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Statistical Modelling of Selected Real Sectors and Economic Growth in Nigeria.

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Abstract
The statistical modelling of selected service sectors and the economic growth of Nigeria was considered. A linear regression with three predictors (Telecommunication, Industrial and Agricultural sectors) was built. The study considered P-value, VIF, R^2, and analysis of variance. The data used was from 1960 to 2022, covering the period of lack of technology and the period when technology have been advanced. It was revealed that the Telecom and Industrial sectors had positive impact while the Agricultural sector had negative impact on the economic growth of Nigeria with their respective values of 〖3.0×10〗^(-5), 0.784 and 1.404. Also, the coefficient of determination was found to be 73.98%, which showed that the model was a good fit and the predictors (Telecom, Industrial and Agricultural sectors) were able to explain the variations in the response variable. The study recommended among others that more investment should be made in the Agricultural and Industrial sectors to ensure creation of jobs and profitable growth in Nigeria economy.

Keywords: Agriculture, Industry, Telecommunication, Economy, Regression.

Introduction

The development of Technology in Nigeria was a good adventure, and the Government have keyed into the trend of development as occasioned from the technological sector of every country's economy. Uchendu and Onogwu (2020) state that the Federal Ministry of Science and Technology was established in 1980 with the goal of elevating Nigeria to the position of a world leader in technological development. Despite having a ministry of Science and Technology in place for forty years and sixty years after independence, Nigeria has failed to become a technological powerhouse on a regional or global scale. Still, most people believe that a nation like Nigeria can quickly and easily improve its economy by focusing on agriculture and industry. If effectively used, their potential may increase a nation's revenue. The agricultural sector, on the one hand, helps meet basic human needs by producing food, raw materials, jobs, income, and foreign currency. It also helps businesses by providing them with labour, capital, and a market for their products. Mechanised agriculture has the potential to alleviate poverty in Nigeria, as shown in Shiru's (2012) research. Conversely, industrialisation is expected to bring about economic growth, new job opportunities, higher productivity, lower prices, more savings, economic diversification, improved agriculture, less reliance on imports, and more foreign exchange (Kamil et al., 2017). Agricultural efforts in Nigeria were overshadowed by the country's oil boom. Actually, the sector's overall contribution to GDP has been declining for decades. The sector's contribution to GDP dropped significantly from 55.8% in 1960–1970 to 28.4% in 1971–1980.

One other approach for a nation like Nigeria to diversify its economy is via industrialisation. To encourage industrialisation among indigenous peoples and their traditional practices, the government of Nigeria has established and is enforcing an indigenisation policy. Import substitution, export promotion, small-scale vs large-scale industrial development, and balanced growth are some of the techniques that the government has used to foster industry development in Nigeria.

In addition, Onu and Inamete (2022) used descriptive statistics, correlation, and multiple linear regression to look at

how ten listed insurance businesses in Nigeria fared financially from 2010 to 2021 in connection to corporate governance. Examining the relationships between these predictions and the answers was the primary goal of the research. Additionally, it was discovered that ROA had a mean of 47.66 and a standard deviation of 28.57, while EPS had a mean of 10.47 and a standard deviation of 25.94. According to the coefficient of determination, corporate governance could only account for 2.87% of the variance in return on assets in the ROA model, and only 1.72% of the variance in earnings per share in the EPS model. Furthermore, Adenomon and Oyejola (2013) found that the structural innovations of GDP in Nigeria came from both agriculture and industry, with the former making a larger contribution, according to the SVAR models. Therefore, the study concluded that infrastructure facilities and particular incentives for farmers should be provided. However, the Nigerian government should really and aggressively seek out innovative methods to revive the country's industrial sector. The implementation of hefty duties on some imported items was another tactic, as was an initiative encouraging Nigerians to buy goods produced inside the country. Industrialisation has a favourable effect on GDP growth, so the Nigerian government is collaborating with other countries to establish industries in Nigeria via the Ministry of Trade and Investment. The administration is also working to industrialise the Nigerian economy by resolving security challenges, which would bring about peace and stability in politics.

The goal of the problem was to determine the effect of actual economic sectors on GDP growth in Nigeria. Three actual industries telecommunications, manufacturing, and agriculture were examined. Gross Domestic Product (GDP) was the economic growth metric for Nigeria. Data was analysed during the years 1960–2022. The research examined the development of Nigeria's economy using a multivariate linear regression model, with these actual sectors serving as the predictors. During this time, Nigeria's technological infrastructure was either non-existent or only partially complete.

Materials and Methods

The multiple linear regression model used in this analysis is represented by;

$$GDP = \beta_0 + \beta_1 Telecom + \beta_2 Industrial + \beta_3 Agricultural + \mathcal{E} \quad (1)$$

when all other explanatory variables equal zero), β_1, β_2, and β_3 are the gradient or the coefficients of the Telecommunication sector, Industrial sector, and Agricultural sector, respectively.

The input matrix which comprises the matrix of Telecommunication sector, Industrial sector, and Agricultural sector is normally expressed as

$$X = \begin{pmatrix} x_{11}\, x_{12} \ldots x_1 p \\ x_{21} x_{22} \ldots x_{2p} \\ \vdots \\ x_{n1} x \ldots . x_{np} \end{pmatrix} \quad (2)$$

This study's input variables, which may be defined as explanatory or predictive factors, were culled from macrotrend.net and span the years 1960–2022.

In equation (1), the vector of GDP, which is the output variable vector, is often expressed as

$$\underline{Y} = \begin{pmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{pmatrix}, \quad (3)$$

Gross domestic product (GDP) growth is the response variable that measures the production. A vector of model parameters, denoted as the weight vector H, is provided.

$$\underline{\beta} = \begin{pmatrix} \beta_1 \\ \beta_2 \\ \vdots \\ \beta_p \end{pmatrix}, \quad (4)$$

And the vector of stochastic error term $\mathcal{E}$ is defined as

$$\underline{\mathcal{E}} = \begin{pmatrix} \mathcal{E}_1 \\ \mathcal{E}_2 \\ \mathcal{E}_3 \end{pmatrix}, \quad (5)$$

And using the Least Squared Equation that is defined as

$$\underline{\beta} = (X'X)^{-1}X'Y \quad (6)$$

We find that variance covariance matrix is

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$(X'X)^{-1} = \frac{Adj(X'X)}{|X'X|}$ (7)

We may get the parameters ų̂ from equation (7) by multiplying the transpose of X' by Y, which gives us X' X. Take note that (1) may be expressed as a matrix, as shown in Kutner et al. (2005) and Onu & Inamete (2022) as

$y = X\beta + \mathcal{E}$, where $\mathcal{E} \sim N(0, \delta_e^2 I_n)$ (8)

and I_n represents an $N \times N$ identity matrix.

Application of Analysis of Variance (ANOVA)

An analysis of variance has been done to equation (1). As stated by Keller and Warrack (2003), the use of an analysis of variance will give us the total sum of squares, the sum of squares of error, and the sum of squares for regression. In order to establish how close two means are to each other, we use the sum of squares treatment. It is denoted as follows:

$SS_{Treat} = \sum_{i=1} n_i (\bar{x}_i - \bar{\bar{x}})^2$ (9)

As shown in Keller and Warrack (2003), a significant discrepancy in the sum of squared treatments indicates that the Grand Mean will be significantly different from one or more of the sample means. The sum of square errors, abbreviated as SSE, is;

$SSE = \sum_{j=1}^{n} \sum_{i=1}^{n} \left(x_{ij} - \bar{x}_j\right)^2$ (10)

this can also be written by expansion as;

$$SSE = (n_1 - 1)S_1^2 + (n_2 - 1)S_2^2 \ldots + (n_K - 1)S_k^2$$

Moreover, the study will determine the mean squares, where the mean square for treatment is calculated as follows;

$MS_{treat} = \frac{SS_{treat}}{n-1}$, (11)

while mean square error $= \frac{SSE}{N-n}$ (12)

Where N stands for total sample size while n is the number of treatments.

t-statistics used in this study is;

$t = \frac{\hat{m}_0}{S(\hat{m}_0)}$ (13)

where $\hat{m}_0$ represents the estimated intercept parameter of the regression model with an intercept, and $S(\hat{m}_0)$ denotes the standard deviation of the intercept term. The t-statistic for the slope parameter, $\hat{m}_1$,, is provided below as shown by Kutner et al (2005);

$t = \frac{\hat{m}_1}{S(\hat{m}_1)}$

But $S(\hat{m}_0) = MSE \left[\frac{1}{n} + \frac{\bar{x}^2}{\sum(xi - \bar{x})^2}\right]$ (14)

$SSE = \sum(y_i - \hat{y}_1)^2$

$SStotal = \sum(y_i - \bar{y})^2$

$SSR = \sum(\hat{y}_1 - \bar{y})^2$

$MSE = \frac{\sum(y_i - \hat{y}_i)}{n-2} = \frac{SSE}{n-2}$

$MSE_{Reg} = \frac{\sum(\hat{y}_1 - \bar{y}_i)}{n-2} = \frac{SSE}{1} = SSR$

A typical example of a one-way ANOVA is shown in Table 1

Table 1: One Way ANOVA

Source of Variation	Df	SS	MS	Fcal
Treatment (B/W)	(k-1)	SS_{treat}	MS_{treat}	$\frac{MS_{treat}}{MSE}$
Error (within)	$(\mu - k)$	SSE	MSE	
Total	$(\mu - k)$	***SST***		

Coefficient of Determination

The Coefficient of determination applied in this study is given as;

$R^2 = \frac{SSR}{SSTotal}$ (15)

$= 1 - \frac{SSE}{SSTotal}$ (16)

Values of coefficients of determination range from zero to one, with higher values indicating better fitness of the model to the data. The adjusted coefficient of determination, which is used as an alternative statistic for testing, is

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$$R^2_{Adjusted=} = \left(\frac{n-1}{n-p}\right)\left(\frac{SS_{Error}}{SS_{Total}}\right) \quad (17)$$

$$= 1 - \frac{\text{MSE}}{SS_{Total}/(n-1)} \quad (18)$$

Regression Analysis: GDP versus Telecom, Industrial & Agricultural Sector

Table 2: Macrotrend.net, 1960 – 2022

Telecom	Industrial	Agricultural	No of Tel 1	GDP
18724	89.45	84.45	187.24	477.39
18724	83.61	86.49	187.24	440.83
18724	72.26	85.28	187.24	432.2
18724	78.15	80.98	187.24	474.52
18724	28.04	26.77	187.24	421.74
18724	83.09	28.04	187.24	375.75
18724	81.83	39.36	187.24	404.65
18724	85.41	58.08	187.24	493.03
18724	94.24	69.92	187.24	574.18
18724	125.66	84.59	187.24	520.12
18724	108.4	129.61	187.24	463.97
18724	109.64	138.7	187.24	414.47
18724	107.64	135.19	187.24	366.99
18724	108.45	106.68	187.24	295.01
18724	115.28	113.5	187.24	339.48
18724	116.87	149.51	187.24	278.26
18724	118.15	155.93	187.24	238.45
18724	110.85	162.25	187.24	175.67
18724	122.06	170.81	187.24	135.76
18724	128.74	135.12	187.24	104.74
18724	123.91	182.66	187.24	95.05
18724	150.25	190.37	187.24	74.03
18724	156.49	203.01	187.24	69.45
18724	159.16	216.21	187.24	59.37
18724	155.17	231.46	187.24	54.6
18724	151.7	248.6	187.24	54.46
18724	146.52	266.48	187.24	51.08
18724	149.49	283.18	187.24	44.06
18724	158.19	299.82	187.24	33.83
18724	161.12	317.28	187.24	27.75
18724	162.99	335.18	187.24	47.79
18724	165.82	348.49	187.24	49.12
18724	167.32	351.63	187.24	54.04

18724	169.24	357.71	187.24	44
18724	170.05	359.99	187.24	49.65
18724	172.43	367.52	187.24	52.68
18724	175.67	370.02	187.24	54.81
18724	177.09	375.64	187.24	73.75
18724	181.68	379.29	187.24	73.48
18724	185.91	390.82	187.24	97.09
18724	188.89	400.23	187.24	142.77
400000	432.76	543.23	4000	164.48
400000	489.63	548.54	4000	64.2
400000	521.41	552.13	4000	47.26
400000	535.34	554.61	4000	36.53
400000	548.92	557.62	4000	36.04
400000	552.12	569.85	4000	36.31
10000000	721.22	894.33	100000	27.78
10000000	734.23	897.41	100000	24.85
10000000	756.73	899.08	100000	15.16
10000000	766.63	903.21	100000	12.27
10000000	772.13	921.23	100000	9.18
10000000	789.9	926.42	100000	12.55
10000000	798.43	937.82	100000	6.63
10000000	813.46	941.05	100000	5.2
10000000	823.65	943.32	100000	5.2
10000000	835.67	953.6	100000	6.37
10000000	841.15	961.24	100000	5.87
10000000	854.32	977.83	100000	5.55
10000000	861.63	989.89	100000	5.17
10000000	876.54	992.34	100000	4.91
10000000	888.83	999.41	100000	4.47
10000000	893.91	999.99	100000	4.2

Table 3: Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	404.3	24.7	16.36	0.000	
Telecom	0.000030	0.000007	4.16	0.000	7.33
Industrial	0.784	0.195	4.02	0.000	26.42
Agricultural	-1.405	0.162	-8.68	0.000	22.40

Table 4: Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
90.2764	73.98%	72.66%	71.44%

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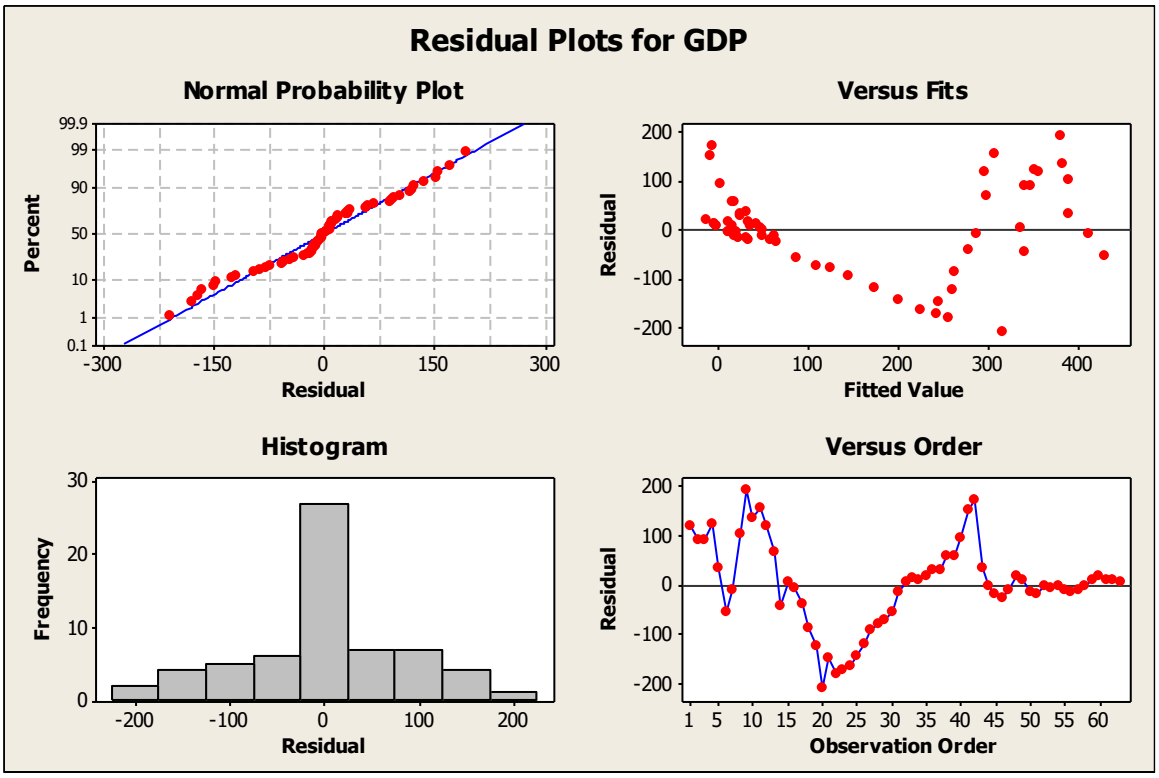
Table 5: Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	3	1367297	455766	55.92	0.000
Telecom	1	140972	140972	17.30	0.000
Industrial	1	131979	131979	16.19	0.000
Agricultural	1	614486	614486	75.40	0.000
Error	59	480840	8150		
Total	62	1848137			

Regression Equation

GDP = 404.3 + 0.000030 Telecom + 0.784 Industrial - 1.405 Agricultural

Fig.: A Residual Plot for GDP



Discussion of Results

The fitted regression model revealed that the Telecommunication and the Industrial sectors had positive contribution on the economic growth of Nigeria with the respective values of 3.0×10^{-5} and 0.784, while the Agricultural sector had negative contribution on the economic growth of Nigeria with the value of 1.404.

In table 2, it was revealed that all the predictors (Telecom, Industrial and Agricultural sectors) had significant contributions on the economy of Nigeria. The negative contribution of Agricultural sector on the economy was so visible and this was such because of the neglect the sector had suffered over the years. This result was revealed by their respective P-values of 0.000. The variance inflation factor (VIF) of the Telecom sector was seen to be less than 10, which means that there was no presence or insignificant presence of multicollinearity in the data set, whereas the Industrial and the Agric sectors showed that there was some presence of multicollinearity as revealed by the value of VIF with the values of 26.424 and 22.404 respectively.

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The coefficient of determination (R^2), which is employed to examine the goodness of fit of the model with the explanatory variable (data), indicated that the multiple linear regression model without interaction and the chosen services sector were able to explain the GDP of Nigeria by approximately 73.98%. This implies that the remaining 26.02% could not be explained. Therefore, the model can be considered to have fitted the data well.

In table 3, the analysis of variance showed that the null hypothesis of no significant difference was rejected, while the alternative hypothesis which stated that there was significant difference among the service sectors was accepted. This was revealed by the F-value of 55.92 and P-value of 0.000.

Conclusion

It was revealed from the analysis, that the Telecom and Industrial sectors had positive impact while the Agricultural sector had negative impact on the economic growth of Nigeria with their respective values of 3.0×10^{-5}, 0.784 and 1.404. Also, the coefficient of determination was found to be 73.98%, which showed that the model was a good fit and the predictors (Telecom, Industrial and Agricultural sectors) were able to explain the variations in the response variable. The study therefore concludes that when service sectors are properly taken care of by the Government, they generally contribute positively to the growth of economy (Nigeria).

Recommendation

The study recommended the following:

1. It is therefore recommended that Government at all levels (Federal, State and Local) should invest massively in agriculture to ensure that agricultural products start contributing positively to the economy of Nigeria. There are so many credits that are lost because of lack of proper investment in the sector, and this has made the agricultural sector show negative contribution to the economic growth such as massive production of agricultural produce and conversion of say 50% of this produce to finished goods for exportation. This was mainly what the Nigeria economy was lacking.
2. Individuals should also invest in Agriculture. Infact, every household is supposed to have at least two agricultural products that they will not buy in the market, instead others should buy from them as they also buy items, they cannot produce from others too.
3. Furthermore, more industries should be built, either by means of public private partnership (PPP) or just private group. This will aid in creating jobs that will help in curbing insecurity.

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