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RESEARCH ARTICLE

APPLICATION OF DYNAMIC REGRESSION (DR) TO MODELING OF THE GROSS DOMESTIC PRODUCT (GDP) OF NIGERIA

Biremo B.[a], Raji I.[a], and Ilugbo S.O.[b*]

[a] *Department of Statistics, Federal University of Technology Akure, Onod State, Nigeria*
[b] *Department of Physics, Lead City University Ibadan, Oyo State, Nigeria*
**Corresponding Author Email: bussytex4peace44@gmail.com*

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ABSTRACT

This study examine the significant contribution of Nigeria Stock Market towards the Gross Domestic Product. The main objective of this work is to assess the level of Stock Market stability in Nigeria by applying Dynamic Regression to modeling of Gross Domestic Product (GDP) using the Quarterly Gross Domestic Product at 1990 constant basic prices of Nigeria from the first quarter of 1985 to the third quarter of 2013. Quarterly all Share Index of the Nigerian Stock Exchange from the first quarter of 1985 to the fourth quarter of 2013 and finally Quarterly Market Capitalization of the Nigerian Stock Exchange for the same period. It was observed that the relationship is statistically significant, which allows the stock market to have an impact on the Nigerian Economy. It was concluded that Government and Economic planner should take more advantage of statistical tools in studying the relationship between the GDP movement and the Stock Exchange.

KEYWORDS

Dynamic Regression, Gross Domestic Product, Stock Exchange

1. INTRODUCTION

The Nigerian Stock Exchange provides a platform for raising long-term capital for expansion and modernization of companies and government investment activities, nurtures, and provides capital to small and medium-scale enterprises via its Second-tier Securities Market. It is a means of allocation the nation's real and financial resources, between various industries and companies and provides liquidity for the conversion of investments into cash; It is a measure of confidence in the economy and serves as an important leading index of economic activity, and provides industrial management with some idea of the current cost of capital and this can be important in determining the level and rate of new investment. It broadening the ownership base and geographically operating the nations' wealth via privatization; and ensures the survival and continuity of companies even after the death of the initial promoters of enterprises.

Nyong developed an aggregate index of stock market development and use it to determine its relationship with long-run economic growth in Nigeria (Nyong, 1997). The study employed a time series data from 1970 to 1994. The result of the study was that stock market development is negatively and significantly correlated with long-run growth in Nigeria. The result also showed that there exists bidirectional causality between stock market development and economic growth. A group researchers appraise the impact of the stock market efficiency on the economic growth of Nigeria using time series data from 1961 to 2004 (Ewan et al., 2009). They found that the stock market in Nigeria has the potential of growth but it has not contributed meaningfully to the economic growth of Nigeria because of low market capitalization, low absorptive capitalization, illiquidity, misappropriation of funds. Akinbohungbe and Adebiyi have argued separately that the capital market is very vital to the growth, development and strength of any country because it supports government and corporate initiatives, finances the exploitation of new ideas and facilitates the management of financial risk (Akinbohungbe, 1996; Adebiyi, 2005). The rate of economic growth has been linked to the sophistication of the financial market and capital market efficiency. Both markets facilitate the mobilization and channelling of funds into productive constituents and ensuring that the funds are used for the pursuit of socioeconomic growth and development without being idle.

The Nigerian capital market from 1961 has growth tremendously, particularly during the periods of the indigenization decrees of 1972 and 1977 (Sule and Momoh, 2009). The securities increased from 8 in 1961 to about 301 in 2008. Over the years, the Nigerian capital market has witnessed relatively stability and also recorded impressive growth. This has positioned it to positively impact the economy. There is clear evidence that the capital market remained an important source of capital for the nation's economic development in financing infrastructural projects, the privatization programme of the government and banking sector recapitalization in Nigeria. According to Okereke-Onyiuke the capital market has been a viable source of financing state and local government infrastructural projects and developmental strides with less pressures and lean on resources (Okereke-Onyiuke, 2000).

The Nigerian Capital Market played a paramount role in the privatization of the State Owned Enterprises (SOEs) by giving creditability and transparency to the exercise (Anyanwu et al., 1997). The bank recapitalization to N25 billion in which 25 banks emerged from the previous 89 banks clearly revealed the importance of the capital market (Soludo, 2006). In fact, most of the banks in Nigeria were able to raise the required capital after going to the capital market through initial public offerings. The main objective of this work is to assess the level of Stock Market stability in Nigeria by applying Dynamic Regression (DP) to modeling of Gross Domestic Product (GDP) of Nigeria using the Quarterly Gross Domestic Product (QGDP) at 1990 constant basic prices of Nigeria from the first quarter of 1985 to the third quarter of 2013.

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2. Methodology

2.1 Data Collection

Data used for this study were obtained from Central Bank of Nigeria Statistical Bulletin. AS mentioned earlier, the data include quarterly Gross Domestic Product at 1990 constant basic prices of Nigeria (in million Naira) from the year 1985 quarter one to 2016 quarter 4. Also included in the data is the quarterly all share index of the Nigerian Stock Exchange (NSE) from the first quarter of year 1985 to fourth quarter of year 2016. And finally, the data include the quarterly market capitalization of the Nigerian Stock Exchange for the same period The main aim of the analysis is to build a dynamic regression model with Gross Domestic Product as the dependent variable while all share index and market capitalization of the Nigerian Stock Exchange will be independent variables. This would allow us see if the Nigerian stock market have significant effects on the GDP. Instead of using the conventional multiple regression in which the residual errors e_t of the model are assumed to follow normal distribution with mean zero and with zero autocorrelations, the residual errors of dynamic regression are modeled with Autoregressive Integrated Moving Average model and the assumption of zero autocorrelation is relaxed. Since the autocorrelation of the residual errors are taken into account by dynamic regression models, the estimates of the residual variance is more accurate which lead to more accurate estimates of the model parameters accompanied by more accurate and valid statistical test of significance.

2.2 The Classical Linear Regression Model

Given an independent variable Y and independent variables $x_1, x_2, x_3, \dots, x_k$. The linear regression model between the dependent variable and the independent variables is given by:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_k + e_t \quad (1)$$

Where e_t is assumed to be white noise that follows normal distribution with mean zero and constant variance σ^2. $\beta_0, \beta_1, \beta_2, \dots, \beta_k$ are the parameters of the model usually estimated using the method of least square.

3. Results and Discussion

3.1 Exploratory Analysis

The three dataset for this study contains one hundred and four observations. Exploratory analysis was carried out on the three datasets. GDP has an estimated mean of 96215.79 (million Naira) with standard deviation 44549.28 (million Naira). Table 1 shows the Summary Statistics for the GDP per Capita Time Series

Table 1: Summary Statistics for GDP Time series (million Naira).

Minimum	First Quartile	Median	Mean	Standard Deviation	Third Quartile	Maximum
48956.05	66854.08	76229.17	96215.79	44549.28	120962.42	228208.15

Figure 1 shows the sequence chart of the GDP per capita time series. Careful inspection reveals an upward trend in the series. This is typical of economic series.

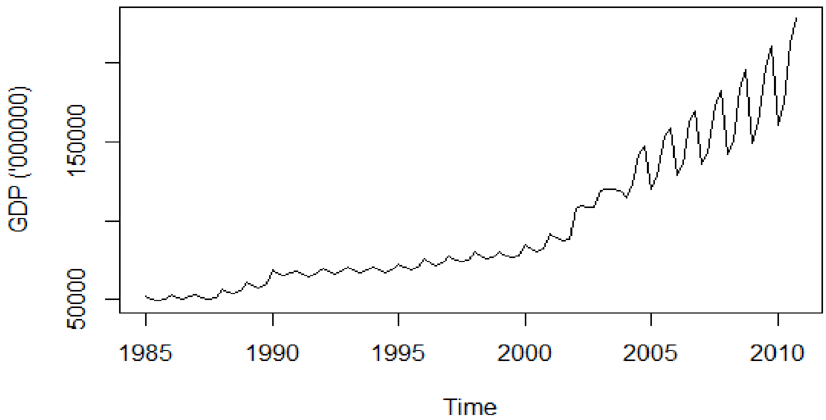

Figure 1: Sequence Chart of GDP (million Naira).

The all-share index on the NSE data has an estimated mean of 34480.87 with standard deviation 43020.11. Table 2 shows the summary statistics for NSE all share index data.

Table 2: Summary Statistics for NSE all share index.

Minimum	First Quartile	Median	Mean	Standard Deviation	Third Quartile	Maximum
336.90	2084.50	17492.60	34480.87	43020.11	63983.76	182858.86

Figure 2 shows the sequence chart of the NSE all share index. The chart shows an upward trend in the NSE all share index.

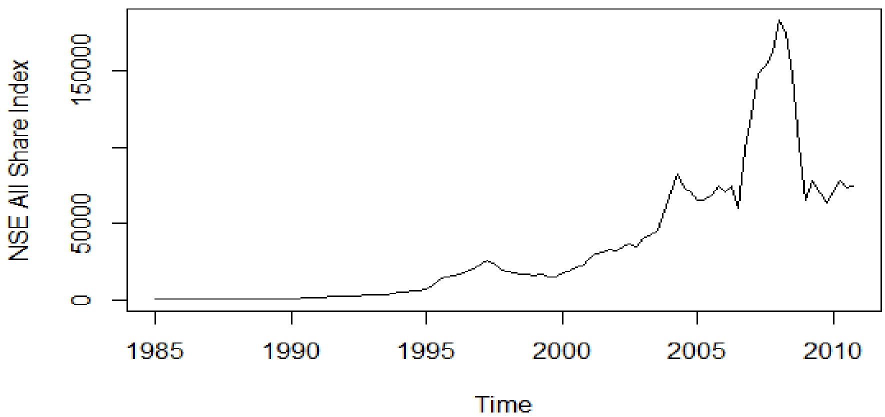

Figure 2: Sequence Chart of quarterly NSE all share index.

The quarterly NSE market capitalization (in billion Naira) series has an estimated mean 5791.317 billion Naira with standard deviation 11002.83 billion Naira. Table 3 shows the summary statistics of the NSE market capitalization time series.

Table 3: Summary Statistics of quarterly NSE market capitalization in billion naira.

Minimum	First Quartile	Median	Mean	Standard Deviation	Third Quartile	Maximum
14.58	98.87	834.22	5791.317	11002.83	5301.76	69347.87

Figure 3 show the sequence chart of quarterly NSE market capitalization time series. The sequence chart shows that the NSE market capitalization experienced a steady growth from year 1995 through to year 2007 after which there was a sudden upward movement (boom) around year 2008 to 2009.

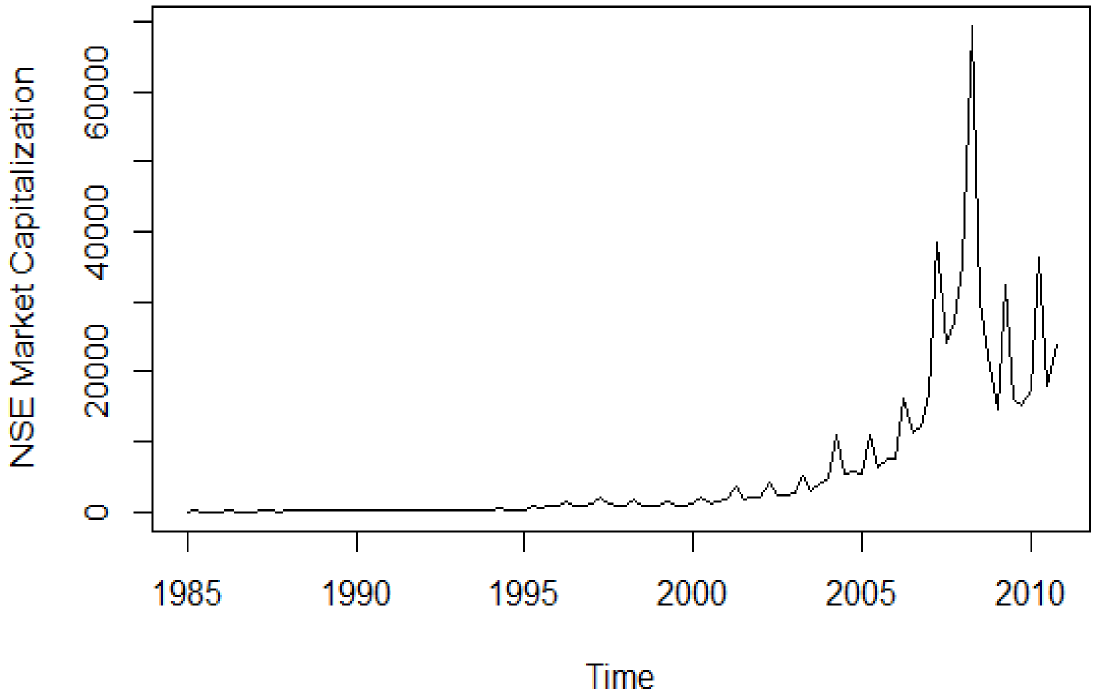

Figure 3: Sequence Chart of quarterly NSE Market Capitalization time series.

3.2 Preliminary Analysis: Data Transformation

Careful observation of the sequence charts of the three series shows that the variances of all the three series are higher at more recent periods of the series. It is necessary to transform the data in order to stabilize the variances of the three series as much as possible. For this study, natural logarithmic transformations are used on the three series so that $Y'_t = \ln Y_t$, $X'_{1t} = \ln X_{1t}$ and $X'_{2t} = \ln X_{2t}$. Figure 4 shows the natural logarithms ($Y'_t = \ln Y_t$) of GDP series; Figure 5 is a plot of the natural logarithms ($X'_{1t} = \ln X_{1t}$) of NSE all share index series; Figure 6 is a plot of the natural logarithms ($X'_{2t} = \ln X_{2t}$) of NSE market capitalization series. Careful inspection of the new charts shows that the logarithmic transformation produced much more stable variance in the three series. Hence the transformed series will be used from here onward.

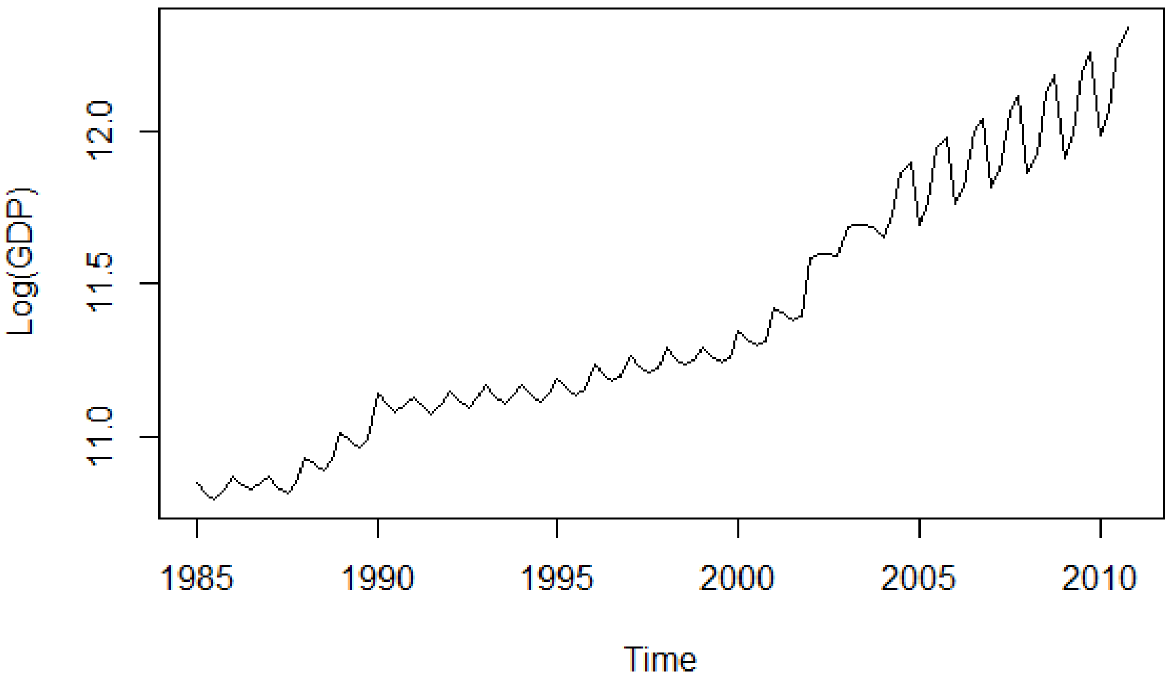

Figure 4: Sequence Chart of Log GDP.

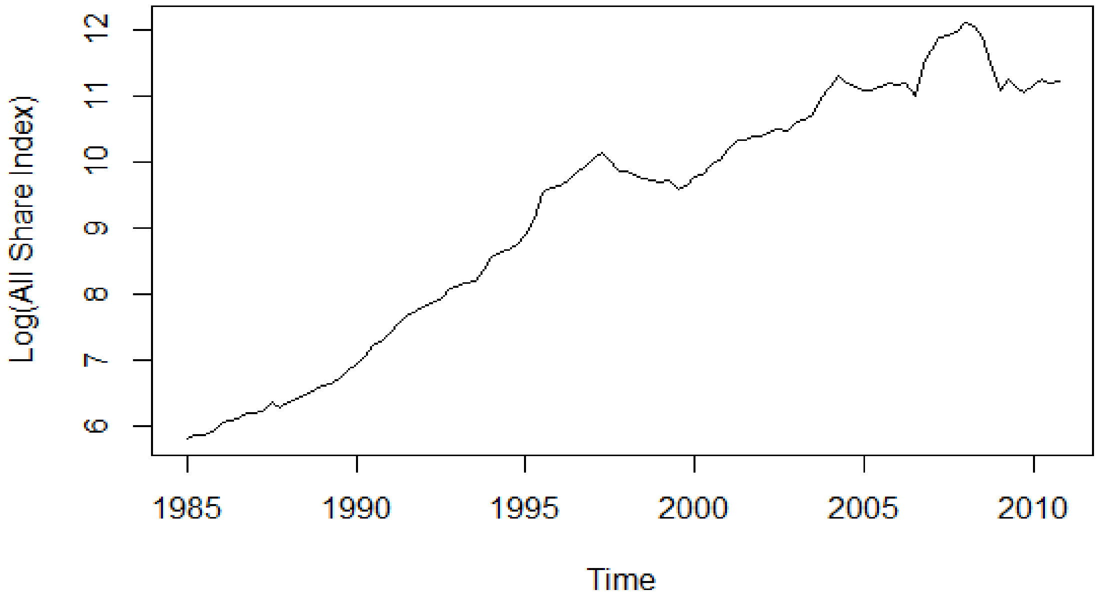

Figure 5: Sequence Chart of Log NSE All Share Index.

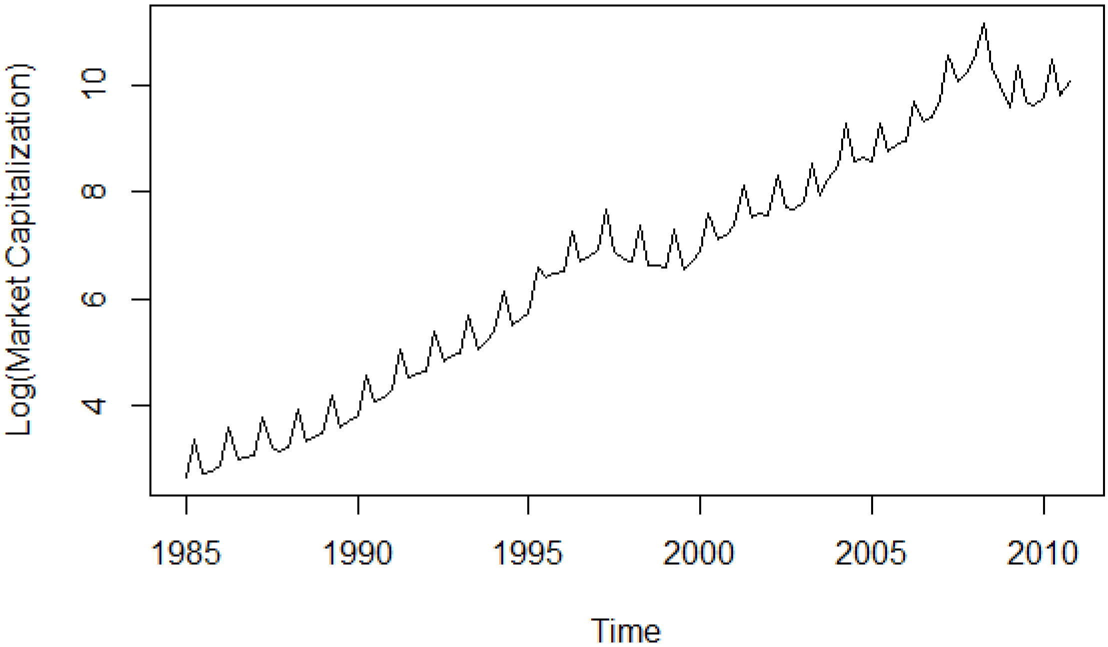

Figure 6: Sequence Chart of Log NSE Market Capitalization.

3.3 Model Estimation, Checking and Reformation.

3.3.1 Tentative Model 1

In order to build the dynamic regression model, we first start with the conventional multiple regression model in which the output variable is the log of GDP series and the two independent variables are the log of NSE all share index and log of NSE market capitalization. The parameters of the model are estimated using the ordinary least estimation method (OLS).

The mathematical specification of this model is given by:

$$Y'_t = C + b_1 X'_{1t} + b_2 X'_{2t} + e_t \quad (2)$$

where $e_t \sim N(0, \sigma^2)$. It is also assumed that e_t do not have significant correlations with previous lags of itself.

The estimates of b_1 and b_2, the parameters of the model defined in equation 2 is presented in the output below (Table 4).

Table 4: Estimation Results of Model 2

Coefficients	Estimate	Standard Error		t value	P-value.
Intercept	10.76408	0.14467		74.405	< 2e-16
b_1	−0.12043	0.03473		-3.467	0.000774
b_2	0.26003	0.02806		9.268	3.67e-15
Residual standard error	0.1409	R Squared	0.8887	Adjusted R Squared	0.8865

The specification of model 2 with the estimated parameters is now given by

$$Y'_t = 10.764 - 0.120X'_{1t} + 0.260X'_{2t} + e_t \quad (3)$$

The absolute t values of all estimated parameters of the model are more than 2, hence all the estimated parameters are significant and they seem to be contributing well to the model 3. Also, the R squared and adjusted R square are in the 88 percent range, this implies that both X'_{1t} and X'_{2t} account for up to 88 percent of the variations in Y'_t. Model 3 seems to be a good fit from the above conclusions motivated by the test of significance.

But before we can confirm these conclusions, we have to observe the autocorrelation pattern of the residuals e_t as significant autocorrelations in e_t will invalidate the results of the test statistics and hence provide misleading conclusion. To get the residuals e_t, rearrange model 3 to get:

$$e_t = Y'_t - 10.764 + 0.120X'_{1t} - 0.260X'_{2t} \quad (4)$$

Shown below in Figure 3.7 is the plot of Sample Autocorrelation Function of the residuals e_t. The plot shows that there are still significant autocorrelations in e_t. This implies that one of the conditions of the Linear Regression model which states that e_t is a random shockwith noautocorrelation patterns has been broken. Hence all the test of significance of the parameters $b_1$and b_2 is invalid and it is therefore misleading to conclude that model 3 is a good model.

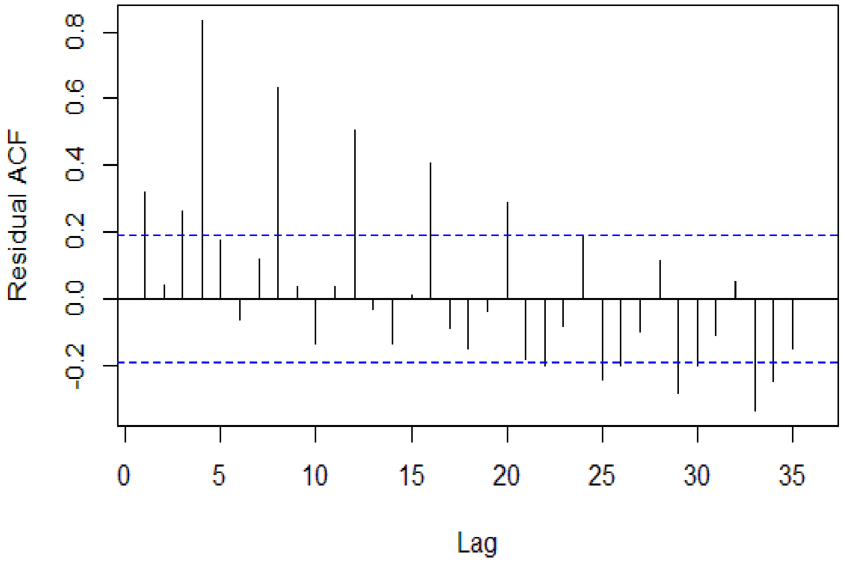

Figure 7: Residual SACF plot for model 3.

To further investigate this point, table 5 below shows the output of Ljung-Box test for significant autocorrelations in e_t. The reported p-value (0.001023) is less than 0.05, hence we reject the null hypothesis that e_t do not have significant auto correlations and conclude that the residuals e_t is indeed correlated with previous lags of itself.

In addition, a plot of the residuals e_t against time will also show if e_t a white noise is indeed or if it has patterns (motivated by autocorrelations). Figure 8 below show the plot of the residuals against time. Notice that the residuals do follow a pattern and hence e_t is not a white noise.

Table 5: Ljung-Box Test for Residuals e_t of Model 3

LJUNG-BOX TEST		
Test Statistics	Degree of Freedom	P-Value
10.786	1	0.001023

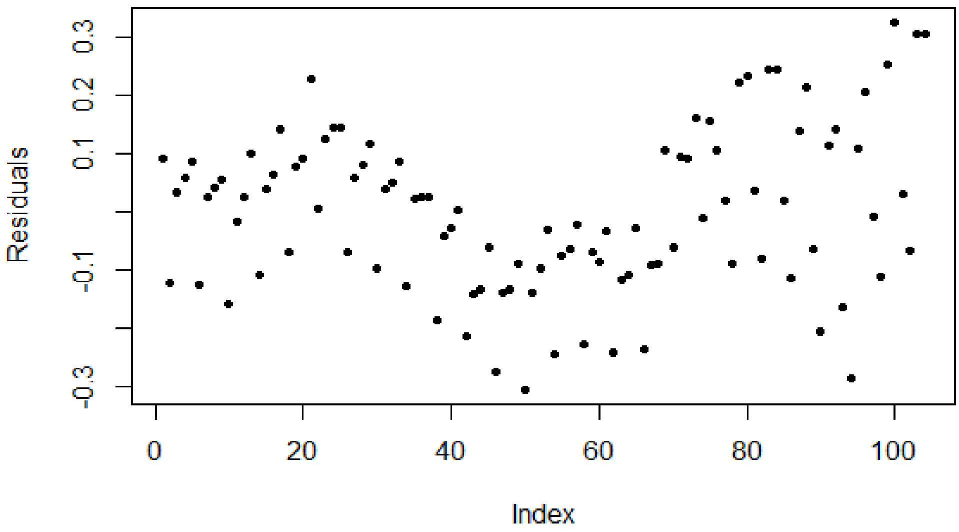

Figure 8: Plot of Residuals e_t against time index.

Since there are significant autocorrelations in the residuals e_t, it is paramount to modify the regression model to reflect or capture the autocorrelation pattern of the residuals. Careful observation of Figure 7 and Figure 8 reveals that the residuals e_t series is not stationary and hence a non-seasonal differencing of order (d = 1) may help in achieving stationary. This will give us a simple tentative ARIMA model for the residuals e_t defined by:

$$\nabla e_t = a_t \quad (5)$$

where$\nabla e_t = (1 - B)e_t = e_t - Be_t = e_t - e_{t-1}$ and it is assumed that $a_t \sim N(0, \sigma^2)$

Model 5 above also implies that the residuals e_t will be represented by zero mean a_t. Since model 5 above is only a tentative model for the residuals e_t, further differencing more than order $d = 1$ may be needed to totally capture the autocorrelation patterns e_t. Hence we rewrite model 3.4 as $e_t = \frac{a_t}{\nabla}$ and substitute into model 2. Multiplying through by ∇ will give us a new tentative (dynamic) regression model that captures part of the autocorrelation patterns in e_t. Mathematical specification of this new tentative dynamic regression model is given by:

$$\nabla Y'_t = C + b_1 \nabla X'_{1t} + b_{2\nabla} X'_{2t} + a_t \quad (6)$$

where it is assumed that $a_t \sim N(0, \sigma^2)$ and that a_t is a random shock with insignificant autocorrelation patterns.

3.3.2 *Tentative Model 2*

Model 6 above implies that the input and output series of the model will be differenced with order $d = 1$ before estimation of parameters. After the parameters b_1 and b_2 are estimated, we'll have access to the residuals a_t and further analysis of a_t series will allow us capture more autocorrelation patterns of the residuals in the next dynamic regression model. The parameters of model 3.5 can be estimated using the ordinary least square estimation method. Table 6 below shows the estimates of the dynamic regression model 6.

<table>
<tr><th colspan="6">**Table 6:** Estimation Results of Model 5.</th></tr>
<tr><td>Coefficients</td><td>Estimate</td><td colspan="2">Standard Error</td><td>t value</td><td>P-value.</td></tr>
<tr><td>Intercept</td><td>0.016144</td><td colspan="2">0.009392</td><td>1.719</td><td>0.0887</td></tr>
<tr><td>b_1</td><td>0.001591</td><td colspan="2">0.074949</td><td>0.021</td><td>0.9831</td></tr>
<tr><td>b_2</td><td>−0.025064</td><td colspan="2">0.018710</td><td>−1.340</td><td>0.1834</td></tr>
<tr><td>Residual standard error</td><td>0.08751</td><td>R Squared</td><td>0.01942</td><td>Adjusted R Squared</td><td>−0.0001912</td></tr>
</table>

The specification of model 3.5 with the estimated parameters is:

$$\nabla Y'_t = 0.016144 + 0.001591\nabla X'_{1t} - 0.025064\nabla X'_{2t} + a_t \quad (7)$$

The absolute t values of all estimated parameters in model 7 is less than two which implies that the estimated parameters are not significant at 5 percent confidence level as can be seen from the p-value column. Note however that the residual standard error has reduced in model 7 (0.08751) as compared to that of model 3 (0.1409). This implies that by capturing part of the autocorrelation patterns of the residuals e_t of model 3 in 7, we have experienced an improvement in the model as indicated by the reduced residual standard error. Parameters b_1 and b_2 becoming insignificant in model 7 actually buttress the argument that the statistical test of significance for b_1 and $b_2$in model 3 are invalid because of the autocorrelations present in e_t of model 3. To capture more pattern of the residuals e_t of model 3, we have to analyze the residuals a_t of model 7 and see if a_t is indeed white noise or if it has autocorrelation patterns.

Figure 9 below shows a plot of the residual sample autocorrelation function (SACF) of a_t of model 3.6. In addition, Figure 10 also shows a plot of the sample partial autocorrelation function (SPACF) of the residuals a_t.

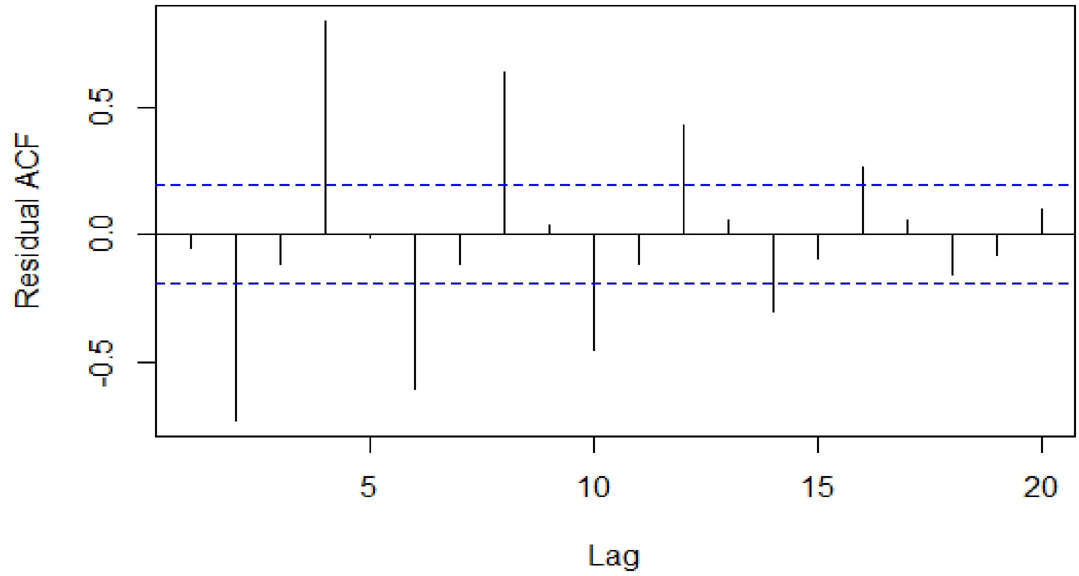

Figure 9: Residual SACF plot for model 7

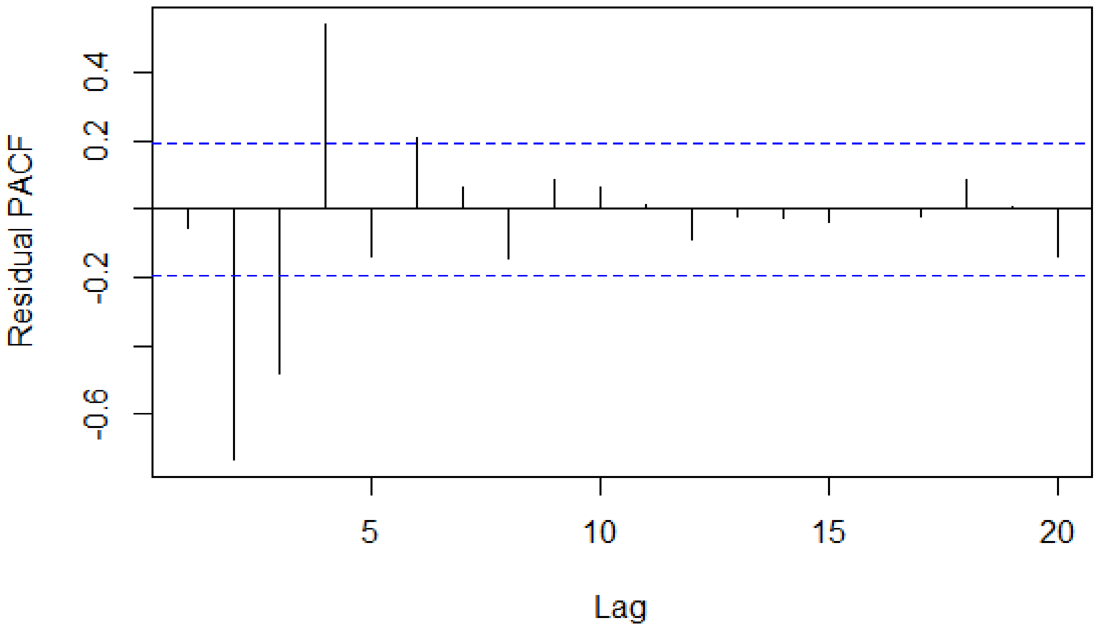

Figure 10: Residual SPACF plot for model 7

On examining Figure 9 above, the non-seasonal differencing of order seems to have helped in achieving stationarity in the residuals e_t of model 3 because the autocorrelations decay sharply to zero. However, there are still significant autocorrelations especially at lags s = 4, 2s, 3s and 4s that seem to be much more complex. The PACF plot in Figure 10 reveals three significant partial autocorrelations at lags 2, 3, and 4. This implies that an Autoregressive model of order 3 AR (3) is a possible candidate for the residuals a_t. The residuals ACF plot in figure 3.9 also show a significant autocorrelation at lag 2 which implies that moving average model of order 1 MA(1) or moving average of order 2 MA (2) are possible candidates. After trying some few models in this range, ARMA (3,2) is selected as the best model as it produced the lowest BIC value.

3.4 The Final Dynamic Regression Model.

From the two tentative models above, we have identified a tentative ARIMA (3,1,2) model for the residuals e_t of model 2 and 3. In backshift notation form, this model is given by:

$$(1-\phi_1 B-\phi_2 B^2-\phi_3 B^3)\nabla e_t=(1-\theta_1 B-\theta_2 B^2)a_t \quad (8)$$

where $\nabla e_t=(1-B)e_t=e_t-Be_t=e_t-e_{t-1}$ and it is assumed that $a_t\sim N(0,\sigma^2)$.

Solving Model 8 for e_t gives

$$e_t=\frac{(1-\theta_1 B-\theta_2 B^2)a_t}{\nabla(1-\phi_1 B-\phi_2 B^2-\phi_3 B^3)} \quad (9)$$

Substituting e_t in model 2 gives

$$Y'_t=C+b_1X'_{1t}+b_2X'_{2t}+\frac{(1-\theta_1 B-\theta_2 B^2)a_t}{\nabla(1-\phi_1 B-\phi_2 B^2-\phi_3 B^3)} \quad (10)$$

Multiplying 10 through by ∇ gives the specification of our final dynamic regression shown below:

$$\nabla Y'_t=C+b_1\nabla X'_{1t}+b_2\nabla X'_{2t}+\frac{1-\theta_1 B-\theta_2 B^2}{1-\phi_1 B-\phi_2 B^2-\phi_3 B^3}a_t \quad (11)$$

where $\nabla Y'_t=Y'_t-Y'_{t-1}$; $\nabla X'_{1t}=X'_{1t}-X'_{1t-1}$; $X'_{2t}=X'_{2t}-X'_{2t-1}$ and it is assumed that a_t is white noise with mean zero. Table 7 shows the results of the estimated parameters of model 11.

Table 11: Estimation Results of Model 11.

Coefficients	Estimate	Standard Error		t value		Sig.	
Intercept	0.0129	0.0023		5.609		<0.05	
ϕ_1	−0.9635	0.0429		−22.459		<0.05	
ϕ_2	−0.9689	0.0377		−25.700		<0.05	
ϕ_3	−0.9689	0.0364		−25.629		<0.05	
θ_1	0.9179	0.0962		9.542		<0.05	
θ_2	0.4124	0.0900		4.582		<0.05	
b_1	−0.0204	0.0280		−0.729		>0.05	
b_2	0.0223	0.0283		0.788		>0.05	
Residual standard error	0.001042	AIC	−387.22	AICc	−385.28	BIC	−363.51

Substituting the estimated parameters into model 3.10 gives

$$\nabla Y'_t=0.0129-0.0204\nabla X'_{1t}+0.0223\nabla X'_{2t}+\frac{1-0.9179B-0.4124B^2}{1+0.9635B+0.9689B^2+0.9689B^3}a_t \quad (12)$$

The residual standard error of model 12 (0.001042) is reduced compared to that of model 3.6. This improvement is because model 12 is able to capture more of the autocorrelation patterns of the residuals e_t of model 2. Also, the reported Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) are quite small indicating that model 12 is a very good fit. Before drawing further conclusions, it paramount to analyze the residuals a_t of model 12, it is assumed that a_t follows normal distribution with mean zero and constant variance i.e. $a_t\sim N(0,\sigma^2)$. Also a_t is assumed to be white noise or random shock with zero or insignificant autocorrelation patterns. Shown below in Figure 11 is the plot of the sample autocorrelation function of the residuals a_t. The plot supports the assumption or claim that a_t do not have any significant autocorrelation patterns as all in the autocorrelations are within the dotted blue dashed line. This is further confirmed by Ljung-Box test presented in Table 12. The p-value (0.7575) is greater than 0.05, hence we do not reject the null hypothesis of zero autocorrelation.

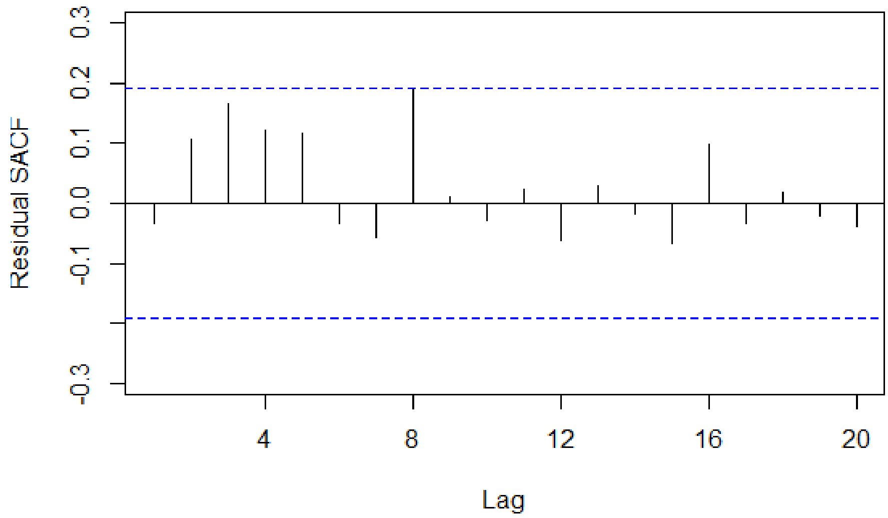

Figure 11: Residual SPACF plot for model 3.11

Table 12: Ljung-Box Test for residuals e_t of Model 3

LJUNG-BOX TEST		
Test Statistics (χ^2)	Degree of Freedom	P-Value
0.0954	1	0.7575

Figure 12 below show the histogram of the residuals a_t. The histogram shows that a_t does not depart much from normal distribution. The histogram also show that a_t has mean zero (as indicated by the blue vertical line). Figure 13 showing the quantile-quantile plot of a_t also supported the normality assumption as the quantiles do not depart much from the dashed red line.

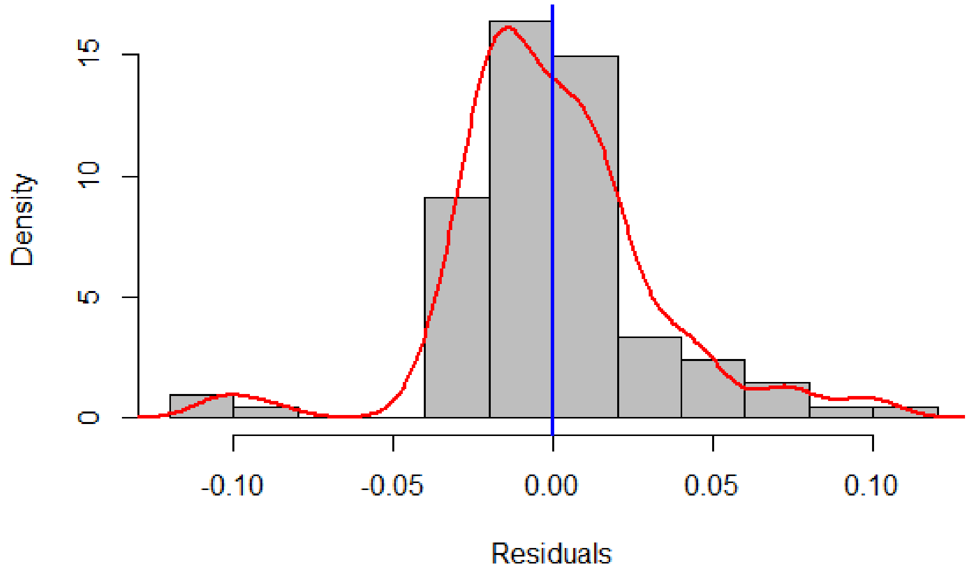

Figure 12: Histogram of residuals of model 12

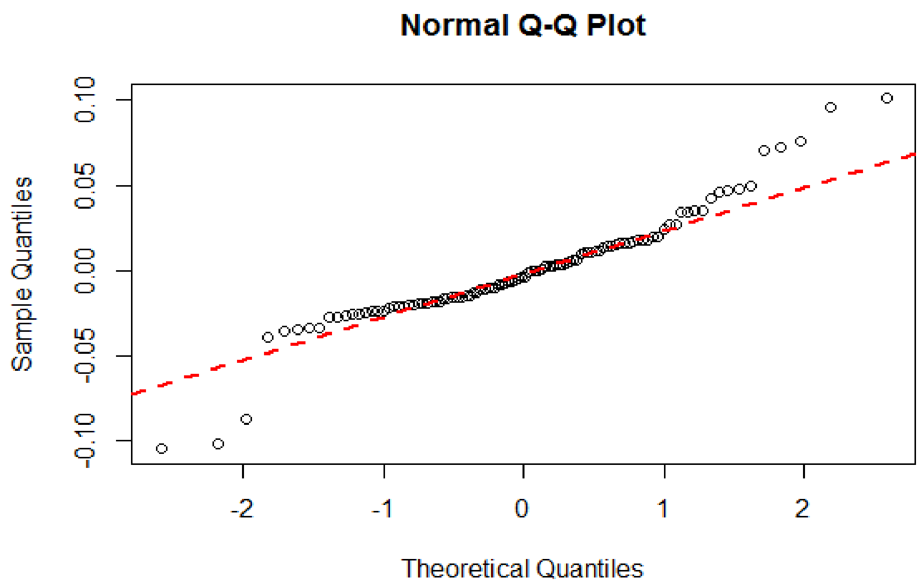

Figure 13: Q-Q plot of residuals of model 12

So having confirmed that residuals a_t of model 12 satisfy all the necessary conditions as checked above, we can conclude that model 3.11 is a good fit for $Y'_t = \ln Y_t$.

3.5 Model Interpretation and Discussion

3.5.1 3 Model Coefficients

Surprisingly, the coefficient of $\nabla X'_{1t}$ is negative. Literally, this means that as the all share index of the Nigerian Stock Exchange increases, the Gross Domestic Product at constant basic prices reduces. Note however that the coefficient b_1 of $\nabla X'_{1t}$ is not significant, hence conclusion above is not valid. The implication of an insignificant b_1 is that the all share index of the NSE does not significantly contribute enough to the model as against what is suggested by the test of significance of model 3. This confirms once again that autocorrelated residuals do invalidate test of significance of model parameters.

The coefficient of $\nabla X'_{2t}$ is positive indicating that as the market capitalization of the NSE increases, the GDP increases. However, the coefficient b_2 of $\nabla X'_{2t}$ is also insignificant to conclude that the market capitalization indeed affect or contribute to the growth of the Gross Domestic Product.

The coefficients $\phi_1, \phi_2, \phi_3, \theta_1, \theta_2$ of the residuals a_t and the intercepts of the model all contribute significantly to the model as they are all significant at 0.05 level.

3.5.2 Forecasting

Because of the initial transformation of Y_t using natural logarithms, the output of the dynamic regression model will also be in the log metric. Forecast outputs and their respective confidence intervals can be re transformed back to the original scale by taking the exponent. Specifically, if $f(t)$ is a forecast for time t from the DR model with an associated confidence interval $f \pm 2s$ where s is the standard error of the forecast, the corresponding forecast in the original scale is $\exp[f(t)]$ and the corresponding confidence interval is $\exp\,[f \pm 2s]$.

Future values of X_{1t} and X_{2t} are needed in order to forecast for Y_t. The two input series will be initially transformed using natural logarithms before they're used for forecasting.

To forecast Y'_t, X'_{1t} and X'_{2t} are fixed into the regression part of the DR model. This forecast value is then modified using the ARIMA model for the forecast errors e_t that would occur if X'_{1t} and X'_{2t} only were used in forecasting Y'_t (the forecast errors of model 4.2).

3.5.3 Forecasts

Twenty forecasts (from 2012 to 2016) of the dynamic regression in natural logarithms are shown in table 13.

Table 13: Forecasts for Y'_t from 2013 Q1 to 2017 Q4 in natural logarithms			
Time	**Forecast**	**Lower (95%)**	**Upper (95%)**
2013 Q1	12.1939	12.05228	12.33552
2013 Q2	12.2501	12.09679	12.40341
2013 Q3	12.41718	12.26131	12.57306
2013 Q4	12.46411	12.30803	12.62020
2014 Q1	12.25511	12.08957	12.42065
2014 Q2	12.30137	12.12610	12.47663
2014 Q3	12.46153	12.28401	12.63906
2014 Q4	12.50948	12.33166	12.68731
2015 Q1	12.14432	12.08643	12.56127
2015 Q2	12.32986	12.15607	12.63544
2015 Q3	12.46531	12.08303	12.52874
2015 Q4	12.57521	12.26398	12.76382
2016 Q1	12.1785	12.02516	12.24175
2016 Q2	12.32174	12.22538	12.63259
2016 Q3	12.37824	12.28637	12.47012
2016 Q4	12.46834	12.00752	12.63679
2017 Q1	12.13189	12.02152	12.24225
2017 Q2	12.19334	12.06793	12.31875
2017 Q3	12.35861	12.24011	12.49712
2017 Q4	12.42078	12.29215	12.54941

The corresponding retransformed forecasts of Y_t along with the corresponding 95% percent confidence interval are shown in Table 14.

Table 14: Forecasts for Y_t from 2012 Q1 to 2017 Q4 in original scale.			
Time	**Forecast**	**Lower (95%)**	**Upper (95%)**
2012 Q1	185700.107	166295.771	207368.651
2012 Q2	197470.148	174195.179	223854.986
2012 Q3	235298.918	206923.793	267565.078
2012 Q4	247900.566	217978.464	281930.103
2013 Q1	197580.013	171489.594	227639.828
2013 Q2	209002.020	179295.906	243629.904
2013 Q3	247009.249	211357.450	288674.796
2013 Q4	258878.442	221466.460	302610.371
2014 Q1	15386244.7	14358005.2	17868563.3
2014 Q2	1608918.54	15462549.0	18662138.7
2014 Q3	17478331.1	15216210.2	19308369.7
2014 Q4	18124751.2	16226762.3	20323614.3
2015 Q1	16251953.5	14765438.6	18367652.4
2015 Q2	16458522.1	14227064.7	18924643.6
2015 Q3	17986491.9	15298374.2	19341677.1
2015 Q4	18516193.5	16195264.8	20475342.3
2016 Q2	186978.831	171319.550	204069.431
2016 Q3	224283.133	204605.697	245852.996
2016 Q4	237576.080	216721.964	260436.886
2017 Q1	164875.427	158731.952	196735.023
2017 Q2	171904.427	164751.684	214074.751
2017 Q3	187559.437	179415.796	247426.512
2017 Q4	191455.607	165882.420	263029.738

Figure 14 hows the plot of the forecasted GDP values in natural logarithmic scale while Figure 15 shows the corresponding forecasts in the original scale.

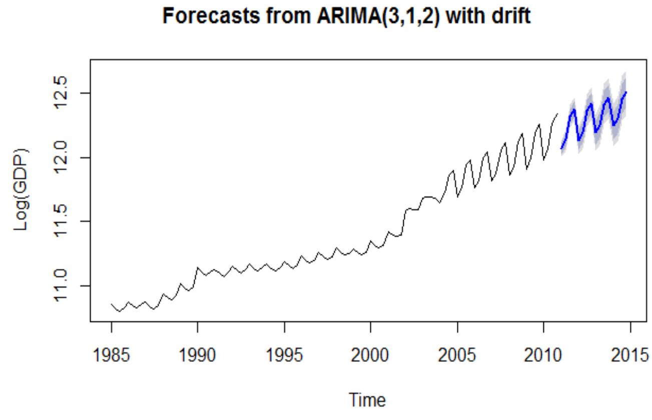

Figure 14: Plot of forecasts for Y'_t with shaded confidence interval.

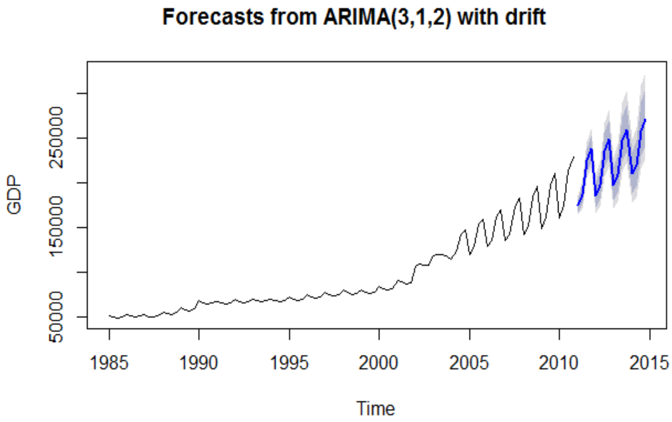

Figure 15: Plot of forecasts for Y_t with shaded confidence interval.

Notice the narrow confidence interval in the two plots. This is an indication of small standard errors of the forecast which in turn is an indication of a good fit.

3.5.4 Model Accuracy Measures

The forecasts of the dynamic regression model were compared with the actual values. The actual observed GDP at 1990 constant basic prices values for 2011 quarter 1 to 2013 quarter 3 (11 data points) were obtained from the Nigerian Bureau of Statistics (NBS) GDP report. The actual GDP (at 1990 constant prices) value for 2013 quarter 4 could not be obtained because of the rebasing of GDP (2010 constant prices were used in adjusting the GDP instead of 1990 constant prices) exercise done by NBS in the first quarter of year 2014. Table 15 shows the actual observed and forecasted values for 2011 through 2013 quarter 3.

Table 15: Comparison of actual and observed values with errors				
Time	**Forecast**	**Observed**	**Error**	**Percent Error**
2012 Q1	185700.107	182119.44	-3580.667	-1.966109164
2012 Q2	197470.148	199831.56	2361.412	1.181701229
2012 Q3	235298.918	243263.1	7964.182	3.273896452
2012 Q4	247900.566	263678.91	15778.344	5.983923401
2013 Q1	197580.013	194063.45	-3516.563	-1.812068682
2013 Q2	209002.02	212182.42	3180.4	1.498898919
2013 Q3	247009.249	259839.44	12830.191	4.937738089
2014 Q1	15386244.7	15438679.5	52434.8	0.339632673
2014 Q2	1608918.54	16084622.3	-4563.1	-0.028369332
2014 Q3	17478331.1	17479127.5	796.4	0.004556291
2014 Q4	18124751.2	18150356.4	25605.2	0.141072711
2015 Q1	16251953.5	16050601.3	201351.7	1.254480728
2015 Q2	16458522.1	16463341.9	4819.8	0.029275951
2015 Q3	17986491.9	17976234.5	-10257.4	-0.057060893
2015 Q4	18516193.5	18533752.1	17558.6	0.094738506

Table 16 shows the popular forecast accuracy measures for the forecasts produced by dynamic regression model 12. The training set measures how close the fitted values are to the actual observed values while the test set measures how the forecasts are close to the observed values.

Table 16: Some forecast accuracy measures for model 12

Measures	Training Set	Test Set
RMSE	0.0320	0.0311
MAE	0.0230	0.0263
MAPE	0.2009	0.2133
MASE	0.4129	0.4747

Table 16 shows quite small error measures for both the training and test set so we can conclude that our model is a good fit. Figure 16 is the plot of the observed and fitted/forecasted values. The black vertical line indicates the end of the estimation period.

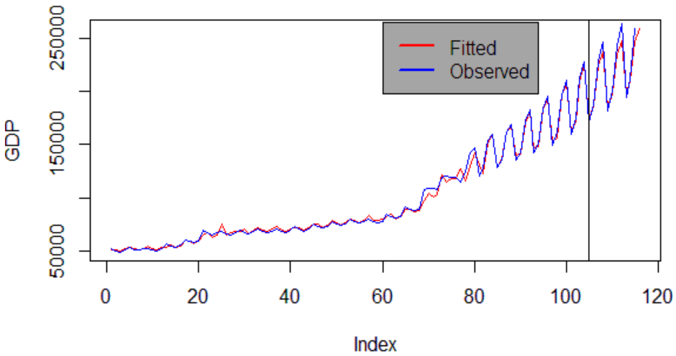

Figure 16: Plot of forecasts and fitted values for Y_t .

4. Summary

Stock market is seen as having impact on any economy particularly on its economic growth. As a result, countries over the world have embarked upon various policy measures at improving stock market. Monetary authorities and Policy makers in Nigeria are not left out in this line reasoning. Hence, successive governments have been making concerted efforts at improving the stock market. Creation of a favorable stock market and investment climate for improving stock market has been one of the central policies of the past President Olusegun Obasanjo's administration. As a result, the outcome of this is the unprecedented awareness and growth recorded in the stock market. The primary objective of this study is to examine the relationship between the stock market and Nigeria's GDP. This is achieved through the use of the dynamic regression to modelling of Gross Domestic Product (GDP) of Nigeria, sourced from the Central Bank of Nigeria Statistical Bulletin. The study also gave an opportunity for the assessment of market capitalization in the stock market on economic growth in Nigeria. The regression results confirm that there exists a positive relationship between the stock market and the Nigerian economy. The relationship is statistically significant; this in essence means that the impact of the stock market on the Nigerian economy is strong and significant.

5. Conclusions

In this study, the quarterly Gross Domestic Product was modeled using dynamic regression method. The dataset used in modeling was obtained from the CBN statistical bulletin and it includes quarterly Gross Domestic Product at 1990 constant basic prices of Nigeria (in million Naira) from the year 1985 to year 2010, quarterly all share index of the Nigerian Stock Exchange (NSE) from 1985 to 2016 and quarterly Nigerian Stock Exchange Market Capitalization (equities only) in billion Naira for the same period. The quarterly Gross Domestic Product is the dependent variable while quarterly All Share Index and Market Capitalizations are the independent variables after being transformed using natural logarithm to stabilize the variance. Modeling was done using R programming language with 'forecast' package. Two tentative models were fitted in order to arrive at the final dynamic regression model. The first tentative model is a classical multiple linear regression model.

This model gives us access to the residuals e_t so that they can be modeled using ARIMA so as to capture more information in the subsequent model. The final dynamic regression model proved to be quite a good fit with a very small residual standard error of 0.001042, a small Akaike Information Criterion of −387.22 and small Bayesian Information Criterion −363.51. Residual Analysis carried out showed insignificant autocorrelations between the residuals at different lags. The residual also follow the normality assumption satisfying all the residual assumptions. The fitted dynamic regression model was used in forecasting future values in order to access the prediction accuracy of the model.

The actual observed values and forecasts were compared and some model accuracy measures were computed. The computed accuracy measures had small values both in the test and training set indicating a good model fit. The relationship is statistically significant, which shows that the stock market has an impact on the Nigerian Economy. From the study, government and economic planner should take more advantage of Statistical tools in studying the relationship between the GDP movenement and the Stock Exchange. This will help in economic planning. Further research could be done to determine more economic variables that affect the GDP. These variables could be added to the dynamic regression model in order to improve prediction accuracy.

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