Available online at www.elixirpublishers.com (Elixir International Journal)

Statistics

Elixir Statistics 83 (2015) 33156-33164

ISSN: 2229-712X

Application of Multivariate Analysis on the Effects of World Development Indicators on GDP Per Capita of Nigeria (1981-2013)

Ekum M. I[1], akinmoladun O. M[1], Aderele O. R[1] and Esan O. A[2]

[1]Department of Mathematics & Statistics, Lagos State Polytechnic, Lagos, Nigeria.

[2]Department of Mathematics, Yaba College of Technology, Yaba, Lagos, Nigeria.

ARTICLE INFO

Article history:

Received: 14 January 2015;

Received in revised form:

3 June 2015;

Accepted: 13 June 2015;

Keywords

Econometrics,

Multiple Linear Regression,

Ordinary Least Squares,

Explanatory variable,

Dependent variable.

ABSTRACT

In this paper, we employ Multiple Linear Regression Model to fit a model of Gross Domestic Product Per Capita of Nigeria using some World Development Indicators (WDI) as explanatory variables. Data were collected from 1981 to 2013. The five WDI are OER-Official Exchange Rate (LCU Per US$, Period Average), BM-Broad Money (% of GDP), INF-Inflation, GDP deflator (Annual %), TNR-Total Natural Resources Rents (% of GDP) and FDI-Foreign Direct Investment, Net Inflows (% of GDP).At the end of the analysis it was discovered that the OER and BM are statically significant while INF, TNR and FDI are not statistically significant. The average estimated GDP per capita of Nigeria when the effect of OER, BM, INF, TNR and FDI are zero is $-360.81. Also, 1 unit increase in OER-Official Exchange Rate (LCU Per US$, Period Average) will lead to a significant increase in GDP per capita by $4.42 (4.42USD); if BM-Broad Money (% of GDP) increases by 1% then GDP per capita will increase by $25.17; if INF-Inflation, GDP deflator (Annual %) increases by 1% then GDP per capita will decrease by $0.08; if TNR-Total Natural Resources Rents (% of GDP) increases by 1% then GDP per capita will decrease by $0.63 and if FDI-Foreign Direct Investment, Net Inflows (% of GDP) increases by 1% then GDP per capita will increase by $13.52. (Note: All the estimated parameters are significant at 5% without exception). 71.1% of the total variation in GDP per capita of Nigeria can be explained by the variations in OER-Official Exchange Rate (LCU Per US$, Period Average), BM-Broad Money (% of GDP), INF-Inflation, GDP deflator (Annual %), TNR-Total Natural Resources Rents (% of GDP) and FDI-Foreign Direct Investment, Net Inflows (% of GDP) while the remaining 28.9% could be explained by other variables other than the ones used in this model.

Introduction

Nigeria is a middle income, mixed economy and emerging market, with expanding financial, service, communications, technology and entertainment sectors. It is ranked 26th in the world in terms of GDP (nominal: 30th in 2013 before rebasing, 40th in 2005, 52nd in 2000), and is the largest economy in Africa (based on rebased figures announced in April 2014). It is also on track to become one of the 20 largest economies in the world by 2020. Its re-emergent, though currently underperforming, manufacturing sector is the third-largest on the continent, and produces a large proportion of goods and services for the West African region. Nigeria recently changed its economic analysis to account for rapidly growing contributors to its GDP, such as telecommunications, banking, and its film industry. As a result of this statistical revision, Nigeria has added 89% to its GDP, making it the largest African economy (Wikipedia 2014)

Statement of the Problem

The problem of low Gross Domestic Product Per Capita (RGDP) as compared with that of the world's top 20 economies, high rate of inflation, unemployment, poverty and illiteracy in Nigeria are as a result of lack of adequate planning by the government resulting from inefficiency in management of our human and natural resources. Some of the key problems that need urgent attention and if adequately attended to may improve Nigeria's GDP are:

- Power and energy infrastructure
- Food security and agriculture
- Wealth creation and employment
- Mass transportation
- Land reforms
- Security (including stability to Niger Delta and Boko-Haram menace)
- Education

However, the government has embraced a policy know as vision 2020 to fight this economic problem in the country during late President Musa Yar'adua tenure and National Economic Empowerment strategy (NEEDS).

The fact remains that Nigeria as a country must develop a model to guide her becoming one of the world's top 20 economies in year 2020. This model is on Gross Domestic Product per Capital and how it is being affected by other World Development Indicators (WDI) such as Official Exchange Rate, Broad Money, Inflation GDP Deflator, Total Natural Resources and Foreign Direct Investment.

Objectives

The objectives of this research shall be

(i)to formulate a regression model for annual GDP Per Capital of Nigeria using data from 1980 – 2013

Tele:

E-mail addresses: matekum@yahoo.com

(ii) to establish statement about predictors included in nation's GDP per Capita
(iii) to carry out a diagnostic statistical testing on the assumption of general linear models
- Multicolinearity
- Heteroscedasticity
- Autocorrelation
- Normality

Literature Review

Econometrics is a rapidly developing branch of economics which, broadly speaking, aims to give empirical content to economic relations (Frisch, 1936). Econometrics can be defined generally as the application of mathematics and statistical methods to the analysis of economic data. (Samuelson, Koopmans and Stone, 1954)

Multiple Regression A multiple linear regression analysis is carried out to predict the values of a dependent variable, Y, given a set of k explanatory variables (x_1,x_2,….,x_k). (Mark Tranma and Mark Elliot, 2012).

The multiple linear regression model is an extension of a simple linear regression model to incorporate two or more explanatory variable in a prediction equation for a response variable. Multiple regression modeling is now a mainstay of statistical analysis in most fields because of it's power and flexibility. As you will quickly learn it requires very little effort (and sometimes even less thought) to estimate very complicated models with large numbers of variables. Practical experience has shown however, that such models may be very hard to interpret and give very misleading impressions. As a first example, we will consider a reasonably uncomplicated analysis with two predictor variables, beginning with an initial analysis based on simple linear regressions.

The work of Azeez B. A , Kolapo F. T and Ajayi L. B (2012) examines the effect of exchange rate volatility on macroeconomic performance in Nigeria from 1986 to 2010. The model formulated depicts Real GDP as the dependent variable while Exchange Rate (EXR), Balance of Payment (BOP) and Oil Revenue (OREV) are proxied as independent variables. It employs the Ordinary Least Squared (OLS) and Johansen co-integration estimation techniques to test for the short and long runs effects respectively. The ADF test reveals that all variables are stationary. OLS results show that OREV and EXR are positively related while BOP is negatively related to GDP. Further findings reveal that oil revenue and balance of payment exert negative effects while exchange rate volatility contributes positively to GDP in the long run. It recommends that graft should be tackled frontally in the oil sector to ensure better utilisation of oil revenue, more attention be paid to Agriculture and Solid mineral sectors and that the monetary authorities should pursue policies that would curb inflation and ensure stability of exchange rate.

The work of Irfan Hameed and Ume-Amen focuses on the impact of Monetary Policy on GDP. GDP no doubt is affected by the Monetary Policy of the state. The research papers of various authors have been studied in this regard to prove the Hypothesis and afterin depth analysis by applying Regression Analysis technique it has been observedthat the relationship between the two exists. The data of past 30 years of Pakistanhas been used for driving the conclusion. The study proved that the interest ratehas minor relationship with GDP but the Growth in Money Supply greatly affectsthe GDP of an economy, obviously various unknown factors also affects the GDP.Growth in Money Supply has a huge impact on GDP. The Research study canfurther be used for developmental projects for the Growth of Economy, Qualityimprovements, Household production, the underground economy, Health and lifeexpectancy, the environment, Political immunity and ethnic justice

Foreign direct investment (FDI) has been a vital source of economic growth for Ghana, bringing in capital investment, technology and management knowledge needed for economic growth. This paper aims to study the relationship between FDI and economic growth in Ghana for the period 1980-2010 using time series data. The GDP, GDP growth rate, GNI, Manufacturing Value Added, External Debt Stock, Inflation, Trade, Industry Value added and Foreign Direct Investment net inflows as percent of GDP (FDI ratio). We used the simple ordinary least square (OLS) regressions and the empirical analysis is conducted by using annual data on FDI and other variables over the periods 1980 to 2010. We used annual data from IMF, International Financial Statistics tables, published by International Monetary Fund. The goal of this study is to determine the extent to which these variables are related. From this, we can conclude that the independent variables GDP, GDPg, GNI, MVA, GDPc and TRA are all significant to explain FDI since their corresponding p-values of the t-statistic are less than 5 percent and thus have an influence of FDI in Ghana. These findings embrace practical implications for policy makers, government and investors. (Samuel , Ebenezer and Atta)

José Pineda and Francisco Rodríguez 2010 argues against a natural resource curse for human development. We find evidence that changes in human development from 1970 to 2005, proxied by changes in the Human Development Index, are positively and significantly correlated with natural resource abundance. While our results are consistent with those of other authors who have recently argued that natural resources do not adversely affect growth, we find strong evidence that natural resources have a positive effect on human development and particularly on its non-income dimensions. However, results from Latin America interactions show that the positive impact of natural resources in this region is significantly smaller than in the rest of the world. These results contribute to a broader discussion about the "resource curse" by showing that natural resources may be a blessing rather than a curse for human development, primarily through its effects on education and health rather than income.

GDP per capita: GDP Per Capita is gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in current U.S. dollars.

Official exchange rate (LCU per US$, period average): Official exchange rate refers to the exchange rate determined by national authorities or to the rate determined in the legally sanctioned exchange market. It is calculated as an annual average based on monthly averages (local currency units relative to the U.S. dollar).

Broad money (% of GDP): Broad money is the sum of currency outside banks; demand deposits other than those of the central government; the time, savings, and foreign currency deposits of resident sectors other than the central government; bank and traveler's checks; and other securities such as certificates of deposit and commercial paper.

Inflation, GDP deflator (annual %): Inflation as measured by the annual growth rate of the GDP implicit deflator shows the rate of price change in the economy as a whole.

Table 1. Data on Gross Domestic products and Other Five World Development Indicators

YEAR	RGDP	OER	BM	INF	TNR	FDI
1981	772.10	0.62	30.03	16.21	30.18	0.91
1982	624.98	0.67	32.13	2.61	29.19	0.87
1983	428.13	0.72	33.31	16.14	35.71	1.04
1984	336.74	0.77	33.40	16.95	47.46	0.67
1985	330.98	0.89	32.00	3.69	47.04	1.71
1986	229.52	1.75	32.31	-1.50	31.82	0.96
1987	259.41	4.02	26.54	50.08	33.39	2.60
1988	246.39	4.54	26.44	21.38	29.16	1.66
1989	250.63	7.36	19.29	44.38	40.54	7.90
1990	291.87	8.04	22.08	7.16	47.48	2.06
1991	273.17	9.91	24.10	20.17	42.22	2.61
1992	319.30	17.30	20.82	83.62	35.70	2.74
1993	203.49	22.07	20.52	52.64	48.51	6.30
1994	220.22	22.00	21.58	27.77	41.14	8.28
1995	255.50	21.90	16.12	55.97	38.01	3.84
1996	313.44	21.88	13.11	36.90	40.11	4.51
1997	314.30	21.89	14.62	1.36	39.38	4.25
1998	272.44	21.89	18.58	-5.55	25.98	3.27
1999	287.92	92.34	21.79	12.29	32.60	2.89
2000	371.77	101.70	22.16	38.17	46.91	2.48
2001	378.83	111.23	24.52	10.74	39.87	2.48
2002	455.33	120.58	21.83	31.47	27.98	3.17
2003	508.43	129.22	20.20	11.20	34.40	2.96
2004	644.03	132.89	18.26	20.73	37.36	2.13
2005	802.79	131.27	17.73	19.76	43.15	4.44
2006	1014.58	128.65	19.04	19.56	38.12	3.34
2007	1129.09	125.81	28.03	4.81	34.84	3.64
2008	1374.67	118.55	36.35	10.98	37.00	3.96
2009	1091.26	148.90	40.68	-4.41	25.46	5.07
2010	1443.21	150.30	32.48	26.78	32.56	2.65
2011	1501.72	154.74	33.58	2.34	42.00	3.62
2012	2,835.3	157.50	20.70	9.30	20.35	1.53
2013	3,082.5	157.31	20.09	5.90	17.30	1.07

Source: World Bank Databank

Table 2. Descriptive Statistics

	RGDP	OER	BM	INF	TNR	FDI
Mean	546.6529	59.17419	24.95581	21.10968	37.26677	3.193871
Median	336.7400	21.90000	22.16000	16.95000	37.36000	2.890000
Maximum	1501.720	154.7400	40.68000	83.62000	48.51000	8.280000
Minimum	203.4900	0.620000	13.11000	-5.550000	25.46000	0.670000
Std. Dev.	394.6922	59.83504	7.028194	20.33136	6.564829	1.852448
Skewness	1.266699	0.396011	0.361981	1.133511	0.021551	1.098100
Kurtosis	3.272902	1.346771	2.159476	4.176164	2.124904	4.182897
Jarque-Bera	8.386255	4.340601	1.589530	8.425216	0.991550	8.037450
Probability	0.015099	0.114143	0.451687	0.014808	0.609099	0.017976
Sum	16946.24	1834.400	773.6300	654.4000	1155.270	99.01000
Sum Sq. Dev.	4673458.	107407.0	1481.865	12400.93	1292.909	102.9469
Observations	33	33	33	33	33	33

Source: Eviews 7 Output

Table 3. Model Estimation

Dependent Variable: RGDP
Method: Least Squares
Date: 11/10/14 Time: 10:40
Sample: 1981 2013
Included observations: 33

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-360.8066	350.4897	-1.029436	0.3131
OER	4.418800	0.749895	5.892559	0.0000
BM	25.16643	6.988559	3.601090	0.0014
INF	-0.083536	2.386736	-0.035000	0.9724
TNR	-0.630434	6.780852	-0.092973	0.9267
FDI	13.52268	25.69556	0.526265	0.6033

R-squared	0.711040	Mean dependent var	546.6529
Adjusted R-squared	0.653248	S.D. dependent var	394.6922
S.E. of regression	232.4172	Akaike info criterion	13.90693
Sum squared resid	1350444.	Schwarz criterion	14.18448
Log likelihood	-209.5574	Hannan-Quinn criter.	13.99740
F-statistic	12.30341	Durbin-Watson stat	0.892975
Prob(F-statistic)	0.000004		

Source. Eviews 7 Output

Table 4. Multicollinearity Test Coefficients

Model	Collinearity Statistics	
	Tolerance	VIF
OER	.894	1.118
BM	.746	1.340
INF	.765	1.308
TNR	.909	1.101
FDI	.795	1.258

Source. SPSS 19 Output

Table 5. Heteroscedasticity Test

Heteroskedasticity Test:

F-statistic	2.517738	Prob. F(5,25)	0.0561
Obs*R-squared	10.38210	Prob. Chi-Square(5)	0.0651
Scaled explained SS	3.322179	Prob. Chi-Square(5)	0.6504

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 11/10/14 Time: 11:01
Sample: 1981 2013
Included observations: 33

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	47279.07	30985.56	1.525842	0.1396
OER^2	2.235423	0.883933	2.528951	0.0181
BM^2	8.001620	21.35098	0.374766	0.7110
INF^2	-3.766398	5.459171	-0.689921	0.4966
TNR^2	-12.63237	15.22098	-0.829932	0.4144
FDI^2	-251.3733	463.5016	-0.542335	0.5924

R-squared	0.334906	Mean dependent var	43562.71
Adjusted R-squared	0.201888	S.D. dependent var	43927.93
S.E. of regression	39243.95	Akaike info criterion	24.16497
Sum squared resid	3.85E+10	Schwarz criterion	24.44251
Log likelihood	-368.5570	Hannan-Quinn criter.	24.25544
F-statistic	2.517738	Durbin-Watson stat	1.369051
Prob(F-statistic)	0.056067		

Source. Eviews 7 Output

Table 6. Autocorrelation Test

Serial Correlation Test:

F-statistic	5.569216	Prob. F(2,23)	0.0107
Obs*R-squared	10.11445	Prob. Chi-Square(2)	0.0064

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 11/10/14 Time: 23:22
Sample: 1981 2013
Included observations: 33
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	43.90523	306.3209	0.143331	0.8873
OER	0.631747	0.678502	0.931091	0.3615
BM	-4.629178	6.622532	-0.699004	0.4916
INF	3.055970	2.268608	1.347069	0.1911
TNR	1.542192	5.832277	0.264424	0.7938
FDI	-25.18113	23.36469	-1.077743	0.2923
RESID(-1)	0.698406	0.225296	3.099942	0.0050
RESID(-2)	0.015268	0.227078	0.067236	0.9470

R-squared	0.326273	Mean dependent var	-1.54E-13
Adjusted R-squared	0.121225	S.D. dependent var	212.1669
S.E. of regression	198.8916	Akaike info criterion	13.64103
Sum squared resid	909831.2	Schwarz criterion	14.01109
Log likelihood	-203.4360	Hannan-Quinn criter.	13.76166
F-statistic	1.591205	Durbin-Watson stat	1.682777
Prob(F-statistic)	0.188054		

The GDP implicit deflator is the ratio of GDP in current local currency to GDP in constant local currency.

Total natural resources rents (% of GDP): Total natural resources rents are the sum of oil rents, natural gas rents, coal rents (hard and soft), mineral rents, and forest rents.

Foreign direct investment, net inflows (% of GDP): Foreign direct investment are the net inflows of investment to acquire a lasting management interest (10 percent or more of voting stock) in an enterprise operating in an economy other than that of the investor. It is the sum of equity capital, reinvestment of earnings, other long-term capital, and short-term capital as shown in the balance of payments. This series shows net inflows (new investment inflows less disinvestment) in the reporting economy from foreign investors, and is divided by GDP.

Theoretical Framework

Model Specification

The K-Variable linear equation model is used to study the relationship between a dependent variable and one or more independent variables. The specification of such a model is given as

$$y_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_k x_k + U_i, \qquad i = 1, \dots, n \qquad 2.1$$

Where

Y is the dependent or explained variable

X1, Xk are the independent or explanatory or regressor variables

U is the random or disturbance or stochastic term

Matrix Formulation of the K-Variable Model

In matrix form

$$Y = X\beta + U \qquad 2.2$$

Where

$$Y = \begin{bmatrix} y_1 \\ y_2 \\ \cdot \\ \vdots \\ y_n \end{bmatrix} \quad X = \begin{bmatrix} 1 & x_{11} & \cdots & x_{1k} \\ 1 & x_{21} & \cdots & x_{2k} \\ \vdots & \vdots & \cdots & \cdot \\ \cdot & \cdot & \cdots & \cdot \\ 1 & x_{n1} & \cdots & x_{nk} \end{bmatrix} \quad \beta = \begin{bmatrix} \beta_0 \\ \beta_1 \\ \cdot \\ \vdots \\ \beta_k \end{bmatrix} \quad U = \begin{bmatrix} u_1 \\ u_2 \\ \cdot \\ \vdots \\ u_n \end{bmatrix} \qquad 2.3$$

Y - We can pack all response values for all observations into a n-dimensional vector called the response vector.

X - We can pack all predictors into a n x k + 1 matrix called the design matrix. (Note the initial column of 1's. The reason for this will become clear shortly).

β - We can pack the intercepts and slopes into a k+1-dimensional vector called the slope vector,

U - We can pack all the errors terms into a n-dimensional vector called the error vector. (Olubusoye, O. E 2013, Alaba O. O 2013)

Assumptions of the Multiple Regression Model

To make any progress with the estimation of the vector of coefficients, β, we must make some further assumptions about how the observations in (2.1) have been generated.

Assumption 1: Linearity – The model specifies a linear relationship between the response variable and the independent variables. It may be linear either in the original variables or after some suitable transformation.

Assumption 2: Full Rank – There is no exact linear relationship among any of the independent variables. The columns of X are linearly independent.

Assumption 3: Exogeneity of the independent variables – The disturbance is assumed to have conditional expected value zero (0) at every observation.

$$E[u] = \begin{bmatrix} E(u_1) \\ E(u_2) \\ \cdot \\ \vdots \\ E(u_n) \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ \cdot \\ \vdots \\ 0 \end{bmatrix} = 0 \qquad 2.4$$

This implies that

$$E[Y] = X\beta \qquad 2.5$$

Assumption 4: Spherical Disturbance – This concerns the variance and the covariance of the disturbances.

$$Var(U_i/X) = \sigma^2, \quad for\ all\ i = 1, \dots, n \qquad 2.6$$

Note: Constant variance is called homoscedasticity.

And

$$Cov(U_i, U_j/X) = 0, \quad for\ all\ i \neq j \qquad 2.7$$

Note: This equation implies Non autocorrelation (i.e no serial correlation).

The two assumptions implies that

$$E[UU^1] = \begin{bmatrix} \sigma^2 & 0 & \cdots & 0 \\ 0 & \sigma^2 & \cdots & 0 \\ \vdots & \vdots & \cdots & \cdot \\ \cdot & \cdot & \cdots & \cdot \\ 0 & 0 & \cdots & \sigma^2 \end{bmatrix} \qquad 2.8$$

$$= \sigma^2 I$$

Note: Disturbances that meet the assumption of homoscedasticity and non-autocorrelation are sometimes called spherical disturbances.

Assumption 5: Exogenously generated data – X may be fixed or random, but it is generated by a mechanism that is unrelated to U. The disturbance is assumed to have conditional expected value zero (0) at every observation.

Assumption 6: Normality – It is convenient to assume that the disturbances are normally distributed with mean zero (0) and constant variance (σ^2). i.e $U \sim N(0, \sigma^2)$.

Methodology

Basically, the multiple linear regression models can be estimated using the Ordinary Least Square (OLS).

Least Squares Estimation

There are number of different approaches to estimate the parameters of equation (2.1). The method of least squares has long been the most popular. Moreover, in the most cases in which some other estimation method is found to be preferable, least squares remains the benchmark approach, and often, the preferred method ultimately amounts to a modification of least squares.

Let $\hat{\beta} = (\hat{\beta}_1, \hat{\beta}_2, \dots \hat{\beta}_k)$

Recall (2.2)

$$Y = X\beta + U$$

Where U denotes the column vector of n residuals

That is

$$U = Y - X\beta \qquad 3.1$$

The sum of squared residuals is

$$\sum_{i=1}^{n} e_i^2 = e^1 e \qquad 3.2.1$$

$$= (Y - X\hat{\beta})^1 (Y - X\hat{\beta}) \qquad 3.2.2$$

$= Y^1Y - 2\hat{\beta}^1X^1Y + \hat{\beta}^1X^1X\hat{\beta}$ 3.2.3

(Note:
$\hat{\beta}^1X^1Y$ *is a scalar and thus equal to its transpose* $Y^1X\hat{\beta}$
)

Differentiate e^1e with rspect to $\hat{\beta}$ and equate it to zero, we have

$$de^1e/d\hat{\beta} = -2X^1Y + 2\hat{\beta}X^1X = 0 \quad 3.4$$

$$2\hat{\beta}X^1X = 2X^1Y \quad 3.5$$

$$\hat{\beta} = (X^1X)^{-1}X^1Y \quad 3.6$$

Equation 3.6 is called the least squares estimate.

Test for Multicollinearity

Multicollinearity is a violation of the assumption that no independent variable is a limear function of one or more independent variables.

There are many ways to detect if mulicollinearit is present but we shall adopt the method of variance inflation factor (VIF).

$$VIF_i = \frac{1}{1 - R^2_i}, \quad i = 1, \dots, n \quad 3.7$$

Where

n is the number of independent variables. Note that the R^2 here is derived when one of the independent variables is regressed on the remaining independent variable. This will be done for all the n independent variables. A VIF is associated with each independent variable.

A VIF ≥ 5, suggest a level of multicolinearity. The standard erros of the coefficients increase in the presence of multicollinearity). The VIF measures how much the variances of the estimated coefficients are inflated as compared to when the predictor variables are not linearly related. If there are five (2) independent variables, the VIF computed should also be five (5). The solutions to multicollinearity is that (1) drop the correlated regressors (2) combine/transform variables (3) principal component regression (4) large number of observations.

Test for Heteroscedasticity

One of the assumptions is that the disturbances U_i in the population regression function are homoscedastic i.e have the same variance.

$$\left.\begin{aligned} E(UU') &= \sigma^2 I_n \\ E(U^2_i) &= \sigma^2, \text{for all } i \\ E(U_iU_j) &= 0, \quad \text{for all } i \neq j \end{aligned}\right\} \text{spherical disturbance} \quad 3.8$$

When this assumption breaks down it results in Heteroscedasticity i. e unequal variance.

The presence of Heteroscedasticity makes t-test unreliable and standard error estimates will be large even if the coefficients are linear, unbiased and consistent.

One of the methods of detecting Heteroscedasticity is the Spearman's Rank Correlation method. This is an easy approach that can be applied to both small and large samples.

If $Y = \beta_1 + \beta_2X_i + U$ 3.9

a. Regress Y on X

b. Obtain the residual e_1 and rank the $e_1's$ in ascending or descending order. Ignore the signs.

c. Compute the rank correlation coefficient

$$r_{e,x} = 1 - \frac{6\sum D_i^2}{n(n^2-1)} \quad 3.10$$

Where

D_i is the difference between the rank of corresponding pairs of X and e, n is the number of observations in the sample. A high rank correlation coefficient suggests the presence of Heteroscedasticity.

The problem of Heteroscedasticity can be remedy by (i) Weighted Least Squares (ii) Maximum Likelihood Method (iii) Transform the data and Perform regression again (iv) Use different Functional Form.

Test for Autocorrelation

Autocorrelation emanates from the breakdown of the classical assumption that the error term/disturbance is random or uncorrelated. It is the serial correlation of the error term which is usually associated with time series data but can also affect cross-sectional data. Autocorrelation is the correlation across the error term. The presence of autocorrelation has the following consequences: Standard error of regression coefficients are underestimated, R^2 may be overstated, residual variance underestimate the true variance, t and F tests are no longer valid even if the estimators are linear, unbiased and consistent.

$$E(U_iU_j) \neq 0, \quad \text{for all } i \neq j \quad 3.11$$

There are many types of autocorrelation but we shall discuss Autoregression of order 1 (AR(1)) and Moving average of order 1 (MA(1)).

We can test for autocorrelation as follows:

a. If the elements off the main diagonal of the variance-covariance matrix are non zero, then autocorrelation is present.

b. If the plot of residuals or residuals squared shows a pattern, then autocorrelation is present.

c. The most popular test is the Durbin-Watson d-test. The basic assumptions underlying the d-statistic are:

(i) The data are time series data

(ii) Autocorrelation is of first order, ρ is the coefficient of autocorrelation

(iii) The regression equation does not include lagged values of the dependent variable.

The hypotheses are:

$H_0: \rho = 0$

$H_1: \rho > 0$ (First order positive autocorrelation)

$H_0: \rho = 0$

$H_1: < 0$ (First order negative autocorrelation)

The test statistic

$$d = \frac{\sum_{i=2}^{n}(e_i - e_{i-1})^2}{\sum_{i=1}^{n} e_i^2}$$

Where e_i's are the residuals obtaind from OLS regression and the relationship between d and ρ is given as:

d = 2(1-ρ)

There are remedies for autocorrelation and they are: (i) Rectify the model (ii) Maximum likelihood method (iii) Generalized least squares.

Data Presentation

Empirical Analysis

The proposed Econometric model is given by

$$Y_t = \beta_0 + \beta_1 OER_t + \beta_2 BM_t + \beta_3 INF_t + \beta_4 TNR_t + \beta_5 FDI_t + \varepsilon_{it}$$

For t = 1, 2, … , T where T = 33

Note: The data are time series data but multiple linear regression is fitted with the independent variables carefully selected so that they are correlated with the dependent variable but are not correlated with other independents variables. Hence, the independent variables are not correlated with one another (no multicollinearity).

This section presents the empirical results of our model with the objective to assess the impact of some world development indicators (OER, BM, INF, TNR, FDI) on variables on gross domestic product per capita of Nigeria. Estimates are made using the ordinary least squares model.

It can be seen from Table 2 that the average RGDP per capita is $546.65, the average Official Exchange Rate (in local currency) is 59.17, the average broad money is 24.96, the average inflation rate (GDP deflator) is 21.11, the total natural resources % of GDP is 37.27 and the foreign direct investment % of GDP is 3.19.

It is also evident that the GDP per capita minimum ever attained is $203.49 and the maximum ever attained is $1501.72. The standard deviation for the 31 dataset for RGDP is 394.69 with skewness and kurtosis of 1.27 and 3.27 respectively.

Interpretation of Regression Results

The model fitted is

$$\widehat{RGDP}_t = -360.8066 + 4.4188 OER_t + 25.1664 BM_t - 0.0835 INF_t - 0.6304 TNR_t + 13.5227 FDI_i$$

Base on the probability values in Table 3, OER and BM are statically significant while INF, TNR and FDI are not statistically significant. Note that all the regressors are not in the same unit. The average estimated GDP per capita of Nigeria when the effect of OER, BM, INF, TNR and FDI are zero is $-360.81. Also, 1 unit increase in OER-Official Exchange Rate (LCU Per US$, Period Average) will lead to a significant increase in GDP per capita by $4.42 (4.42USD); if BM-Broad Money (% of GDP) increases by 1% then GDP per capita will increase by $25.17; if INF-Inflation, GDP deflator (Annual %) increases by 1% then GDP per capita will decrease by $0.08; if TNR-Total Natural Resources Rents (% of GDP) increases by 1% then GDP per capita will decrease by $0.63 and if FDI-Foreign Direct Investment, Net Inflows (% of GDP) increases by 1% then GDP per capita will increase by $13.52. (Note: All the estimated parameters are significant at 5% without exception)

Table 3 also shows that 71.1% of the total variation in GDP per capita of Nigeria can be explained by the variations in OER-Official Exchange Rate (LCU Per US$, Period Average), BM-Broad Money (% of GDP), INF-Inflation, GDP deflator (Annual %), TNR-Total Natural Resources Rents (% of GDP) and FDI-Foreign Direct Investment, Net Inflows (% of GDP) while the remaining 28.9% could be explained by other variables other than the ones used in this model.

The variance inflation factors are less than 5.0 for all the independent variables. This shows that there is no multicollinearity present in the dataset.

The null hypothesis states that there is no heteroscedasticity as against the alternative hypothesis that states that there is heteroscedasticity (H_0: Equal variances vs H_1: Unequal variances). Since we cannot reject the null hypotheses because the test is not significant (P-value (0.0651) > 0.05). it is therefore conclude that there is no heteroscedasticity in the dataset.

The Chi-square test shows that there is autocorrelation in the dataset at 5% level of significance.

Since the p-value is higher than 5%, we cannot reject the null hypothesis that there is no autocorrelation.

The normality test shows that the mean is approximately zero (0) and with variance 45016.11. The coefficient of skewness is 0.0358 and the kurtosis is 1.99. This implies that the dataset is normally distributed.

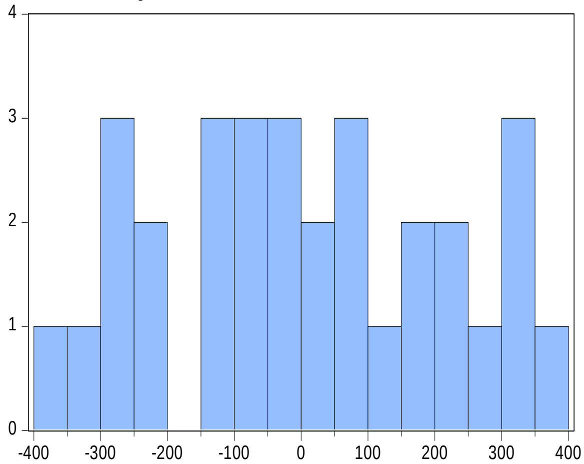

Table 7. Normality Test Result

Conclusion

The data collected from World Bank Database for Nigeria from 1981 to 2013, which were summarized and analyzed in order to achieve the objectives of this work are hereby conclude as follows:

1. The model fitted is

$$\widehat{RGDP}_t = -360.8066 + 4.4188 OER_t + 25.1664 BM_t - 0.0835 INF_t - 0.6304 TNR_t + 13.5227 FDI_i$$

2. Base on the model above, we can conclude that Nigeria OER, BM have significant positive effect on GDP per Capita. FDI have a positive effect on GDP per Capita. INF and TNR have negative effects on GDP per Capita.
3. We observed that that 71.1% of the total variation in GDP per capita of Nigeria can be explained by the variations in OER-Official Exchange Rate (LCU Per US$, Period Average), BM-Broad Money (% of GDP), INF-Inflation, GDP deflator (Annual %), TNR-Total Natural Resources Rents (% of GDP) and FDI-Foreign Direct Investment, Net Inflows (% of GDP) while the remaining 28.9% could be explained by other variables other than the ones used
4. We can conclude that there is no multicollinearity present in the dataset.
5. We can conclude that there is no heteroscedasticity in the dataset.
6. We cannot conclude that there is no autocorrelation.
7. We can conclude that the dataset is normally distributed.

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