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Multivariate Time Series Modelling with Seasonal Univariate Components; Evidence from Nigeria GDP

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Abstract

The patterns of GDP variables are graphically examined using time plot presented the time plot for the GDP variables concerning time presented a combined single time plot for all the considered GDP variables. The relationship, as well as the degree of relationship between/among the GDP variables, was further revealed by computing the pairwise correlation. Based on the output, each variable when crossed classified with itself have a strong positive correlation with an output of (1), while pairwise correlation reveals a positive figure with the least estimate being (0.3149), this implies that for all the variables there exist a positive correlation. All the pairwise relationship reveals a strong positive association with all the estimates revealing a value between (0.8-0.9) except 'trade and industry' that shows a positive relationship but not strong with an estimate of (0.3149).

The initial test in fitting a time series model is to examine the series for stationarity. The Augmented Dickey-Fuller test revealed that 'Agriculture', 'Construction', and Services'" satisfies the requirement of stationarity while the series 'industry and "Trade" are non-stationary initially but later became stationary after the application of the first difference transformation which was confirmed after the application of the ADF test to the first differenced series. The Johansen co-integration's Trace test was employed to determine the order of co-integration and it was revealed that the series are cointegrated hence presentation of the equation of integration.

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We presented the lag length estimation criteria which revealed that the lag length of order 5 is appropriate for the VAR model as suggested by Akaike Information Criteria (AIC), Hannan-Quinn (HQ) Information Criteria, Schwarz Information Criteria (SC). The $VAR_{(5)}$ model was fitted for all the considered GDP variables.

Keywords: Akaike Information Criteria (AIC); Hannan-Quinn (HQ) information criteria; Schwarz Information Criteria (SC); Bayesian Information Criterion (BIC).

1 Introduction

Nigerian Economy is not stable over the years and as a result, the country is facing some economic crises, challenges or shocks which are internally or externally over some decades. Internally, as a result of investments and consumption pattern, as well as the improper implementation of public policy and change in expectation. Externally, the crises could be as a result of population increase, revolution or war etc. Economic development of a country shows its ability to increase the production of goods and services. It clearly defines an increase in the Gross Domestic Product (GDP) of a country [1,2,3].

Nigeria is a middle income, mixed economy and emerging market, with expanding manufacturing, financial, service, communications, technology and entertainment sectors. It is ranked as the 21st largest economy in the world in terms of nominal GDP, and the 20th largest in terms of Purchasing Power Parity. It is the second-largest economy in Africa after South Africa; its re-emergent manufacturing sector became the largest on the continent in 2013 and produces a large proportion of goods and services for the West African subcontinent. Also, the debt-to-GDP ratio is only 11 per cent, which is 8 per cent below the 2014 ratio [4,5]. Previously hindered by years of mismanagement, economic reforms of the past decade have put Nigeria back on track towards achieving its full economic potential. Nigerian GDP at purchasing power parity (PPP) has almost tripled from \$170 billion in 2000 to \$451 billion in 2014, although estimates of the size of the informal sector (which is not included in official figures) put the actual numbers closer to \$630 billion. Correspondingly, the GDP per capita doubled from \$1400 per person in 2000 to an estimated \$2,800 per person in 2014 (again, with the inclusion of the informal sector, it is estimated that GDP per capita hovers around \$3,900 per person). (Population increased from 120 million in 2000 to 160 million in 2012). These figures are to be revised upwards by as much as 80% when metrics are recalculated after the rebasing of its economy in April 2016 [6,7].

Macro-economic variables are instrumental in the economic performance of any country. Nigeria's Economy has faced numerous challenges which have led to a fall in its growth rate in both Agricultural and non-Agricultural sectors which in turn affect the Gross Domestic Product (GDP). It is, therefore, the intent of this work to study the inter-relationships among these sectors in Nigeria's GDP. The variables under consideration are Agriculture, Industry, Construction, Trade, and Services [6,8,9].

1.1 Overview of the contribution of GDP to the Nigerian economy

In 2016, Nigeria changed its economic analysis to account for rapidly growing contributors to its GDP, such as telecommunications, banking, and its film industry. In 2005, Nigeria achieved a milestone agreement with the Paris Club of lending nations to eliminate all of its bilateral external debt. Under the agreement, the lenders will forgive most of the debt, and Nigeria will pay off the remainder with a portion of its energy revenues. Outside of the energy sector, Nigeria's economy is highly inefficient. Moreover, human capital is underdeveloped—Nigeria ranked 151 out of countries in the United Nations Development Index in 2004—and non-energy-related infrastructure is inadequate [6,10].

A longer-term economic development program in the United Nations (UN)-sponsored National Millennium Goals for Nigeria. Under the program, which covers the years from 2000 to 2015, Nigeria is committed to achieving a wide range of ambitious objectives involving poverty reduction, education, gender equality, health, the environment, and international development cooperation [2,11]. In an update released in 2004, the UN found that Nigeria was making progress toward achieving several goals but was falling short on others. Specifically, Nigeria had advanced efforts to provide universal primary education, protect the environment, and develop a global development partnership (UN Report, 2015).

A prerequisite for achieving many of these worthwhile objectives is curtailing endemic corruption, which stymies development and taints Nigeria's business environment. President Olusegun Obasanjo's campaign against corruption, which includes the arrest of officials accused of misdeeds and recovering stolen funds, has won praise from the World Bank [3,12]. In September 2005, Nigeria, with the assistance of the World Bank, began to recover US$458 million of illicit funds that had been deposited in Swiss banks by the late military dictator Sani Abacha, who ruled Nigeria from 1993 to 1998 [13,14,15]. However, while broad-based progress has been slow, these efforts have begun to become evident in international surveys of corruption. Nigeria's ranking has consistently improved since 2001 ranking 147 out of 180 countries in Transparency International's 2007 Corruption Perceptions Index [6,8,16]. The above-itemized steps and decisions had been touted as a prerequisite to either rise or fall to the Gross Domestic Product of Nigeria.

1.2 Source of data

In carrying out this research work, quarterly data on GDP variables published by the Central Bank of Nigeria (2014 and 2015) through their statistical bulleting was used for this research study.

2 Materials and Methods

2.1 Source of data

In carrying out this research work, quarterly data on GDP variables published by the Central Bank of Nigeria (2010 and 2018) through their statistical bulleting was used for this research study.

2.2 Time series as a stochastic process

A time series is a series of data points indexed (or listed or graphed) in time order. Most commonly, a time series is a sequence taken at successive equally spaced points in time. A stochastic process is a family of time-indexed random variables, $X(\omega, t)$; where ω belongs to simple space and t belongs to an indexed set for a fixed t, $X(\omega, t)$ is a random variable. Thus a time series is a realization or sample function from a stochastic process.

A process is said to be strictly or strongly stationary if its n-dimensional distribution function is time variant that is:

$$F\{X(t_1 + k), X(t_2 + k) \dots X(t_n + k) = FX(t_1), X(t_2) \dots X(t_n)\}$$

With proper understanding that a stochastic process, $X(\omega, t)$ is a set of time-indexed random variables defined on a sample space. We simply write $X(\omega, t)$ as $X(t)$ or X_t.

The mean function of the process is defined as: $\mu_t = E(X_t)$

The variance function of the process is: $\sigma_t^2 = E(X_t - \mu_t)^2$

The covariance functions between X_{t1}, X_{t2}: $\gamma(t_1, t_2) = E(X_{t1} - \mu_{t1})(X_{t2} - \mu_{t2})$

And the correlation functions between X_{t1}, X_{t2}: $p(t_1, t_2) = \frac{\gamma(t_1, t_2)}{\sqrt{\sigma_{t1}^2}\sqrt{\sigma^2_{t2}}}$

For a strictly stationary process defined above, $\mu_t = \mu$ is a constant and $\sigma_t^2 = \sigma^2$ for all t.

The theory of time series as a stochastic process plays an important role in the investigation of random phenomena depending on time, a time series is a kind of stochastic process indexed by time.

2.3 Stationary process

A stochastic process is said to be stationary if its mean and variance are constant over time i.e. time-invariant, and the value of the covariance between the periods depend only on the distance or lag between them and not the actual time at which the covariance is computed.

$$\gamma(\tau) = \mathrm{cov}(X_t, X_{t+\tau}), \tag{1}$$

For integers τ; It is vital to remember that, for the real world, the autocovariance of a stationary process is a model, albeit a useful one. Many actual processes are not stationary. $\rho(\tau) = \gamma(\tau)/\gamma(0)$, for integers τ and where $\gamma(0) = \mathrm{cov}(Xt,Xt) = \mathrm{var}(Xt)$.

Stationary and Ergodic Multivariate Time Series: A multivariate time series (Yt) is covariance stationary and ergodic if all of its component-time series are stationary and ergodic

$E(Y_t) = \mu = (\mu_1, \ldots \mu_n)'$
$\mathrm{Var}(Y_t) = \varrho_0 = E[(Y_t - \mu)(Y_t - \mu)']$

Where

$$\varrho_0 = \begin{pmatrix} \mathrm{var}(y_{1t}) & \mathrm{cov}(y_{1t}, y_{2t}) & \ldots \mathrm{cov}(y_{1t}, y_{nt}) \\ \mathrm{cov}(y_{1t}, y_{2t}) & \mathrm{var}(y_{2t}) & \ldots \mathrm{cov}(y_{2t}, y_{nt}) \\ \vdots & \vdots & \vdots \\ \mathrm{cov}(y_{nt}, y_{1t}) & \mathrm{cov}(y_{nt}, y_{2t}) & \mathrm{var}(y_{nt}) \end{pmatrix}$$

Stationary Vector Auto-Regressive Model: Let $Y_t = (Y_{1t}, Y_{2t}, \ldots, Y_{nt})$ T denote an (n×1) vector of time series variables. The basic p lag vector auto-regressive (VAR (p)) model has the form

$$Y_t = C + \Pi_1 Y_{t-1} + \Pi_2 Y_{t-2} + \cdots \Pi_p Y_{t-p} + \mathcal{E}_t; \tag{2}$$
t= 1, 2… T

Where c denotes an n×1 vector of constants and Π_j an n×n matrix of the autoregressive coefficient for j= 1, 2… p. the n×1 vector of ε_t is a vector of generalization of white noise.

Let C_1 denote the i^th element of the vector c and let $\Pi_{ij}{}^{(1)}$ denote the row I, column j element of the matrix Π_1 then the first row of the vector system specifies that

$$Y_{1t} = C_1 + \Pi_{11}^{(1)} Y_{1,t-1} + \Pi_{12}^{(1)} Y_{2,t-1} + \ldots + \Pi_{1n}^{(1)} Y_{n,t-1} + \Pi_{11}^{(2)} Y_{1,t-2} + \Pi_{12}^{(2)} Y_{2,t-2} + \ldots + \Pi_{1n}^{(2)} Y_{n,t-2} + \Pi_{11}^{(p)} Y_{1,t-p} + \Pi_{12}^{(p)} Y_{2,t-p} + \ldots + \Pi_{1n}^{(p)} Y_{n,t-p} + \mathcal{E}_{it} \tag{3}$$

Thus, a vector auto-regression is a system in which each variable is regressed on a constant and p of its lags as well as on p lags of each of the other variables in the VAR. Note that each regression has the same explanatory variables using lag operator notation, the equation can be written in the form:

$$\Pi(L) Y_t = C + \varepsilon_t \tag{4}$$

Where $\Pi(L) = In - \Pi_1 L - \cdots - \Pi_p L^p$

The VAR (p) is stable if the root of det (I_n- $\Pi_1 Z - \cdots - \Pi_p Z^p$)=0 lie outside the complex unit circle (have a modulus greater than one), or, equivalently, if the eigenvalues of the companion matrix.

$$F=\begin{pmatrix} \Pi_1 \Pi_2 & \cdots & \Pi_n \\ In \ 0 & \ddots & \vdots \\ 0 \ \ 0 & \cdots & 0 \end{pmatrix}$$

have modulus less than one. Assuming that the process has been initialized in the infinite past, then a stable VAR (p) process is stationary with time-invariant means, variances, and autocovariance.

The basic VAR (p) model may be too restrictive to represent sufficiently the main characteristics of the data. Exogenous variables may be required as well the general form of the VAR (p) model with deterministic terms and exogenous variables are given by;

$$Y_t = \Pi_1 Y_{t-1} + \Pi_2 Y_{t-2} + \cdots + \Pi_p Y_{t-p} + \Phi D_t + G X_t + \mathcal{E}_t \tag{5}$$

Where $D_t$represents an (L×1) matrix of deterministic components, $X_t$represents a n×1 vector of exogenous variables and Φ and G are the parameter matrices.

Tests for Stationarity: Before fitting any model to time series data, the series must be made stationary. Stationarity occurs in a time series when the mean and autocovariance of the series remains constant over the time series. Therefore, the stochastic process Y_t is said to be stationary if $E(Y_t)$ = μ, constant for all value of t

$$\text{The cov } (Y_t, Y_{t-j}) = \Gamma_j = E[(Y_t - \mu)(Y_t - \mu)^T = \Gamma_{-j}^T \tag{6}$$

for all t and j = 0,1,2….

To test for stationarity a series, several procedures have been developed. The most popular ones are the Augmented Dickey-Fuller (ADF) test and the Philip-Perron (PP) test. Outlines the basic features of unit root tests are discussed below:

Consider a simple AR(1) process:

$$Y_t = \beta Y_{t-1} + X_t \sigma + \mathcal{E}_t \tag{7}$$

Where X_t are the optional exogenous regressors which may consist of constant or a constant and trend, p and δ are parameters t to be estimated, and$\boldsymbol{\mathcal{E}_t}$ to be the white noise. If $|p|$> 1, y is a non-stationary series, the variance of y increases with time and approaches infinity. If $|p|$<1, y is a stationary series. Thus, the hypothesis of (trend) stationary can be evaluated by testing whether the absolute value p is strictly less than one.

Hypothesis:

H_0: The series is not stationary (p=1) Vs H_1: the series is stationary (p<1)

Augmented Dickey-Fuller (ADF) Test: The standard Augmented Dickey-Fuller test is conducted by estimating a simple AR (1) process after subtracting $\boldsymbol{Y_{t-1}}$ from both sides of the equation

$$\Delta Y_t = \alpha Y_{t-1} + X_t \delta + \mathcal{E}_t \tag{8}$$

Where $\alpha = p - 1 \ and \Delta Y_t = Y_t - Y_{t-1}$

The hypothesis can be written as; H_0: α = 0 VS H_1: $\alpha < 0$, and evaluated using the conventional t-ratio for, α: $t_\alpha = \frac{\hat{\alpha}}{(se(\hat{\alpha}))}$

where $\hat{\alpha}$ is the estimate of α, and $se\ (\hat{\alpha})$ is the coefficient standard error.

The Augmented Dickey-Fuller (ADF) test constructs a parametric correction for higher-order correlation by assuming that the series follows an AR (p) process and adding lagged difference terms of the dependent variable y to the right-hand side of the test regression:

$$\Delta Y_t = \alpha Y_{t-1} + X_t\delta + \beta_1 \Delta Y_{t-1} + \beta_2 \Delta Y_{t-2} + \cdots + \beta_p \Delta Y_{t-p} + U_p \tag{9}$$

This augmented specification is then used to test the hypothesis using the t-ratio. An important result obtained by fuller is that the asymptotic distribution of the t-ratio for α is independent of the number of lagged first differences included in the ADF regression. Moreover, Dickey (1984) demonstrate that ADF test is asymptotically valid in the presence of moving average (MA) component, provided that sufficient lagged difference terms are included in the test regression.

2.4 Estimating the order of VAR

The lag length for the VAR model may be determined using model selection criteria. The general approach is to fit VAR model with orders **m**=0, … ,P_{max} and choose the value of m which minimizes some model selection criteria. The general form model selection criteria have the form:

$$C(m) = \log\left|\hat{\sum}_m\right| + C_T\ .\varphi(m,k) \tag{10}$$

Where

$\hat{\sum}_m =\ T^{-1}\sum_{t=1}^{T}\hat{\mathcal{E}}_t\hat{\mathcal{E}}_t$is the residual covariance matrix estimator for a model of order m, φ(m,k) is a function of order m which penalizes large VAR orders and$\boldsymbol{C_T}$is a sequence which may depend on the sample size and identifies the specific criteria. The term $\log\left|\hat{\sum}_m\right|$ is a non-increasing function of the order m while (m,k) increases with m. the lag order is chosen which optimally balances these two forces.

The two most commonly used information criteria for selecting the lag order are the Akaike information criterion (AIC), Schwarz information criteria (SC):

Akaike Information Criterion: Akaike proposed a criterion in 1974 on model fitting. This is the Final Prediction Error (FPE), the one-step-ahead prediction error after fitting an AR (P) model.

$$FPE(P) = \sigma_p^2(1 + p/n) \tag{11}$$

Where σ_p^2 is the least square estimate of the variance of the residuals after an AR(p) model and n is the number of observation. An improvement of this was given by Akaike (1977). He said if a statistical model of M parameter is fitted to data, and n effective number of observations then for ARMA model,

$$\text{AIC(M)= -2ln\{maximum likelihood\} + 2M} \tag{12}$$

The AIC criterion then reduces to:

$$AIC\ M = n \ln \hat{\sigma}_E^2 = +2M \tag{13}$$

Where $\hat{\sigma}_{\boldsymbol{E}}^{\boldsymbol{2}}$ is the least square estimate of the variance of the residuals after fitting an ARMA (p,q). The optimal order of the model is then given by the value M, which is a function of p and q for which AIC (M) is the minimum.

Bayesian Information Criterion (BIC): In 1976, Shiabata showed that AIC criterion tends to overestimate the order of the auto-regression. Akaike (1976, 1979) has recently developed an extension due to this. This is given by:

$$BIC(M) = n \log \sigma_E^2 - (n - M) \ln \left(1 - \frac{M}{n}\right) + M \ln n + M\left(\left({\sigma_E^2}/{\sigma_E^2} - 1 \right)/M\right) \tag{14}$$

Where σ_E^2 is the maximum likelihood estimate, M is the number of parameters and is the sample variance of the series.

Alternatively,

$$AIC(m) = \log\left|\hat{\sum}_m\right| + \frac{2}{T} mk^2 \tag{15}$$

$$SC = \log\left|\hat{\sum}_m\right| + \frac{\log T}{T} mk^2 \tag{16}$$

In each case $\varphi(m, k) = mk^2$ is the number of VAR parameters in the model with order m and k. Thus, among the three criteria, AIC always suggests the largest order, SC chooses the smallest order. This does not preclude the possibility that all two criteria agree in their choice of VAR order.

2.5 Co-integration

Co-integration is a statistical property of time series variables. Two or more time series are cointegrated if they share a common stochastic drift. If two or more series are individually integrated (in the time series sense) but some linear combinations of them have a lower order of integration, then the series is said to be co-integrated. The possible presence of co-integration must be taken into account while choosing a technique to test hypotheses concerning the relationship between two variables having unit-roots (i.e. integrated in at least order one).

Quite generally, co-integration might be characterized by two or more I(1) variables indicating a common long-run development, i.e. they do not drift away from each other except for transitory fluctuations. This defines a statistical equilibrium which, in empirical applications, can often be interpreted as a long-run economic relation. The elements of a k-dimensional vector Y are co-integrated of order (d, c), Y ~ CI(d, c), if all elements of Y are integrated of order d, I(d), and if there exists at least one non-trivial linear combination z of these variables, which is I(d-c), where $d = c > 0$ holds, i.e. if and only if$\breve{U}'Y_t = Zt \sim I(d - c)$.

The vector ß is denoted as co-integration vector. The co-integration rank r is equal to the number of linearly independent co-integration vectors. The co-integration vectors are the columns of the co-integration matrix B, with$B'Y_t = Zt$. If all variables are,$I(1)$ it holds that $0 = r < k$. For r = 0, the elements of the vector Y are not co-integrated. Correspondingly, the appropriate model is a system of first differences. Important properties of co-integrated relations were summarized by R.F. ENGLE and C.W.J. GRANGER (1987). The most important part of this theorem is:

If the $k \times 1$ vector Y is co-integrated of order $CI(1,1)$ with co-integration rank r, besides the AR representation

$$A(L)Y_t = U_t \tag{17}$$

with $_{out}$ being white noise, there also exists an error correction representation

$$A \times (L)(1-L)Y_t = -iZ_{t-1} + U_t \quad (18)$$

With $A(1) = \bar{\imath}.\beta', \bar{\imath}$ and β' being $k \times 1$ matrices of rank r, 0 < r < k, and $Z_t = \beta' Y_t$ being an $r \times 1$ vector of I(0) variables.

Testing for Co-integration Using Johansen Approach: The approach proposed by SØREN JOHANSEN (1988) is a maximum likelihood estimation that considers restriction assuming the system does not contain the deterministic term, and then we can write:

$$\Delta Y_t + \Gamma\beta'^{Y_{t-1}} = A_1\Delta Y_{t-1} + \cdots + A_{p-1}\Delta Y_{t-p+1} + U_t \quad (19)$$

Where Y_t is a k-vector of non-stationary $I(1)$variables.

We get the maximum likelihood estimation of $A_j^*, j = 1, \dots, p-1$ by applying ordinary least squares if Γ and β are given. Eliminating the influence of the short-run dynamics on $\Delta Y_t$and Y_{t-1} by regressing $\Delta Y_t(Y_{t-1})$ on the lagged differences, we get the residuals $R_{0t}(R_{1t})$ for which $R_{0t} = -\Gamma\beta' R_{1,t} + \widehat{U}_t$ holds. Here, R_0 is a vector of stationary and R_1 is a vector of non-stationary processes. The idea of Johansen's approach is to find the linear combination $\beta' R_1$which shows the highest correlation with R_0.

The starting point in this procedure in determining the number of co-integrating vectors is the VAR representation Y_t and it is assumed as a vector autoregressive model of order p.

Johansen proposed two tests for estimating the number of cointegrating vectors THE TRACE STATISTICS and THE MAXIMUM EIGEN VALUE.

Trace Statistics investigate the null hypothesis of r co-integrating relations against the alternative of n co-integrating relations, where n is the number of variables in the system for r=0,1,2,…,n-1. Define $\hat{\lambda}_i = 1,2, \dots, k$ to be a complex model of eigenvalues of $\widehat{\Pi}$ and let them be ordered such that$\lambda_1 > \lambda_2 > \cdots > \lambda_n$. The Trace Statistics is computed by:

$$\lambda_{trace}(r) = -T\sum_{i=r+1}^{n} \log(1-\lambda_i). \quad (20)$$

The Maximum Eigenvalue Statistic test the null hypotheses of r co-integrating relations against the alternative of r+1 co-integrating relations for r=0,1,2,…,n-1. The test statistic is computed as:

$$\lambda_{max}(r, r+1) = -T\log(1-\lambda_{r+1}) \quad (21)$$

whereλ_{r+1} is the $(r+1)^{th}$ ordered eigenvalue of Π, and T is the sample size.

2.6 Model diagnostics

Test for Residual Autocorrelation: The portmanteau autocorrelation test is employed in this study to examine whether or not the residuals are autocorrelated. It test for residual autocorrelation using the null hypothesis that all residual autocovariance is zero, that is $H_0: E(\varepsilon_t\varepsilon_{t-1}) = 0(i = 1,2,3 \dots)$

Is tested against the null hypothesis that at least one autocovariance, autocorrelation is zero. The test statistic is based on the residual autocovariance and has the form:

$$Q_h = T\sum_{j=1}^{h} tr(\hat{Y}_j\hat{Y}_0^{-1}\hat{Y}_j\hat{Y}_0^{-1}) \quad (22)$$

Where $\hat{Y}_j = T^{-1}\sum_{t=j+1}^{T}(\hat{\varepsilon}_t\hat{\varepsilon}'_{t-j})$ and the$\hat{\varepsilon}_t$'s are the estimated residuals.

3 Results

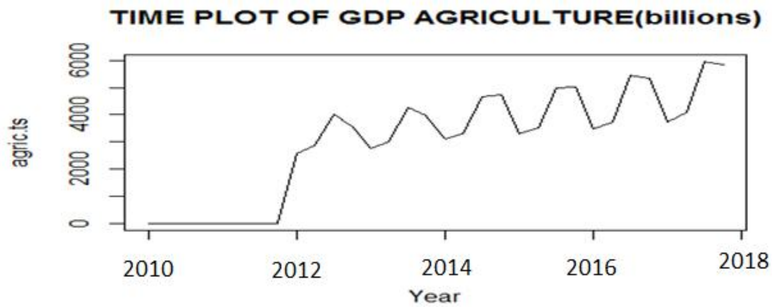

Fig. 1. Time plot of "Gross Domestic Product of Agriculture by Year"

The "Gross Domestic Product of Agriculture by Year" exhibits neither unstable nor progressive tread starting from the year 2012. The plot reveals an unbalanced fluctuation in Gross Domestic Product of Agriculture for all years from 2012, excluding the balanced tread from 2010 till the beginning of 2012.

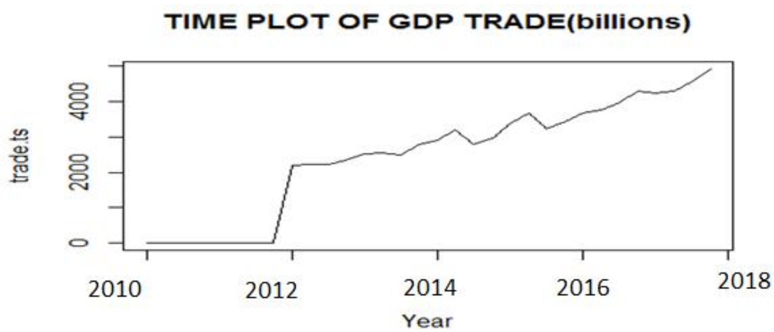

Fig. 2. Time plot of "Gross Domestic Product of Trade by Year"

The "Gross Domestic Product of Trade by Year" exhibits a rather balanced tread from the year 2010-2012, the increasing trend between 2012 and 2014 and an unbalance upward and slight downward movement thereafter and appears to portray an irregular variation.

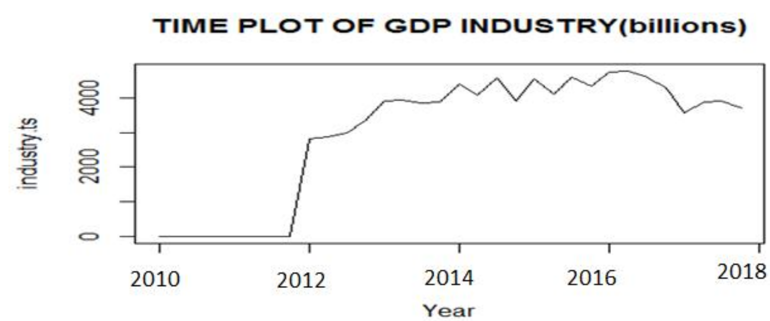

Fig. 3. Time plot of "Gross Domestic Product of Industry by Year"

The "Gross Domestic Product of the industry by Year" exhibits a partially progressive tread from the year 2012 till 2014 and a fluctuated tread thereafter till 2018; also, there was a clear drop from the beginning of the year 2015. Excluding the balanced tread from 2010 till the beginning of 2012.

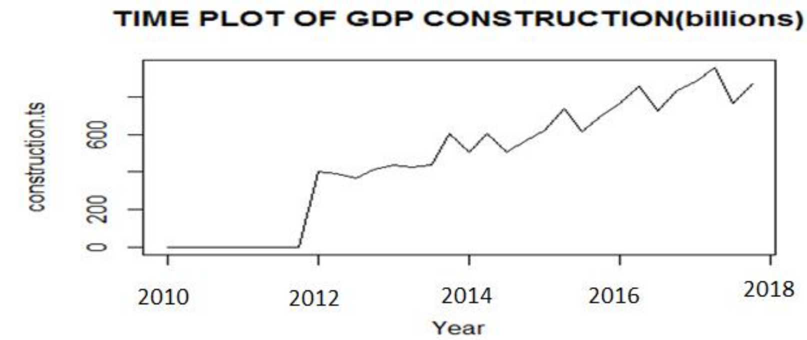

Fig. 4. Time plot of "Gross Domestic Product of Construction by Year"

The "Gross Domestic Product of construction by Year" exhibits a continuous progressive growth over the years commencing from 2012. Excluding the balanced tread from 2010 till the beginning of 2012.

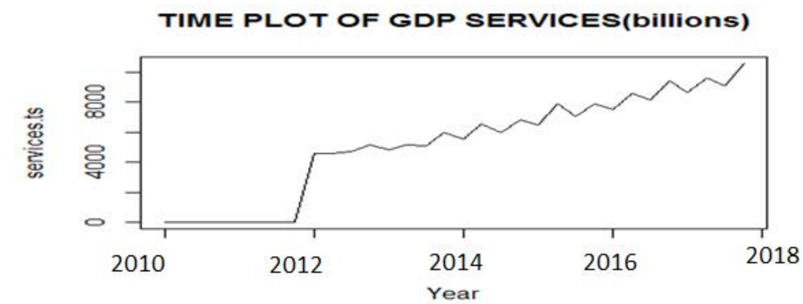

Fig. 5. Time plot of "Gross Domestic Product of Services by Year"

The "Gross Domestic Product of services by Year" exhibits a continuous progressive growth over the years commencing from 2012. Excluding the balanced tread from 2010 till the beginning of 2012.

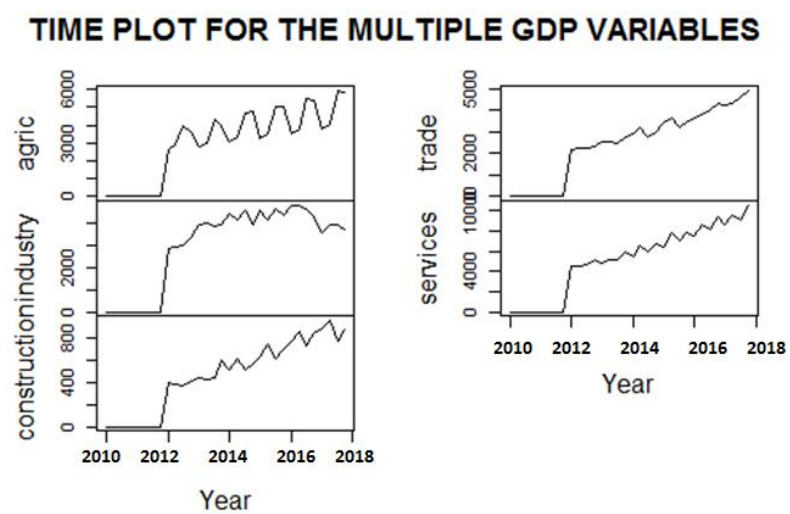

Fig. 6. Time plot of "Gross Domestic Product for the multiple GDP variables by Year"

Table 1. Descriptive statistics of the multiple gross domestic products

	Agric	Industry	Construction	Trade	Services
Min	1.471	1.863	0.0477	0.851	0.63
1st Q	1946.798	2121.36	276.9225	1643.74	3423.29
Median	3495.545	2991.969	506.545	2772.495	5759.12
Mean	3043.5	4295.675	468.8536	2456.413	5184.17
3rd Quarter	4381.67	4295.675	729.9425	3662.488	7880.07
Max.	5959.47	4779.55	956.15	4924.47	10582.74

The above table presents a general summary of the data used in this research study. The table reveals that constructions have the minimum average returns across all the sectors while services have the highest average returns.

Table 2. Correlation matrix of variables

	Agriculture	Industry	Construction	Trade	Services
Agriculture	1	0.9031	0.889	0.9306	0.934
Industry	0.901	1	0.897	0.9149	0.9067
Construction	0.8895	0.8974	1	0.9856	0.9901
Trade	0.9306	0.3149	0.9856	1	0.9953
Services	0.9348	0.9067	0.9901	0.9953	1

The table above presents the pairwise correlation between each variable of GDP.

Based on the above output, as expected each variable when crossed classified with itself has a strong positive correlation with an output of (1). As it can be deduced from the output thus presented, all pairwise correlation reveals a positive figure with the least estimate being (0.3149), this implies that for all the variables there exist a positive correlation. All the pairwise relationship reveals a strong positive association with all the estimates revealing a value between (0.8-0.9) except 'trade and industry' that shows a positive relationship but not strong with an estimate of (0.3149).

3.1 Testing for stationarity using statistical test

The series of the Gross Domestic Product shall be tested for stationary before an attempt to fit a time series model, that is, the variables should be checked for the presence of unit root (I).

The stationary status for the series is determined by testing the following hypothesis:

H_0: Series has a unit root (non-stationary) Vs H_1: Series has no unit root (stationary)

Using the Augmented Dickey-Fuller test: The summary of the result for the Augmented Dickey-Fuller test is presented in the Table 3.

Table 3. Test for stationarity

Series	Test statistic	5% Critical Value	P-Value
Agric	-1.5095	-3.50	0.00229
Industry	-0.9035	-3.50	0.3818
construction	-2.242	-3.50	0.04797
Trade	-2.063	-3.50	0.261
Services	-2.4817	-3.50	0.02495

The above R-Output reveals that the null hypothesis that the series contains a unit root can be rejected for the series 'Agric', 'Construction', and Services' only, because the p-value(s) generated for the three series are less than the level of significance and also, the absolute value of Augmented Dickey-Fuller test statistic is less than the 5% critical values for the three series. Meanwhile, the null hypothesis of non-stationarity cannot be rejected for the series 'industry and "Trade" because the p-value is greater than the level of significance and also the Augmented Dickey-Fuller test statistic is greater than the 5% critical value for the two series.

Since the null hypothesis cannot be rejected for the series 'Industry and 'Trade' which is an indication that the series is non-stationary and in order to determine the order of integration, the first difference of the non-stationary series was obtained and the Augmented dickey-Fuller test was reapplied to the differenced series to test the existence of unit root.

Unit Root for Others after First Differencing: The summary for the Augmented Dickey-Fuller test for the differenced series 'Property' and 'Others' is presented in Table 4.

Table 4. Test for stationarity after first difference

Series	Test statistic	5% Critical Value	Prob.
dTrade	-3.6253	-3.50	0.0001532
dIndustry	-3.3269	-3.50	1.391e-05

'd' indicates the first differenced series

It can be seen from the table above that the null hypothesis that the first differenced series contains a unit root can be rejected because the p-value generated for the two series is less than the level of significance.

Determining the Order of Co-integration: It is imperative to determine the order of co-integration for the series to determine the type of model to be considered and the Johansen co-integration test was adopted.

The Table 5 presents the summary of the Johansen co-integration conducted on the series using the trace statistic.

Table 5. Co-integration test

Number of co-integrating vector	Eigenvalue	Trace test	
		Values of test statistic	5% critical value
Zero	89235e-01	93.08	87.31
At most 1	2.796112e-01	55.63	62.99
At most 2	4.073960e-01	30.05	42.44
At most 3	5.860803e-01	14.8	25.32
At most 4	7.251179e-01	5.37	12.25

The above analysis reveals that there is a presence of co-integration between/among the variables, hence the need to further present the equation of integration.

Table 6. Eigenvectors, normalised to the first column
(These are the cointegration relations- l1- lag 1)

	Agric.l1	Industry.l1	Construction.l1	Trade.l1	Services.l1	Trend.l1
Agric.l1	1	1	1	1	1	1
Industry.l1	-0.2925	0.0223	-0.5366	-0.7096	-1.3958	-19.2875
Construction.l1	3.7479	2.8872	29.9325	4.7813	-46.7146	-496.992
Trade.l1	-0.9807	-0.8299	0.1174	6.6993	-17.4388	228.3611
Services.l1	-0.3288	-0.7948	-2.9027	-4.3381	11.9896	-61.1163
Trend.l1	16.2644	141.9724	-50.9516	196.0256	269.6865	6183.19

Lag length estimation for the model: Estimation of the lag length is a strong implication and an integral part of VAR modelling for subsequent choices. The lag length estimation for the VAR(p) model was determined using the model selection criteria and the model selection criteria used for determining the lag length are; the Akaike Information Criteria (AIC), Hannan-Quinn (HQ) Information Criteria, Schwarz Information Criteria (SC), Final Prediction Error (FPE).

Table 7. Lag length estimation

Selection criteria	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5	Lag 6	Lag 7	Lag 8
AIC(p)	5.397405e+01	5.029374e+01	4.890291e+01	-	-Inf (*)	-Inf	-Inf	-Inf
HQ(p)	5.442984e+01	5.107508e+01	5.000982e+01	-	-Inf(*)	-Inf	-Inf	-Inf
SC(p)	5.569205e+01	5.323887e+01	5.307519e+01	-	-Inf(*)	-Inf	-Inf	-Inf
FPE	3.009572e+23	1.138745e+22	1.001018e+22	-7.573246e-24 (*)	0	0	0	0

Considering the Akaike Information Criteria (AIC), Hannan-Quinn (HQ) Information Criteria, Schwarz Information Criteria (SC), the table above revealed that the lag length is 5 excluding Final Prediction Error (FPE) which specifies a lag length of 4, therefore the VAR(5) model is the preferred model and the lag order 5 will be considered for further analysis because it had been confirmed that the fit will be good at the optimum lag length of order 5.

Fitting the Vector Autoregressive Model: Having obtained a set of stationary series, observed that the series and obtained the optimum lag length for the Vector autoregressive model to be of order, we can proceed to estimate the Vector Autoregressive model.

The model to be estimated will have the following structure.

$$\boldsymbol{Y_t} = \mathbf{C} + \boldsymbol{\Pi_1 Y_{t-1}} + \boldsymbol{\Pi_2 Y_{t-2}} + \cdots \boldsymbol{\Pi_p Y_{t-p}} + \boldsymbol{\mathcal{E}_t}; \qquad \mathbf{t = 1, 2, \dots, T}$$

Where $\boldsymbol{Y_t = Y_{1t}, Y_{2t}, \dots, Y_{nt}}$, **p** is the lag length, $\boldsymbol{\Pi_i}$ is an **(n×n)** matrix of coefficients, **t** is the time period, **n** denotes the numbers of endogenous variables.

The generalized form of the vector autoregressive (VAR) model can be specified representing the series Agriculture, industry, construction, trade and services with A, B, C, D and E respectively:

$$A_t = \varphi_1 + \sum_{i=1}^{p} \alpha_1 A_{t-i} + \sum_{i=1}^{p} \beta_1 B_{t-i} + \sum_{i=1}^{p} \Delta_1 C_{t-i} + \sum_{i=1}^{p} \Phi_1 D_{t-i} + \sum_{i=1}^{p} \Phi_1 E_{t-i} + \mathcal{E}_t$$
$$B_t = \varphi_1 + \sum_{i=1}^{p} \alpha_1 A_{t-i} + \sum_{i=1}^{p} \beta_1 B_{t-i} + \sum_{i=1}^{p} \Delta_1 C_{t-i} + \sum_{i=1}^{p} \Phi_1 D_{t-i} + \sum_{i=1}^{p} \Phi_1 E_{t-i} + \mathcal{E}_t$$
$$C_t = \varphi_1 + \sum_{i=1}^{p} \alpha_1 A_{t-i} + \sum_{i=1}^{p} \beta_1 B_{t-i} + \sum_{i=1}^{p} \Delta_1 C_{t-i} + \sum_{i=1}^{p} \Phi_1 D_{t-i} + \sum_{i=1}^{p} \Phi_1 E_{t-i} + \mathcal{E}_t$$
$$D_t = \varphi_1 + \sum_{i=1}^{p} \alpha_1 A_{t-i} + \sum_{i=1}^{p} \beta_1 B_{t-i} + \sum_{i=1}^{p} \Delta_1 C_{t-i} + \sum_{i=1}^{p} \Phi_1 D_{t-i} + \sum_{i=1}^{p} \Phi_1 E_{t-i} + \mathcal{E}_t$$
$$E_t = \varphi_1 + \sum_{i=1}^{p} \alpha_1 A_{t-i} + \sum_{i=1}^{p} \beta_1 B_{t-i} + \sum_{i=1}^{p} \Delta_1 C_{t-i} + \sum_{i=1}^{p} \Phi_1 D_{t-i} + \sum_{i=1}^{p} \Phi_1 E_{t-i} + \mathcal{E}_t$$

And the estimated $\text{VAR}_{(P=5)}$ model substituted coefficient is given by

VAR Estimation Results:

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Estimated coefficients for equation agric:

==

Call:

agric = agric.l1 + industry.l1 + construction.l1 + trade.l1 + services.l1 + agric.l2 + industry.l2 + construction.l2 + trade.l2 + services.l2 + agric.l3 + industry.l3 + construction.l3 + trade.l3 + services.l3 + agric.l4 + industry.l4 + construction.l4 + trade.l4 + services.l4 + agric.l5 + industry.l5 + construction.l5 + trade.l5 + services.l5 + const

```
   agric.l1   industry.l1 construction.l1      trade.l1    services.l1      agric.l2    industry.l2
  2597.9899      247.7679     -2112.4818      795.6601     -1823.0052     -569.7593       440.7505
construction.l2      trade.l2    services.l2      agric.l3   industry.l3 construction.l3      trade.l3
 -5923.2051     2019.9908      -572.9067     -716.1607      -859.6385    -6856.8355     -2368.3096
 services.l3      agric.l4   industry.l4 construction.l4      trade.l4    services.l4      agric.l5
  2072.0348     -739.5468       254.1235     4234.0497     -1917.3465     1378.6765     -3555.3626
 industry.l5 construction.l5      trade.l5    services.l5         const
  2196.0199   -10651.3768     -2868.3234     3428.2682      3001.8055
```

R- Output

Equation Agriculture $_{(t)}$ $= 2597.99A_{t-1} + 247.77B_{t-1} - 2112.48C_{t-1}+795.66D_{t-1}-1823.01E_{t-1} - 569.76A_{t-2} + 440.75B_{t-2} - 5923.21C_{t-2} + 2019.99D_{t-2} - 572.9067E_{t-2} - 716.16A_{t-3} - 859.64B_{t-3} - 6856.84C_{t-3} - 2368.31D_{t-3} + 2072.03E_{t-3} - 739.55A_{t-4} + 254.12B_{t-4} +4234.05C_{t-4} - 1917.35D_{t-4} + 1378.68E_{t-4} - 3555.36A_{t-5} + 2196.02B_{t-5} - 10651.38C_{t-5} - 2868.32D_{t-5} + 3428.26E_{t-5} + 3001.81$

Estimated coefficients for equation industry:

===

Call:

industry = agric.l1 + industry.l1 + construction.l1 + trade.l1 + services.l1 + agric.l2 + industry.l2 + construction.l2 + trade.l2 + services.l2 + agric.l3 + industry.l3 + construction.l3 + trade.l3 + services.l3 + agric.l4 + industry.l4 + construction.l4 + trade.l4 + services.l4 + agric.l5 + industry.l5 + construction.l5 + trade.l5 + services.l5 + const

```
   agric.l1   industry.l1 construction.l1      trade.l1    services.l1      agric.l2    industry.l2
  2827.9771      269.3236     -2293.6991      863.4482     -1983.4478     -618.8493       480.1827
construction.l2      trade.l2    services.l2      agric.l3   industry.l3 construction.l3      trade.l3
 -6442.3640     2196.6538      -624.2625     -777.7854      -936.6722    -7459.5141     -2578.6062
 services.l3      agric.l4   industry.l4 construction.l4      trade.l4    services.l4      agric.l5
  2255.0856     -805.2206       276.3897     4605.8214     -2088.8388     1501.9809     -3868.4087
 industry.l5 construction.l5      trade.l5    services.l5      const
  2390.9683   -11593.0464     -3123.3685     3730.8101     3265.9101
```

R-Output

Equation Industry $_{(t)}$ $= 2827.98A_{t-1} + 269.32B_{t-1} - 2293.70C_{t-1}+863.45D_{t-1}- 1983.48E_{t-1} - 618.85A_{t-2} + 480.18B_{t-2} - 6442.36C_{t-2} + 2196.65D_{t-2} - 624.267E_{t-2} - 777.79A_{t-3} -936.68B_{t-3} - 7459.51C_{t-3} - 2578.61D_{t-3} +2255.09E_{t-3} - 805.22_{t-4} + 276.39B_{t-4} +4605.82C_{t-4} - 2088.84_{t-4} +1501.98E_{t-4} - 3868.41_{t-5} + 2390.97B_{t-5} - 11593.05C_{t-5} - 3123.37D_{t-5} + 3730.81E_{t-5} + 3265.91$

Estimated coefficients for equation construction:

```
===================================================
Call:
construction = agric.l1 + industry.l1 + construction.l1 + trade.l1 + services.l1 + agric.l2 + industry.l2 + construction.l2 + trade.l2 + services.l2 + agric.l3 + industry.l3 + construction.l3 + trade.l3 + services.l3 + agric.l4 + industry.l4 + construction.l4 + trade.l4 + services.l4 + agric.l5 + industry.l5 + construction.l5 + trade.l5 + services.l5 + const

      agric.l1     industry.l1 construction.l1        trade.l1      services.l1        agric.l2      industry.l2
     402.05007        38.47541      -327.38632       123.43758      -282.31708       -88.35999        68.25388
construction.l2        trade.l2     services.l2        agric.l3     industry.l3 construction.l3         trade.l3
    -918.14174       312.74363       -88.56589      -111.02194      -133.05048     -1061.46069       -366.64723
   services.l3        agric.l4     industry.l4 construction.l4        trade.l4     services.l4         agric.l5
     320.90393      -114.89147        39.55067       653.75456      -296.98980       213.81742       -550.40506
   industry.l5 construction.l5        trade.l5     services.l5           const
     339.95907     -1648.41413      -444.25821       530.76039       465.28399
```

R-Output

Equation Construction $_{(t)} = 402.05A_{t-1} + 38.47B_{t-1} - 327.39C_{t-1} + 123.44D_{t-1} - 282.32E_{t-1} - 88.36A_{t-2} + 68.25B_{t-2} - 918.14C_{t-2} + 312.74D_{t-2} - 88.57E_{t-2} - 111.02A_{t-3} - 133.05B_{t-3} - 1061.41C_{t-3} - 366.65D_{t-3} + 320.90E_{t-3} - 114.89_{t-4} + 39.55B_{t-4} + 653.75C_{t-4} - 296.99_{t-4} + 213.82E_{t-4} - 550.41_{t-5} + 339.96B_{t-5} - 1648.41C_{t-5} - 444.26D_{t-5} + 530.76E_{t-5} + 465.28$

Estimated coefficients for equation trade:

```
==========================================
Call:
trade = agric.l1 + industry.l1 + construction.l1 + trade.l1 + services.l1 + agric.l2 + industry.l2 + construction.l2 + trade.l2 + services.l2 + agric.l3 + industry.l3 + construction.l3 + trade.l3 + services.l3 + agric.l4 + industry.l4 + construction.l4 + trade.l4 + services.l4 + agric.l5 + industry.l5 + construction.l5 + trade.l5 + services.l5 + const

      agric.l1     industry.l1 construction.l1        trade.l1      services.l1        agric.l2      industry.l2
     2195.3978        209.3960      -1789.7713        672.9723      -1540.4476       -481.2153         372.1600
construction.l2        trade.l2     services.l2        agric.l3     industry.l3 construction.l3         trade.l3
    -5005.3863       1705.9963       -483.8483       -605.4748       -726.1506      -5793.6811       -2001.3296
   services.l3        agric.l4     industry.l4 construction.l4        trade.l4     services.l4         agric.l5
     1750.9743       -625.7052        215.2562       3575.3540      -1620.6789       1165.7543       -3005.0600
   industry.l5 construction.l5        trade.l5     services.l5           const
     1855.6959      -9002.7544      -2424.6140       2898.0496       2537.8774
```

R- Output

Equation Trade $_{(t)} = 2195.40A_{t-1} + 209.40B_{t-1} - 1789.77C_{t-1} + 672.97D_{t-1} - 1540.45E_{t-1} - 481.22A_{t-2} + 372.16B_{t-2} - 5005.39C_{t-2} + 1705.99D_{t-2} - 483.85E_{t-2} - 605.48A_{t-3} - 726.15B_{t-3} - 5793.68C_{t-3} - 2001.33D_{t-3} + 1750.97E_{t-3} - 625.71_{t-4} + 215.26_{t-4} + 3575.35C_{t-4} - 1620.68_{t-4} + 1165.75E_{t-4} - 3005.06_{t-5} + 1855.70B_{t-5} - 9002.75C_{t-5} - 2424.61D_{t-5} + 2898.05E_{t-5} + 2537.8$

Estimated coefficients for equation services:

===

Call:
services = agric.l1 + industry.l1 + construction.l1 + trade.l1 + services.l1 + agric.l2 + industry.l2 + construction.l2 + trade.l2 + services.l2 + agric.l3 + industry.l3 + construction.l3 + trade.l3 + services.l3 + agric.l4 + industry.l4 + construction.l4 + trade.l4 + services.l4 + agric.l5 + industry.l5 + construction.l5 + trade.l5 + services.l5 + const

```
   agric.l1    industry.l1 construction.l1      trade.l1    services.l1      agric.l2    industry.l2
  4577.7700       436.5761     -3727.5311      1402.6275     -3212.1666    -1004.0857       776.2924
construction.l2     trade.l2    services.l2      agric.l3    industry.l3 construction.l3      trade.l3
 -10439.1402      3557.3750     -1008.5026     -1261.9489     -1514.5679   -12080.1140     -4174.3453
 services.l3      agric.l4    industry.l4 construction.l4      trade.l4    services.l4      agric.l5
  3651.6457     -1305.1913       448.8525      7455.4581     -3380.1488     2431.3736     -6265.0629
 industry.l5 construction.l5     trade.l5    services.l5        const
  3869.8541    -18770.7057     -5055.4105      6041.6536      5290.9524
```

R-Output

Equation Services $_{(t)}$ = $4577.77A_{t-1} + 436.58B_{t-1} - 3727.53C_{t-1} + 1402.63D_{t-1} - 3212.17E_{t-1} - 1004.09_{t-2} + 776.29B_{t-2} - 10439.14C_{t-2} + 3557.38D_{t-2} - 1008.50E_{t-2} - 1261.95A_{t-3} - 1514.57B_{t-3} - 12080.11C_{t-3} - 4174.35D_{t-3} + 3651.65E_{t-3} - 1305.19_{t-4} + 448.85_{t-4} + 7455.46C_{t-4} - 3380.15_{t-4} + 2431.37E_{t-4} - 6265.06_{t-5} + 3869.85B_{t-5} - 18770.71C_{t-5} - 5055.41D_{t-5} + 6041.65E_{t-5} + 5290.95$

3.2 Model diagnostic measures

To ascertain that the model provides an appropriate representation, some misspecification tests are performed.

Test for Residuals Autocorrelation: The Portmanteau Autocorrelation test is a Q-statistic test for the Vector Autoregressive model residual serial correlation and it tests the following hypothesis:

H_0: There is no residual Autocorrelation up to lag h Vs H_1: There is residual Autocorrelation up to lag h

The table below summarizes the portmanteau test carried out the residual of the fitted model; the table was constructed to test the residual autocorrelation up to lag 8.

Portmanteau autocorrelation test summary

```
Portmanteau Test (asymptotic)

Data:  Residuals of VAR object data3
Chi-squared = 372.03, df = 375, p-value = 0.5336
```

R-Output

We fail to reject the null hypothesis since p-value is greater than the level of significance (0.05) and conclude that there is no residual autocorrelation up to lag 8 among the variables.

3.3 Forecasting from the vector autoregressive model

Having confirmed that the model provides a true representation of the data and the variables under study, the forecast can then be made with the fitted model. The fitted model was used to forecast the classification of GDP for 2 years which is distributed by quarter.

Table 8. Agriculture

Quarter	Forecast value	Lower	Upper
1	5910.422	4263.366	7557.478
2	5615.437	3661.459	7569.415
3	5694.115	3530.720	7857.511
4	5675.782	3346.624	8004.940
1	5757.439	3288.467	8226.412
2	5794.111	3204.934	8383.287
3	5860.372	3166.526	8554.217
4	5908.566	3122.782	8694.351

Table 9. Industry

Quarter	Forecast value	Lower	Upper
1	3623.435	2404.3994	4842.470
2	3506.003	1866.1420	5145.864
3	3474.707	1550.4056	5399.008
4	3413.650	1276.8700	5550.429
1	3376.239	1073.9202	5678.558
2	3325.848	891.0085	5760.687
3	3282.239	739.6072	5824.871
4	3233.296	601.8003	5864.791

Table 10. Construction

Quarter	Forecast value	Lower	Upper
1	858.2770	667.0607	1049.493
2	928.4693	678.2588	1178.680
3	927.4105	634.4127	1220.408
4	956.0201	629.0451	1282.995
1	962.3442	606.8522	1317.836
2	979.6400	599.6496	1359.630
3	989.3730	587.9978	1390.748
4	1002.8216	582.5577	1423.086

Table 11. Trade

Quarter	Forecast value	Lower	Upper
1	4861.079	3988.803	5733.356
2	4988.145	3794.842	6181.447
3	5034.344	3605.935	6462.753
4	5128.009	3510.597	6745.421
1	5191.877	3415.890	6967.863
2	5270.749	3358.162	7183.337
3	5338.129	3305.857	7370.402
4	5409.587	3271.117	7548.057

Table 12. Services

Quarter	Forecast value	Lower	Upper
1	10065.41	8191.806	11939.02
2	10627.98	8054.160	13201.79
3	10567.69	7494.477	13640.90
4	10863.42	7391.611	14335.22
1	10942.21	7136.960	14747.46
2	11141.84	7049.392	15234.29
3	11264.28	6920.292	15608.27
4	11426.23	6859.013	15993.44

4 Discussion

The patterns of GDP variables are graphically examined using time plot presented the time plot for the GDP variables concerning time presented a combined single time plot for all the considered GDP variables.

Presents the general summary of the data used in this research study. The table reveals that constructions have the minimum return across all the considered variables of GDP while the maximum return is services.

The relationship, as well as the degree of relationship between/among the GDP variables, was further revealed by computing the pairwise correlation. Based on the output, each variable when crossed classified with itself have a strong positive correlation with an output of (1), while pairwise correlation reveals a positive figure with the least estimate being (0.3149), this implies that for all the variables there exist a positive correlation. All the pairwise relationship reveals a strong positive association with all the estimates revealing a value between (0.8-0.9) except 'trade and industry' that shows a positive relationship but not strong with an estimate of (0.3149).

The initial test in fitting a time series model is to examine the series for stationarity. The Augmented Dickey-Fuller test revealed that 'Agriculture', 'Construction', and Services'" satisfies the requirement of stationarity while the series 'industry and "Trade" are non-stationary initially but later became stationary after the application of the first difference transformation which was confirmed after the application of the ADF test to the first differenced seriesThe Johansen co-integration's Trace test was employed to determine the order of co-integration and it was revealed that the series are cointegrated hence presentation of the equation of integration.

We presented the lag length estimation criteria which revealed that the lag length of order 5 is appropriate for the VAR model as suggested by Akaike Information Criteria (AIC), Hannan-Quinn (HQ) Information Criteria, Schwarz Information Criteria (SC). The $VAR_{(5)}$ model was fitted for all the considered GDP variables. The tests of significance for the models indicated that they are all significant as the p-value generated for the model is less than the 5% level of significance. The portmanteau autocorrelation test was conducted to confirm the claim that there is no residual autocorrelation up to lag h.

Based on the modelled equation, GDP value was forecasted for the next 8 quarters (2 years) and the summary was presented for all the variables.

5 Conclusion

In conclusion, The classifications of GDP variables in Nigeria state exhibit different patterns within the period under study as several patterns are found to be embedded in each classification which makes the production, manufacturing, services, trade and agricultural activities unstable across the different sector of the economy. There exist a significant relationship and strong positive association among all the variables of GDP and this implies that this variable plays a significant role in the rise and drop of the other variable.

The forecasted analysis, only industry reveals a not progressive prediction over quarters of the year while all other GDP variables reveal a progressive prediction. In order of ranking the contribution of the considered GDP variables to the economic upliftment of the country, it was revealed that Services is still leading in the rank followed by agriculture, trade, the industry with construction lagging distantly.

Competing Interests

Authors have declared that no competing interests exist.

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