Afropolitan Journals

ISSN: 3027-2882 www.afropolitanjournals.com

Comparative Analysis of Transformation Techniques to Reduce Multi-Collinearity Using Real GDP of Some Transport Variables that Contributes to Economic Growth in Nigeria

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DOI: *https://doi.org/10.62154/j74h3q95*

Abstract

This study was carried out to compare transformation techniques of reducing multi-collinearity in linear regression using real GDP of some transport variables that contributes to economic growth in Nigeria from 1991-2020. The multiple regression model was used to establish the mathematical relationship between real GDP as the dependent variable and road transport, rail and pipeline transport, water transport, air transport and post and courier service as independent variables. In this work, regression was carried out on the original data to compare the number of independent variables significant with the same data for which the presence of multi-collinearity was reduced using inverse transformation and regression repeated. The results showed that; for original data 1 variable is significant, R^2 = 93% and the number of independent variables with high VIF that is above 10 are two (road transport and water transport). Furthermore, the result for the reduce multi-collinearity inverse transformation reviewed that 5 variables were significant, R^2 =95.2% and the number of independent with high VIF that is above 10 is three (road transport, air transport and post and courier service). Conclusively, the result from inverse transformation gives the best, using R^2 and significant variables as basis for comparison. However useful recommendation was given based on the findings.

Keywords: Multi-Collinearity, GDP, Variance Inflation Factors (VIF), Transport, Economic Growth.

Introduction

Transport which can also be referred to as transportation was derived from two Latin words "trans" which mean "across" and "portare" which mean "carry". (Longman Dictionary of Contemporary English. (4th ed),2003). defined transportation as a process or business of taking goods from one place to another or a system for carrying passengers or goods from one place to another. According to (Good and Jebbin, 2015), transportation is a system for carrying passengers, raw materials and goods from one place to another both internally and internationally, often through power driven machines. It is commonly said to refer to movement of people and goods from one place to another (Okeafor, 1998). Historically, transportation in Nigeria dates back to the colonial era where road network, rails, and water (inland and sea water ways), were tailored towards the gains of the colonialist in the exportation of cash crops, such as groundnuts, cocoa, cotton and palm produce and to the

importation of cheap, mass-produced consumption goods. These early transport systems were planned in based on the then economic situation, as typified in sub-standard road and rail alignments and a sub base, which later proved inadequacy to accommodate heavy vehicles. But following the independence of the country in the 60s, transport became one of the instruments of the country and an important tool for social and economic development (Anyanwu, Oaikhena, Oyefusi and Dimowo, 1997). At present, the means or mediums of transportation in Nigeria include road transport, rail transport and pipelines, water transport, air transport, transport services, post and courier services (Central Bank of Nigeria (CBN), 2019). A good transport system gives people the gift of flexible movement, civilization, source of well-being and wealth that brings people and from village to city and vice-versa. As important as the vein is to blood flow in human body's survival, so also is the transport system to the economy (Binali, 2019). Therefore, the development and advancement of various transportation means has become pivotal to physical and economic growth of any nation. The means such as roads, railways, air, sea, inland waterways, pipelines, ropeways and cableways etc. are inevitable for the global and urban economic survival (Said and Shah, 2020).

Economic growth according to Jhingan, (2003) is the process whereby the real per capital income of a country increases over a long period of time, and is measured by the increase in the amount of goods and services produced in a country. A growing economy produces more goods and services in each successive time period. Thus, in a wider perspective, it implies raising the standard of living of the people and reducing inequality of income distribution (Mamudu and Okosodo, 2019). In the words of Zhattau, (2013) economic growth is the basis of increase prosperity and it comes from accumulation of more capital and innovations which lead to technical progress. This idea is similar to Solow growth model who sees economic growth in terms of growth in total GDP due to increase in population, technical progress and investment. Growth according to Classical Economist signifies increase in the rate of investment (Abdulsalam and Abdullahi, 2016).

Furthermore, transportation is crucial to the survival and growth of the industrial sector as inputs, outputs, and human resources are moved from one place to another creating value for economic progress. In the 1960s and 1970s, road and rail transport systems were used alternatively (optimally) to transport goods in Nigeria. The use of the rail system was abandoned in the 80s resulting to lots of pressure on the roads and this led to a busy and quick depreciating road infrastructure, causing a lot of negative externalities in the form of traffic, accidents, and pot holes, cracks and low productivity in the economy etc. Nigerian rail lines as at the year 2011 were 4,332 km, consisting of 3,505 routes km and 827 km of loop and siding lines according to Oni and Okanlawon (2012).

Statement of the Problem

Multi-collinearity has been a major problem in statistical analysis, it has been known that this problem cannot be eradicated because every variable in real life data are in one way or the other correlated. As it is known that the presence of multi-collinearity inflates the

standard error of the parameters being estimated and thereby reducing the effectiveness of the precision. Several transformation techniques have been proposed by different authors to reduce the variability of the parameter in question. The need to compare some of these transformation techniques so as to know which one to remedy this inevitable problem motivated this research.

Aim and Objectives of the Study

The aim of this study is to carry out comparative analysis of transformation techniques of reducing multi-collinearity in linear regression. The objectives are:

i. To fit in multiple regression model for the data.
ii. To test for the presence of multi-collinearity for the data.
iii. To reduce the presence of multi-collinearity using some existing transformation techniques.
iv. To fit a linear regression equation using several transformed data.
v. To make comparison of the performance of the techniques on comparing the R2-values and the numbers of significant variables obtained in 1 and 4.

Literature Review

Apanisile and Akinlo (2013) examined the link between rail transport and economic growth in Nigeria over the period 1970-2011 using Error Correction modeling approach. The economic variables used were; GDP, capital, government expenditure on rail, rail and pipeline output and inflation. The results showed that there is long-run relationship among the variables. In addition, the ECM models showed that the error correction term is correctly signed and significant while there is inverse relationship between rail transport and economic growth in Nigeria. There is negative relationship between inflation and economic growth in Nigeria over the period under review. This explained the decadence in the sector due to the neglect of the sector by the government. The study therefore concluded that government should embark on development policies that will aim at strengthening the sub-sector of the economy so that it can operate in its full capacity and neutralize the decadence that is evident in the sector.

Onokala and Olajide (2020) analyzed the current problems and challenges facing the four major modes of transportation in Nigeria, which affect their continued contribution to the economic development of the country in the 21st Century as well as their prospects for further development in the future. Presently, the movement of people and all types of goods all over the country is handled by road transport, while roads are overused and also wrongly used in Nigeria the waterways have a lot of capacity that is not being utilized. In addition, pipelines are no longer used and petroleum product are now moved the already congested roads so pipeline are not discussed separately. It was revealed that roads are overused and also wrongly used in Nigeria while the waterways have a lot of capacity that is not being utilized. Railways were heavily used in the past but sparingly used now, while the airways are heavily used but still need a lot of improvement and expansion. The major

result of the predominant use of road transportation over all the other modes are environmental problems of road transportation and high frequency of road traffic accidents on Nigerian roads. The problem of inefficiencies at the ports of Nigeria has led to missed opportunities for receiving more imports at the Nigerian seaports from other countries as well as transport to the economic development of the country. The study suggested sustainable ways of handling these problems and challenges so that these modes can continue their contributions to the economic development of Nigeria in the 21st Century. A lot of improvement and expansion is still needed as all these problems adversely affects the contributions of these modes of transport to the economic development of the country.

Adegoriola, Siyan and Wafure (2020) investigated the impact of rail freight and passengers' volume on economic growth in Nigeria on annual time series data from 1970 to 2017 sourced from Nigerian Railway Corporation, Federal Ministry of Transport, Central Bank of Nigeria and National Bureau of Statistics on the application of the Johansen co-integration and Error Correction Model (ECM). The results showed that a long run equilibrium relationship between the key variables, Gross Domestic Product (GDP), Volume of Freight (VOF) and Volume of Passengers (VOP). ECM also revealed the expected negative sign and between the accepted region of less than unity. The result showed VOP had positive relationship with GDP but insignificant impact on GDP. VOF had negative relationship but significant impact on GDP. The negative impact of VOF on economic growth can be attributed to total neglect of railway sub-sector in Nigeria by successive government. The study therefore recommended that government should continue to increase capital expenditure in the rail sub-sector in order to rehabilitate old and provide modern rail tracks, purchase modern coaches and locomotives will aid movement of passengers and goods across cities and the hinterland which will boost economic activities, increase output, facilitate trade and generate employment across the country.

Some years back after independence, Nigerian rail transport infrastructures investment still remains primary in Nigeria's transport system. While the maritime sector has been developed in terms of capacity and fair country-wide spread, the rail sector continues to be bogged down by systemic neglect (Akwara, Udaw and Ezirim, 2014).

Methodology

The data used is a secondary data collected from the website of Central Bank of Nigeria covering 1991 to 2020 investigating the real GDP of some transport variables such as road transport, rail and pipeline transport, water transport, air transport and post and courier services.

Model Specification

One way of detecting multicollinearity is through the aid of variance inflation factor among others. The speed with which variance and covariance increases can be seen with the VIF which equals VIF = $\frac{1}{1-R_j^2}$ and R_j^2 is the coefficient of determination of an auxiliary regression of one explanatory variable Xj on the remaining explanatory variables. VIF value of a

predictor is indicating that the variance of the coefficient of such predictor will be inflated by that value compare to when the predictors are uncorrelated. A VIF larger than 10 is usually taken as an indicator of multi-collinearity.

For assessing multi-collinearity, the mean of the VIF values is also computed

$$\overline{VIF} = \frac{\sum_{k=1}^{p-1} VIF_K}{P-1}$$

A mean VIF considerably larger than 1, is indicative of serious multi-collinearity problems.

Transformation Techniques

Transformation techniques: literature offers several transformations for reducing multi-collinearity (Gujarati, 2004). In addition to commonly accepted methods, this paper also presents other transformations from statistical literatures to offer researchers the broadest spectrum of transformations for their specific needs. In data analysis transformation is the replacement of a variable by a function of that variable: for example, replacing a variable x by the square root of x or the logarithm of x. in a stronger sense, a transformation is a replacement that changes the shape of a distribution or relationship. There are many reasons for transformation: convenience, reducing skewness, equal spreads, linear relationships and additive relationships.

Inverse Transformation

The inverse, x to $\frac{1}{x_i}$ is a very strong transformation with a drastic effect on distribution shape. It cannot be applied to zero values. Although it can be applied to negative values, it is not useful unless all values to positive. The values of a ratio may often be interpreted as easily as the ratio itself that is:

$$Y = \alpha + \beta_1 \frac{1}{x_1} + \beta_2 \frac{1}{x_i} + \beta_3 \frac{1}{x_i} + \beta_4 \frac{1}{xi} \ldots\ldots\ldots + \varepsilon i$$

Although this model is non-linear in the variable X because it enters inversely. The model is linear in $\beta i \; and \; \beta 2$ and is therefore a linear regression.

Logarithm Transformation

The logarithm, X to log base 10 of X, is a strong transformation with a major effect on distribution shape. It is commonly used for reducing right skewness and is often appropriate for measured variables. It cannot be applied to zero or negative values. One unit on a logarithmic scale means a multiplication by the base of logarithms being used. Exponential growth or decline

$y = aexp(\beta x)$ is made linear by

$$\log Y = log\beta i + \beta 2 logXi + \varepsilon i$$

Where the natural log to the base e and e = 2.7183 so that the response variable y should be logged.

The above equation can be written as:

$$\log Y = \alpha + \beta_2 logX + \varepsilon i$$

Where $\alpha = \log \beta i$, this model is linear in the parameter $\alpha \; and \; \beta$, linear in the logarithm of the variables Y and X, and can be estimated by OLS regression. (Gujarati, basic Econometric pg. 181).

The data set features transport variables like:

The Independent variables include;

Road Transport.....X1

Rail and pipeline transport.....X2

Water transport.....X3

Air transport X4

Post and Courier Service.....X5

Real GDP.....Y] *Dependent variable*

The regression line will be fitted by multiple linear model:

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} \ldots \ldots + \varepsilon i$$

A test for the relationship between each pair of the predictor variables will be conducted and check for possible presence of multi-collinearity in the data set on the basis of Variance Inflation Factor (VIF) and Tolerance Value and a remedy/ reduction procedure was carried out to alleviate the problem. The data analysis would be carried out by the use of SPSS version 20 software.

Results and Discussion

Table 1: Correlation Matrix for Original Data

Coefficient Correlations[a]

Model			Post And Courier Services	Rail Transport And Pipelines	Air Transport	Water Transport	Road Transport
1	Correlations	Post And Courier Services	1.000	.170	-.162	-.036	-.368
		Rail Transport And Pipelines	.170	1.000	-.325	.011	.209
		Air Transport	-.162	-.325	1.000	-.329	-.350
		Water Transport	-.036	.011	-.329	1.000	-.590
		Road Transport	-.368	.209	-.350	-.590	1.000
	Covariances	Post And Courier Services	964461.672	941105.180	-56723.449	-428099.165	-16323.987
		Rail Transport And Pipelines	941105.180	31804197.870	-654366.606	738091.335	53097.864
		Air Transport	-56723.449	-654366.606	127244.591	-1420811.976	-5631.452
		Water Transport	-428099.165	738091.335	-1420811.976	146790372.026	-322505.538
		Road Transport	-16323.987	53097.864	-5631.452	-322505.538	2038.917

a. Dependent Variable: Gross domestic production

The table above show the coefficient correlation of the model, the first column shows the correlation of post and courier services, rail transports and pipeline, air transport, water transport and road transport on GDP, to be all significant and have the present of perfect positive correlation among them except for air transport, water transport and road transport which have a present of perfect negative correlation.

Table 2: Coefficient for original data

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-50398.027	27551.655		-1.829	.080		
	Road Transport	84.013	45.154	.407	1.861	.075	.061	16.407
	Rail Transport And Pipelines	-3195.080	5639.521	-.034	-.567	.576	.790	1.266
	Water Transport	8968.600	12115.708	.142	.740	.466	.080	12.525
	Air Transport	1405.764	356.714	.635	3.941	.001	.113	8.889
	Post And Courier Service	-1804.593	982.070	-.234	-1.838	.079	.181	5.533

a. Dependent Variable: Gross domestic production

Source: Author's Computation

The regression equation is

GDP (N`BILLION) = - 50398.027 + 84.013 Road Transport- 3195.080 Rail Transport and Pipelines + 8969.600 Water Transport + 1405.764 Air Transport – 1804.593 Post and Courier Services.

The table shows the significant of the parameter of b_0=0.080, b_1= 0.075, b_2=0.567, b_3=0.466, b_4=0.001 and b_5=0.079 which are all greater than 0.05, which implies that b_i`s are not significant at 5% level of significant. Table 2 above shows the regression coefficient of the original data, it displays the regression parameter, the tolerance and the VIF for the data, a VIF of 10 and above represent the present of multi-collinearity in the data, the table shows that road transport and water transport have a present of multi-collinearity in the data because they are both above 10, we there by remove them from the model and re-run the regression analysis.

Table 3: Model summary for original data

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.964[a]	.930	.915	13970.46666

a. Predictors: (Constant), Post And Courier Services, Rail Transport And Pipelines, Air Transport, Water Transport, Road Transport.

Source: Author's Computation

Table 3 shows the model summary, which show the R-square to be 0.930, which implies that 93% of the variation in GDP can be explained by the variable inside the model and the remaining 7% of variation can be explain outside the model, which implies that the model is very good enough,

Table 4: Analysis of variance for original data

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	62124436786.928	5	12424887357.386	63.661	.000[b]
	Residual	4684174528.319	24	195173938.680		
	Total	66808611315.247	29			

a. Dependent Variable: Gross domestic production

b. Predictors: (Constant), Post And Courier Services, Rail Transport And Pipelines, Air Transport, Water Transport, Road Transport

Source: Author's Computation

Table 4 above shows the ANOVA result of the regression model, it shows the p-value 0.000 to be less than 0.05, which implies that the model is significant at 5% level of significant.

Table 5: Coefficient correlation after removing the collinearity variables

Coefficient Correlations[a]

Model			Post And Courier Services	Rail Transport And Pipelines	Air Transport
1	Correlations	Post And Courier Services	1.000	.354	-.858
		Rail Transport And Pipelines	.354	1.000	-.223
		Air Transport	-.858	-.223	1.000
	Covariances	Post And Courier Services	927765.736	2075238.405	-218972.545
		Rail Transport And Pipelines	2075238.405	37089552.054	-360476.723
		Air Transport	-218972.545	-360476.723	70165.467

a. Dependent Variable: Gross domestic production

Source: Author's Computation

Table 5 above show the coefficient correlation of the model after removing the variables with the present of multi-collinearity, the first column shows the correlation of post and courier services, rail transports and pipeline, air transport on GDP, to be all significant and have the present of perfect positive correlation among them except for air transport which have a present of perfect negative correlation.

Table 6: Coefficient after removing the collinearity variables

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-21244.236	6629.029		-3.205	.004		
	Rail Transport And Pipelines	-7506.228	6090.119	-.081	-1.233	.229	.850	1.176
	Air Transport	2174.980	264.888	.983	8.211	.000	.256	3.905
	Post And Courier Services	-432.456	963.206	-.056	-.449	.657	.236	4.241

a. Dependent Variable: Gross domestic production

Source: Author's Computation

The regression equation is

GDP (N`BILLION) = - 21244 - 7506 Rail Transport and Pipelines + 2175 Air Transport - 432 Post and Courier Services.

Table 6 shows the significant of the parameter of b_o=0.004, b_1= 0.229, b_2=0.00 and b_3=0.657, which are less than 0.05, which implies that b_i`s are significant at 5% level of significant. The table also shows the regression coefficient of the original data after removing the present of multi-collinearity variable for the model, it displays the regression parameter, the tolerance and the VIF for the data, a VIF of 10 and above represent the present of multi-collinearity in the data, it shows that the model above does not have the present of multi-collinearity in the date because they are all less than 10.

Table 7: Model summary after removing the collinearity variables

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.951[a]	.905	.894	15651.62624

a. Predictors: (Constant), Post And Courier Services, Rail Transport And Pipelines, Air Transport

Source: Author's Computation

Table 7 above shows the model summary after removing the variable with the present of multi-collinearity, which show the R-square to be 0.905, which implies that 90.5% of the variation in GDP can be explained by the variable inside the model and the remaining 9.5% of variation can be explain outside the model, which implies that the model is very good enough.

Table 8: Analysis of variance after removing the collinearity variables

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	60439302812.971	3	20146434270.990	82.239	.000[b]
	Residual	6369308502.276	26	244973403.934		
	Total	66808611315.247	29			

a. Dependent Variable: Gross domestic production

b. Predictors: (Constant), Post And Courier Services, Rail Transport And Pipelines, Air Transport

Source: Author's Computation

Table 8 above shows the ANOVA result of the regression model after removing the variable with the present of multi-collinearity, it shows the p-value 0.000 to be less than 0.05, which implies that the model is significance at 5% level of significance.

Table 9: Coefficient for Inverse Transformation Correlation Matrix.

Coefficient Correlations[a]

Model			Post And Courier Services	Rail Transport And Pipelines	Water Transport	Air Transport	Road Transport
1	Correlations	Post And Courier Services	1.000	.233	.253	.015	-.852
		Rail Transport And Pipelines	.233	1.000	.005	-.630	.076
		Water Transport	.253	.005	1.000	-.258	-.392
		Air Transport	.015	-.630	-.258	1.000	-.407
		Road Transport	-.852	.076	-.392	-.407	1.000
	Covariances	Post And Courier Services	6.989E-007	8.027E-010	1.495E-007	3.545E-008	-4.318E-005
		Rail Transport And Pipelines	8.027E-010	1.702E-011	1.426E-011	-7.514E-009	1.896E-008
		Water Transport	1.495E-007	1.426E-011	4.999E-007	-5.281E-007	-1.682E-005
		Air Transport	3.545E-008	-7.514E-009	-5.281E-007	8.356E-006	-7.127E-005
		Road Transport	-4.318E-005	1.896E-008	-1.682E-005	-7.127E-005	.004

Dependent Variable: Gross Domestic Production

Source: Author's Computation

Table 9 above displays the coefficients of inverse transformation matrix, the first column shows the correlations of the other variables with gdp, to be all significant and have the present of perfect positive correlation among them except for air transport and road transport which have a present of perfect negative correlation.

Table 10: Coefficient for Inverse Transformation.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.000	.000		-3.129	.005		
	Road Transport	-.057	.061	-.273	-.943	.355	.024	41.718
	Rail Transport And Pipelines	-2.416E-005	.000	-.410	-5.857	.000	.412	2.429
	Water Transport	.002	.001	.383	3.398	.002	.158	6.320
	Air Transport	-.009	.003	-.542	-3.167	.004	.069	14.518
	Post And Courier Services	.005	.001	1.346	6.158	.000	.042	23.724

Dependent Variable: Gross domestic production

Source: Author's Computation

The regression equation is

GDP (N`BILLION) = 0.000 -0.057 Road Transport- 2.416E-005 Rail Transport and Pipelines + 0.002 Water Transport -0.009 Air Transport + 0.005 Post and Courier Services.

The table shows the significance of the parameter of b_0=0.005, b_1= 0.355, b_2=0.000, b_3=0.002, b_4=0.002 and b_5=0.000 which are all less than 0.05, which implies that b_i's are significance at 5% level of significance. Table 10 shows the regression coefficient of the inverse transformation data, it displays the regression parameter, the tolerance and the VIF for the data, a VIF of 10 and above represent the present of multi-collinearity in the data, the table shows that road transport, air transport and post and courier have a present of multi-collinearity in the data because they are both above 10.

Table 11: Model summary for inverse transformation

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.976[a]	.952	.942	.000091303

Predictors: (Constant), Post And Courier Services, Rail Transport And Pipelines, Water Transport, Air Transport, Road Transport

Source: Author's Computation

Table 11 shows the model summary for the inverse transformation data, which show the R-square to be 0.952, which implies that 95.2% of the variation in GDP can be explained by the variable inside the model and the remaining 4.8% of variation can be explain outside the model, which implies that the model is very good enough.

Table 12: Analysis of variance for inverse transformation

ANOVA[A]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	.000	5	.000	94.522	.000[b]
	Residual	.000	24	.000		
	Total	.000	29			

a. Dependent Variable: Gross domestic production

b. Predictors: (Constant), Post And Courier Services, Rail Transport And Pipelines, Water Transport, Air Transport, Road Transport

Source: Author's Computation

Table 12 shows the ANOVA result of the regression model for the inverse transformation data, it shows the p-value 0.000 to be less than 0.05, which implies that the model is significant at 5% level of significant.

Table 13: Summary of finding using transformation techniques

TRANSFORMATON	R^2	ADJ-R^2	S.E	VIF VARIABLES	NUMBER OF SIGNIFICANT VARIABLES	SIGNIFICANT VARIABLES
Original data	0.930	0.915	13970.46666	2	1	X_4
Inverse	0.952	0.942	.000091303	3	5	$X_2, X_3, X_4, \& X_5$

Source: Author's Computation

Table 13 shows, that the inverse transformation, which show the R-square to be 0.952 and adjusted R-square to be 0.942, which implies that 95.2% of the variation in GDP can be explained by the variable inside the model and the remaining 4.8% of variation can be explain outside the model, which implies that the model is very good enough, it is important that to note that all variables are begin considered together when these values are computed.

Discussion

For Regression Analysis for Original Data

The regression equation is

GDP (N`BILLION) = - 50398.027 + 84.013 Road Transport- 3195.080 Rail Transport and Pipelines + 8969.600 Water Transport + 1405.764 Air Transport – 1804.593 Post and Courier Services.

It shows the significant of the parameter of b_0=0.080, b_1= 0.075, b_2=0.567, b_3=0.466, b_4=0.001 and b_5=0.079 which are all greater than 0.05, which implies that b_i's are not significance at 5% level of significance.

It shows the regression coefficient of the original data, it displays the regression parameter, the tolerance and the VIF for the data, a VIF of 10 and above represent the present of multi-collinearity in the data, the table shows that road transport and water transport have a present of multi-collinearity in the data because they are both above 10, we there by remove them from the model and re-run the regression analysis.

It shows the model summary, which show the R-square to be 0.930, which implies that 93% of the variation in GDP can be explained by the variable inside the model and the remaining 7% of variation can be explain outside the model, which implies that the model is very good enough.

It shows the ANOVA result of the regression model, it shows the p-value 0.000 to be less than 0.05, which implies that the model is significance at 5% level of significance.

Correlation after removing the collinearity variables shows the coefficient correlation of the model after removing the variables with the present of multi-collinearity, the first column shows the correlation of post and courier services, rail transports and pipeline, air transport on GDP, to be all significant and have the present of perfect positive correlation among them except for air transport which have a present of perfect negative correlation.

The Regression Analysis after Removing the Collinearity Variables

The regression equation is

GDP (N`BILLION) = - 21244 - 7506 Rail Transport and Pipelines + 2175 Air Transport - 432 Post and Courier Services.

It shows the significant of the parameter of b_0=0.004, b_1= 0.229, b_2=0.00 and b_3=0.657, which are less than 0.05, which implies that b_i's are significance at 5% level of significance.

It shows the regression coefficient of the original data after removing the present of multi-collinearity variable for the model, it displays the regression parameter, the tolerance and the VIF for the data, a VIF of 10 and above represent the present of multi-collinearity in the data, it shows that the model above does not have the present of multi-collinearity in the date because they are all less than 10.

It shows the model summary after removing the variable with the present of multi-collinearity, which show the R-square to be 0.905, which implies that 90.5% of the variation in GDP can be explained by the variable inside the model and the remaining 9.5% of variation can be explain outside the model, which implies that the model is very good enough.

It shows the ANOVA result of the regression model after removing the variable with the present of multi-collinearity, it shows the p-value 0.000 to be less than 0.05, which implies that the model is significance at 5% level of significance.

The inverse transformation for the data displays the coefficients of inverse transformation matrix, the first column shows the correlations of the other variables with GDP, to be all significant and have the present of perfect positive correlation among them except for air transport and road transport which have a present of perfect negative correlation.

The regression equation is

GDP (N`BILLION) = 0.000 -0.057 Road Transport- 2.416E-005 Rail Transport and Pipelines + 0.002 Water Transport -0.009 Air Transport + 0.005 Post and Courier Services.

It shows the significant of the parameter of b_0=0.005, b_1= 0.355, b_2=0.000, b_3=0.002, b_4=0.002 and b_5=0.000 which are all less than 0.05, which implies that b_i's are significant at 5% level of significant.

It shows the regression coefficient of the inverse transformation data, it displays the regression parameter, the tolerance and the VIF for the data, a VIF of 10 and above represent the present of multi-collinearity in the data, the table shows that road transport, air transport and post and courier have a present of multi-collinearity in the data because they are both above 10.

Conclusion

The study was carried out to compare transformation of reducing multi-collinearity in linear regression using the real GDP of some transport variables from 1991-2020. The multiple linear regression model was used to establish the mathematical relationship between real GDP as the dependent variable, and road transport, rail and pipeline transport, water transport, air transport and post and courier service as independent variables. In this work regression was carried out on the original data to compare the number of independent variables significant with the same data for which the presence of multi-collinearity was reduced using inverse transformation and regression repeated. Results showed that; for original data 1 variable is significant, R^2 = 93%

and the number of independent variables with high VIF that is above 10 are two (road transport and water transport). Furthermore, the result for the reduce multi-collinearity inverse transformation reviewed that 5 variables were significant, R^2 =95.2% and the number of independent with high VIF that is above 10 is three (road transport, air transport and post and courier service). Conclusively, the result from inverse transformation gives the best using R^2 and significant variables as basis for comparison.

Recommendations

- It is recommended that, the variables like road transport, rail and pipeline transport, water transport, air transport and post and courier service) should be considered as important transport variables contributing to the real GDP in Nigeria.
- More models should be further investigated.

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