A STATISTICAL ANALYSIS OF NIGERIA'S EXTERNAL RESERVES, 1960-2017

KORVE, K. N.[♦]
Department of Business Administration,
Federal University of Agriculture, Makurdi,
Benue State, Nigeria.

TYONA, T.
Department of Accounting and Finance,
Federal University of Agriculture, Makurdi,
Benue State, Nigeria.

AWUZIE, E. I.
Department of Business Administration,
Federal University of Agriculture, Makurdi,
Benue State, Nigeria.

ABSTRACT
This study considered data on Nigeria's external reserves from 1960-2017. The objective is to analyze the trend over the period and determine the level of volatility of the reserves. The autoregressive moving average model is constructed to enable forecast of the foreign reserves. The results show that Nigeria's external reserves are not normally distributed but stationary, they have a dependence on previous historical values, and the volatility of the reserves is not constant. The order of the model that best fits the data is the autoregressive model of order 2 (AR2) and moving average of order 1 (MA1). The autoregressive model that best fits the data is therefore ARMA (2,1). The model was used to obtain forecast of the reserves into the future and is recommended for long forecast horizons.

Key words: Autoregressive Model, External Reserves, Moving Average, Nigeria, Time Series

ABSTRAIT
Cette étude a examiné les données sur les reserves extérieures du Nigéria de 1960 à 2017. L'object if estd'analyserl'évolution de la période et de déterminer le niveau de volatilité des réserves. Le modèle autorégressif de moyenne mobile est construit pour permettre la prévision des réserves de change. Les resultants montrent que les reserves extérieures du Nigéria ne sont pas normalement distribuées mais stationnaires, ells dépendent des valeurs historiques antérieures et la volatilité des reserves n'est pas constante. L'ordre du modèle qui correspond le mieux aux données est le modèle autorégressif d'ordre 2 (AR2) et la moyenne mobile d'ordre 1 (MA1). Le modèle autorégressif qui

[♦]**Address of Corresponding Author**: KORVE, K, N., Department of Business Administration, Federal University of Agriculture, Makurdi, Benue State, Nigeria. Tel: 08039103354, E-mail: korvekenneth@gmail.com

correspond le mieux aux données est donc ARMA (2,1). Le modèle a été utilisé pour obtenir des prévisions des réserves dans le futur et est recommandé pour de longs horizons de prévision.

Mots-clés: Modèle autorégressif, Réserves externes, Moyenne mobile, Nigéria, Séries chronologiques

INTRODUCTION

External Reserves are variously called International Reserves, Foreign Reserves or Foreign Exchange Reserves. While there are several definitions of external reserves, the most widely accepted is the one proposed by the International Monetary Fund, IMF (2009). It defined external reserves as "consisting of official public sector foreign assets that are readily available to, and controlled by the monetary authorities, for direct financing of payment imbalances, and directly regulating the magnitude of such imbalances, through intervention in the exchange markets to affect the currency exchange rate and/or for other purposes"

Globally, external reserves have increased significantly and quite rapidly in recent years. This phenomenal growth is a reflection of the enormous importance countries attach to holding an adequate level of the reserves. The reasons for holding reserves include safeguarding the value of domestic currency; timely meeting of international payment obligations; as a store of value to accumulate excess wealth for future consumption purposes; management of the exchange rate, in addition to enabling an orderly absorption of international money and capital flows; to boost a country's credit worthiness; to provide a fall back for the "rainy day"; and to provide a buffer against external shocks, Zubair and Olanrewaju (2014).

Nigeria has taken numerous policy initiatives and measures in the management of its external reserves. Although very little was achieved because the structure in place then could not support efficient reserves management, enduring lessons could be distilled from the nation's past experience. Thus, Since the 1970s, Nigerian economy has persistently depended on oil as the main source of foreign exchange earnings with the attendant cycles of economic booms and bursts, Doguwa and Alade (2015).

From 1999, world oil prices began to rise again resulting in another but better managed boom and unprecedented accumulation in the level of reserves from U$4.98 billion in May 1999, to US$62.08 billion as at September 2008. The level of reserves thereafter declined drastically to as low as US$28.59 in January 2017, Tlegenova (2015).

Statement of the Problem

Nigeria's dependence on oil for over 90% of its foreign exchange earnings makes its capital account vulnerable to the fluctuations in crude oil prices. This, in addition to its high import bills contributed to the fluctuations in the level of reserves over the years and consequently the way the reserves are being managed, Nwanko (2014). During the oil boom of the mid-seventies which has resulted in the buildup of reserves, the external reserves were diversified into an array of financial instruments including foreign government bonds and treasury bills, foreign government guaranteed securities, special drawing rights (SDRs), fixed term deposits, call accounts and current accounts, Doguwa and Alade (2015). This provided significant investment income as well as liquidity. However, during the glut in the global oil market which led to collapse in the crude oil prices and consequently a drawdown in the reserves, the reserves were held mainly in current accounts and treasury bills. This underscored the need to diversify the sources of foreign exchange inflow of the country.

It is against this backdrop that this study considered data on Nigeria's external reserves from 1960-2017 for the purpose of analyzing the trend over the period and determining the level of volatility of the reserves. The autoregressive moving average (ARMA) model is constructed to know which order of the model best fits the data and then to use the model to provide forecasts of the reserves into the future.

OBJECTIVES OF THE STUDY

The objectives of the study are to:

I. Analyze the trend of Nigeria's external reserves from 1960-2017
II. Determine the level of volatility of the reserves
III. Construct ARMA model for the data
IV. Obtain a forecast of the reserves using the constructed model

SIGNIFICANCE OF THE STUDY

The study would contribute to existing literature by determining the trend and level of volatility of Nigeria's external reserves. The study would also provide a forecast of the reserves and then make recommendations to policy makers on ways to restructure the foreign exchange market in Nigeria.

LITERATURE REVIEW

Many studies have been carried out on the use of time series analysis to model Nigeria's external reserves. The Box-Jenkins Autoregressive Integrated Moving Average (ARIMA) models of the Nigeria's foreign reserves has appeared in various scholarly articles.

Akpanta and Okorie (2015a) attempted to identify and build a suitable and reliable Box-Jenkins model for modelling and forecasting the Nigeria's foreign reserves. Nigeria's 55 years foreign reserve data from January 1960 to December 2013 was used to perform analysis in R, where ARI (5, 1, 0) model with the smallest Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) statistics was found to out-perform the ARIMA (5, 1, 1) model. One-year forecast was made with the best ARI (5, 1, 0) model and the Nigeria's foreign reserve was trending upwards. The paper therefore proposed the ARI (5, 1, 0) model for forecasting Nigeria's foreign reserves.

Iwueze et al. (2013) recommended the Auto Regressive Integrated Moving Average (ARIMA) process of order (2, 1, 0) for forecasting the natural log-transformed Nigeria's foreign reserves, using 11 years data (from January 1999 to December 2008), where the Nigeria's foreign reserves was found to be on the increase. Although, the point forecast from this model shows a large discrepancy from the observed and was attributed to the decline in income from petroleum products which is the major composition of the Nigeria's foreign reserves.

Zubair and Olanrewaju (2014) tentatively identified ARIMA (1, 2, 2) model as a suitable model for modelling and forecasting Nigeria's foreign reserves using a monthly 50 years data (January 1960-December 2008). The Nigeria's foreign reserves was found to be on the increase and the paper further called on the Nigeria government to exercise fairness, justice, and equity for all in order to strengthen her economy.

Akpanta and Okorie (2014) applied the Box-Jenkins technique in modelling and forecasting the Nigeria's crude oil price using a monthly data from the Central Bank of Nigeria (CBN) official website for the period of 33 years. ARIMA (6, 1, 7), ARIMA (2, 1, 2) were tentatively entertained and the reduced ARIMA (2, 1, 2) was found to provide a best fit to the data and was used for forecast. The study concluded that the observed Nigeria's crude oil price does not show any statistically significant difference from the forecast values.

Akpanta and Okorie (2015b) developed the time series model for the Nigeria's Consumers Price Index (CPI) data using 19 years monthly data from January 1996 to December 2013 constituting 216 observations. The model was found to satisfactorily forecast the future Nigeria's CPI. One of the major findings of the model was that the Nigeria's CPI was on the increase and had neither fallen below 21.19 nor risen above 152.29 from January 1996 to December 2013.

This paper considers the data on Nigeria's external reserves from 1960-2017 for the purpose of analyzing the trend over the period and determining the level of volatility of the reserves. The autoregressive moving average (ARMA) model is constructed to know which order of the model best fits the data and then the best fit model is used to provide forecasts of the reserves into the future.

METHODOLOGY

Research Design

The study uses a historical research design which is designed to collect, verify, and synthesize evidence from the past to establish facts. Historical research design uses secondary data sources and a variety of primary documentary evidence, such as, diaries, official records, reports, archives, and non-textual information. The limitation is that the sources must be both authentic and valid. The historical approach is well suited for trend analysis. The information used in this study is Nigeria's external reserves from 1960-2017 obtained from the CBN website which makes it both authentic and valid.

Data Collection

The Nigeria's external reserves in billions of US dollars were obtained from the records of Nigeria's Central Bank on the internet for the period from January 1960 to December 2017 (a period of 58 years, i.e. 696 months).

Model and variable Specification

The Nigeria's external reserves is fitted using the best possible ARMA (p, q) model as follows:

$y[t] = a[0] + a[1]y[t-1] + \ldots + a[p]y[t-p] + b[1]e[t-1] + \ldots + b[q]e[t-q[+ e[t].$

Here p and q indicate the number of lag periods used for Auto regression and moving average, respectively.

Data Analysis Technique

Time series analysis is applied to the monthly exchange reserves data to enable an understanding of the behavior of the reserves data. Monthly reserves are computed as log (p_2/p_1), where p_1 and p_2 are the reserves at the end of month 1 and month 2, respectively. The trend is analyzed over the period and the level of volatility of the reserves is determined. The autoregressive moving average (ARMA (p, q)) model is constructed to know which order of the model best fits the data and then the model is used to provide forecasts of the reserves into the future.

The analyses are facilitated using Microsoft Excel, IBM SPSS version 22, and R version 3.4.4, Ledolter (2013) and R Foundation (2018).

RESULTS AND DISCUSSION

Statistical Analysis of the Nigeria's foreign reserves data

a). Test of Normality

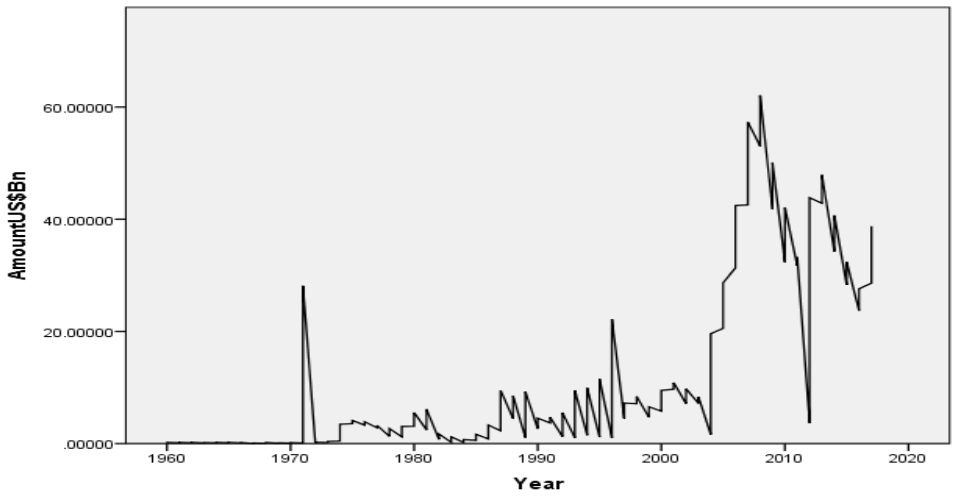


Figure 1: Basic plot of monthly reserves over the past 58 years

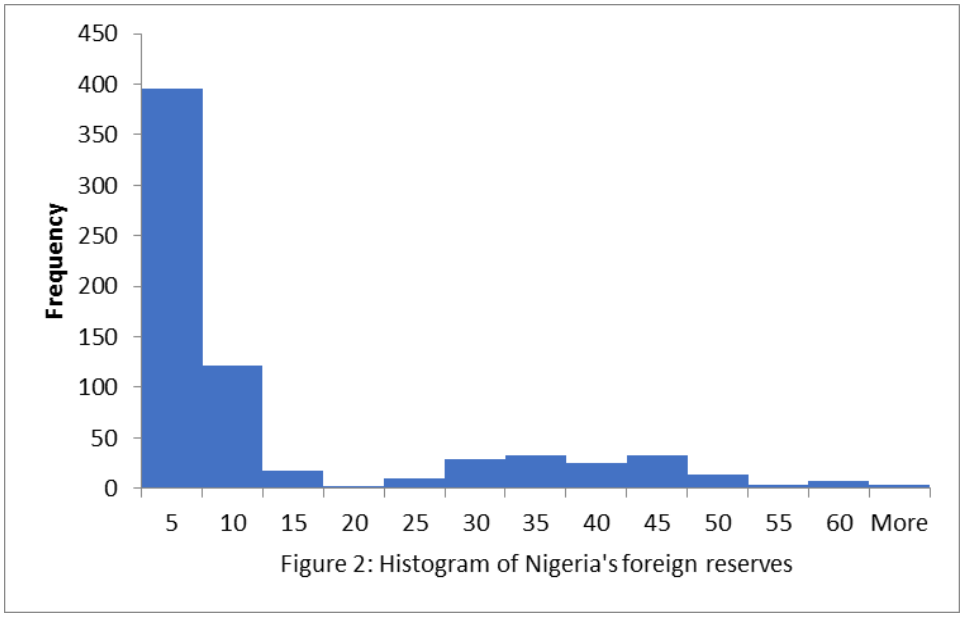


Figure 2: Histogram of Nigeria's foreign reserves

Figures 1 and 2 show that there are extreme values on the right thus indicating that the distribution of reserves is not normal.

(b). Descriptive Statistics of monthly reserves

Table 1: Descriptive Statistics

Parameters	**Coefficients**
Mean	10.93272941
Standard Error	0.582137447
Median	3.70285
Mode	0.17232
Standard Deviation	15.35784063
Sample Variance	235.8632687
Kurtosis	0.990829519
Skewness	1.504111616
Range	62.06458
Minimum	0.01728
Maximum	62.08186
Sum	7609.17967
Count	**696**

From table 1, we find that though the mean and median reserves are positive, the distribution is positively skewed (positive coefficient of skewness), the worst-case fall (0.017) is much lower than the best-case increase (62.081). Similarly, Coefficient of Excess Kurtosis is above zero (0.990) indicating that the tail is much fatter than a normal distribution.

(c). Shapiro Wilk Test (Shapiro-Wilk test).

This test is used in finding out whether the external reserves are normally distributed, and the results are given in Table 2.

Table 2: Shapiro-Wilk test of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	df	Sig.
Amount US$Bn	.272	696	.000	.714	696	.000

a. Lilliefors Significance Correction

The p-value (p = 0.000) of less than 0.05 suggests that the external reserves are not normally distributed at 95% level of confidence.

(d). Quantile-Quantile Plot (Q-Q Plot) for Normality

This is a visual plot of normality of the data. A q-q plot is a plot of the quantiles of the external reserves data set against the theoretical quantiles of the normal distribution. If the data comes from a normal distribution, all the points should fall on the 45^0 straight line.

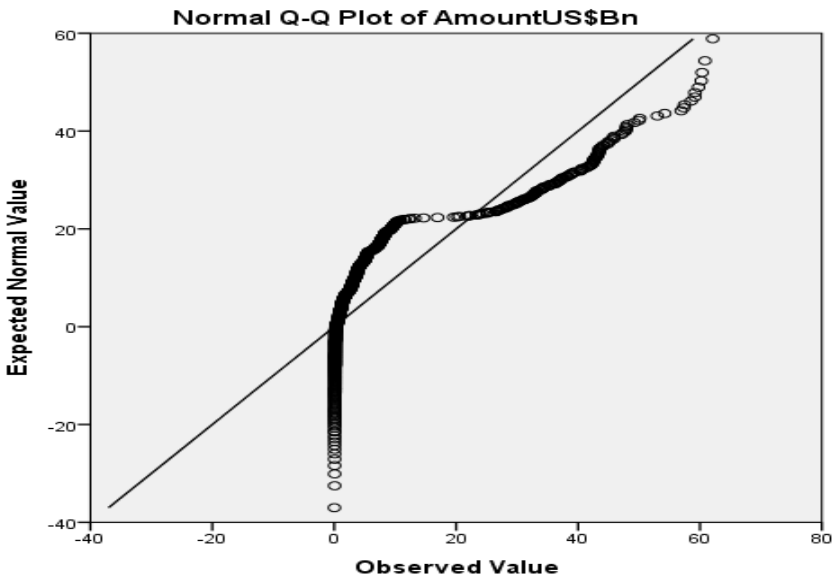


Figure 3: Q-Q plot of Nigeria's foreign reserves

Figure 3 shows haphazard points around the 45^0 straight line, suggesting that the reserves are not normally distributed.

(e). JarqueBera Test for normality

JarqueBera-test is a joint statistic using skewness and kurtosis coefficients. It is a goodness-of-fit test of whether sample data have the skewness and kurtosis matching a normal distribution. It tests the null hypothesis that the external reserves data come from a normal distribution vs. an alternate hypothesis that the data do not.

Table 3: JarqueBera test of Normality

Jarque-Bera Statistic	59.864
p-value	1.001 E-13

A very small p-value, as shown above indicates that the null hypothesis can be rejected at 95% confidence level, thus concluding that the external reserves are not normal.

Overall, using various methods listed above, we can assess that the Nigeria's external reserves do not follow a normal distribution. Distributions of monthly reserves are rather symmetric about their means, but the tails are fatter.

Testing for Independence of Monthly External Reserves

Understanding the independence of monthly reserves will influence the type of methods that need to be used for predictions and forecasts. There are different tests to accomplish this tasks. One of the most popular tests in this regard is Ljung-Box test.

Ljung-Box test

This test examines the null hypothesis of independence in a given time series.

Table 4: Box-Ljung Test Results Series: Amount US$Bn

Lag	Autocorrelation	Std. Error[a]	Box-Ljung Statistic		
			Value	df	Sig.[b]
1	.976	.038	665.544	1	.000
2	.973	.038	1328.931	2	.000
3	.966	.038	1982.895	3	.000
4	.960	.038	2630.292	4	.000
5	.956	.038	3272.711	5	.000
6	.949	.038	3907.026	6	.000
7	.944	.038	4534.737	7	.000
8	.937	.038	5154.570	8	.000
9	.929	.038	5764.412	9	.000
10	.923	.038	6367.954	10	.000
11	.914	.038	6960.198	11	.000
12	.907	.038	7544.606	12	.000
13	.900	.037	8121.130	13	.000
14	.894	.037	8690.870	14	.000
15	.888	.037	9253.481	15	.000
16	.880	.037	9807.113	16	.000

a. The underlying process assumed is independence (white noise).

b. Based on the asymptotic chi-square approximation.

In Table 4, the p-value <0.05 (p = 0.000), the null hypothesis can be rejected at 95% confidence and hence it can be inferred that the external reserves are not independent. The current month's reserves are influenced by the reserves of earlier months. This gives rise to the usage of Auto regression models for estimating the current period reserves.

Testing for Stationarity of the Time Series

Augmented Dickey-Fuller Test

This is one of the most important statistical tests that is performed on a time series data to check whether the series is stationary or the series exhibit unit root. The null hypothesis of the series having a unit root is tested against the alternate hypothesis of the series being stationary. A regression equation with a constant and a linear trend is used and the t-statistic for a first order autoregressive coefficient equals one is computed. The lag is taken as the cube root of one less than the sample size (Sample size-1).

Table 5: Augmented Dickey-Fuller Test Results

Dickey Fuller Statistic	3.00696
Lag order tested	1
p-value	0.00273

As the p-value (p = 0.00273) of the statistic is less than 0.05, we reject the null hypothesis at 95% level of confidence and conclude that monthly external reserves are stationary.

KPSS Test

Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test evaluates the null hypothesis that the time series data is either trend stationary or level stationary or not at all stationary (has a unit root).

Table 6: Test for Level Stationarity:

KPSS level Statistic	0.74607
Lag order Tested	7
p-value	0.1
Test for Trend Stationarity:	
KPSS trend Statistic	0.036723
Lag order tested	7
p-value	0.1

The p-values (both p = 0.1) of the above tests are greater than 0.05 indicating that the null hypothesis of stationarity cannot be rejected. Hence it can be inferred that the external reserves are level stationary as well as trend stationary.

Phillips-Perron Unit Root Test

The null hypothesis for this test also is that the time series has a unit root and is not stationary. This is tested against the alternate hypothesis indicating the stationarity of the external reserves. The general regression equation which incorporates a constant and a linear trend is used and the z (alpha) statistic for a first order autoregressive coefficient equals one are computed.

Table 7: Dickey-Fuller Test Results

Dickey-Fuller z (alpha)	-999.9
Lag order tested	7
p-value	0.01

The p-value (p = 0.01) of less than 0.05 indicates that the null hypothesis can be rejected at 95% confidence level. Hence it can be concluded that the external reserves are stationary.

Fitting an ARMA (p, q) Model

Since the time series is stationary, we can characterize its values of the current period using Auto Regressionand Moving Average (ARMA). The following ARMA models are fitted to the data.

Table 8: ARMA models fitted to the external reserves data

Model	**Equation**	**BIC**
ARMA (1,0)	y[t] = -8.885 + 0.948* y[t-1]	2.333
ARMA (0,1)	y[t] = -9.433 - 0.723* e[t-1]	3.786
ARMA (2,0)	y[t] = -7.935 + 0.479* y[t-1] + 0.494 * y[t-2]	2.063
ARMA (0,2)	y[t] = -9.422 - 0.838 * e[t-1] – 0.643* e[t-2]	3.282
ARMA (1,1)	y[t] = -6.659 + 0.991 * y[t-1] + 0.525 * e[t-1]	2.053
ARMA (1,2)	y[t] = -7.083 + 0.989 * y[t-1] + 0.595 * e[t-1] - 0.128 * e[t-2]	2.046
ARMA (2,1)	y[t] = -7.128 + 0.727* y[t-1] + 0.259 * y[t-2] + 0.337 * e[t-1]	2.044
ARMA (3,0)	y[t] = -7.480 + 0.403 * y[t-1] + 0.421 * y[t-2] + 0.153 * y[t-3]	2.049
ARMA (0,3)	y[t] = -9.410 - 0.857 * e[t-1] – 0.811 * e[t-2] - 0.497 * e[t-3]	3.001

From the above models fitted, it appears that the Normalized Bayesian Information Criteria (BIC) is the lowest for ARMA (2,1) model and hence we can infer that we can model the Nigeria's

external reserves of next month by using the reserves of the current month and the reserves of last month along with the error in the estimate (difference between predicted and actual values) of current month.

Auto Correlation Function (ACF) and Partial Auto Correlation Function (PACF)

PACF shows significant spikes at lag 1 and lag 2. Hence auto regression of second order seems to be an appropriate fit for the data. Similarly, ACF shows a spike at lag 1 and the other lags, suggesting moving average model of order 1 would be appropriate (See Fig. 4 and Fig. 5 about here). Hence ARMA (2,1) is a more reasonable model to forecast the Nigeria's external reserves.

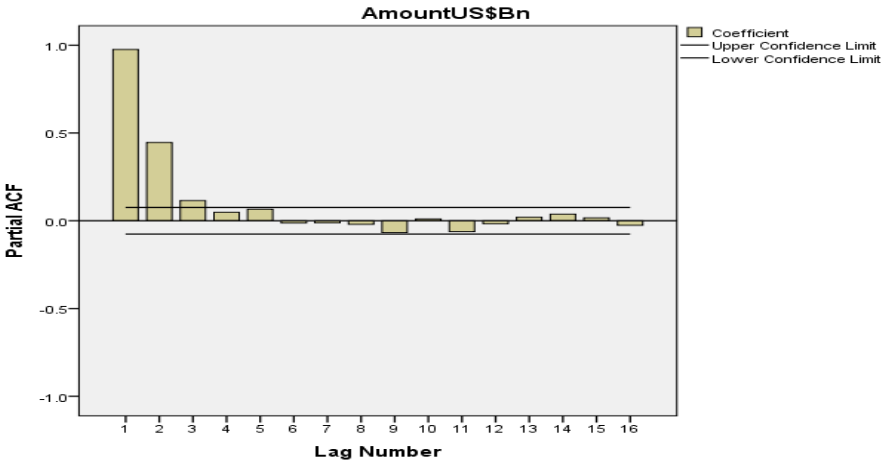


Figure 4: Autocorrelation function (ACF) for Nigeria's foreign reserves

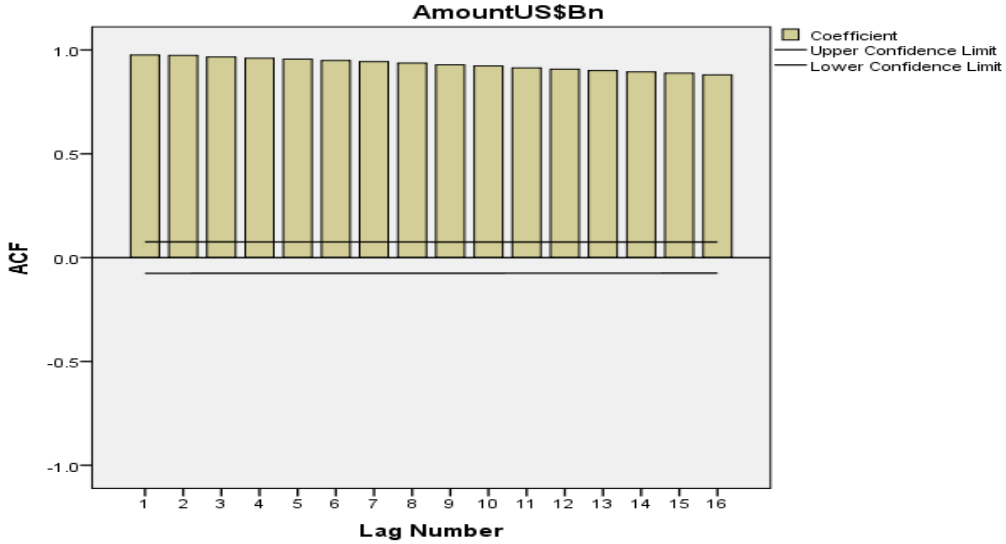


Figure 5: Partial Autocorrelation function (PACF) for Nigeria's foreign reserves

Forecasting Using the ARMA (p, q) Model

As part of this research objectives, which include to determine the best fitted model for the Nigeria's external reserves, Figure 6 shows the fitted values using the ARMA (2, 1) model. The graph indicates that the Nigeria's external reserves will be on the increasing state for the next few years.

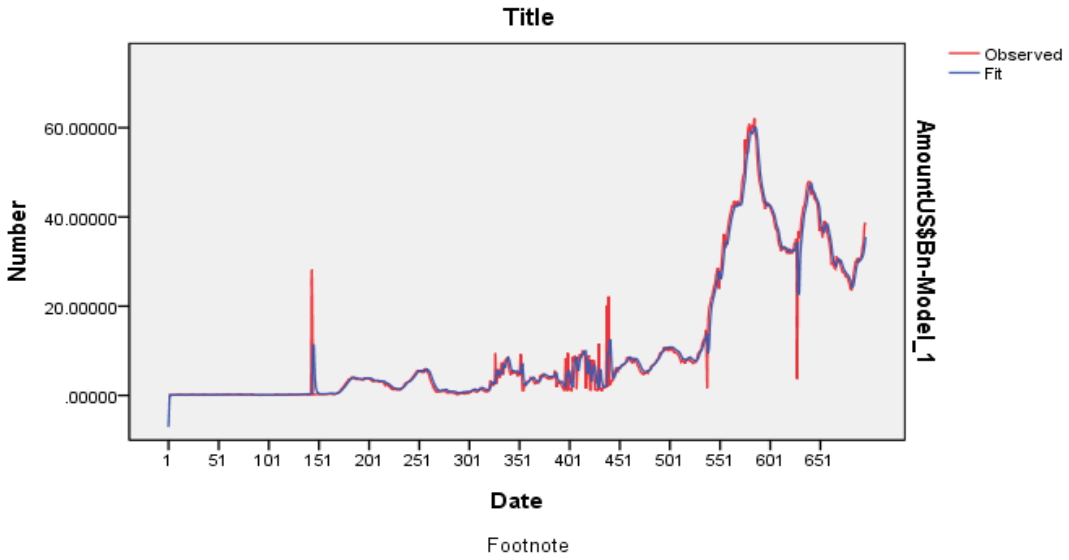
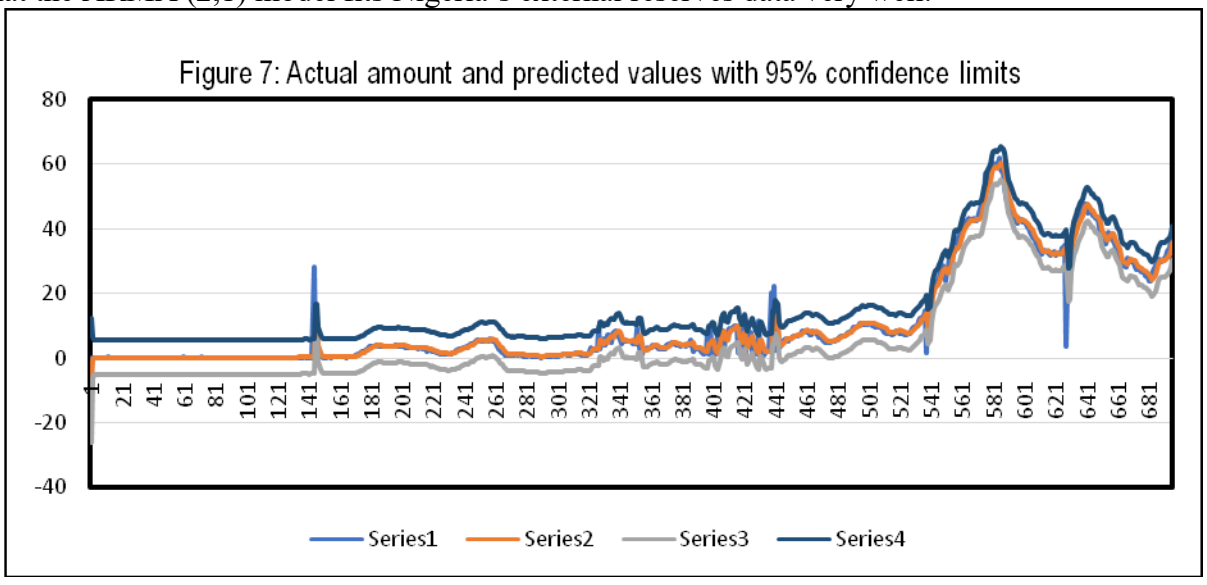


Figure 6: Fitted values of Nigeria's foreign reserves

Figure 7 shows the actual amount and the forecasted values with 95% confidence limits, showing that the ARMA (2,1) model fits Nigeria's external reserves data very well.



CONCLUSION

Based on the presentation and the analysis of the data collected, the following conclusions have been drawn.

a) The Nigeria's external reserves are not normally distributed but stationary.
b) They are also not independent and identically distributed; they have a dependence on previous historical values.
c) Volatility of the external reserves is also not constant.
d) The order of the model that best fit the data at hand are: Autoregressive of order 2 (AR2), and Moving average of order 1 (MA1).
e) The ARMA model that best fit the data is ARMA (2,1).

RECOMMENDATION

It is recommended that as a result of the volatility of Nigeria's external reserves, seasonality should be considered as an important factor and the seasonal ARMA (2,1) model should be used for long forecast horizons.

REFERENCES

Akpanta, A. C. &Okorie, I. E. (2014). Application of Box-Jenkins Techniques in Modelling and Forecasting Nigeria Crude Oil Prices. *International Journal of Statistics and Applications,* 4(6), 283-291.

Akpanta, A. C. Okorie, I. E. (2015a). ARI (p, d) Modelling and Forecasting of Nigeria's External Reserves.*World Journal of Probability and Statistics Research,* 1(1), June. 1-9.

Akpanta, A. C &Okorie, I. E. (2015b). On the Time Series Analysis of Consumer Price Index Data of Nigeria- 1996 to 2013. *American Journal of Economics,* 5(3), 363-369.

Doguwa S. I. &Alade S. O. (2015). On Time Series Modelling of Nigeria's External Reserves. *CBN Journal of Applied Statistics,* 6(1a), June. 1-28.

IMF (2009). Balance of Payments and International Investment Position Manual, 6th Edition. International Monetary Fund. Washington.

Iwueze, I. S.; Nwogu, E. C. &Nlebedim, V. U. (2013). Time Series Modeling of Nigeria External Reserves. *CBN Journal of Applied Statistics,* 4(2), 111-128.

Ledolter, Y. (2013). Data Mining and Business Analytics with R. John Wiley and Sons Inc. Hoboken, New Jersey.

Nwanko, S. C. (2014). Autoregressive Integrated Moving Average (ARIMA) Model for Exchange Rate (Naira to Dollar). *Academic Journal of Interdisciplinary Studies,* 3(4), 429-433.

Tlegenova, D. (2015). Forecasting Exchange Rates Using Time Series Analysis: The Sample of the Currency of Kazakhstan: *https://arxiv.org/abs/1508.07534*.

R. Foundation (2018). R version 3.4.4. R Foundation for Statistical Computing.

Zubair, M. A. & Olanrewaju, S. O. (2014). Time Series Model of Nigeria's External Reserves. *The International Journal of Engineering and Science* (IJES), 3(1), 1-10.