**INVESTIGATING THE IMPACT OF HETEROSKEDASTICITY AND STRUCTURAL BREAKS ON REGRESSION MODEL OF SOME NIGERIA’S MACROECONOMIC VARIABLES.**

**By**

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**Abstract**

This study investigated the impact of heteroskedasticity and structural breaks on regression model on data of some macroeconomic variables namely, Revenue, Expenditure, Foreign Direct Investment and Exchange rate on Nigerian Gross Domestic Product obtained from Central Bank of Nigeria (CBN) for the period 1961-2010 in the presence of heteroskedasticity in Nigeria. Data analysis utilized the Weighted Least Squares method, White’s test and the Bai and Perron structural breaks approach. Results showed the existence of heteroskedasticity and the regression model with correction for heteroskedasticity showed that Revenue, Expenditure, Foreign Direct Investment provided positive and significant effects on GDP while the Exchange rate had negative effects on GDP while the regression model with heteroskedasticity showed that Revenue, Expenditure, Foreign Direct Investment significantly affect GDP positively while Exchange rate has negative effect on the GDP. The model with correction for heteroskedasticity is by far more efficient than the model without correction for heteroskedasticity as evidenced by the information criteria. Finally, the Bai-Perron multiple breakpoint test identified five (5) breaks within this periods namely; 1973, 1980, 1987, 1994 and 2001 and the changing breaks is an indicator of weak policies unhealthy for economic growth.

**Keywords:** Model, Macroeconomic variables, Heteroskedasticity, Structural breaks

**1.0 Introduction**

The basic responsibility of any government is to ensure that her citizens are secured, enjoy freedom and have good welfare scheme among others. To perform these among other subsidiary functions, governments require adequate funding. However, the size, structure and growth of government expenditure have increased tremendously and become increasingly large over the years especially in developing countries following their fast growing population and low technological development. In Nigeria for instance, the Population and Housing Census of 2006 put the population at 140,431,790 and this increased to 181,403,148 in the year 2014 with a growth rate of 3.2% between 2006 and 2014 (NBS 2015). According to World Population Review of 2019, the population of Nigeria has increased to203,234,841 with a growth rate of 2.6%.

Nigeria as a country is located in West Africa. It lies between 41.6o and 13.53o North of Latitude and 2.40o and 14.41o East of Longitude and is bordered in the West, North, East and South by Republic of Benin, Niger, Chad and Cameroun and Atlantic Ocean respectively.

The Nigerian economy depends largely on oil revenue for execution of its basic functions and economic development programmes. Of course, oil prices and hence, oil revenue is determined by foreign exchange which is influenced by forces of demand and supply moreso as exchange rate is affected by the factors such as relative prices of the commodities, rate of inflation, and interest rates.

The Nigerian economy has been slow in development following high dependency on foreign goods and services which necessitated the demand for foreign direct investment into the country for which the government of Nigeria has taken some measures necessary to attract foreign investors. These measures included the repeal of laws that are inimical to foreign investment growth, promulgation of investment laws, various oversea trips for image laundry among others.

The essence of investigating the effect of revenue, expenditure, foreign direct investment and exchange rate on Nigerian Gross Domestic Product by providing a model that explain the behavior of the variables under consideration will help in policies that will boost Gross Domestic Product. However, modeling these variables using the classical regression model leads to inefficient estimates. Furthermore, the changing governments, changing policies and market forces have the ability of introducing heteroskedasticity and even structural breaks with own impact on the predictive ability of the model.

**2.0 Literature Review**

Works on modeling the effect of revenue and expenditure on gross domestic product include that of Easterly and Rebelo (1993) in their study on impact of government expenditure and income on gross domestic product using regression analysis found that government activities as pertaining macroeconomic variables influence the direction of economic growth in Nigeria. In the same vein, Devarajan *et al.* (1996), in their study on effect of expenditure on economic growth used panel data for fourteen (14) developed countries for a period ranging from 1970 to 1990 and applied the ordinary least square method on 5-year moving average. They took various functional types of expenditure (health, education, transport, etc) as explanatory variables and found that health, transport and communication have significant positive effect while education and defense have a negative impact on economic growth.

Ogbulu (2009), investigated the relationship between budgetary operation and economic growth. In this study, gross domestic product was regressed on six-predictor variables including Oil Revenue, Non-Oil Revenue, Administrative Expenditure, Economic Expenditure, Social Expenditure and Transfer Expenditure of period each spanning thirty-seven years. Using the error correction model approach, he showed the inability of oil revenue to strongly cause an increase in the output level of gross domestic product in the short-run is occasioned by the fact that most equipment, technology, fund and even expert manpower used in the oil sector are imported.

Bleaney *et al.* (2001) studied the impact of government spending on economic growth. They applied ordinary least square and generalized least square methods and found that productive public expenditures enhance economic growth, but non-productive public spending does not.

Adeleke *et al.* (2014) investigated the impact of foreign direct investment on Nigeria economic growth over the period of 1999-2013 using secondary data sourced from various publications of Central Bank of Nigeria, such as; statistical bulletin, annual reports and statement of accounts. The study employed regression analysis of the ordinary least square and revealed that economic growth is directly related to inflow of foreign direct investment and it is also statistically significant at 5 % level which implies that a good performance of the economy is a positive signal for inflow of foreign direct investment. This implies that foreign direct investment is an engine of economic growth.

Ayinde *et al.* (2015) which uses linear regression model and data obtained from Central Bank of Nigeria’s publication. They reported a positive effect of capital expenditure, recurrent expenditure, oil revenue and federation retained revenue on economic growth for the long-run modeling and positive impact of capital expenditure, oil revenue, federation account and federal retained revenue on economic growth for the short-run modeling. The study recommends a re-evaluation and re-assessment of direction of recurrent expenditure and non-oil revenue towards Nigerian development to achieve positive influence on economic growth.

Nworji *et al.* (2012) and Agbonkhese & Asekome (2014) examined the effect of public expenditure on economic growth in Nigeria for the period 1970 – 2009. They applied ordinary least square multiple regression model to analysed data extracted from the statistical Bulletin of the Central Bank of Nigeria. They reported that capital and recurrent expenditure on economic services had insignificant negative effect on economic growth during the study period.

In the study by Ugochukwu *el al.* (2013), they employed growth model via the ordinary least square method to investigate the relationship between foreign direct investment (FDI) and economic growth in Nigeria. Their work covered a period of twenty eight years (1981-2009) using an annual data from Central Bank of Nigeria statistical bulletin. The study also added gross fixed capital formation (GFCF) with a view to capture the effect of domestic investment on the growth of the economy for the period under review. Interest rate and exchange rate were also added as control variables in the model. The result of the ordinary least square techniques indicated that FDI has a positive and insignificant impact on the growth of Nigerian economy for the period under study.

Rahaman (2015) evaluated the impact of foreign direct investment (FDI) on the economic development of Bangladesh by conducting statistical analysis of the relationship between FDI and its impact on selected macroeconomic indicators such as gross domestic product, inflation rate and balance of trade using time series data over a period of fifteen years, from 1999 to 2013 and multiple regression analysis. The study disclosed a negative correlation between FDI and economic growth and may be a concern for the government of Bangladesh. The government might focus on required reforms and policy implications to make foreign investment more beneficial.

Adeniran *et al.* (2014) in their study of impact of exchange rate on economic growth employed correlation and regression analysis of the ordinary least square to analyze the data spanning the year 1986 to 2013 sourced from Central Bank of Nigeria statistical bulletin of various issues. The result revealed that exchange rate has positive impact but not significant. The result also indicated that interest rate and rate of inflation have negative impact on economic growth but not significant. In the same way, Aslam (2016) employed multiple regressions model using ordinary least squared method to test the impact of exchange rate on the economic growth in Sri Lanka. Annual time series data from 1970 to 2015 were used and the variables such as gross domestic product, exchange rate, inflation rate and interest rate were considered. The outcome of the multiple regression model confirmed that exchange rate has a positive influence on the economic growth in Sri Lanka at one percent level of significant.

Greene (2002) in his work dealing with heteroskedasticity argued that though weighted least square (WLS) procedure is an efficient estimation if the exact form of heteroskedasticity is known, it is not easy to determine the exact form of heteroskedasticity in most cases . He also disclosed that the general form of the heteroskedastic regression model has too many parameters to estimate by ordinary methods in order to achieve feasible generalized least square (FGLS) estimator. In order to resolve the problem of finding consistent estimators of the unknown parameters in the model, he proposes two methods: two-step GLS estimation and two-step maximum likelihood estimation.

Wooldridge (2009) disclosed that if heteroskedasticity is detected using one of the tests, one possible response is to use heteroskedasticity-robust statistics after estimation by ordinary least square (OLS). He presented that another response to a finding of heteroskedasticity is to specify its form and use weighted least squares (WLS) approach. He argued that if we have correctly specified the form of heteroskedasticity, then WLS is more efficient than OLS and WLS leads to new and statistics that have and distributions. He proposed the modeling or estimation of heteroskedasticity, use data to estimate the unknown parameter in the model and then use the WLS procedure. He termed this approach as feasible generalized least square (FGLS) or estimated generalized least square (EGLS).

In the case of structural breaks, Bai and Perrron (1998) in their study considered issues related to multiple structural changes, occurring at unknown dates in the linear regression model estimated by least squares. The main aspects of their work are the properties of the estimators, including the estimates of the break dates and the construction of tests that allow inference to be made about the presence of structural change and the number of breaks.

Zeileis *et et al.* (2001) introduces ideas and methods for testing for structural change in linear regression models and presents how these have been realized in an R package called strucchange. They features tests from the generalized fluctuation test framework as well as from the F test (Chow test) framework. Extending standard significance tests it contains methods to fit, plot and test empirical fluctuation process (like CUSUM, MOSUM and estimates-based processes) on the one hand and to compute, plot and test sequences of F statistics with the SupF, aveF and expF test on the other.

Kleibergen (2002) proposed a novel statistic for conducting joint tests on all the structural parameters in instrumental variables regression. The statistic equals a quadratic form of the score of the concentrated log-likelihood and straightforward to compute. It therefore attains its minimal value equal to zero at the maximum likelihood estimator. The statistic has a limiting distribution with a degrees of freedom parameter equal to the number of structural parameters.

Onel (2005) in his work tested for multiple structural breaks in the nominal interest rate and inflation rate using the methodology developed by Bai and Perron (1998). He used monthly data on Turkish 90 days’ time -deposits interest rate and consumer price index inflation rate over the period of 1980: 1-2004:12. The empirical results give little evidence of mean breaks in the interest rate series. However, the data on inflation rates is consistent with two breaks that are located at 1987: 9 and 2000:2

Antoshin *et al*. (2008) proposed modification to the methodology adopted by Bai and Perron (2006) to investigate structural breaks in small samples. They used Monte Carlo simulations to determine sample-specific critical values under the null each time the test is run. They draw on the results of their simulations to offer practical suggestions on handling serial correlation, model misspecification and the use of alternative test statistics for sequential testing. They revealed that for most types of data generating processes in samples with as low as 50 observations, their proposed modifications perform substantially better.

Allaro *et al.* (2011) examines the structural break dates for export, import and GDP in Ethiopia using annual macreconomic time series data spanning the years from 1974 through 2009. They used Chow test which was formalized from Perron (1989) to perform tests on the time series data on three assumed dates 1992, 1993, and 2003 to determine the date(s) at which there was a statistically significant structural break. They discovered that Ethiopia economy has been subjected to a structural break and regime shift during the sample period. They also infers that endogenously determined structural break time for the macroeconomic variables (export, import and GDP) of Ethiopian economy was found to be 2003.

Chen and Hong (2012) proposes a consistent test for smooth structural changes, which may be more realistic in economics than abrupt breaks. Their aim was to verify the observation of Hansen (2001) which pointed out that it may seem unlikely that a structural break could be immediate and might seem more reasonable to allow a structural change to take a period of time to take effect.

This study therefore, focuses on modeling the effect of revenue, expenditure, foreign direct investment and exchange rate on Nigerian gross domestic product obtained from CBN from 1961-2010 using regression models with correction for heteroskedasticity and investigation of structural break.

**3.0 Regression Modeling, Heteroskedasticity and Structural Break**

**3.1 Regression Model**

The specification of linear regression model with four explanatory variables is given as

 (1)

where is the GDP, is the revenue, is the expenditure, is the foreign direct investment, is the exchange rate, , , , and are the parameters and is the error term. Here, it is assumed that , and so that by ordinary least squares the estimators of the regression parameters , , , and is given as:

 (2)

with

 (3)

Where is the estimated mean square error. However, if then, there is presence of heteroreskedasticty as the variance of the error term is no longer constant.

**3.2 Test for Heteroskedasticity of Error Terms: The White Test**

Consider this Equation (1), let

 (4)

The unadjusted is given as

 (5)

The Lagrange Multiplier (LM) test statistic is

 (6)

where , and

the hypothesis of homoscedasticity of error terms against error terms not homoscedastic is given vs such that the LM statistic follows a distribution with degrees of freedom and level of significance where is the number of parameters in the regression model. In this case, is rejected if otherwise, is not rejected, which implies that the residuals are homoscedastic. The White’s test has been found useful in samples of 30 or more

**3.2.1 Corrections for Heteroskedasticity in Linear Regression Model.**

Consider the linear regression model specified in Equation (1) and the general case of heteroskedasticity where . To correct the inefficiency of OLS estimators, the Generalized (or Weighted) Least Squares (GLS or WLS) estimator is utilized. Thus, we let

 and

where is a square (nxn) matrix whose diagonal element is .

 Therefore,

 (7)

So that, By pre-multiplying on y and X, we get

 (8)

and

 (9)

and the GLS estimator can be obtained by regressing on . Thus, the GLS estimator of is given as

 (10)

where is a diagonal matrix whose diagonal element is . The Weighted Least Squares (WLS) estimator is obtained by applying Ordinary Least Squares to the GLS estimator gives

 (11)

If the variance is proportional to the square of one of the regressors i.e. , then the transformed regression model for GLS is

 (12)

where . If the variance is proportional to one of the regressors, i.e , then the transformed regression model for GLS is

 (13)

Where

In most cases, it is difficult to determine the exact form of heteroskedasticity but this can be estimated. Thus is estimated by , giving rise to feasible GLS (FGLS) estimator which is sometimes called estimated GLS or EGLS whose parameters are estimated by

 (14)

 **3.3 Regression Model with Structural Break Model**

Structural break is the sudden changes in time series data or regression parameter as a result of changes in government policy, serious disaster or civil war among others. Let the sample period be , has break-date as break date fraction , pre-break sample as ( observations) and post-break sample be ; observations.

The full structural break model can be represented as

 (15)

or

while the partial structural break model is

 (16)

Considering the general model

 (17)

The variance break model is represented as

It is worth to note that breaks do not necessarily affect point forecasts but they affect forecast variance, intervals, and densities and so on.

 **3.3.1 Identification of Multiple Structural Breaks**

Basically, Model stability is very important for appropriate statistical inference, out-of-sample forecasts, and any policy implications drawn from the model. Moreover, the existence of relatively constant linear relationships between economic variables is important for model parameters to be regarded as marginal propensities or elasticities and such economic interpretations will be invalid in the presence of structural breaks. Therefore, detection and identification of structural breaks are important.

Bai and Perron (1998) proposed test for investigation of multiple structural breaks. Their methodology considers the following multiple structural break model with m breaks or (m+1) regimes

 (18)

where is the observed dependent variable at time t; and are vectors of covariates, and are the corresponding vectors of coefficients; and is the disturbance term at time t. the break points are treated as unknown, and are estimated together with the unknown coefficients when observations are available. The aim is to estimate the unknown regression coefficients and the break dates when observations on are available.

Consider the matrix representation of the model with break as:

 (19)

where , , , and is the matrix which diagonally partitions at the m-partition, i.e., with The estimation method is based on the squares principle proposed by Bai and Perron (1998) so, that for each of the m-partition , denoted, the associated least squares estimate of is obtained by minimizing the sum of squares residuals, ie, (20)

 Let denote the resulting estimate. Substituting it in the objective function and denoting the resulting sum of squared residuals as the estimated break dates are such that

 (21)

where the minimization is taken over all partitions such that . Note that is the minimal number of observations in each segment. Thus the break points estimators are global minimizers of the objective function. Finally, the regression parameter estimates are the associated least-squares estimates at the estimated m-partition , i.e. .

Bai and Perron (1998) first consider the type test of no structural break against the alternative hypothesis that there are breaks. Here, are partitioned such that . The test is given as

 (22)

Where is the conventional matrix such that and

 Here is the sum of squared residuals under the alternative hypothesis, which depends on . In order to carry out the asymptotic analysis, some restrictions are imposed on the possible values of the break dates. In particular, they defined the following set for some arbitrary small possible number, say,

 (23)

The sup F type test statistic is then define as

 (24)

which is a generalization of the sup F test considered by Andrews (1993) and others for the case .

**4.0 Results**

Result from the White tests for the presence of heteroskedasticity is shown on Table 1 while Tables 2 and 3 respectively, show the estimated parameter of the regression model in the presence of heteroskedasticity and also, the estimated model parameter when heteroskedasticity is corrected. Table 4 presents the Bai-Perron multiple breakpoint tests with sequentially determined breaks 1973, 1980, 1987, 1994 and 2001 while Table 5 shows the Bai-Perron breaks Test statistics employ with HAC covariances assuming common data distribution.

|  |  |
| --- | --- |
| **Table 1: Breusch-Godfrey Serial Correlation LM Test and White Test for Heteroskedasticity**  |  |
|  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| F-statistic | 94359.45 |     Prob. F(10,10) | 0.0000 |
| Obs\*R-squared | 49.99947 |     Prob. Chi-Squares(10) | 0.0000 |
| Test for HeteroskedasticityTest statistic: LM = 21.3112p-value = 0.000707397 |  |  |  |
|  |  |  |  |

**Table 2**: **Estimated Parameter of regression model in the Presence of Heteroskedasticity**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Coefficient** | **Std. Error** | **t-ratio** | **p-value** |  |
| Const | -117334 | 143587 | -0.8172 | 0.41814 |  |
| REV | 0.943019 | 0.262159 | 3.5971 | 0.00080 | **\*\*\*** |
| EXPDT | 5.36869 | 0.569786 | 9.4223 | <0.00001 | **\*\*\*** |
| FDI | 0.421656 | 0.209253 | 2.0151 | 0.04990 | **\*\*** |
| EXCHRATE | -11993.9 | 6626.31 | -1.8100 | 0.07697 | **\*** |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Mean dependent Var |  3802191 |  | S.D. dependent Var |  7762453 |
| Sum squared resid |  3.25e+13 |  | S.E. of regression |  849261.4 |
| R-squared |  0.989007 |  | Adjusted R-squared |  0.988030 |
| F(4, 45) |  1012.164 |  | P-value(F) |  1.96e-43 |
| Log-likelihood | -750.9190 |  | Akaike criterion |  1511.838 |
| Schwarz criterion |  1521.398 |  | Hannan-Quinn |  1515.479 |
| Rho | -0.006536 |  | Durbin-Watson |  1.739178 |

 Dependent variable: GDP

 Legend: REV = Revenue, EXPDT = Expenditure, FDI = Foreign Direct Investment and EXCHRATE = Exchange Rate. Level of significance is equal to

**Table 3**: **Estimated Model Parameter with Correction for Heteroskedasticity using Weighted Least Squares (WLS)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|   | **Coefficient** | **Std. Error** | **t-ratio** | **p-value** |  |
| Const | 1383.85 | 17620.7 | 0.0785 | 0.93775 |  |
| REV | 1.22765 | 0.242247 | 5.0677 | <0.00001 | \*\*\* |
| EXPDT | 4.37859 | 0.658877 | 6.6455 | <0.00001 | \*\*\* |
| FDI |  0.599315 | 0.218382 | 2.7443 | 0.00868 | \*\*\* |
| EXCHRATE | -14280.5 | 5808.5 | -2.4586 | 0.01786 | \*\* |

Statistics based on the weighted data

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Sum squared resid |  38.16635 |  | S.E. of regression |  0.920946 |
| R-squared |  0.990672 |  | Adjusted R-squared |  0.989843 |
| F(4, 45) |  1194.762 |  | P-value(F) |  4.87e-45 |
| Log-likelihood | -64.19521 |  | Akaike criterion |  138.3904 |
| Schwarz criterion |  147.9505 |  | Hannan-Quinn |  142.0310 |
| Rho | -0.053126 |  | Durbin-Watson |  1.660446 |

**Statistics based on the original data**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Mean dependent Var |  3802191 |  | S.D. dependent Var |  7762453 |
| Sum squared resid |  3.53e+13 |  | S.E. of regression |  885427.7 |

 Dependent variable: GDP

|  |
| --- |
| **Table 4. Bai-Perron Multiple Breakpoint Tests**  |
|  |  |  |  |  |
|  |  |  |  |  |
| **Variable** | **Coefficient** | **Std. Error** | **t-Statistic** | **Prob.** |
|  |  |  |  |  |
|  |  |  |  |  |
| 1961 - 1972 -- 12 observations |
|  |  |  |  |  |
|  |  |  |  |  |
| C | -54891.00 | 30161.10 | -1.819927 | 0.0838 |
| EXPDT | 2.943283 | 0.479137 | 6.142879 | 0.0000 |
| EXCHRATE | 78189.16 | 41469.75 | 1.885450 | 0.0740 |
| REV | 0.750854 | 0.674787 | 1.112728 | 0.2790 |
| FDI | 1.805417 | 1.793994 | 1.006368 | 0.3263 |
|  |  |  |  |  |
|  |  |  |  |  |
| 1973 - 1979 -- 7 observations |
|  |  |  |  |  |
|  |  |  |  |  |
| C | -80012.28 | 24309.17 | -3.291444 | 0.0036 |
| EXPDT | 0.187465 | 0.606729 | 0.308977 | 0.7605 |
| EXCHRATE | 121770.0 | 36039.26 | 3.378816 | 0.0030 |
| REV | 3.983262 | 0.276362 | 14.41319 | 0.0000 |
| FDI | 0.471200 | 0.664480 | 0.709126 | 0.4864 |
|  |  |  |  |  |
|  |  |  |  |  |
| 1980 - 1986 -- 7 observations |
|  |  |  |  |  |
|  |  |  |  |  |
| C | -17436.69 | 4103.097 | -4.249641 | 0.0004 |
| EXPDT | -1.537138 | 0.268756 | -5.719453 | 0.0000 |
| EXCHRATE | 89707.21 | 3635.156 | 24.67768 | 0.0000 |
| REV | 2.214733 | 0.365412 | 6.060922 | 0.0000 |
| FDI | 0.315344 | 0.082312 | 3.831106 | 0.0010 |
|  |  |  |  |  |
|  |  |  |  |  |
| 1987 - 1993 -- 7 observations |
|  |  |  |  |  |
|  |  |  |  |  |
| C | 53468.84 | 30599.07 | 1.747401 | 0.0959 |
| EXPDT | 2.354515 | 1.368744 | 1.720200 | 0.1008 |
| EXCHRATE | -15156.91 | 22204.73 | -0.682598 | 0.5027 |
| REV | 1.837683 | 0.292892 | 6.274264 | 0.0000 |
| FDI | 0.427720 | 0.378796 | 1.129158 | 0.2722 |
|  |  |  |  |  |
|  |  |  |  |  |
| 1994 - 2000 -- 7 observations |
|  |  |  |  |  |
|  |  |  |  |  |
| C | 1102236. | 241575.2 | 4.562701 | 0.0002 |
| EXPDT | -0.964467 | 1.098639 | -0.877875 | 0.3904 |
| EXCHRATE | -34278.64 | 23756.69 | -1.442905 | 0.1645 |
| REV | 3.288322 | 1.446387 | 2.273473 | 0.0342 |
| FDI | 0.895754 | 0.132223 | 6.774589 | 0.0000 |
|  |  |  |  |  |
|  |  |  |  |  |
| 2001 - 2010 -- 10 observations |
|  |  |  |  |  |
|  |  |  |  |  |
| C | -19448097 | 3079167. | -6.316026 | 0.0000 |
| EXPDT | 5.369923 | 0.661166 | 8.121899 | 0.0000 |
| EXCHRATE | 170050.0 | 25863.82 | 6.574820 | 0.0000 |
| REV | -0.052843 | 0.248251 | -0.212863 | 0.8336 |
| FDI | 0.649835 | 0.320302 | 2.028820 | 0.0560 |
|  |  |  |  |  |
|  |  |  |  |  |
| R-squared | 0.998527 |     Mean dependent var | 3802191. |
| Adjusted R-squared | 0.996392 |     S.D. dependent var | 7762453. |
| S.E. of regression | 466269.3 |     Akaike info Crite | 29.22662 |
| Sum squared resid | 4.35E+12 |     Schwarz Crite | 30.37384 |
| Log likelihood | -700.6656 |     Hannan-Quinn Crite | 29.66349 |
| F-statistic | 467.6084 |     Durbin-Watson stat | 1.984678 |
| Prob(F-statistic) | 0.000000 |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

 Estimated number of breaks: 5 Dependent variable: GDP

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
| **Table 5: Bai-Perron Breaks Test Statistics with HAC Covariances Assuming Common Data Distribution** |
|  |  |  |  |
|  |  |  |  |
| **Sequential F-statistic determined breaks: 5** | **5** |
|  |  |  |  |
|  |  | **Scaled** | **Critical** |
| **Break Test** | **F-statistic** | **F-statistic** | **Value\*\*** |
|  |  |  |  |
|  |  |  |  |
|  **0 vs. 1 \*** | 102.1626 | 510.8129 | 18.23 |
| **1 vs. 2 \*** | 32.85846 | 164.2923 | 19.91 |
| **2 vs. 3 \*** | 10.04348 | 50.21739 | 20.99 |
| **3 vs. 4 \*** | 112.8911 | 564.4556 | 21.71 |
| **4 vs. 5 \*** | 8.674255 | 43.37127 | 22.37 |
|  |  |  |  |
|  |  |  |  |
| \* Significant at the 0.05 level. \*\* Bai-Perron Critical Values |  |
|  |  |

Results on Table 1 shows the White test for heteroskedasticity. Here, the hypothesis of constant variance is rejected with implying the presence of heteroskedasticity. The regression model in the presence of heteroskedasticity on Table 2 is represented as

 .

This results shows that Revenue, Expenditure, Foreign Direct Investment have significant positive effect on GDP since the while Exchange rate has negative but non-significant affect GDP. This result to some extent, agrees with the work of Easterly and Rebelo (1993) and Adeleke (2014)

However, when we consider the regression model where heteroskedasticity is corrected ( see Table 3), represented as = 1383.85 + 1.22765X1i + 4.37859X2i + 0.599315X3i 14280.5X4i , the estimated model parameters in this case, shows that all the independent variables under study, namely, Revenue, Expenditure, Foreign Direct Investment and Exchange rate have significant positive effect on GDP when the Weighted Least Squares (WLS) method is used. Again, this result agrees with Easterly and Rebelo (1993) and Adeleke (2014)

For the test of structural change, the result of the multiple break point using the Bai-Perron test for the period 1961 to 2010 on Table 4 presents the break points as 1973, 1980, 1987, 1994 and 2001 with the corresponding models thus:

 = 54891 + 0.7509X1i + 2.9433X2i + 1.8054X3i 78189.2X4i ; (1961 -1972 with 12 observations). Here, only Expenditure contributes to increase in GDP with p-value (P=0.0000<0.05). This is period in the history of Nigeria where there was oil boom and political instability was the order of time culminating into civil war and the post-war effects. For the period 1973 to 1979 with 7 observations, the model for this structure is given as

 = 80012.3 + 3.9833X1i + 0.1875X2i + 0.4712X3i 121770.0X4i

This period marked the peak of oil boom, transition from military to civilian regime. Here, Exchange rate and Revenue had significant positive impact on GDP with (P<0.05).

For the third set that occured from 1980 to 1986 with 7 observations ( a period marked by government stringency measures and sudden change from civilian to military regime), the model for this structure is presented as

 = 17436.7 + 2.2147X1i  1.53714X2i + 0.3153X3i 89707.2X4i

Here, the various changes influence the impact of these variables on GDP as Government Expenditure, Exchange rate, Revenue and FDI were all significant. However, Expenditure had negative relationship with the GDP.

For the structure 1987 to 1993 with seven (7) observations marked by Structural Adjustment Programme of the military regime, the model is

 = 53468.8 + 1.8377X1i + 2.3545X2i + 0.4277X3i 15156.9X4i

In this structure, only Revenue has significant positive effect on GDP with P-value (P=0.0000<0.05).

For the period1994 to 2000 with seven (7) observations, the model for this structure is given as

 = 1102236 + 3.2883X1i  0.9645X2i + 0.8958X3i34278.6X4i

This period marked the peak period of military rule in Nigeria and transition to another civil rule. Here, Revenue and FDI with P=0.0000<0.05) contributes significantly and positively to GDP. For the last break period of 2001 to 2010 with 7 observations, ( a period of civilian regime with socio economic challenges including restiveness, terrorism and global gluts leading to various reforms), the model is represented as

 = 19448097 0.05284X1i + 5.3699X2i + 0.6498X3i+170050X4i

For the structure, Governments Expenditures and Exchange rate contributes to the increase in GDP with p-value (P=0.0000<0.05).

Comparing the model with Heteroscedasticity and without Heteroscedasticity using the Akaike Information Criteria (AIC), it is clear that the AIC=138.04 for model with correction for heteroskedasticity is by far less than the AIC = 1511.838 for the model without correction for heteroskedasticity, an indication that the model with correction for heteroskedasticity is preferable. This result is further collaborated by the coefficient of determination R2 = 99.1% against R2 = 98.91% for model with correction for heteroskedasticity and the model without correction for heteroskedasticity respectively.

The overall model using Bai-Perron multiple breakpoint test shows an AIC = 29.663 with R2 = 99.6% showing that the structural breaks actually exist and the Bai-Perron procedure provides a good modeling environment to predict the behavior of the variables when it is suspected that multiple breaks exist and this result agree with the work of Onel (2005)

**5.0 Concluding Remarks**

This study provided a model for investigating the impact of some macroeconomic variables on Nigeria’s economic growth, using GDP as proxy to growth. It performed the test for the presence of heteroskedasticity using the White test, identified the presence of heteroskedasticity and corrected. It further determined the presence of multiple break points using Bai and Perron approach and examined the effect of government Revenue, Expenditure, Foreign Direct Investment (FDI) and Exchange rate on Nigerian Gross Domestic Product (GDP) from the weighted regression model covering the period 1961 to 2010. It observed that the presence of heteroskedasticity and persistent structural break is not a good indicator of economic development as it posits instability in economic policies and hence, economic development.

Similarly, the estimated parameters using model with adjustment for constant mean and variance over time shows that Revenue, Expenditure, Foreign Direct Investment significantly affect GDP positively while the constant term and Exchange rate negatively affect the GDP. Furthermore, it is noticeable that the model with correction for heteroskedasticity appears more stable than the model with the presence of heteroskedasticity.

Consequently, this study supports growing evidence that government Revenue, Expenditure, Foreign Direct Investment and Exchange rate has strong relationship with and exerts significant effect on Nigerian Gross Domestic Product (GDP) in the presence of stable policies. Therefore, government Revenue, Expenditure, Foreign Direct Investment and Exchange rate are important variables in explaining Nigeria’s GDP and adequate control measures must be put in place to ensure control that will enhance stable economic growth. It further suggests use of structural change model for prediction when it is suspected in the economic data.

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