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On the Contribution of Some Economic Sectors to Nigeria Gross Domestic Product

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Abstract

The contribution of various sectors to Nigeria's Gross Domestic Product (GDP) was investigated in this report, as well as the creation of a model for forecasting Nigeria's GDP over a 33-year period (1981-2013). Regression analysis and time series analysis were used to analyze data from the Central Bank of Nigeria. The regression results show a positive relationship between the three sectors: Agricultural, Industrial, and Service, with only the Industrial and Service sectors contributing significantly with coefficients of 0.286 and 0.631, respectively, while the contribution of the Agricultural sector is not significant with a coefficient of -0.039, implying that the service sector contributes the most. The agricultural sector makes a negligible contribution. A time domain model (fundamental approach) based on the Box Jenkins approach was used to forecast Gross Domestic Product for the period 1981 to 2013 using the ARIMA model in a developing country like Nigeria. The outcome shows an upward trend, and the series' first difference was stationary, indicating that the series was I (1). ARIMA was found to be the best model for explaining the series using expert modelers (1, 1, 0). The diagnosis on such a model was verified, the error was white noise, there was no serial correlation, and a 10-year forecast was made, indicating that GDP would continue to rise over the forecasted time period.

Keywords: Gross Domestic Product, Time series analysis, ARIMA, Nigeria.

1.0 INTRODUCTION

The development of the Nigerian Economy is one that emanated from a monoculture economy beign based purely on the agricultural sector of the economy, therefore making the sector the main stay of the economy [1]. The discovery of the crude oil in (1956) in commercial quantity has however nullified this assertion, since it has relegated the hitherto mainstay of the economy to the background. This makes it rely solely on the fortunes accuring from the proceeds of oil sector for the growth and development of the Nigerian economy. It is however important to note that the various sectors of any economy has a contribution to the development of that economy, this is to say that no matter how small the contribution of any sector, to the national income of that economy, it add up to the aggregate income of the economy and thus contributing directly or indirectly to the gross domestic earning of such economy. The Gross Domestic Product (GDP) is a basic measure of a country's overall economic performance [2]. It is the market value of all final goods and services made within the border of a country in a year and are often positively correlated with the standard of living. GDP is the most frequently used indicator of economic activity and is most often measured annually or quarterly to gauge the growth of a country's economy between one period and another [3]. A country is said to have good economy if its GDP is relatively high. GDP is important in determining if an economy is growing quickly or slowly than the same quarter the year before, it is used to compare the size of economics that is relative growth rate of economies throughout the world [4]. Also for investors, the GDP is used as a means of adjusting their assets location and to decide where the best opportunities lie. The Gross Domestic Product (GDP) of Nigeria is made up of diverse sectors which includes; Agriculture, Industry, Services, etc. Agriculture is one of the dominant sectors of the Nigerian economy. Though since independence, its role in the economy has been on the downward trend especially its contribution to GDP. The sector comprises of crops, livestock, fishing and forestry [5]. It involves the cultivation of land, raising and rearing of animal for the purpose of production of food for man, feed for animals and raw materials for industries. It is essential for the expansion of employment opportunities, reducing poverty and improvement of income contribution for speedy industrialization [6-9]. The service sector has been increasing in major activities of the economy. The service sector comprises of transport, communication, utilities, hotel and restaurant, insurance etc. The service sector has major contribution in value added and gross fixed capital formation in Nigeria. It is an important source of revenue for the nation. Employment share in service sector is increasing, people are moving from other economic sectors to service sector. Industrialization is an integral part of development and structural change in any nation [10]. The industrial sector comprises of the crude petroleum and natural gas, solid mineral and the manufacturing industries. History recorded that the industrial sector performance in Nigeria's economic growth is as old as the nation itself. It dates back to the amalgamation of the southern parts of the country in 1914 for the geographical land mass called Nigeria [11]. A number of fiscal and monetary policies together with institutional reform measures have been undertaken since independence. Right from the first national development plan (1962-1968) to the fourth national development plan (1981-1985) rapid industrialization received priority in Nigeria's development objectives.

2.0 METHODOLOGY

The statistical methods to be used in analyzing the data presented above will be highlighted as follows:

2.1 Regression Analysis

In statistics, regression analysis is a statistical tool that is commonly used for estimating the relationships among variables. It includes many techniques for modeling and analyzing several variables, when the focus is on the relationship between a dependent variable and one or more independent variables. More specifically, regression analysis helps one understand how the typical value of the dependent variable (or 'criterion variable') changes when any one of the independent variables is varied, while the other independent variables are held fixed. Most commonly, regression analysis estimates the conditional expectation of the dependent variable given the independent variables – that is, the average value of the dependent variable when the independent variables are fixed. Under regression, we have simple regression, multiple regression, polynomial regression etc. But for the purpose of this research, we shall make use of multiple regressions to determine the contributions of some economic sectors to GDP. Multiple regressions is an extension of simple linear regression. It is used when we want to predict the value of a dependent variable based on the value of two or more independent variables. This is obtainable where there is need to include more independent variables in a simple regression in order to improve one's analysis result. The independent variables in this research work are the selected sectors of the economy.

The multiple regression models can be expressed as follows;

$$Y = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} \dots + \beta_K X_{ik} + \varepsilon_i \qquad i = 1, 2, \dots, n \qquad (1)$$

Where

Y is the dependent variable

$X_1, X_2, \dots, X_k$ are the independent variables

$\beta_0, \beta_1, \dots, \beta_k$ are the parameters referred to as regression coefficients.

ε_i represents the error which is normally distributed with mean 0 and variance $\delta^2 I$

In matrix notation the model in Equation 3.1 can be written as; $Y = X\beta + \varepsilon$

Where:

$$Y = \begin{bmatrix} y_1 \\ y_2 \\ \cdot \\ \vdots \\ y_p \end{bmatrix} \quad X = \begin{bmatrix} 1 & x_{11} & x_{12} & \dots & x_{1k} \\ 1 & x_{21} & x_{22} & \dots & x_{2k} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ 1 & x_{n1} & x_{n2} & \dots & x_{nk} \end{bmatrix} \quad \beta = \begin{bmatrix} \beta_0 \\ \beta_1 \\ \cdot \\ \vdots \\ \beta_p \end{bmatrix} \quad \varepsilon = \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \cdot \\ \vdots \\ \varepsilon_p \end{bmatrix} \qquad (2)$$

The least square estimate of the multiple regressions coefficients is given as:

$$\hat{\beta} = (X'X)^{-1}X'Y \qquad (3)$$

2.2 Time Series Analysis

A time series is a sequence of observations that are arranged according to the time of their outcome. Spiegel and Larry (1980) defines it as a set of observation that is obtained at regular periods of time. It is a set of observations generated sequentially in time. There are obviously numerous reasons to record and analyze the data of a time series. Among these is the wish to gain a better understanding of the data generating mechanism, the production of future values or the optimal control of a system. In statistical literature, time series refers to that body of principals and techniques which deals with analysis of observed data $X_t, t = 1, 2, \ldots, n$ [12-14].

Some fundamental concepts in the theory of time series models include the following:

1. Stochastic Processes

A statistical phenomenon that evolves in time according to probabilistic laws is called a stochastic process. A sequence of random variables $\{Y_t: t = 0, \pm 1, \pm 2, \ldots\}$is called a stochastic process and serves as a model for an observed time series.

2. Stationary and Non- Stationary Stochastic Model

An important class of stochastic models for describing time series, which has received a great deal of attention is the so called stationary models, which assumes that the process remains in equilibrium about a constant mean level. Specifically, a process Y_t is said to be strictly stationary if the joint distribution of $Y_{t1}, Y_{t2}, \ldots, Y_{tn}$ is the same as the joint distribution of $Y_{t1-k}, Y_{t2-k}, \ldots, Y_{tn-k}$ for all choices of time points $t_1, t_2, \ldots, t_n$ and all choices of time lag k [15].

A non-stationary time series implies that the process has no constant mean, non-stationary time series can be stationarized by a suitable degree of differencing.

3. Autoregressive Models

A stochastic process $Y_t, t \in Z$ is said to be an autoregressive process of order p, denoted by AR (p) if it satisfies the difference equation

$$Y_t = \sum_{j=1}^{p} \emptyset_j Y_{t-j} + e_t$$

$$Y_t = \phi_1 Y_{t-1} + \phi_2 Y_{t-2} + \cdots + \phi_p Y_{t-p} + e_t \quad (4)$$

Where $\phi_1, \ldots, \phi_p$ are constant and $e_t \sim N(0, \delta^2)$ is a white noise process [16].

4. Moving Average Models

A stochastic process $Y_t, t \in Z$ is said to be a moving average process of order q , denoted by MA(q) if it satisfies the difference equation

$$Y_t = \sum_{j=1}^{q} \theta_j Y_{t-j} + e_t$$

$$Y_t = \theta_1 Y_{t-1} + \theta_2 Y_{t-2} + \cdots + \theta_q Y_{t-q} + e_t \quad (5)$$

Where $\theta_1, \ldots, \theta_q$ are constant and $e_t \sim N(0, \delta^2)$ is a white noise process.

5. Autoregressive Moving Average

A stochastic process $Y_t, t \in Z$ is said to be an autoregressive moving average process of order p and q, denoted by ARMA (p, q) if it satisfies the difference equation

$$Y_t = \phi_1 Y_{t-1} + \phi_2 Y_{t-2} + \cdots + \phi_p Y_{t-p} + e_t - \theta_1 Y_{t-1} - \theta_2 Y_{t-2} - \cdots - \theta_q Y_{t-q} \quad (6)$$

Where $\phi_1, \ldots, \phi_p$ and $\theta_1, \ldots, \theta_q$ are constant and $e_t \sim N(0, \delta^2)$ is a white noise process.

6. Autoregressive Integrated Moving Average

A stochastic process $Y_t, t \in Z$ is said to be an autoregressive integrated moving average process of order p, d and q, denoted by ARIMA (p, d, q) if it satisfies the difference equation

$$\phi(B)(1 - B)^d X_t = \theta(B) e_t \quad (7)$$

Where $\phi(B)$ and $\theta(B)$ are polynomials of orders p and q respectively, d is the order of non- seasonal differencing and e_t is a white noise process

7. Autocorrelation

Given n observations $X_1, X_2, \ldots, X_n$ on a discrete time series we can form (n-1) pairs of observations namely $(X_1\ X_2), (X_2\ X_3), \ldots, (X_{n-1}\ X_n)$. The autocorrelation coefficient is given by:

$$\rho_k = \frac{\sum_{t=1}^{n}(X_t - \bar{X})(X_{t+k} - \bar{X})}{\sum_{t=1}^{n}(X_t - \bar{X})^2} \quad \text{Where } \bar{X} = \frac{1}{n}\sum_{t=1}^{n} X_t \quad (8)$$

This is called the autocorrelation at lag k

8. Partial Autocorrelation

The partial autocorrelation function (PACF) is the partial correlation coefficients between the series and lags of itself over time.

9. Lag

The lag operator is denoted by L. It shifts a time series so that the shifted time series lags one time unit behind. This is shown as

$$(LY)_t = Y_{t-1} \tag{9}$$

2.3 Data Sources and Limitation

The data used for this study is a secondary data collected from CBN statistical bulletin on gross domestic product of some economic sectors; agriculture, industry and services at 1990 constant basic prices (N' Billion).

Table-1: GDP and its various sectors

YEAR	Industrial sector	Service sector	Agricultural sector	GDP
1988	89.45	34.50	84.43	251.05
1989	83.61	33.84	86.49	246.73
1990	72.26	31.63	85.28	230.38
1991	78.15	30.65	80.98	227.25
1992	28.04	39.36	26.77	253.01
1993	83.09	29.28	28.04	257.78
1994	81.83	30.14	39.36	256.00
1995	85.41	31.45	58.08	275.41
1996	94.24	34.51	69.92	295.09
1997	125.66	32.64	84.59	328.61
1998	108.40	40.73	129.61	328.64
1999	109.99	43.12	132.70	337.29
2000	109.64	44.61	135.19	342.54
2001	107.04	46.19	106.68	345.23
2002	108.45	47.10	113.50	352.65
2003	115.28	33.83	149.51	367.22
2004	116.87	50.14	155.93	377.83
2005	118.15	59.17	162.25	388.47
2006	110.85	53.28	170.81	393.11
2007	122.06	55.18	135.12	412.33
2008	128.74	59.17	182.66	431.78
2009	123.91	72.46	190.37	451.79
2010	150.25	72.75	203.01	495.01
2011	156.49	79.18	216.21	527.58
2012	159.16	85.48	231.46	561.93
2013	155.17	93.33	248.60	595.82
2014	151.70	102.62	266.48	634.25
2015	146.52	117.00	283.18	672.24
2016	149.49	130.44	299.82	718.98
2017	158.19	145.07	317.28	776.33
2018	161.12	161.52	335.18	834.00
2019	162.99	177.05	348.49	888.89
2020	165.82	193.15	365.28	950.11

3.0 DATA ANALYSIS

The analysis on the contribution of some economic sectors to GDP is done using multiple regression analysis.

The summary of the model is presented in table 4.1

Table-2: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.989	.978	.975	0.02870

The value of R= 0.989 tells us that there is a high positive relationship between the predictor variables (Agriculture, industry and service sector) and GDP. The value of R^2 of 0.978 (known as the coefficient of determination) tells us that 98% of the variation in GDP could be explained by Agriculture, industry and service sector while the remaining 2% could not be accounted for. The Adjusted R^2 of 0.975 is close to the R^2 value of 0.978 meaning that the model is fit for making generalization [17, 18].

The SPSS software was used to estimate the parameter for this model and it is displayed below as:

Table-3: Model Parameter

Model		Unstandardized Coefficients	
		B	Std. Error
	(Constant)	0.995	0.087
	Agricultural sector	-0.039	0.049
	Industrial sector	0.286	0.069
	Service sector	0.631	0.041

The regression model given in equation 1 is given as:

$$GDP = \beta_0 + \beta_1(Agriculture) + \beta_2(industry) + \beta_3(services) + \varepsilon_k$$
$$= 0.995 - 0.039\,(Agriculture) + 0.286(industry) + 0.631(services)$$

From table 3, it could be observed that for every one billion naira increase in the agricultural sector there is a corresponding decrease of 39 million naira in GDP if all other sectors are under control. Industrial sector also contributes to the GDP; for every one billion naira increase in the industrial sector GDP increases by 286 million naira if all other sectors are under control. For every one billion naira increase in the service sector, GDP increases by 631 million naira if all other sectors are under control. If there is no increase in any of the three sectors GDP increases by 995 million naira. From the analysis it shows that service sector contributes the most, followed by the industrial sector and the agricultural sector contributes the least.

Table-4: Adequacy of the model

ANOVA						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.047	3	.349	423.546	.000[b]
	Residual	.024	29	.001		
	Total	1.071	32			

The result from the p-value of the Anova table (Table 4) shows that GDP has been explained by the variables in the model, this shows that the model is adequate. The Significance of the parameter is presented in table 5.

Table-5: For obtaining the parameter significance

Parameter	T-value	P-value	Remark
β_1 = -0.039	-0.804	0.428	Non- Significant
β_2 = 0.286	4.173	0.000	Significant
β_3 = 0.631	15.516	0.000	Significant

The p-value in table 4 shows that industrial sector and service sector contributes significantly to GDP while the contribution of the agricultural sector is not significant. The analysis on the modeling and forecasting GDP is done using time series analysis.

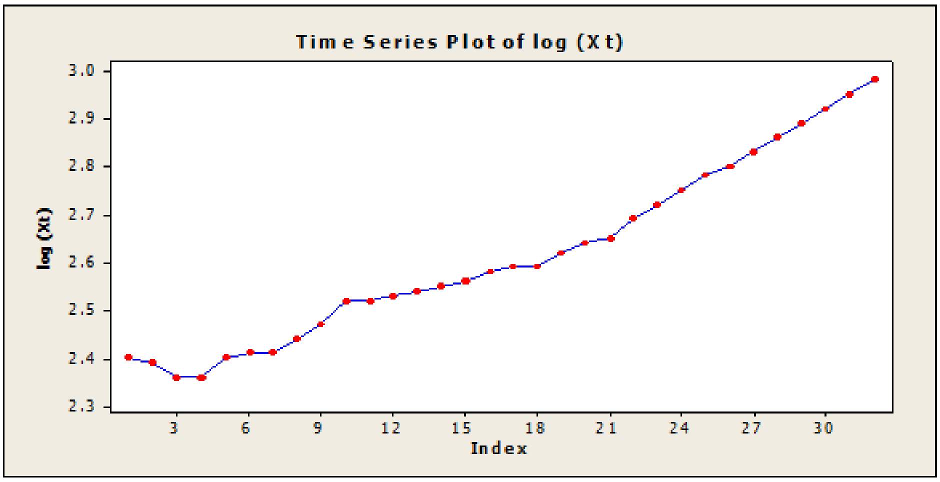

Fig-1: The line graph of log (X_t)

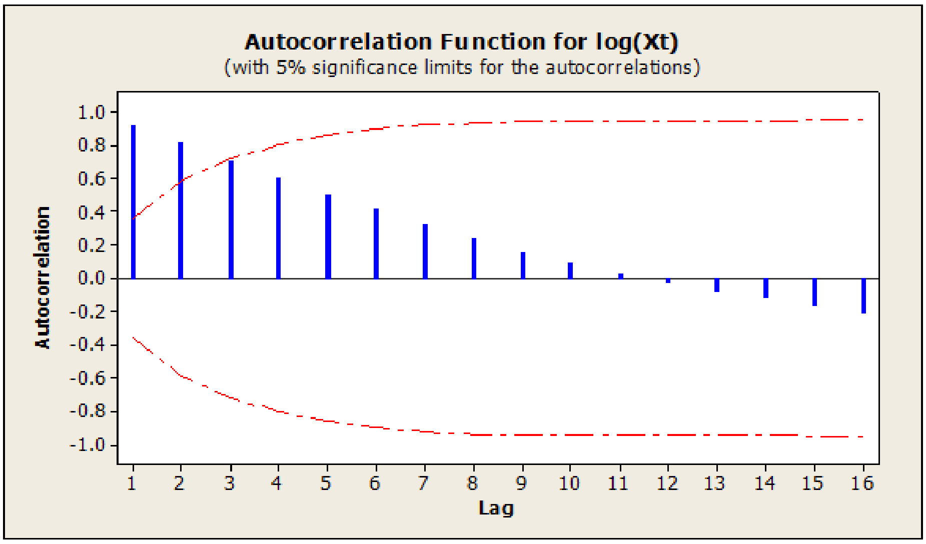

Fig-2: ACF of the Log Transformed GDP Data

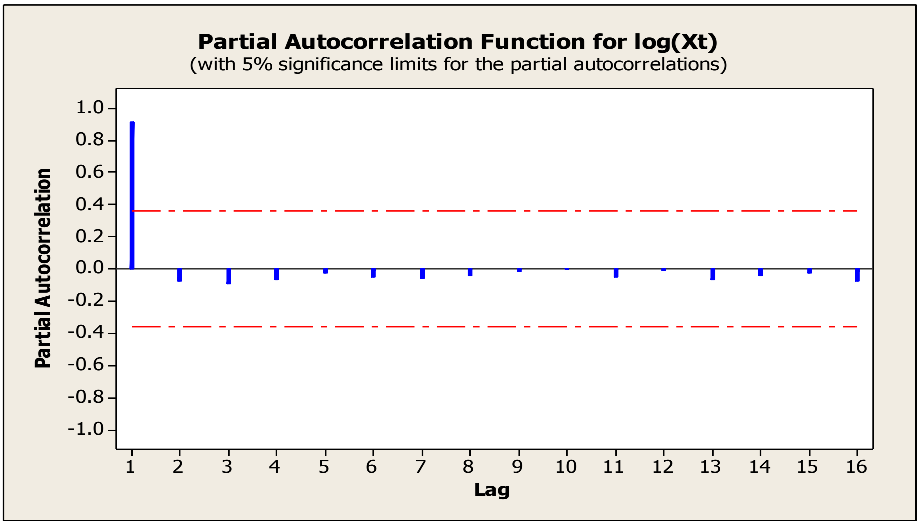

Fig-3: PACF of the Log Transformed GDP Data

From 1, the graph log (X_t) is not stationary. The original ACF and PACF plot are found not to be stationary; hence a differencing of the first order is carried out to make the data stationary.

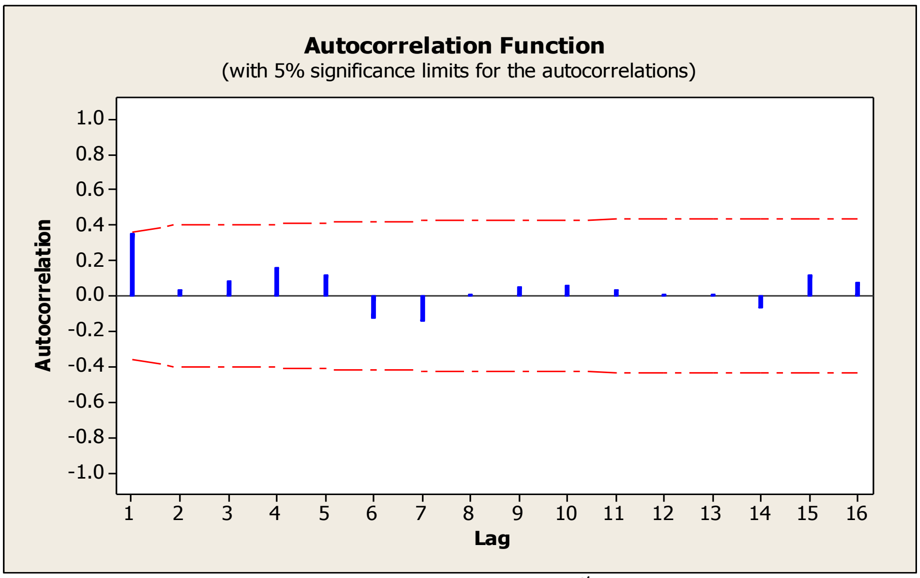

Fig-4: Auto correlation function of the 1st differenced series

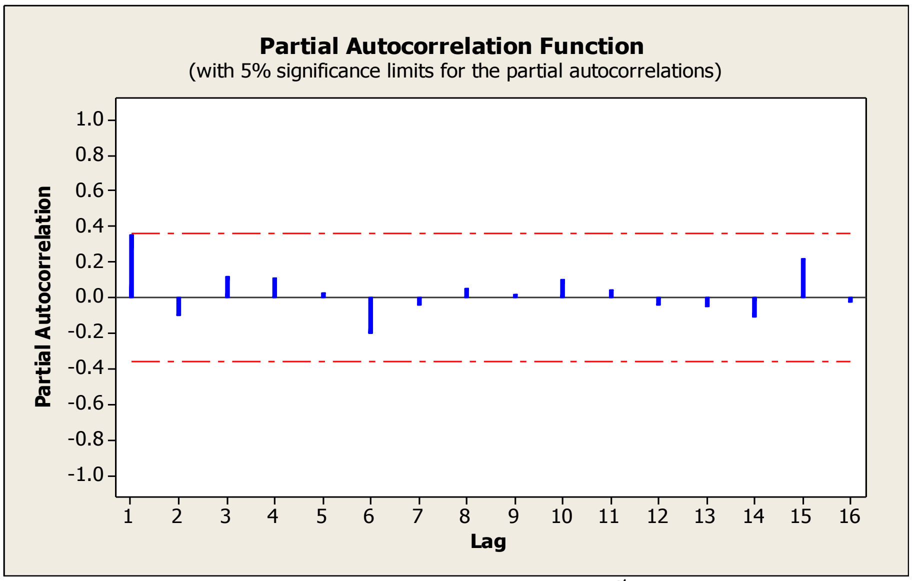

Fig-5: Partial auto correlation function of the 1st differenced series

The first order differencing cuts off after lag 1 as observed in the PACF which indicated an AR of order 1 process. The expert modeler function in SPSS software was used to fit an adequate model for the data and the model fitted is presented in table 5:

			Model Type
Model ID	var2	Model_1	ARIMA(1,1,0)

The model identified can be stated as

$X_t = \varphi_0 + \varphi_1 (X_{t-1} - X_{t-2}) + X_{t-1} + \varepsilon_t$

After a tentative model has been identified, the parameters of the model will be estimated. The SPSS software was also used to estimate the parameter for this model and it is displayed in table 6

					Estimate	SE	T	Sig.
var2-Model_1	var2	Log Transformation	Constant		.041	.010	4.028	.000
			AR	Lag 1	.382	.169	2.258	.031
			Difference		1			

The value φ_0 of in the model is 0.041, and φ_1 is 0.382. We can now state the model as:

$$X_t = 0.041 + 0.382\,(X_{t-1} - X_{t-2}) + X_{t-1} + \varepsilon_t$$

3.1 Test of Significance of the Model Parameter

H_0 : Model parameter is not significant

H_1 : Model parameter is significant

Level of significance: $\alpha = 0.05$

Decision rule: Reject H_0 if $|t_{cal}| > t_{tab}$: otherwise do not reject.

Test statistics: $t_{cal} = \frac{\hat{\varphi}}{se} \sim t_{n-1\,(\alpha)}$

Where; $\hat{\varphi}$ = estimate and se = standard error

Calculations

$$t_{cal} = \frac{0.382}{0.169} = 2.26$$

$$t_{tab} = 1.658$$

CONCLUSION

Since 2.26 > 1.658 we reject H_0 and conclude that the model parameter $\hat{\varphi}$ is statistically significant.

3.2 Model Verification

Since the model fitted in this research work is a tentative one, there is always a need for us to check for the adequacy of the fitted model through diagnostic checking. If the fitted model is adequate enough, it will transform the error components or residuals into white noise process [19-22].

We shall test the diagnostic of this model using the Ljung-Box Q (18) in table 7.

Table-7: Model Statistics

Model	Number of Predictors	Model Fit statistics		Ljung-Box Q(18)			Number of Outliers
		Stationary R-squared	Normalized BIC	Statistics	DF	Sig.	
var2-Model_1	0	.131	5.234	8.215	17	.962	0

We observed that from Table 7 that the p-value is 0.962 and we conclude that the model is adequate. The graph of the Autocorrelation and Partial Autocorrelation of the residuals is shown in Fig 5 and Fig 6.

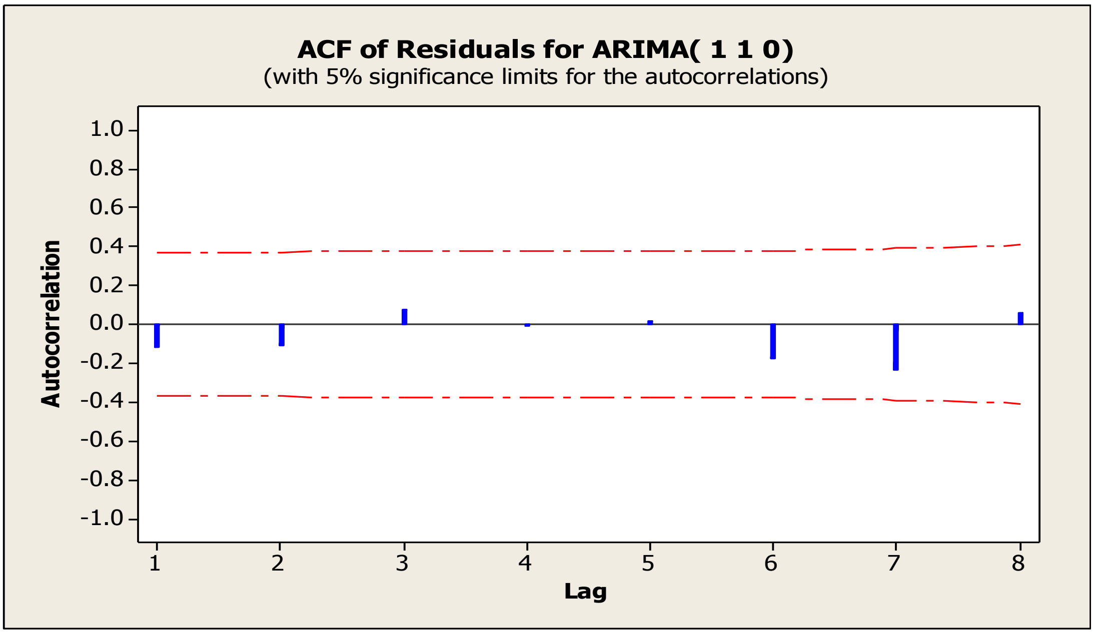

Fig-6: Residual auto correlation function

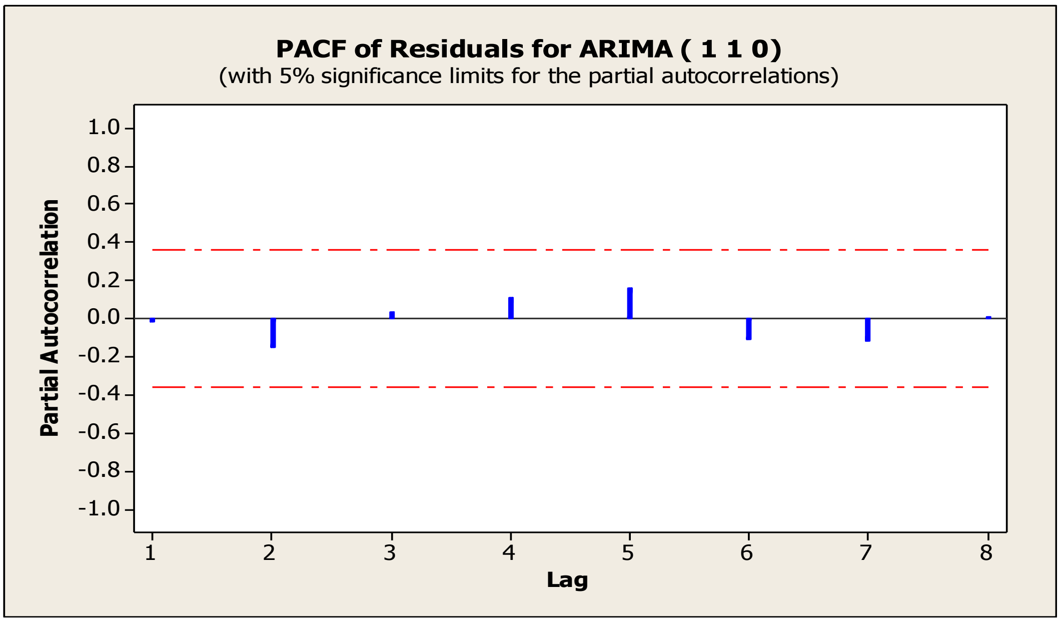

Fig-7: Residual partial auto correlation function

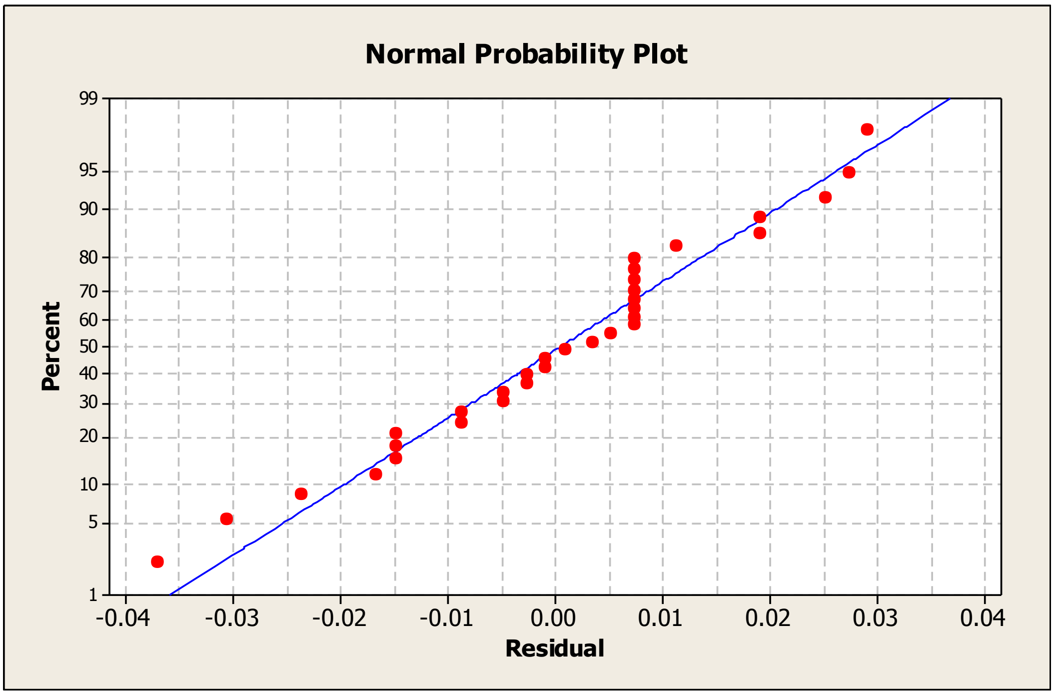

Fig-8: Residual normal probability plot partial

From the graph residual autocorrelation function plotted against the lags, all the observation falls within the pegged limit. It is a confirmation that the model fitted is a good fit. The plot of the residual shows that error is normally distributed [23-25].

3.1 Forecasting

The model ARIMA (1 1 0) above has been subjected to rigorous testing and has been found to be adequate for forecasting. Hence, in this section we would apply our tentative model developed in forecasting. The GDP 1990 constant basic prices for year 2021-2030.

$$X_t = 0.041 + 0.382\,(X_{t-1} - X_{t-2}) + X_{t-1} + \varepsilon_t$$

The forecast was carried out on a 95 percent confidence limit and it is displayed on the table below:

Table-8: Forecast table

PERIOD	FORECAST	LOWER LIMIT	UPPER LIMIT
2021	1000.25	928.36	1076.29
2022	1047.30	921.43	1185.82
2023	1094.33	920.68	1291.82
2024	1142.60	925.25	1396.72
2025	1192.64	934	1502.42
2026	1244.73	946.01	1610.25
2027	1299.05	960.65	1721.20
2028	1355.71	977.50	1836.00
2029	1414.84	996.27	1955.25
2030	1476.54	1016.76	2079.44

4.0 CONCLUSION

The regression results shows that the three sectors; Agricultural sector, Industrial sector and Service sector has a positive relationship and only the Industrial sector and the Service sector contributes significantly with a coefficient of 0.286, 0.631 while the contribution of the Agricultural sector is not significant with a coefficient of -0.039. The F- test shows that the overall model is significant with a p-value of 0.000. The test for parameter significant also revealed that the agricultural sector is not statistically significant. The modeling cycle for the Box –Jenkins approach was in three stages, the first stage was model identification stage, where the series was non- stationary base on the result provided by the ACF and time plot. It was found out that the series was stationary at the 1^{st} difference. The second stage was the model estimation, where the parameters conforms to the stationary conditions (less than one) and finally the third stage was model diagnosis where the errors derived from the model was normally distributed and random (no time dependence). From the result obtained it can be seen that only the industrial and service sector sectors of the economy contributes significantly to the Gross Domestic Product of Nigeria while the contribution of the agricultural sector is not significant. This implies that service sector contributes the most with 286 million naira followed by the industrial sector with 631 million naira while the agricultural sector does not contribute significantly since it decreases by 39 million naira. However the model identified from the time series analysis was ARIMA (1 1 0). From the graph of residual autocorrelation function plotted against the lags, all observation falls within the pegged limit. It is a confirmation that the model fitted is a good fit. From my forecast table (4.2.5), we can see all the prediction made for subsequent years and it also reveals that GDP will continue to appreciate with these forecasted time period.

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