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AN IMPROVEMENT FORECAST USING VECTOR AUTOREGRESSION APPROACH ON TAX REVENUE IN NIGERIA

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ABSTRACT

The paper proposed an improved Multivariate time series model for tax revenue using Vector Auto regression (VAR) approach. The advantage of this study is to verify the error variance decomposition on both the transformed and un-transformed data. To check the efficiency this, approach the four stages of VAR were observed with R package to examine the MAE, RMSE, MAPE, and MSE. The result shows that, the error variance decomposition in transformed data is less than the error variance decomposition in Untransformed data (i.e 1.5e-15 < 2.2e-16) which means that, there's significant difference in the error variance decomposition The models suggested by information criterion procedure are different because VAR (1) model is selected for transformed data for all the criterions while by information criterion procedures, however VAR (3) model is the most suitable model for the data sets based on the model adequacy checking and accuracy testing.

Keywords: Data-Transformation, Forecasting, Tax-Revenue Vector Auto Regression (VAR)

INTRODUCTION

Tax Revenue in Nigeria has been and still the major source of government revenue and the most dependable source of government funding. In many countries, tax relief is the significant tools that boost the economic growth. Taxation policy itself is a fundamental element for economic policies, ensuring that countries are able to maintain and improve its global competitiveness and to expand. This applies to both developed, developing and countries. The attractiveness of the tax system structure is important to ensure that it able to attract domestic and foreign investors. Hence, the decision of the Nigerian government to diversify or change its system from mono economy of crude oil dependency to tax revenue is an interesting economic issue. Nigeria depend on crude oil as the major source of revenue became frustrating when the economic recession began in the 2008 though Nigeria did not feel the impact of the recession at the initial stage of it (recession) on till 2015 when the price of crude oil fall below expectation and the government can no longer meet up with her obligation.

Taxation has been used as the main policy instrument for government to generate and transferring resources to the public sector. Federal Inland Revenue Service (*FIRS*) as a tax collection agent for the government. This act gives the Board more autonomy especially in financial and personnel management to improve the quality and effectiveness of tax administration. Developed country's aim for the fiscal policy is to achieve the economic stability. However, the developing countries use taxes to achieve the economic development. The governments use taxes to raise the economic and productive efficiency of the state, by monitoring the economic resources and to exploit these recourses in full (Hijazi, 2001). In addition, the fiscal policy of the state supports the stability of the economy and determines the economic policies. the tax legislations affect the economy through the influence on the investment, consumption, saving, employment and inflation (ALMahaeni, 2003); Meswadi and Almufleh (2015). The aim of this study is to test for Granger causality on the tax revenue data whether there's co integration amongst the component of tax revenue and to verify which of the data yield a better result in forecasting with vector auto regression model before the hybridization.

LITERATURE REVIEW

Vector autoregressive models (VAR) introduced by Sims (1980) are considered to prevail in the econometric modeling of monetary policy transmission mechanism. The analysis of the monetary policy transmission mechanism with VAR models spread to the emerging markets of Central and Eastern Europe.

Again, we identify individual level of studies and comparative analyses for different groups of countries in the region. Thus, Hurník and Arnoštová (2005) analysed the transmission mechanism of monetary policy in the Czech Republic for the period 19942004 using a VAR methodology. Their results show that an unexpected contractionary monetary policy shock leads to a lower production; prices increase in the first two quarters after the shock (price puzzle), exchange rate drops (appreciation) for 4-5 quarters and after it raises (delayed overshooting).

Demchuk et al. (2012) assessed the key characteristics of the monetary policy transmission mechanism in Poland, using VAR and SVAR during 19982011 (both monthly and quarterly data) and highlighted the following conclusions: an increase in short term interest rate by 1 % strongly reflects on output, price level and exchange rate (consumer price index decreases by about 0.3% after 6 quarters, the production by the same percentage after four quarters, an appreciation of the national currency that lasts 14 to 16 quarters). More recently, the VAR and SVAR approach of monetary policy transmission mechanism in Romania was applied by Andries (2008). Considering the period 2000:1 - 2007:6 and Cholesky identification method the author's main result highlighted that a sudden increase in the effective short-term interest rate causes a decrease in consumer prices that reflects the greatest amplitude after 6 months and an appreciation of the national currency with a maximum recorded in the same period after the shock. VAR system estimates considered by the two authors have suggested that despite a weaker development of national financial systems, the responses of macroeconomic variables to a monetary policy shock are similar between the three countries, and not significantly different from those of the advanced European economies. Adediran O et al 2017 using VAR prove that money supply and exchange rate have a significant impact on growth through unemployment. Presently there is a new wave of interest to identifying and analysing the implications of the recent financial crisis and on the monetary policy transmission mechanism based on VAR method (eg, Boivin et al. (2010), Cecioni and Neri (2010)). Central and Eastern Europe countries researches are still in their infancy. In this regard we note the study of Lyziak et al. (2011), which highlighted the impact of recent global turmoil on the effectiveness of monetary policy transmission mechanism, depends on structural characteristics of the economy. The financial crisis, which affected both components led to a change in monetary policy rule and a significant lower efficiency of monetary policy. In the same line, Demchuk et al. (2012) pointed out that during the recent international destress, the monetary policy transmission mechanism in a small open economy such as Poland suffered extensive disturbance, with the interest rate channel being the most affected To date, the relationship between monetary policy and inclusive growth remains inconclusive; The first strand contend that unemployment is not the legislative function of monetary authorities and that price and financial stability as well as banking supervision are enormous task nonetheless of adding unemployment to these objectives (Bhattacharyya, 2012; Orphanides, 2013; Vinayagathasan, 2013). As a result, they argue that Central banks should not be blamed for every fluctuation in either inflation or unemployment. Similarly, Bhattacharyya (2012) noted that despite the success of employment objective documented in Australia, Korea, United State and Japan by monetary policy, it still appears inappropriate for monetary authorities to assume this role. Orphanisede (2013) further claimed that overburdening monetary policy may eventually weaken and compromise the independence and credibility of the Central Banks, thereby reducing its effectiveness in maintaining price stability and contributing to crisis management. Hence, they often argue that price and financial stability do not necessarily imply macroeconomic stability that can lead to growth and generate employment creation (William, 2004; Epstein, 2014, Chang and Jaffar, 2014; Sayeed and Abass, 2014; Adeleke *et al.* 2015). This strand of the literature therefore advocates for central banks to explicitly incorporate employment as part of their main mandates, where monetary policy can primarily be focused on employment creation just like some developed countries in Europe, United States and Australia.

In Nigeria, Fasanya *et al.* (2013) examined the impact of monetary policy on economic growth using time series data covering the period 1975-2010. The effects of stochastic shocks of each of the endogenous variables were explored using Error Correction Model (ECM). Findings of these study reveal a long run relationship among the variables. Also, the core finding of the study shows that inflation rate, exchange rate and external reserve are significant monetary policy instruments that drive growth in the economy. In a related study, Adeoye and Saibu (2014) analyzed the effects of monetary policy shocks using changes in various monetary policy instruments on exchange rate volatility in Nigeria. It was concluded that inflation rate, reserves, interest rate and money supply depreciate and cause volatility in nominal exchange rate which further reinforce other findings that monetary policy is crucial to exchange rate management in Nigeria.

METHODOLOGY

Unit Root Tests

The data used for this study is obtained from Central Bank of Nigeria (CBN) and National Bureau of Statistics (NBS) from 1981 to 2016 selecting the component of tax revenue variables. However the structure model for design in the framework below It is important to determine the characteristics of the individual series before conducting the co integration analysis. Many studies have shown that majority of macroeconomics time series are not stationary, rather they are stationary with a deterministic trend. To test the order of integration, we used Augmented Dickey-Fuller test (ADF), Phillip-Perron test (PP), Kwiatkowski et al. test (KPSS) and Eagle Granger Correction Model (EGCM). It is widely acknowledged that ADF, PP and EGCM tests are not very efficient in distinguishing between a unit root and a near unit root case. To complement ADF, PP and EGCM tests, we employ the KPSS test proposed by Kwiatkowski et al. (1992). The KPSS test assumes that the null hypothesis is stationary against the alternative hypothesis that the variable does have a unit root.

Stationarity Test

Before the model is estimated, stationarity tests were performed using unit root tests. If the time series is not stationary the t distribution will have nonstandard distributions and thus test results may be misleading. A serious problem is the possibility of finding spurious regressions, i.e. having significant regression results while the variables have no long run relationship (Johnston and DiNardo, 1997). The ADF tests are performed with level and differenced data. The ADF tests used relaxes the assumption of homoskedasticity and thus tend to be more powerful than the Augmented Dickey Fuller test in the presence of heteroskedasticity (Hamilton, 2006). The ADF is specified as,

$$\Delta y_t = \gamma y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta y_{t-1} + \varepsilon_t$$

$$\varepsilon \sim IID(0, \sigma^2) \qquad (1)$$

$H_0 : \gamma = 0$ (nonstationary, i.e unit root)

$H_1 : \gamma < 0$ (Stationary, i.e no unit root)

Where

Y is the Annual Tax Revenue γ is the stationarity Coefficient is the white noise process

$\alpha_0 and \beta_i$ are the parameters to be estimated

Johansen and Juselius Co Integration Test

Granger (1969) proposes the concept of co integration and, Engel and Granger (1987) provide further in depth discussion of the technique. The components of the vector Xt are said to be co integrated of order d, b, and denoted by Xt~CI(d,b) if (i) Xt is I(d) and (ii) there exists a nonzero vector α such that α' Xt~I(db), d≥b≥0. The vector α is called the co integrating vector. Co integration suggests that there exists a longrun equilibrium relationship linking these variables, or they tend to move together over time. Therefore, co integration reveals long-run effects between time series variables. In this study, we employ Johansen and

Juselius (JJ) co integration test. The JJ co integration approach suggests an alternative method to perform the co integration test. Basically, the JJ method is presently used and takes the following equation:

$$\Delta Y_t + \prod Y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-1} + BX_t + \varepsilon_t \quad (2)$$

Where, Yt is a k-vector of nonstationary I(1) variables, Xt is a d-vector of deterministic trace test statistic. It is to be noted that the variables under consideration should have variables, and t ε is vector of white noises with zero mean and finite variance. The number of co integrating vectors is represented by the rank of the coefficient matrix ∏ Johansen's method is to estimate the ∏matrix in an unrestricted form, then test whether one can reject the restrictions implied by the reduced rank of ∏ The likelihood ratio (LR) test for the hypothesis that there are at most r co integration vectors is called the identical orders, and in particular are integrated of order one (Engle and Granger, 1987). Testing for co-integration of the type CI (d,b) for b

Granger Causality Test

It is imperative to establish that whether one variable could forecast another factor or variable in time series analysis (Granger, 1969). Multiple linear regressions are behind the methodology of Granger causality technique.

According to Goebel, Roebroeck, Kim, and Formisano (2003) by using the F-statistics on the basis of residuals factor several research studies have already been carried out. As pointed out by the Chen et al. (2009) the ratified trace coefficients could be applied to perform t-test at the level of group statistics. According to McFarlin, Kerr, Green, and Nitschke (2009), the negative trace coefficients are the restrained aftereffects. The pairwise Granger causality expression could be expressed as follows.

$$Y_t = \sum_{n=1}^{k} A_n X_{(t-p)} + \sum_{j=1}^{k} \beta_n Y_{(t-p)} + CZ + \varepsilon_t \quad (3)$$

$$X_t = \sum_{n=1}^{p} A_n Y_{(t-p)} + \sum_{n=1}^{p} \beta_n X_{(t-p)} + CZ_t + \varepsilon_t \quad (4)$$

In Equation (3), 'X' and 'Y' known as the two time series at distinctive time period 't', and 'X_{t-p} ' and 'Y_{t-p} ' are called two data time series at period 't −p'. Here 'p' used as a number of lagged orders of the time period. Similarly, in the above expression (A_n) and (A_n') are ratified trace coefficients then (B_n) and (B_n') are known as the auto regression model. In the above expressions, we considered 'Zt ' as covariables at the time period of 't'. The value of F-statistics could be calculated for the normal Wald test as follows:

$$F = \frac{(RSSR - RSSU)/m}{RSSU/(n-k)} \quad (5)$$

Equation (5) follows the Fm,n−k distribution, in which k=m+n+1. If the estimated value of 'F' greater than the critical value of 'F', then we reject the null hypothesis and concluded that X_t causes Y_t .

Vector Auto Regression Model (VAR. Model)

For the analysis of the multivariate time series, the vector auto regression (V.A.R.) is the obvious choice because this model is very flexible and user friendly. The vector auto regression (V.A.R.) model is the logical annex of univariate A.R. model for the dynamic multivariate data time series. This model is specifically useful for the description of the dynamic behaviour of time series and their forecasting. Sims (1980) was a famous econometrician, who made this model useful and used this effectively in his research. Moreover, Lutkepohl (1991, 1999), Watson (1994), Nau (2014), Zhang (2013), Tiao and Box (1981), and Waggoner and Zha (1999) are examples of the distinctive and technical use of this model. We can derive the following form of the VAR. model, let Yt = (y_{1t} , y_{2t} ,…., ynt) signify for (n x 1) vectors of the time series variables, and fundamental 'p' lags for the vector autoregressive then the VAR. (p) model could be expressed as follows: where: t = 1, ….., T. In equation (6), Π are the(n x m) matrices of coefficients, and 'εt ' is as the (n x 1) non-observable mean white noise vector procedure, which is consecutively uncorrelated or independent with the time in variant covariance matrix Σ Thus, we can express the bivariate VAR (2) model as follows:

$$Y_t = c + \Pi_1 Y_{t-1} + \Pi_2 Y_{t-2} + ... + \Pi_p Y_{t-p} + \varepsilon_t \quad (6)$$

$$\begin{pmatrix} y_{1t} \\ y_{2t} \end{pmatrix} = \begin{pmatrix} c_1 \\ c_2 \end{pmatrix} + \begin{pmatrix} \pi^1_{11} & \pi^1_{12} \\ \pi^1_{21} & \pi^1_{22} \end{pmatrix} \begin{pmatrix} y_{1t-1} \\ y_{2t-1} \end{pmatrix} + \begin{pmatrix} \pi^1_{11} & \pi^1_{12} \\ \pi^1_{21} & \pi^1_{22} \end{pmatrix} \begin{pmatrix} y_{1t} \\ y_{2t} \end{pmatrix} \quad (7)$$

Or, it can also be written as follows:

$$y_{1t} = c_1 + \pi^1_{11} y_{1t-1} + \pi^1_{12} y_{2t-1} + \pi^2_{11} y_{1t-2} + \pi^2_{12} y_{2t-2} + \varepsilon_{1t} \quad (8)$$

$$y_{1t} = c_2 + \pi^1_{21} y_{1t-1} + \pi^1_{22} y_{2t-1} + \pi^2_{21} y_{1t-2} + \pi^2_{22} y_{2t-1} + \varepsilon_{2t}$$

(9)

In the above expressions cov (ε1*t*, ε2*s*) = σ12 for *t* = *s*, 0 otherwise, and it is important to note that each expression has the same regressors –

lagged estimations of $y1t$ and $y2t$. Thus, it is observed that the V.A.R. (p) technique is just an apparently dissimilar regression (S.U.R.) model with lagged factors or variables, and in defined terms, it is same as regressors. The V.A.R. (p) can be written as follows for lag operator notation:

$$\Pi(L)Y_t = c + \varepsilon_t \quad (10)$$

$$F = \begin{pmatrix} \Pi_1 & \Pi_2 & \dots & \Pi_n \\ I_n & 0 & \dots & 0 \\ 0 & : & 0 & : \\ 0 & 0 & I_n & 0 \end{pmatrix} \quad (11)$$

The above expression F-matrix has modulus < 1. Suppose that procedure has been rearranged in the unlimited s:

In the above equation $\Pi(L) = I_n - \Pi_1 L - \dots - \Pi_p L^p$. The model VAR

(p) is considered to be a firm or stable if the roots placed the outer side of the multifaceted unit circle, which have modulus > 1, or evenly (equivalently). The eigen values of the companion matrix can be written as follows:

historical values, thus the firm VAR (p) procedure is considered to be a stationary. Let the series 'Y_t' is reflected as covariance stationary then the unrestricted means can be expressed as follow

$$\mu = \left(I_n - \Pi_1 - \dots - \Pi_p\right)^{-1} c \quad (12)$$

Thus, the mean-adjusted shape of the model VAR (p) is written as:

$$Y_t - \mu = \Pi_1(Y_{t-1} - \mu) + \Pi_2(Y_{t-2} - \mu) + \dots + \Pi_p(Y_{t-p} - \mu) + \varepsilon_t \quad (13)$$

Since the fundamental VAR (*p*) technique is so obstructive to show adequately the major characteristics of the data time series. Specifically, additional deterministic expressions, such as seasonal dummies or linear time trends may require showing the time series correctly; moreover, there is a requirement of stochastic exogenous variables. Hence, the generalized form of AR (*p*) model can be expressed with deterministic terminologies and exogenous factors as follows:

$$Y = \Pi_1 Y_{t-1} + \Pi_2 Y_{t-2} + \ldots + \Pi_p Y_{t-p} + \Phi D_t + \Psi X_t + \varepsilon_t \quad (14)$$

In the above expression '*Dt*' indicates (1 x 1) deterministic module matrices and '*Xt*' signifies (*m* x 1) the exogenous factors matrix, whereas, Φand Ψ are parameter matrices.

RESULTS AND DISCUSSION

Identification of VAR models

The four tests used to check whether the data were in stationary state which is Augmented Dickey Fuller (ADF), Phillip Perron (PP), Kwiatkowski– Phillips– Schmidt–Shin (KPSS) tests and Engle Granger Correction Method. For ADF, PP test and EGCM-test the null hypothesis is rejected (i.e., the data does not have unit roots) when the pvalue is less than the significance level, 0.05. Meanwhile, for KPSS test, rejecting the null hypothesis, when p-value less than significance level 0.05, indicate that the data has unit root

.

Table 1: Unit root testing for stationary of Un-transformed data

Variables	ADF-test		PP-test		KPSS-test		EGCM-test	
	Level	Diff	Level	Diff	Level	Diff	Level	Diff
	– 2.0306	-6.532	2.4538	0.0642	– 0.0015	-7.986	– 2.1568	– 8.2826
CD	0.01	0.01	0.01	0.01	0.0931	0.0563	0.01	0.01
	– 2.9237	-6.7071	2.3725	0.0205	– 2.0529	– 11.2993	– 3.3176	– 11.2844
PTY	0.01	0.01	0.01	0.01	0.04231	0.14	0.01	0.01
	– 1.6628	– 11.8664	0.7397	– 14.8957	2.2192	0.3422	-62799	– 155021
ST	0.01	0.01	0.01	0.01	0.0359	0.181	0.01	0.01
	– 1.5413	– 12.0743	0.6321	– 20.5386	2.2599	0.3926	– 6.8048	– 18.496
PIT	0.01	0.01	0.01	0.01	0.0712	0.0461	0.01	0.01
	2.0918	-31245	9.9288	– 23.0548	0.8706	0.0242	– 28.9314	– 54.7703
CT	0.01	0.01	0.01	0.01	0.061	0.111	0.01	0.01
	0.0108	– 10.3847	0.6796	0.0205	-22.8914	– 20.7588	– 9.9086	– 25.5405
TR	0.01	0.01	0.01	0.01	0.0411	0.041	0.01	0.01

Table 2: Unit root testing for stationary of transformed data

Variables	ADF-test		PP-test		KPSS-test		EGCM-test	
	Level	Diff	Level	Diff	Level	Diff	Level	Diff
	– 2.0306	-6.532	0.006	– 91.4095	2.4538	0.2006	– 2.1568	– 8.2826
LCDT	0.01	0.01	0.01	0.01	0.737	0.2003	0.01	0.01
LPTY	– 2.9237	-6.7071	– 8.4258	– 158.673	1.9492	0.354	– 3.3176	– 11.2844

	0.01	0.01	0.01	0.01	0.701	0.042	0.01	0.01
	– 1.6628	– 11.8664	2.2616	– 14.8957	2.2192	0.3422	-62799	– 15.5021
LSTX	0.01	0.01	0.01	0.01	0.1	0.022	0.01	0.01
LPIT	– 1.5413	– 12.0743	0.9812	179.214	2.2599	0.926	– 4.8048	– 18.496
	0.01	0.01	0.01	0.01	0.215	0.203	0.01	0.01
	2.0918	-31245	– 125.866	– 278.254	0.8706	0.0242	– 28.9314	– 54.7703
LCOT	0.01	0.01	0.01	0.01	0.061	0.111	0.01	0.01
	0.0108	– 10.3847	– 1.6868	-242.06	2.3725	0.2003	– 9.9086	– 22.519
LTOT	0.01	0.01	0.01	0.01	0.021	0.06	0.01	0.01

Figure 1 explain based on significant lags, several models were estimated. In the vein of a parsimonious model first three lags were chosen because they have high correlation coefficients. Further, the choice of these lags is based on administration practice of cascading annual revenue targets into quarterly targets which informs that past collections may have a small influence to the current tax collection targets and volatility

Table 3: Vector Auto Regression VARLag selection for

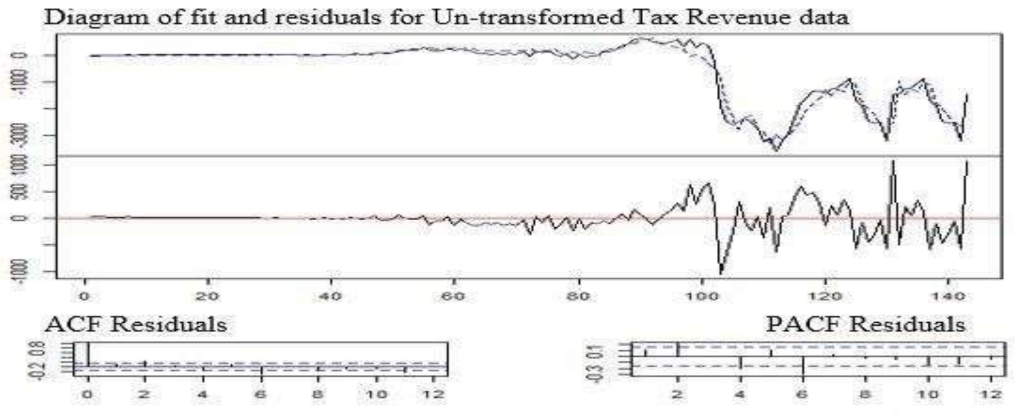
Criteria	1	2	3	4	5
AIC(n)	**0.14321**	0.308454	0.210825	0.368733	0.529118
HQ(n)	**0.450792**	0.835733	0.957803	1.33541	1.715495
SC(n)	**0.900112**	1.605994	2.049007	2.747556	3.448584
FPE(n)	1.154525	1.364598	1.243211	1.467745	1.745513

Table4 Vector Autoregression (VAR) Lag selection

Criteria	1	2	3	4	5
AIC(n)	7.33E+01	7.21E+01	7.15E+01	7.11E+01	**7.04E+01**
HQ(n)	7.37E+01	7.28E+01	7.25E+01	7.24E+01	**7.20E+01**
SC(n)	7.42E+01	**7.37E+01**	7.39E+01	7.43E+01	7.43E+01
FPE(n)	6.82E+31	2.03E+31	8.19E+30	3.88E+30	**1.17E+31**

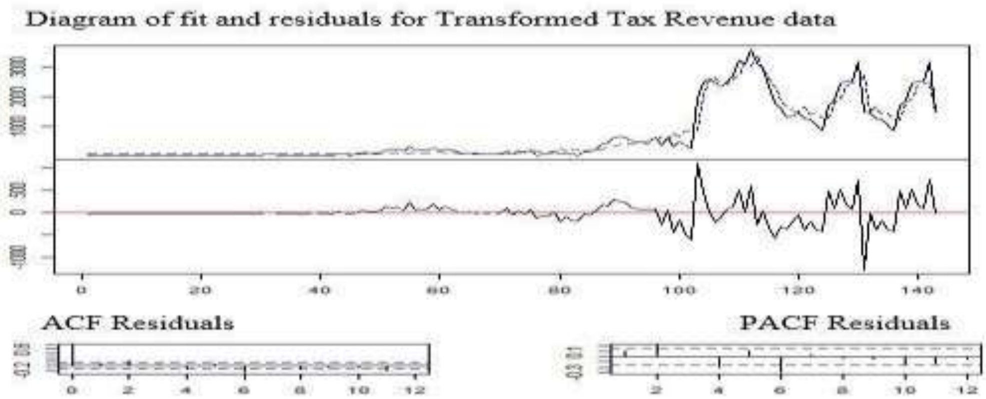
The study identified the correct number of lag order, *p* order by estimating the criterion. The Akaike's Information Criterion (AIC), Hannan-Quinn Information Criterion (HQC), Schwarz Criterion (SC) and Final Prediction Error (FPE) were used to identify the number of lag order that would be used in VAR Modeling.

Figure 1 present the fit and residuals for Un-transformed data



Source: Authors computations

Figure 2 present the fit and residuals for Un-transformed data



Source: Authors computations

Figure 2and 3 explain the trend and shock of the tax revenue on the economy for the un-transformed data from high to low level and fluctuations in the trend. Meanwhile the revise is the case of transformed data where the fluctuations on trends was stationary up till the year 2009 where the shocks begin to affect the tax revenue data

Tax Revenue Forecasting: Vector Autoregression Model (VAR)

Vector Autoregression (V.A.R) model of the order D.(CD), D.(PTY) D.(ST) D.(PIT), D.(CT), D.(TR) is estimated using the **TOTAL TAX REVENUE (TR)** as exogenous variables with the exclusion of wald test. Then forecast values are obtained from first quarter of 2017 to second quarter of 2019 that is ₦ 3.025905 trillion (US $98.89 Billion) as showed in Table, with According to the Federal Inland Revenue Service (FIRS)Board,

Table 5: Cointegration Causality test for Un-Transformed Data

Null Hypothesis	No of Obs	F-statistics	Pr <0.05
CD do not Granger-cause PTY ST PIT CT TR	648	3.0411	1.298e-06
PTY do not Granger-cause CD ST PIT CT TR	648	1.6243	0.02862
ST do not Granger-cause CD PTY PIT CT TR	648	6.2494	2.2e-16
PIT do not Granger-cause CD PTY ST CT TR	648	4.4662	9.59e-12
CT do not Granger-cause CD PTY ST PIT TR	648	5.3662	4.219e-15
TR do not Granger-cause CD PTY ST PIT CT	648	3.8021	2.607e-09

Source: Authors computations

Table 6: Cointegration Causality test for Transformed Data

Null Hypothesis	No of Obs	F-statistics	Pr <0.05
LCDT do not Granger-cause LPTY LSTX LPIT LCOT LTOT	438	4.359	2.2e-16
LPTY do not Granger-cause LCDT LSTX LPIT LCOT LTOT	438	5.6997	2.2e-16
LSTX do not Granger-cause LCDT LPTY LPIT LCOT LTOT	438	8.1693	2.2e-16
LPIT do not Granger-cause LCDT LPTY LSTX LCOT LTOT	438	6.5581	2.2e-16
LCOT do not Granger-cause LCDT LPTY LSTX LPIT LTOT	438	7.2138	2.2e-16
LTOT do not Granger-cause LCDT LPTY LSTX LPIT LCOT	438	5.1427	2.2e-16

Source: Authors computations

The Granger causality test result for the are shown in Table At 95% confidence level, LCDT, LPTY, LSTX, LPIT, LCOT and LTOT Grangercause on the other variables for VAR(2) but for VAR(3), LCDT, LPTY, LSTX, LPIT, LCOT did not Granger-cause the other variables. However, for rainfall variability, it showed that rainfall was Granger cause temperature and wind speed for both VAR (1) and VAR (3). Rainfall was said to Granger-cause temperature and wind speed, meaning that temperature and wind speed could be better predicted using all the three variables; temperature, wind speed and rainfall than it could by using only temperature and wind speed alone.

Table 7: Un-Transformed Data Estimation results for equation Total Revenue:

	Estimate	Std.Error	t-value	Pr(>ItI)
CD	-0.2704	1.0517	-0.257	0.797
PTY	1.2520	1.2804	0.978	0.330
ST	-0.0330	1.3275	-0.025	0.980
PIT	0.3877	0.9872	0.393	0.695
CT	-0.6944	1.0247	-0.678	0.499
TR	0.8121	1.0235	0.793	0.429
Const	-533.3205	671.2822	-0.794	0.428
Trend	13.0683	15.0722	0.867	0.387

Source: Authors computations

Table 8: Transformed Data Estimation results for equation Total Tax Revenue

	Estimate	Std.Error	t-value	Pr(>ItI)
CD	-0.3710	0.9982	-0.3021	0.0291
PTY	0.9451	0.4622	1.045	0.0428
ST	0.2325	0.8315	0.280	0.7802
PIT	0.6124	0.4574	1.339	0.1829
CT	-0.4472	0.3528	-1.267	0.2072
TR	0.5655	0.3571	1.584	0.1156
Const	-552.8395	664.6824	-0.832	0.4070
Trend	14.4743	13.9970	1.034	0.3029

Source: Authors computations

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 Residual standard error: 2966 on 136 degrees of freedom, Multiple R-Squared: 0.9189, Adjusted R-squared: 0.9153,

F-statistic: 256.8 on 6 and 136 df, p-value: < 2.2e-16

Johansen Co-Integration Technique

We employed a test for co integr ation, and for this purpose we e mployed the Johansen approach of Table 6and Table 7exhibited that there is evidence of long run relationship amongst the variables because Maxeigen valu es and Trace statistic values are less than the critical values r >= 3 to 5 r = 5, thus, it is established that there is only long run association existing amongst the variables.

Table 9: Un-Transformed Data cointegration test (Eigen).

	Eigen Value	test	10%	5%	1%
r ≤ 0	0.51579	102.98	36.25	39.43	44.59
r ≤ 1	0.31192	53.09	84.33	33.32	38.78
r≤ 2	0.20942	33.37	24.78	27.14	32.14
r ≤ 3	0.07264	10.71	18.9	21.07	25.75
r ≤ 4	0.06835	10.05	12.91	14.9	19.19
r ≤ 5	0.02722	3.92	6.5	8.18	11.65

Source: Authors computations

Table 10: Transformed cointegration test (Eigen).

	Eigen Value	test	10%	5%	1%
r ≤ 0	0.36462	65.40	30.84	33.32	38.78
r ≤ 1	0.23479	37.89	24.78	27.14	32.14
r ≤ 2	0.18078	28.31	18.90	21.07	25.75
r ≤ 3	0.05523	8.07	12.91	14.90	19.19
r ≤ 4	0.00442	0.63	6.50	8.18	11.65
r ≤ 5	0.00172	0.012	3.63	4.01	7.96

Source: Authors computations

Table11 Elucidate the forecast values of Un-Transformed date

Period	Forecast
2017Q1	26288.33
2017Q2	26242.62
2017Q3	26254.05
2017Q4	26335.53
2018Q1	26502.98
2018Q2	26776.93

2018Q3	27187.17
2018Q4	27785.76
2019Q1	28681.74
2019Q2	30192.66

Note: ₦ Nigerian Naira in Trillion

Source: Authors computations

Table 12: Elucidate the forecast values of Transformed date

Period	Forecast
2017Q1	25924.22
2017Q2	25865.74
2017Q3	25869.47
2017Q4	25949.22
2018Q1	26122.64
2018Q2	26413.89
2018Q3	26860.13
2018Q4	27527.02
2019Q1	28541.19
2019Q2	30259.05

Note: ₦ Nigerian Naira in Trillion

Source: Authors computations

CONCLUTION

The purpose of this study was to test for Granger-causality between government spending and tax revenues for Nigeria. This study finds that there was bidirectional Granger-causality running through the component of tax revenues. It has also been established from our result that, forecasting tax revenue would yield a better result if the data is transformed before using it for forecast, but these results may suffer from the omission of other relevant variables. In addition, non-tax revenues seem to have important contribution to the successfulness of country's growth as compared to tax revenue. Therefore, future research should attempt to incorporate more variables in the analysis and should always transform the data before running the analysis.

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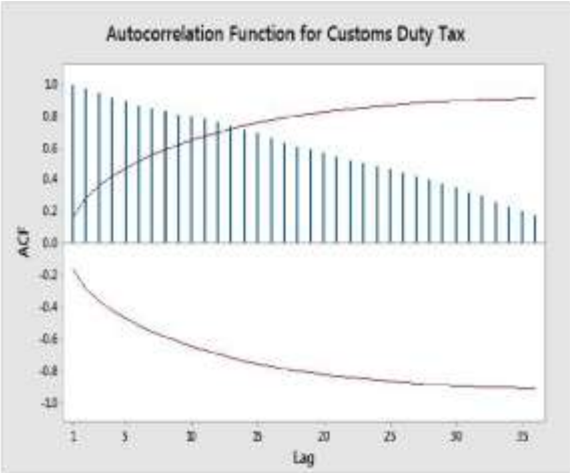
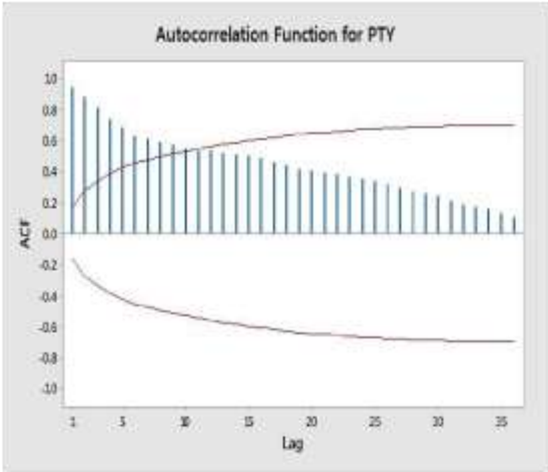
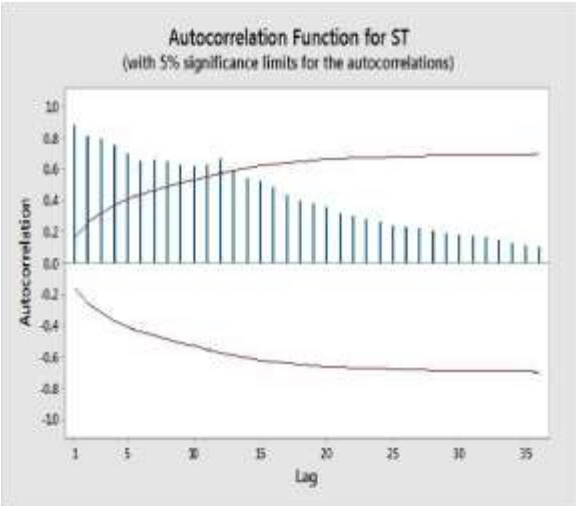
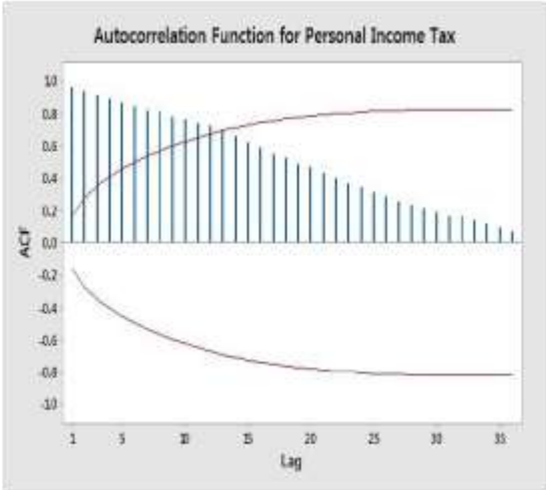
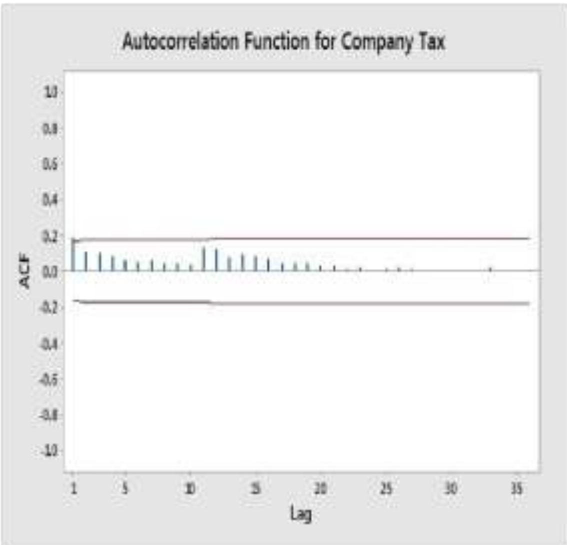
APPENDIX A (ACF Correlograms of Un-Transformed Data)

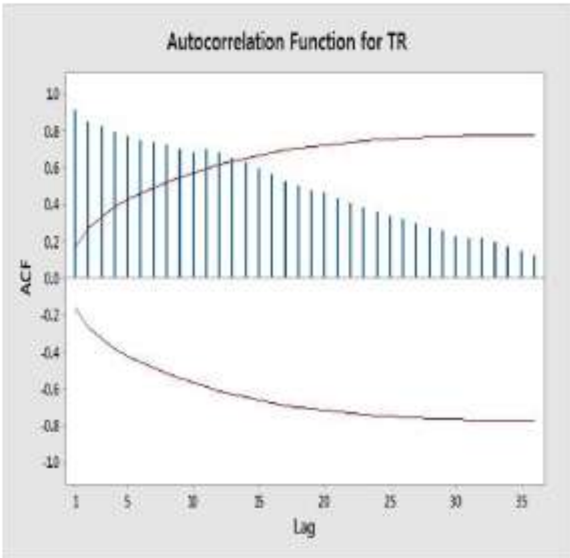




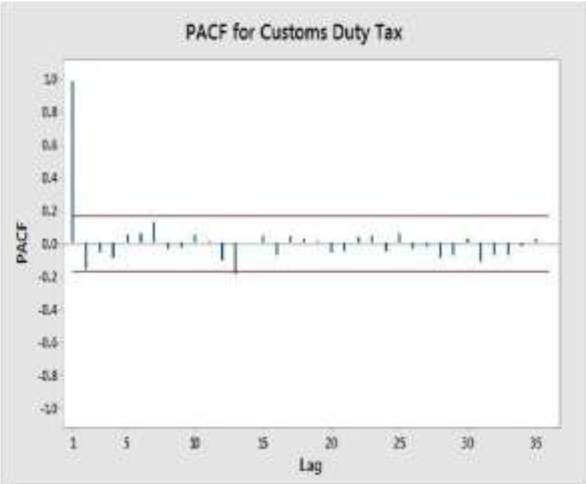


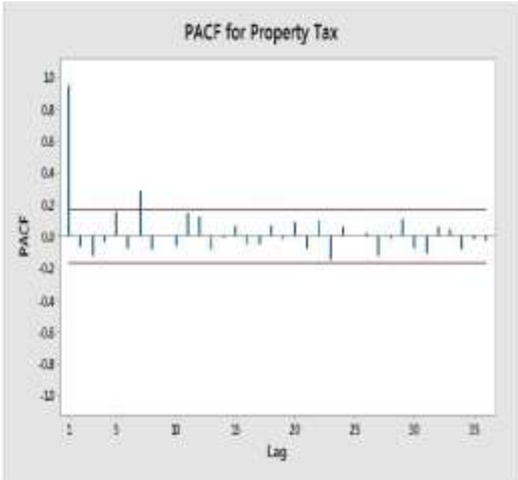


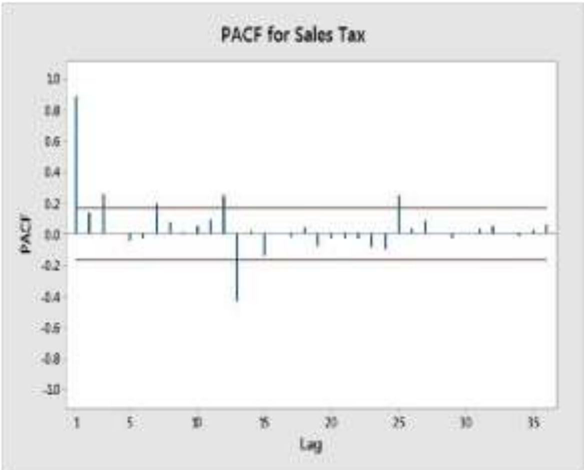


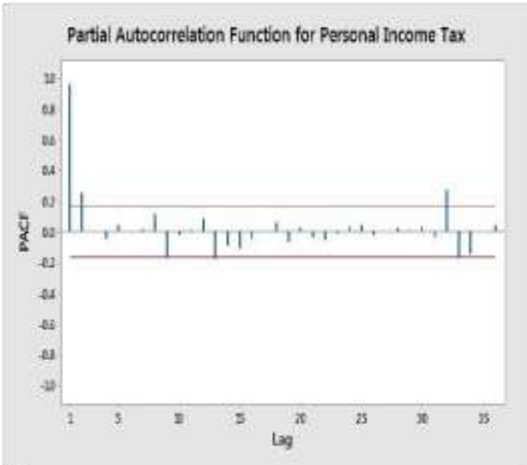


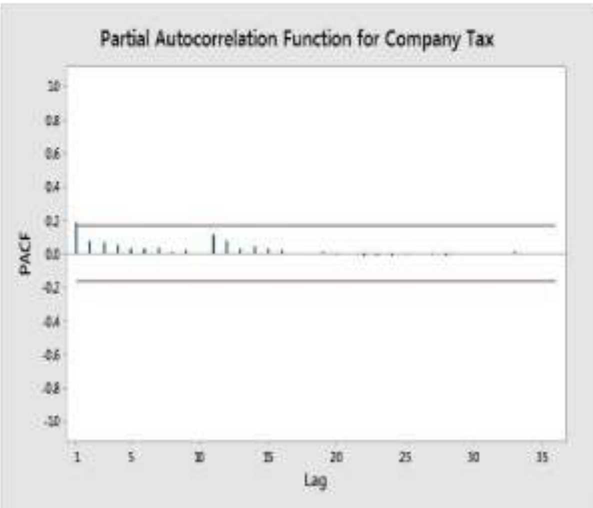
APPENDIX B (PACF Correlograms of Un-Transformed Data)

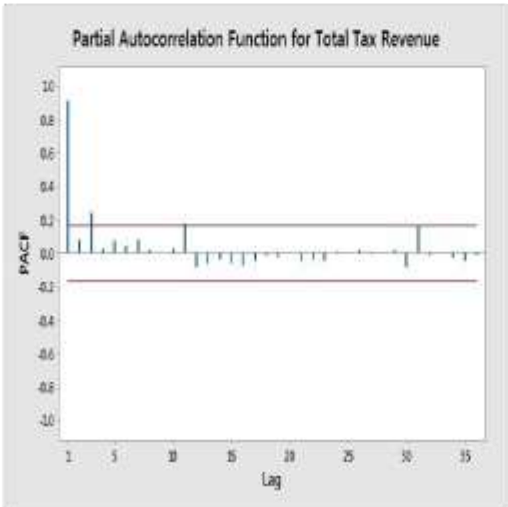




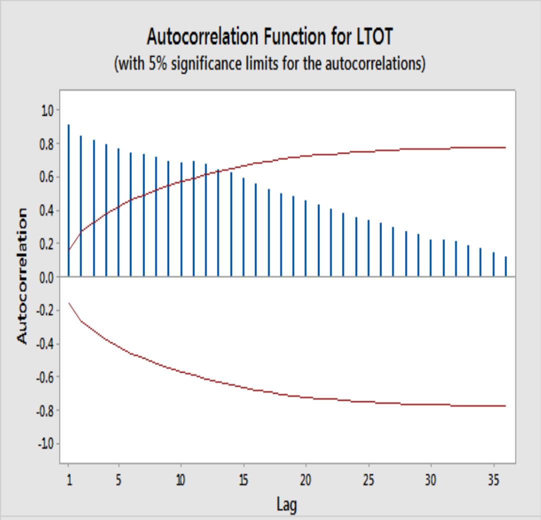


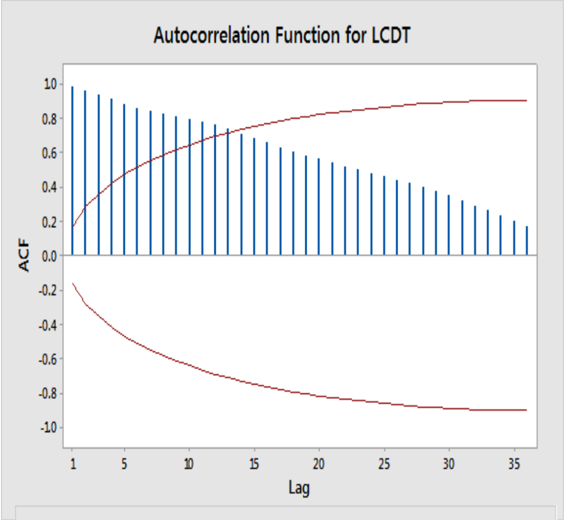


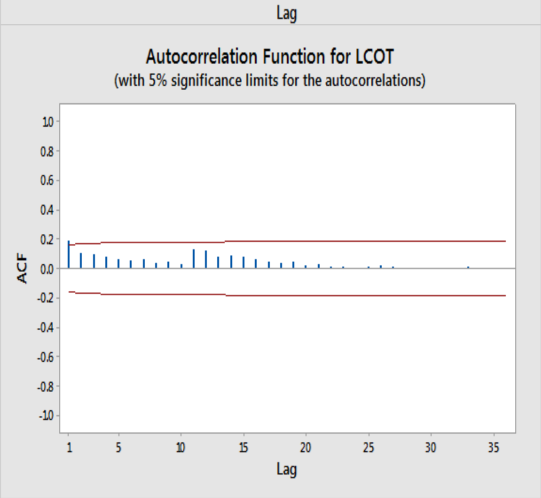


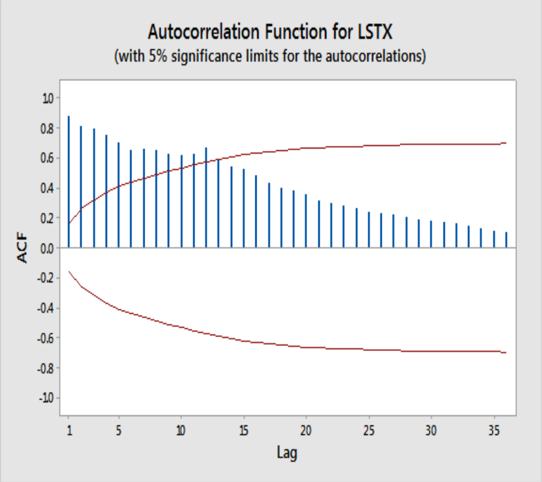


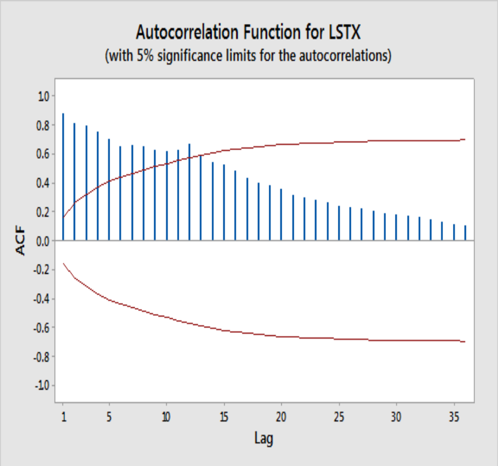
APPENDIX C (ACF Correlograms of Transformed Data)

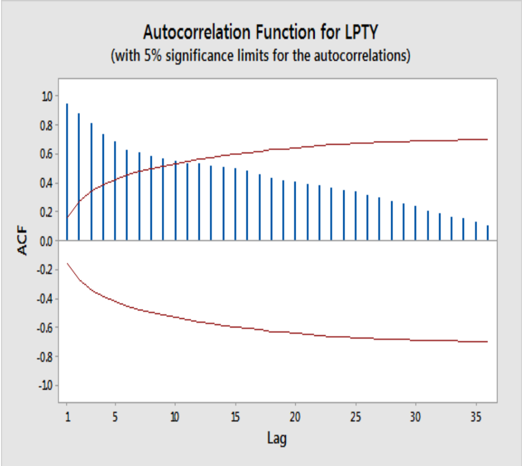




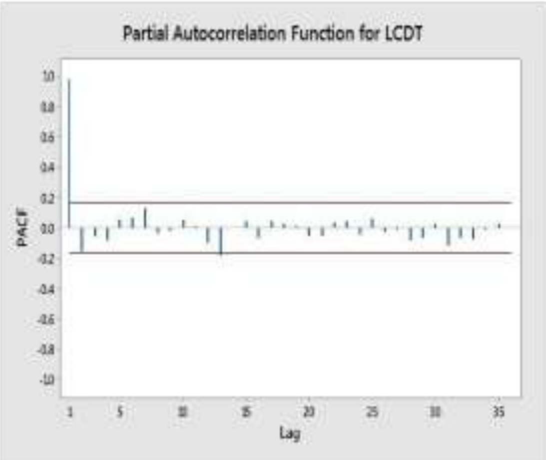


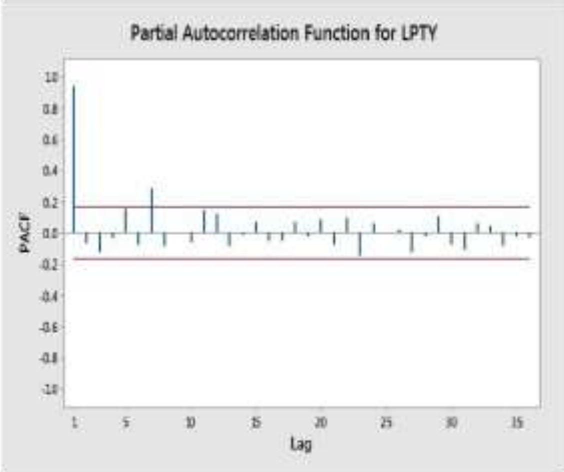


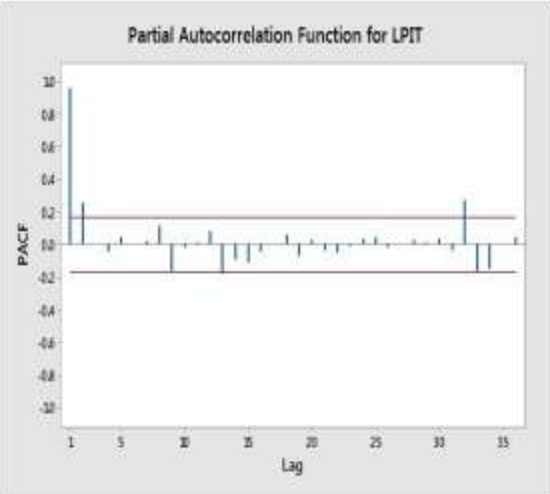


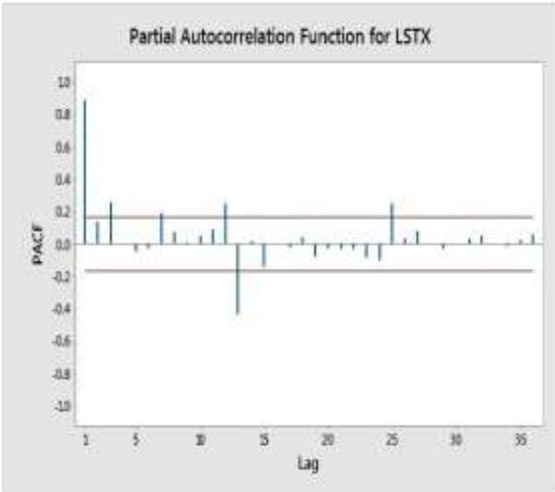


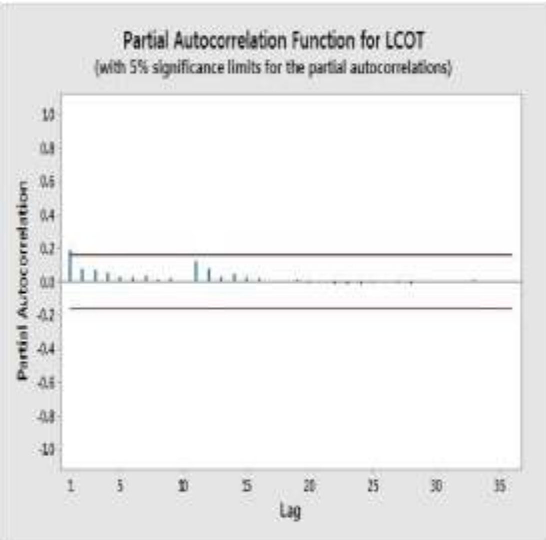
APPENDIX D (PACF Correlograms of Un-Transformed Data)

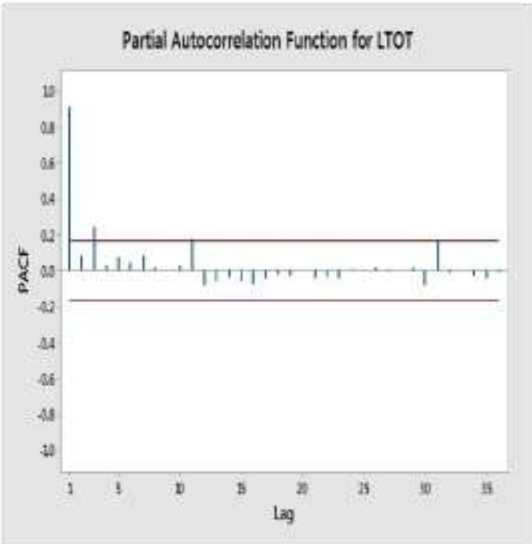












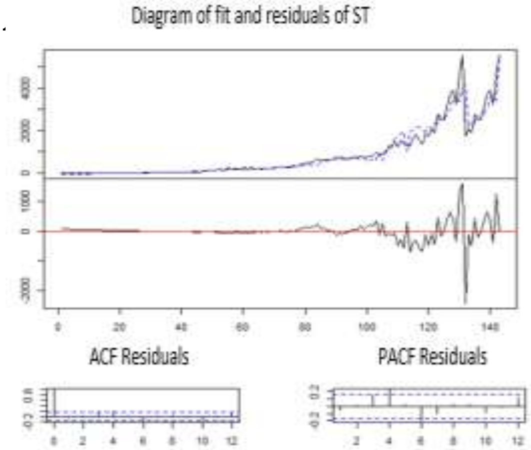


Diagram of fit and residuals of ST
ACF Residuals
PACF Residuals

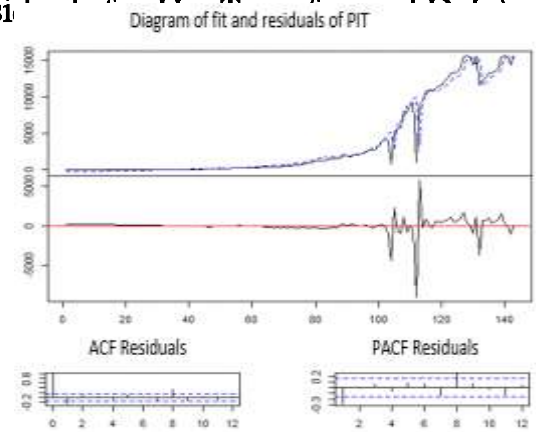
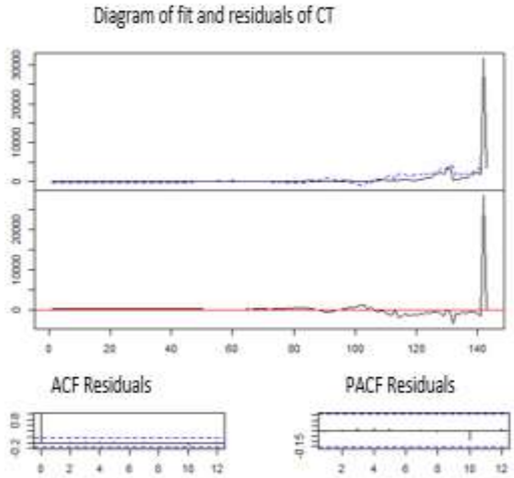


Diagram of fit and residuals of PIT
ACF Residuals
PACF Residuals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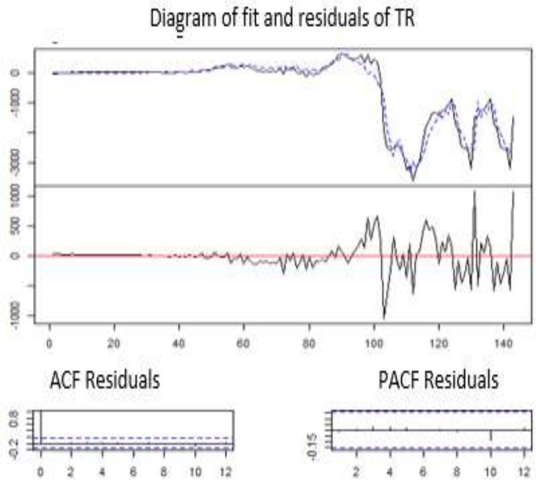
ACF Residuals
PACF Residuals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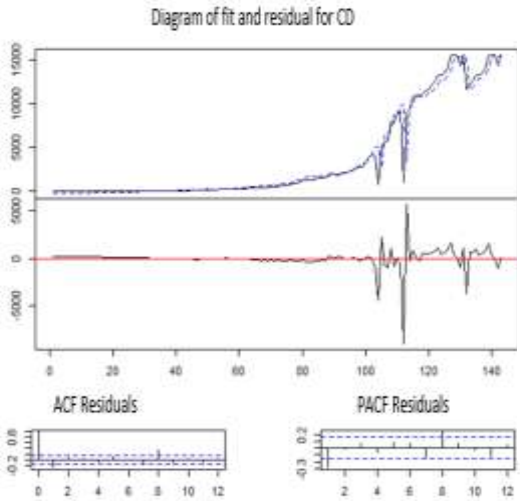
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ACF Residuals
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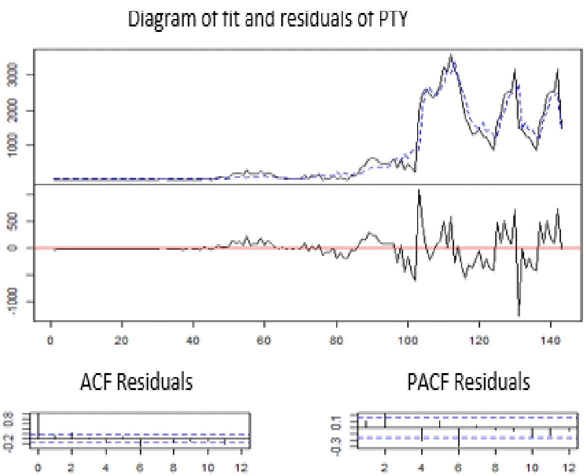
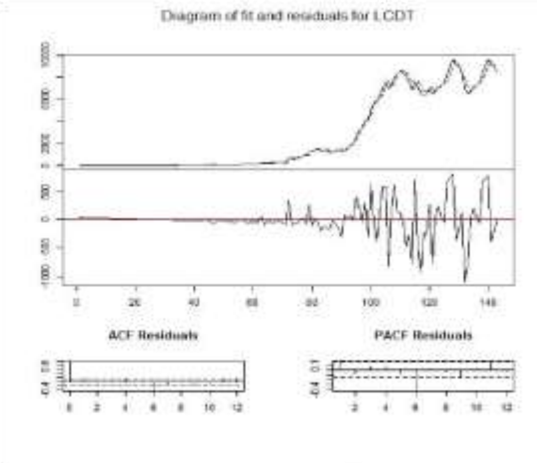
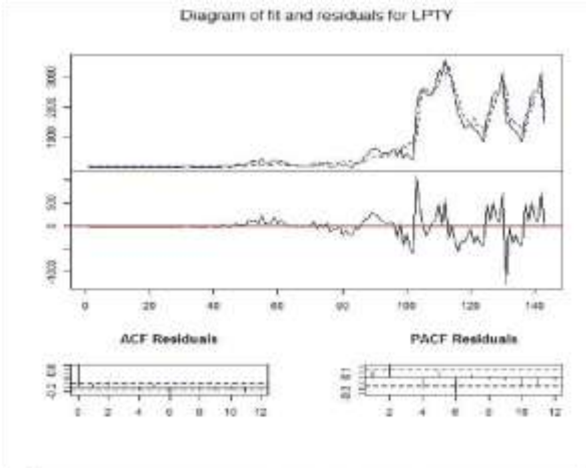
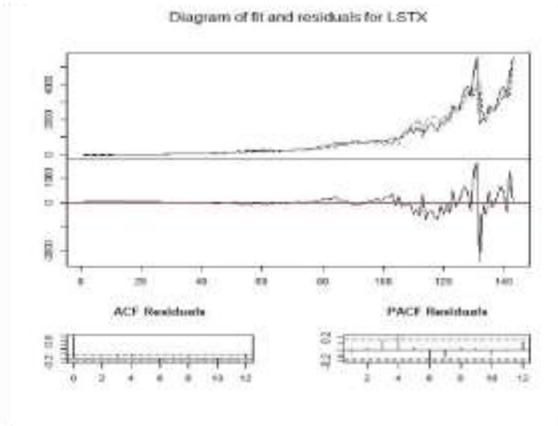


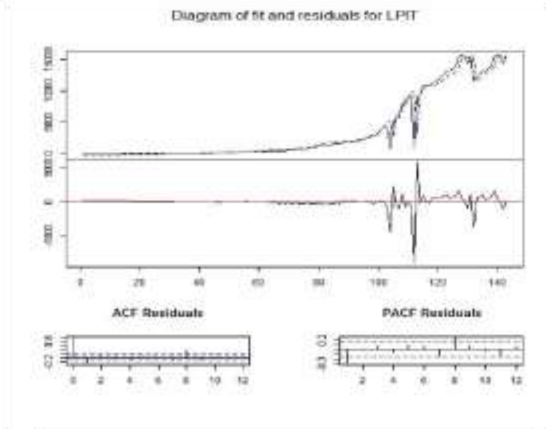
Diagram of fit and residuals of PTY
ACF Residuals
PACF Residuals

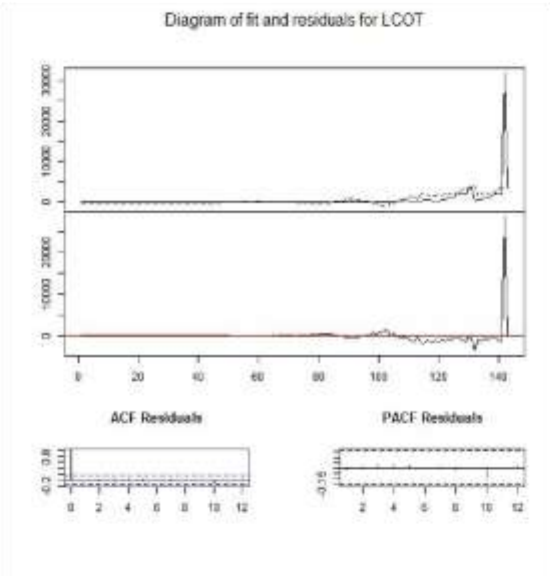
APPENDIX F (Diagram of fit and residuals for Transformed Data)

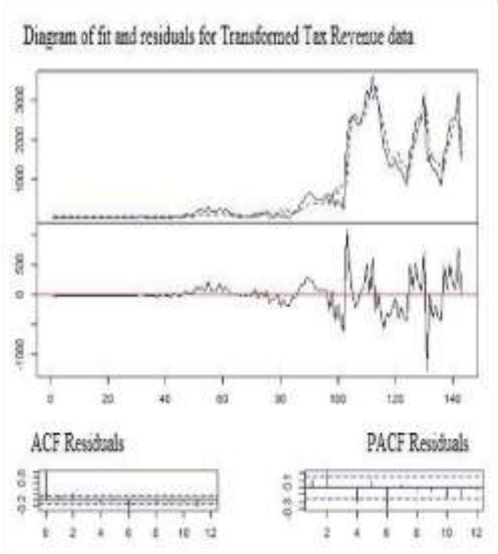


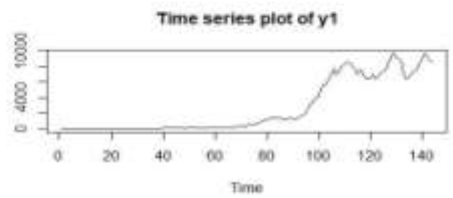


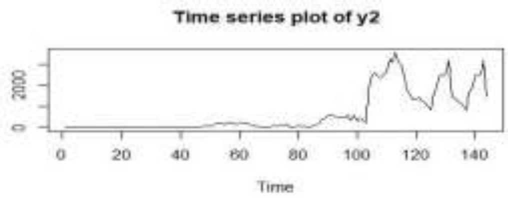









Time series plot of y1
Time


Time series plot of y2
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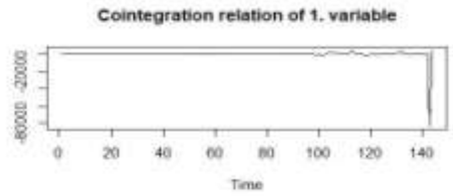
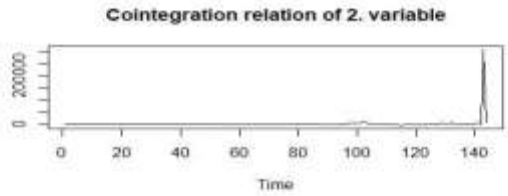

Cointegration relation of 1. variable
Time


Cointegration relation of 2. variable
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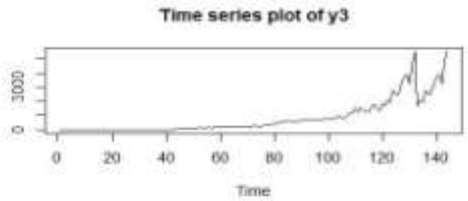
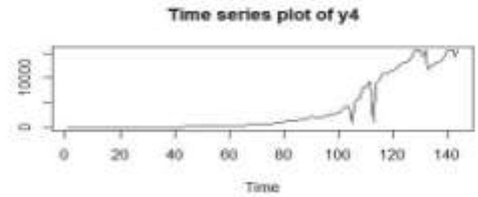
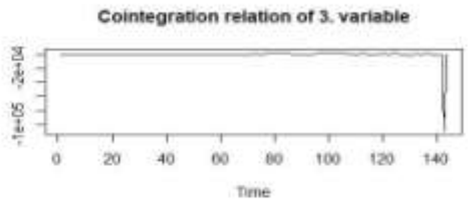
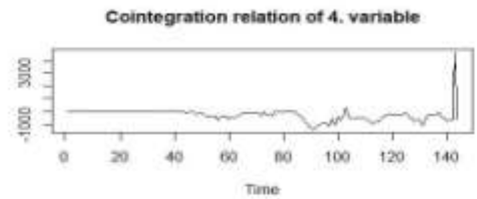
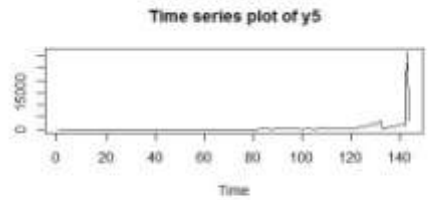

Time series plot of y3
Time


Time series plot of y4
Time


Cointegration relation of 3. variable
Time


Cointegration relation of 4. variable
Time


Time series plot of y5
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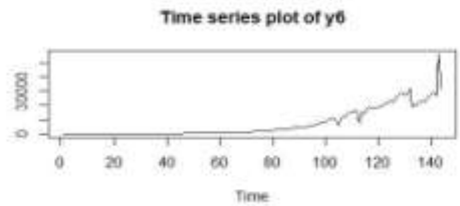
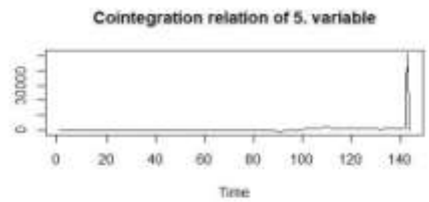
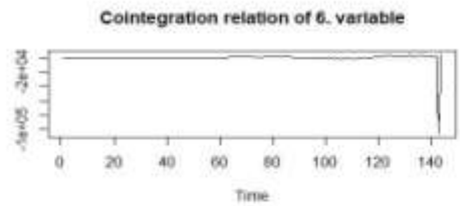

Time series plot of y6
Time


Cointegration relation of 5. variable
Time


Cointegration relation of 6. variable
Time

Reference to this paper should be made as follows: Baba Gimba Alhassan and Nma Musa Tela, (2019), An Improvement Forecast Using Vector Auto Regression Approach on Tax Revenue in Nigeria. *J. of Engineering and Applied Scientific Research,* Vol. 11, No. 2, Pp. 1-34