\beta_0} - \widehat{\beta_1} x_{1j} - \widehat{\beta_2} x_{2j})^2}{\partial \widehat{\beta_1}} = 0 \qquad (3)$$

$$\frac{\partial \sum (y_i - \widehat{\beta_0} - \widehat{\beta_1} x_{1j} - \widehat{\beta_2} x_{2j})^2}{\partial \widehat{\beta_2}} = 0 \qquad (4)$$

Performing the partial differentiations we obtain the following system of three equations in the three unknown parameters of $\widehat{\beta_0}, \widehat{\beta_1}$ and $\widehat{\beta_2}$.

$$\sum y_i = n\widehat{\beta_0} + \widehat{\beta_1} \sum x_{1j} + \widehat{\beta_2} \sum x_{2j} \qquad (5)$$

$$\sum x_{1j} y_i = \widehat{\beta_0} \sum x_{1j} + \widehat{\beta_1} \sum x_j{}^2 + \widehat{\beta_2} \sum x_{1j} x_{2j} \qquad (6)$$

$$\sum x_{2j} y_i = \widehat{\beta_0} \sum x_{2j} + \widehat{\beta_1} \sum x_{1j}\, x_{2j} + \widehat{\beta_2} \sum x_{2j}{}^2 \qquad (7)$$

From the solution of this system we obtain values for $\widehat{\beta_0}, \widehat{\beta_1}$ and $\widehat{\beta_2}$.

Partial derivatives with respect to $\widehat{\beta_0}$.

$$\frac{\partial \sum e_i{}^2}{\partial \widehat{\beta_0}} = \frac{\partial \sum (y_i - \widehat{\beta_0} - \widehat{\beta_1} x_{1j} - \widehat{\beta_2} x_{2j})^2}{\partial \widehat{\beta_0}} = 0 \qquad (8)$$

$$-2 \sum (y_i - \widehat{\beta_0} - \widehat{\beta_1} x_{1j} - \widehat{\beta_2} x_{2j}) = 0 \qquad (9)$$

$$y_i - \widehat{\beta_0} - \widehat{\beta_1} x_{1j} - \widehat{\beta_2} x_{2j} \qquad (10)$$

Partial derivatives with respect to $\widehat{\beta_1}$

$$\frac{\partial \sum e_i{}^2}{\partial \widehat{\beta_1}} = \frac{\partial \sum (y_i - \widehat{\beta_0} - \widehat{\beta_1} x_{1j} - \widehat{\beta_2} x_{2j})^2}{\partial \widehat{\beta_1}} = 0 \qquad (11)$$

$$-2 \sum x_{1j} \left(y_i - \widehat{\beta_0} - \widehat{\beta_1} x_{1j} - \widehat{\beta_2} x_{2j}\right) = 0 \qquad (12)$$

$$\sum x_{1j} y_i - \sum \widehat{\beta_0} x_{1j} - \sum \widehat{\beta_1} x_{1j}{}^2 - \sum \widehat{\beta_2}\, x_{1j} x_{2j} = 0 \qquad (13)$$

Partial derivatives with respect to $\widehat{\beta_2}$

$$\frac{\partial \sum e_i{}^2}{\partial \widehat{\beta_2}} = \frac{\partial \sum (y_i - \widehat{\beta_0} - \widehat{\beta_1} x_{1j} - \widehat{\beta_2} x_{2j})^2}{\partial \widehat{\beta_2}} = 0 \qquad (14)$$

$$-2 \sum x_{2j} \,(y_i - \widehat{\beta_0} - \widehat{\beta_1} x_{1j} - \widehat{\beta_2} x_{2j}) \qquad (15)$$

$$\sum x_{2j} y_i - \sum \widehat{\beta_0} x_{2j} - \sum \widehat{\beta_1} x_{1j} x_{2j} - \sum \widehat{\beta_2} x_{2j}{}^2 \qquad (16)$$

The equations (8), (11), and (14) are the three normal equations of the least squares method. The sample statistic for $\widehat{\beta_0}, \widehat{\beta_1}$ and $\widehat{\beta_2}$ are obtained by the following formula.

$$\widehat{\beta_1} = \frac{(\sum x_1 y)(\sum x_2{}^2) - (\sum x_2 y)(\sum x_1 x_2)}{\sum x_1{}^2 \sum x_2{}^2 - (\sum x_1 x_2)^2} \qquad (17)$$

$$\widehat{\beta_2} = \frac{(\sum x_2 y)(\sum x_1{}^2) - (\sum x_1 y)(\sum x_1 x_2)}{\sum x_1{}^2 \sum x_2{}^2 - (\sum x_1 x_2)^2} \qquad (18)$$

And $\widehat{\beta_0} = \bar{y} - \widehat{\beta_1} \overline{x_1} - \widehat{\beta_2} \overline{x_2}$ (19)

***Regression Analysis***

The residual estimate is given by $e_i = (y_i - \widehat{y_i})$ (20)

The residual sum of squares (SS) is $\sum_{i=1}^{n} e_i^2 = \sum (y_i - \widehat{y_i})^2$ (21)

This can be shown to equivalent to

$$\sum (y_i - \widehat{y_i})^2 = \sum (y_j - \bar{y})^2 - \sum (y_i - \bar{y}) \{\widehat{\beta_1}(x_{1j} - \overline{x_1}) + \widehat{\beta_2}(x_{2j} - \overline{x_2})\} \qquad (22)$$

$$= \sum (y_j - \bar{y})^2 - (\widehat{\beta_1} S_{x_1 y} + \widehat{\beta_2} S_{x_2 y}) \qquad (23)$$

On rearranging we have

$$\sum (y_j - \bar{y})^2 = \left(\widehat{\beta_1} S_{x_1 y} + \widehat{\beta_2} S_{x_2 y}\right) + \sum (y_j - \widehat{y_j})^2 \qquad (24)$$

This can be represented in the ANOVA table shown below

| Source of Variation | Degree of Freedom | Sum of Square | Mean Square | F-ratio |
|---|---|---|---|---|
| Regression | K | SSR | MSR | $\frac{MSR}{MSE}$ |
| Error | n-p | SSE | MSE | |
| Total | n-1 | SST | | |

The coefficient of determination is given by

$$R^2 = \frac{SSR}{SST} = 1 - \frac{SSE}{SSR}$$

The Null hypothesis is expressed as
$H_0: \beta_1 = \beta_2 = \cdots = \beta_k = 0$
$H_1: Atleastoneisdifferent.$
The test for goodness of fit of the estimated regression equation is carried out using the F- statistics. All analysis in this work was done using statistical package SPSS version 20.

## III. Results And Discussion

The coefficient of determination ($R^2$) which attest for the adequacy of the model, explains the total percentage of variation in the data accounted for by the model is high at 73% (0.731). This implies that 73% of the total variation in gross domestic product is explained by oil export and non-oil export, the remaining percent is captured by the stochastic error term ($\varepsilon_t$). Another measure of regression model is the adjusted $R$-squared statistics which is 0.714 from the result is 71% of variation in the data is explained by the model.

**Table 1:** Regression coefficient

| Beta | Coefficients | 95% C.I for β | P-value |
|---|---|---|---|
| $\beta_0$ | 201403.555 | 141286 - 261520 | 0.000 |
| $\beta_1$ | 0.808 | 0.034 – 0.0661 | 0.000 |
| $\beta_2$ | 0.083 | -0.034 – 0.074 | 0.456 |

Significant at p<0.05

**Table2:**ANOVA table for Regression

| Source of Variation | Degree of Freedom | Sum of Square | Mean Square | F-ratio | P-value |
|---|---|---|---|---|---|
| Regression | 2 | 1577943328791.697 | 788971664395.848 | 42.145 | 0.000 |
| Error | 31 | 580327567528.919 | 18720244113.836 | | |
| Total | 33 | 2185270896320.616 | | | |

Significant at p<0.05

The result showed that the residuals of the model are uncorrelated and normally distributed. And only oil exports coefficient are significant in the model(see table 1). Hence the fitted model is given as, $y = 201403.56 + 0.808x_1 + 0.083x_2$. However, if the independent variables are held fixed, the dependent variables (GDP) will increase by 201403.56 units. The first independent variable ($x_1$) is 0.808 which implies that an increase in oil export will improve 0.808 units increase in gross domestic product. Similarly the second independent variables ($x_2$) is 0.083 which also implies a unit rise in the level of non-oil export would increase gross domestic product by 0.083 units. The second independent variable (non-oil export) is statistically insignificant due to the neglect of the activities of the non-oil sectors in Nigeria. Thus 201403.56 fixed the intercept of the plane on general perspective from the fitted model.

***Testing for significance***
$H_0: \beta_1 = \beta_2 = 0$
$H_1: Atleastoneisdifferent$
p-value = 0.000
Decision rule: Since p< 0.05, we reject $H_0$ and conclude that the test is significant. Hence at least one of $\beta_1$and $\beta_2$ is significantly different from zero.

## IV. Conclusion

It might be concluded that Nigerian Government should improve on non-oil commodities. Hence the proposed model is $y = 201403.56 + 0.808x_1 + 0.083x_2$. This is the basis for the forecasting of the series.

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