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STATISTICAL ANALYSIS OF NIGERIA GROSS DOMESTIC PRODUCTS

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ABSTRACT
Gross domestic product (GDP) is one of the major ways of detecting the economic growth of a nation and where the GDP is high, the country is actually moving forward. One of the sectors believed to contribute to the Nigerian GDP is the crude oil. Empirical result from existing literature has showed that over dependence on crude oil has almost crippled all other sectors of the economy. Over the years, the high rate of dependence on the crude oil in the Nigeria's system of government has increased in that, some other sectors of the economy such as agriculture, crude oil, solid minerals, trade, communication, electricity, among others, had not given ardent attention. This paper seeks to analyze GDP from some sectors of Nigerian economy. A dynamic regression model was formulated to analyze Nigerian quarterly GDP data from 1960 to 2010. This study recommends that Government should try as much as possible to look into all other sectors of the economy especially sectors that this paper actually found to be contributing immensely to the growth of Nigerian Gross domestic product.

Keywords: GDP, Nigeria, dynamic regression model, ARIMA, Economic indicators.

INTRODUCTION

Gross domestic product (GDP) is referred to as the value of a country's overall output of goods and services during a year at market prices excluding net income from abroad. It is the broadest qualitative measure of the nation's total economic activity. Without doubt some sectors of economy makes up the GDP of a nation. This study is specifically on Nigerian economy and it measures the contribution of the agriculture, crude oil, solid mineral, building and construction, trade, transport, communication, electricity and water on the overall GDP. When the overall GDP declines for two consecutive quarters or more, the economy is in recession. When GDP grows too quickly, inflation may arise then the Federal Reserve often attempts to stimulate the economy by raising interest rates. Consequentially, GDP is directly proportional to economic growth.

The Nigerian economy has undergone some structural changes over the past four decades. Prior to the country's political independence in 1960, the economy was largely at a rudimentary stage of development. Between 1960 and 1975, agriculture was the core economic activities in Nigeria with manufacturing and mining playing the residual of role. Agriculture is one of the oldest forms of trade which was well embraced by Nigeria[1]. Nigeria was the leading country in the export of major commodities such as cotton, groundnut, rubber, hides and skin. Nigeria was the leading country for cassava production around the world with over 30 million tons annually as at 1998 followed by Brazil with over 19 million tons. Nigeria had the highest oil palm production around the world but did not maximize her potentials for the very important crop until Venezuela took over as the world leader in oil palm production. Agriculture in Nigeria witnessed the sharp decline in agricultural productivity within the shortest time space due to over-dependence in crude oil proceeds and that resulted into economic downturn in Nigeria[2]. Although Nigeria is the largest crude oil producer in the continent of Africa, Nigeria imports over half of its refined products because its own refinery cannot meet domestic demand[2]. Despite the volumes of scientific information to engender improvement, Nigeria was traced to poor government involvement in agriculture at the level of policy formation and implementation. There is dilapidated infrastructure (especially roads and electric power supply) that has led to the collapse of many industries, including high level of unemployment. Iganiga and Unemhilin[3] and Oji-Okoro[4] argued that agricultural output could be significantly influenced by government capital expenditure.

A number of researchers have attempted to examine the effect of government expenditure on economic growth. Iyoha and Oriakhi[5] identified the sources of economic growth in Nigeria using the growth accounting model and found that agriculture contributes more than expected to GDP growth. This was confirmed in Makinde *et al*.[6] Olajide *et al.*[7] applied ordinary least squares regression to analyze the relationship between agricultural resource and economic

growth in Nigeria between 1970 and 2010. Olajide *et al.*[7] showed that there is positive causal relationship between GDP and agricultural output in Nigeria.

In this paper, multiple linear regression model is formulated for Nigerian GDP as a function of some economic indicators. Assumption on autocorrelation of residuals of the regression model will be verified because the data generating process may be time dependent. Solution to the violation of this assumption will be provided in both methodology and numerical results sections below.

MATERIALS AND METHOD

Data

The data used in this research is a secondary data obtained from the CBN Bulletin on quarterly data of Nigerian gross domestic products from 1960-2010. The predictor variables are revenues from agriculture, crude-oil, solid minerals, building and construction, trade, transportation, communication, electricity and water. The predictor variables are measured at constant prices. The response variable is the overall Nigerian gross domestic products.

Methods

This study employed multiple linear regression which involves modelling gross domestic product based on some economic variables like revenue from agriculture, revenue of crude oil, revenue from trade among others. Multiple linear regression for gross domestic product of Nigeria based on the economic indicators is expressed as

$$Y_t = \beta_0 + \sum_{i=1}^{9} \beta_i X_{i,t} + \psi_t \qquad (1)$$

where Y_t is the gross domestic product of Nigeria at time t, $X_{1,t}$ represents the revenue from agriculture, $X_{2,t}$ represents the revenue from crude oil, $X_{3,t}$ represents the revenue from solid mineral, $X_{4,t}$ represents the revenue from building and construction, $X_{5,t}$ represents the revenue from trade, $X_{6,t}$ represents the revenue from transportation, $X_{7,t}$ represents the revenue from communication, $X_{8,t}$ represents the revenue from electricity, $X_{9,t}$ represents the revenue from water. The coefficient of $X_{i,t}$ is β_i for all $i = 1,2,\dots,9$. The term ψ_t is the error term or disturbance. The coefficients of β_i can be estimated using ordinary least squares method or maximum likelihood estimation.

It is expected that the residuals of the fitted model in (eq. 1) are homoscedastic, normally distributed and not auto-correlated. However, if the residuals are auto-correlated, the linear regression model can be re-formulated to handle auto-correlated errors, following Makinde and Abiodun[8], Makinde, Abiodun and Ojo[9].

The formulated regression model for correlated errors, henceforth refers to as dynamic model, combines multiple linear regression with autoregressive integrated moving average model ($ARIMA(p,d,q)$). The dynamic regression model is defined as

$$Y_t = \beta_0 + \sum_{i=1}^{9} \beta_i X_{i,t} + \sum_{j=1}^{p} \phi_j \Delta^d \psi_{t-j} + \varepsilon_t + \sum_{k=1}^{q} \theta_k \varepsilon_{t-k} \quad (2)$$
$$\varepsilon_t \sim N(0, \sigma^2)$$

where ψ_{t-j} is the residuals of the estimated Y_t at lag j, Δ is the backward shift operator, ε_t is the error term corresponding to Y_t in (eq. 2), ϕ_j is the parameter of the autoregressive part and θ_k is the parameter of the moving average part of the dynamic regression model. The coefficients of the dynamic model is estimated using maximum likelihood estimation approach.

RESULTS AND DISCUSSION

The coefficient of determination (R^2) based on equation (1) is 0.9998. This implies that 99.98% of the variation in Y_t based on (eq. 1) can be accounted for by $X_{1,t}, X_{2,t}, X_{3,t}, X_{4,t}, X_{5,t}, X_{6,t}, X_{7,t}, X_{8,t}, X_{9,t}$. Hence, the model (1) is a good fit for the data. Estimates of intercept (β_0) and coefficient of building and construction (β_4) are not significantly different from zero. Removal of building and construction ($X_{4,t}$) from the model does not reduce the performance of the model in terms of R^2 (0.9998).

Diagnostic test was carried out using Bonferroni test to know whether there were outliers in the dataset. The result of Bonferroni test shows that there is no outlier in the data. This is because unadjusted p-values are less than $2.02 \times 10^{-5}$for all observations and the highest Bonferroni p is 0.00418860 across all the observations. One of the assumptions of classical regression is that expectation of residuals is zero. To confirm if this holds, we computed the mean of residuals of the fitted values. The computed mean of residuals is -7.955292$\times 10^{-13}$. This is equivalent to zero. Hence, the assumption holds for the model.

Table 1: Estimates of coefficients of multiple linear regression model on GDP data.

Predictor variable	Estimate	Std. Error	t value	Pr(>|t|)
Intercept	4753.9359	2648.4407	1.7950	0.0742
$X_{1,t}$	1.1604	0.0181	63.9880	<2e-16 ***
$X_{2,t}$	0.9638	0.0226	42.7360	<2e-16 ***
$X_{3,t}$	28.25134	4.79544	5.891	1.67e-08 ***
$X_{4,t}$	0.44255	0.85611	0.517	0.60580
$X_{5,t}$	1.18111	0.09460	12.486	2e-16 ***
$X_{6,t}$	3.06811	0.35531	8.635	2.14e-15 ***
$X_{7,t}$	1.13391	0.51222	2.214	0.02801 *

$X_{8,t}$	-8.80443	3.19259	-2.758	0.00638 **
$X_{9,t}$	-183.87439	45.37092	-4.053	7.32e-05 ***

The result of Ljung-Box test (p-$value$=2.654×10^{-6}) showing significant autocorrelation among the residuals of model in (eq. 1) indicates that the multiple linear model in

Table 2: Estimate of coefficient of dynamic regression model for Nigeria GDP data.

Coefficient	β_1	β_2	β_3	β_5	β_6	β_7	β_8	β_9
Estimate	1.1326	0.9965	7.9974	1.0542	3.202	-2.7272	4.8224	-715.519
s.e.	0.0147	0.0119	4.0553	0.0576	0.3496	0.5991	2.6444	75.7824
Coefficient	drift	θ_1	θ_2	θ_3	θ_4			
Estimate	4363.026	-0.379	0.4156	-0.4422	0.839			
s.e.	1666.728	0.0514	0.059	0.0715	0.0482			

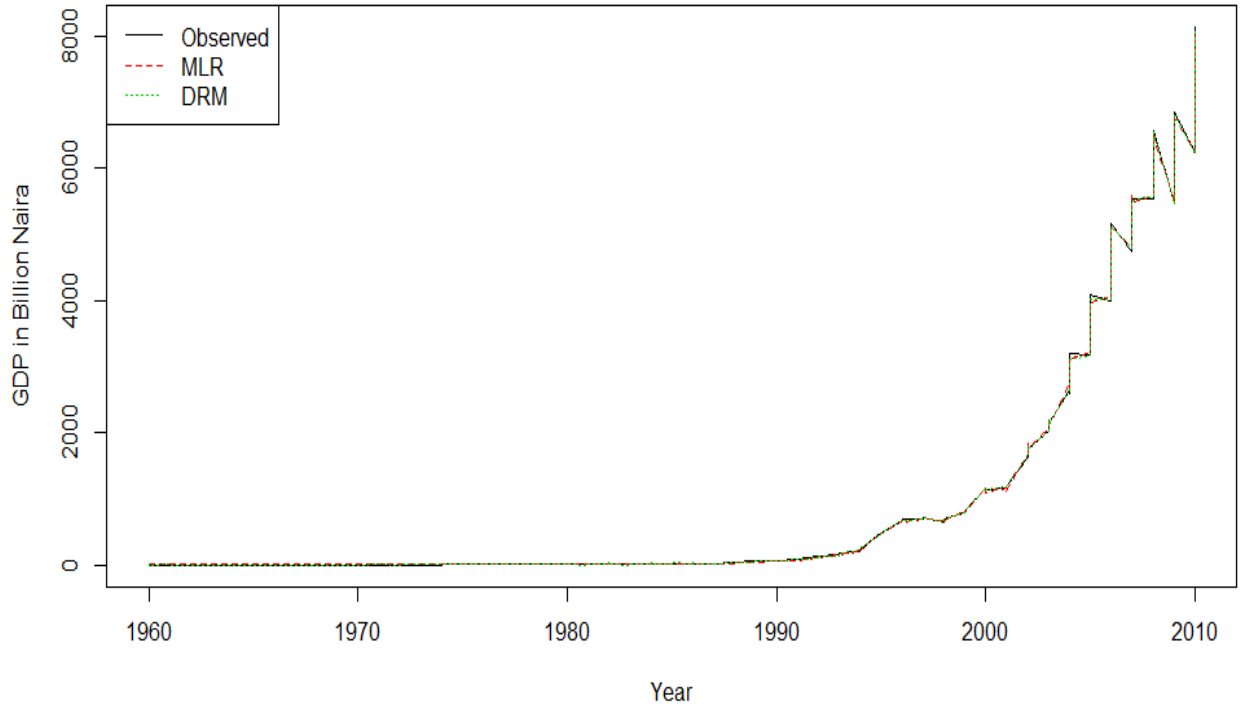

Figure 1: Comparison of observed values and the fitted values from multiple linear regression model (MLR) and dynamic regression model (DRM) on Nigerian GDP data.

(1) is not adequate in capturing the variation in Nigerian GDP. As a remedial measure, dynamic regression model (DRM) in (eq 2) can be fitted to the GDP data. The optimal model for ψ_t is ARIMA(0,1,4). The estimates of the coefficients of the dynamic model for Nigerian GDP data are presented in Table 2. The value of root mean square error of multiple linear regression is 36.8871 while the root mean square error of dynamic model is 15.8906 and the corresponding coefficient of determination R^2 is 0.9998.

The result of Ljung-Box test (p-$value$=0.7571) on residuals of dynamic regression model shows insignificant autocorrelation among the residuals of model in (eq. 2). This indicates that the dynamic regression model in (2) is adequate in capturing the variation in malaria variables.
Figure 1 represents the graph comparing the fitted values of multiple linear regression model (MLR) and dynamic regression model (DRM) with the observed quarterly GDP data. It can be deduced from the figure that both models fit the data well. Overlapping of the three lines (observed and

two fitted values) at most of the points indicates that residuals at all points are approximately zero. However, dynamic regression model fits the data better than multiple linear regression.

CONCLUSION

This study applies multiple linear regression model (MLR) and dynamic regression model (DRM) on gross domestic products of Nigeria. The performance of the two models were compared in terms of root mean square error (RMSE). Dynamic regression model achieves less RMSE. Comparison of observed data with fitted data using MLR and DRM shows that both models fit the data well. However, DRM performs better.

Analysis of data has shown that successful economic development depends essentially on solid minerals, agriculture and transport components; and open balanced interaction between various sectors over a period of time. It is observed from this studies that building and construction section does not significantly contribute to the gross domestic products of Nigeria. The negative signs on the estimates of coefficients of electricity and water may probably due to the epileptic power supply in the country and poor pipe borne water supply by the government to the masses. This implies that the Nigerian government has to look into these sectors of the economy with need to improve the sectors.

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DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

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