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Modeling Nigeria External Reserves for National Transformation

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Abstract

This paper discusses the levels and trend of external reserves in Nigeria. The relevance of this lies in the fact that it could help to monitor the reserves and throw early warning signal about economic crisis. Transformed monthly data on external reserves for the period January 1999 to December, 2008 derived from the 2008 CBN Statistical Bulletin was analysed using ARIMA model. Results of the analyses show that (i) the data requires logarithm transformation to stabilize the variance and (ii) the appropriate model that best describes the pattern in the transformed data is the autoregressive process of order two [AR(2)]. This model is recommended for use until further analysis proves otherwise.

Keywords: External reserves, autoregressive process, transformation, variance stability, payment imbalances.

1.0 Introduction

External reserves, also known as International Reserves, Foreign Reserves or Foreign Exchange Reserves, "consists of official public sector foreign assets that are readily available to and controlled by the monetary authorities for direct financing of payment imbalances and regulating the magnitude of such imbalances through intervention in the exchange market to affect the currency exchange rate and/or for other purposes" [1]. By this definition, external reserves include international reserve assets of the monetary authority but exclude the foreign currency and the securities held by the public including the banks and corporate bodies.

External reserves are needed to guard against possible financial crisis [2]. National reserves are also seen as a store of assets that central banks could use to influence the exchange rate of their domestic currency [3 - 5]. Several authors [6, 7, 8] noted that external reserves help to build international community confidence in the nation's policies and creditworthiness. Adequate reserves do contribute to confidence in a nation by guaranteeing the availability of foreign exchange to domestic borrowers to meet international debt servicing and enhance its credit rating [9, 10], the confidence is often influenced by the soundness of a nation's economic policies and overall investment climate[11]. In his opinion, Dooley [12] argued that reserve accumulation agenda in Asian central banks was to prevent their currencies from appreciating against the U.S. dollar in order to promote their export-led growth strategy.

Conventionally, countries hold external reserves in foreign currencies in order to maintain a desirable exchange rate policy by interfering significantly in foreign exchange markets. The main reasons for a country holding external reserves include foreign exchange market stability, exchange rate stability, exchange rate targeting, creditworthiness, transactions buffer, and emergency such as natural disasters [9, 10]. The external reserve holding has generated serious global interest, as different economies search for alternative strategies that will protect their economies against financial instability and stimulate economic growth. Using data from four Asian countries- Indonesia, South Korea, Malaysia, and Thailand (1997– 1998), Turner [13] identified accumulation of external reserves, among others, as one of the factors associated with banking and currency crises management. Using data from122 emerging market economies (1980‑1996), IMF [14] observed that the factors that determine reserve holdings includes: real per capita GDP, population level, ratio of imports to GDP, volatility of the exchange rate, opportunity cost and capital account vulnerability. Among these determinants, GDP per capita, population level, ratio of import to GDP and the volatility of exchange rate were shown to be statistically associated with external reserves while opportunity cost and capital account vulnerability were not.

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Nigeria's external reserves derive mainly from the proceeds of crude oil production and sales. From the figure of $3.40billion in 1996 , Nigeria's external reserves rose to about $28.28 billion in 2005 and further to about $47.00 billion in 2007[15, 16]. However, with the global financial crisis Nigeria's foreign reserves declined, following the decline in exchange rate, exports, foreign currency inflows [17, 18]. As a consequence, Nigerian Stock Exchange (NSE) was negatively affected by the global fall in investor confidence [19]. The withdrawal of investors from the NSE is evident in figures on Nigerian market capitalization, with the market capitalisation index falling from Nigerian Naira 12,640 trillion in March 2008 to 4,900 trillion in March 2009, a 62 percent loss [20].

From the foregoing, it is clear that the growth or decline of a country's external reserves is an indispensible aspect of her economy. In this study our, interest is to determine the existing levels and trend of external reserves in Nigeria in response to the various factors affecting it in Nigeria. Therefore, the ultimate objective of this study is to construct a statistical model that could be used to monitor the growth of external reserves in Nigeria necessary for economic policy formulation, implementation and monitoring. Specifically, the study (i) examines the available data on external reserves, (ii) determines the times series component in the data and constructs a statistically model that could be used to describe the pattern of external reserves in Nigeria. Using this model, forecasts of future external reserves situation in Nigeria can be obtained and recommendations made.

2.0 Methodology

The method of analysis adopted in this study is the Box, Jenkins and Reinsel [21] procedure for fitting autoregressive integrated moving average (ARIMA) model. The Box, Jenkins and Reinsel multiplative time series model is given by

$$\phi_p(B)\,\Phi_P(B^S)\,(1-B)^d(1-B^s)^D W_t = \theta_q(B)\,\Theta_Q(B^s)\,e_t \qquad (2.1)$$

Where for time t

W_t is the observed value of the series

$$\phi_p(B) = 1 - \phi_1 B - \phi_2 B^2 - \dots - \phi_p B^p \qquad (2.2)$$

and

$$\theta_q(B) = 1 - \theta_1 B - \theta_2 B^2 - \dots - \theta_q B^q \qquad (2.3)$$

are polynomials in B with no common roots which lie outside the unit circle

$$\Phi_P(B^S) = 1 - \Phi_1 B^S - \Phi_2 B^{2S} - \dots - \Phi_P B^{PS} \qquad (2.4)$$

and

$$\Theta_Q(B^s) = 1 - \Theta_1 B^s - \Theta_2 B^{2s} - \dots - \Theta_Q B^{QS} \qquad (2.5)$$

are polynomials in B^s with no common roots which lie outside the unit circle

e_t is the zero mean white process with constant variance $\sigma^2 < \infty$.

$(1-B)^d$ is the regular differencing to remove the stochastic trend (if any) in the series

$(1-B^s)^D$ is the seasonal differencing operator to remove seasonal effect.

Equation (2.1) contains both a seasonal component,

$$\Phi_P(B^S)(1-B^s)^D X_t = \Theta_Q(B^s)\,b_t \qquad (2.6)$$

and a non – seasonal component

$$\phi_p(B)(1-B)^d X_t = \theta_q(B)\,a_t \qquad (2.7)$$

In (2.6) and (2.7) $\{a_t\}$and $\{b_t\}$ are the residuals which may not be white noise. In a series that contains only the non – seasonal part, Equation (2.7) can be rewritten as

$$\phi_p(B)(1-B)^d(1-B^s)^D W_t = \theta_q(B)e_t \qquad (2.8)$$

Where e_t is the white noise process. This is equivalent to the expression in (2.1) with

$$\Phi_P(B^S) = \Theta_Q(B^s) = 1 \qquad (2.9)$$

When there is no seasonal differencing this further reduces to

$$\Phi_P(B)(1-B)^d W_t = \theta_q(B)\,e_t \qquad (2.10)$$

The value of d is determined by the number of regular differencing required to completely isolate the trend from the series. Complete isolation of the trend is indicated the autocorrelation function (acf) shows spike(s) at the first and / or second lags and cuts off thereafter. For a stationary autoregressive (AR) process, the pacf cuts off after the first and / or second lag, while for a stationary moving average (MA) process there is a cut off in the acf after the first and / or second lags. When there is a cut off in both acf and pacf, we may consider the ARMA process. For the series under study, the estimates of the parameters which meet the stationarity and invertibility conditions were obtained using the MINI TAB Software. The Box, Jenkins and Reinsel Procedure outlined above assumes that (i) the underlying distribution of the series under study is normal, (ii) the variance is constant and (iii) that the relationship between the seasonal and non – seasonal components is multiplicative as indicated in Model (2.1). When one or all these conditions are violated the fitted model may be inadequate for the series under study. In order to determine the suitability of the study series for the ARIMA modeling procedure the series was evaluated for these assumptions. The normality assumption was investigated by looking at the histogram and the properties of the series (including the mean, median and measures of skewness and kurtosis). Furthermore, the Box – Cox transformation procedure which jointly investigates the need for and determines the appropriate transformation was also adopted to check the normality assumptions and the stability of variances. For details of the Box – Cox transformation procedure see Bartlett [22]. For time series data Iwueze [23] noted that the appropriate Bartlett's transformation is determined by regressing the logarithm of group standard deviation on the logarithm of group averages. The various values of the regression coefficient β and the appropriate transformations are summarized in the Table 2.1.

Table 2.1: Bartlett's transformation for some values of β

S/№	1	2	3	4	5	6	7
β	0	$1/2$	1	$3/2$	2	3	-1
Transformation	No Transformation	$\sqrt{X_t}$	$\text{Log}_e X_t$	$1/\sqrt{X_t}$	$1/X_t$	$1/X_t^2$	X_t^2

Source: Iwueze et al (2011).

3.0 Choice of appropriate transformation for the External Reserves data

The annual means ($\bar{Y}i$) and standard deviation ($\hat{\sigma}_y$) of Nigeria external reserve from 1999 to 2008 are shown in Table 3.1 while the corresponding graphs are shown in Figure 1. As Table 3.1 and Figure 1 show, the mean appears to be moving upwards in a curve-linear form. The standard deviation appears to be moving horizontally for the entire period. However, between 2004 and 2008 there appears to be a slight upward shift in the level of the standard deviation above the level of the figures for the period 1999 to 2003. These indicate that the variance may not be constant. According to the months, the mean ranged from about 19581 in January to about 23322 in November, indicating that there might be seasonal effect. Furthermore, the monthly standard deviation ranged from about 17472 in January to about 20475 in September. The overall mean (21712.3), the median (10310.4),

Table 3.1: Annual and overall means and standard deviations (and their natural logarithms) of Nigeria external reserve (in US $ Million).

Year	Mean ($\bar{Y}i$)	Standard Deviation (σY_i)	Log (($\bar{Y}i$)	Log ($\sigma(\bar{Y}i$)
1999	5309	571	8.5772	6.34739
2000	7591	1186	8.9347	7.07834
2001	10282	284	9.2382	5.64897
2002	8592	885	9.0586	6.78559
2003	7642	399	8.9414	5.98896
2004	12063	2799	9.3979	7.93702
2005	24321	2986	10.0991	8.00169
2006	37456	3787	10.5309	8.23933
2007	45394	3264	10.7231	8.09071
2008	58473	2682	10.9763	7.89432
Overall Mean	21712.3		9.64774	
Overall STD		1341.17		0.961904

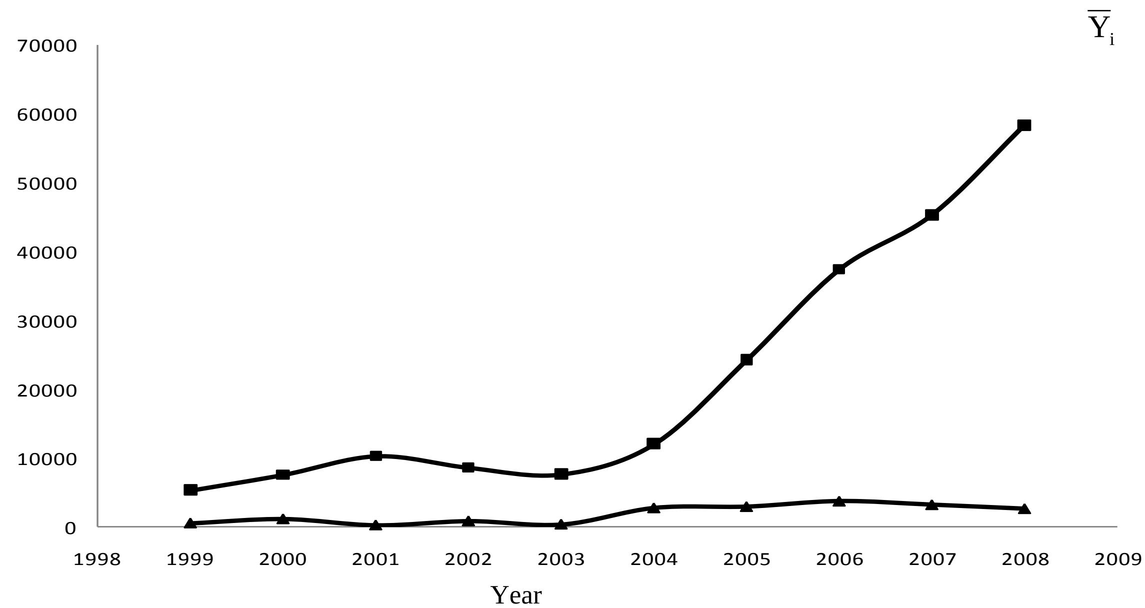

Fig.1: Annual means and Standard deviations of Nigeria External Reserves

the measures of skewness (0.8994) and Kurtosis (-0.69) and the histogram of the original data indicate that the series may not have come from a normal population. In summary there are indications that the underlying distribution may not be normal, the variance may not be stable and hence, that the data needs transformation.

Table 3.2: Monthly means and standard deviations of Nigeria external reserve (in US $ Million).

Month (j)	Mean ($\bar{Y}_j$)	Standard Deviation (σ_j)
Jan	19581	17472
Feb	20389	17998
Mar	21083	18778
April	20920	18955
May	20945	18611
Jun	21263	18750
July	21759	19218
Aug	22257	19529
Sept	23064	20475
Oct	22756	19743
Nov	23322	19713
Dec	23209	19066
All	21712	18177

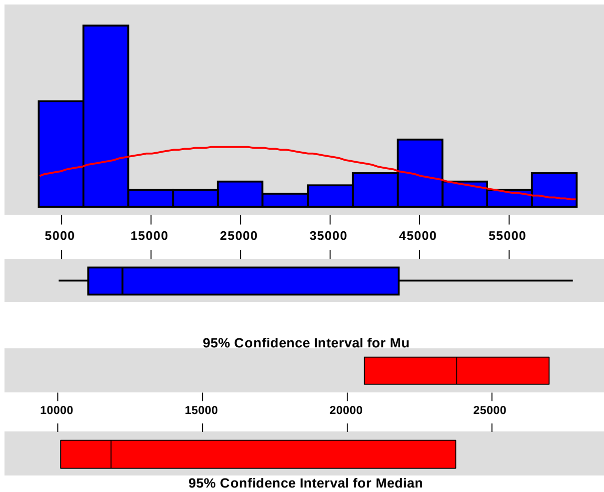

Table 3.3: Normality Test Result of Yt

Anderson-Darling Normality Test	
A-Squared:	9.319
P-Value:	0.000
Mean	23802.3
StDev	18566.5
Variance	3.45E+08
Skewness	0.609437
Kurtosis	-1.19090
N	132
Minimum	4708.2
1st Quartile	7991.2
Median	11834.8
3rd Quartile	42607.3
Maximum	62081.9
95% Confidence Interval for Mu	
20605.5	26999.2
95% Confidence Interval for Sigma	
16564.7	21122.9
95% Confidence Interval for Median	
10106.5	23749.2

Fig. 2. Descriptive statistics of Yt

In order to determine the appropriate transformation, the annual means and standard deviations only are used. The slope (β) of the regression equation of the logarithm of the annual standard deviations ($\log\hat{\sigma}_y$) on the logarithm of the annual means ($\log\bar{y}_i$) of the study series given in Table 1 was found to be equal to be $\hat{\beta} = 0.860$ with the standard error 0.2536 and coefficient of determination $R^2 = 0.539$. From the ANOVA table, this value of $\hat{\beta}$ is significantly different from zero at α = 0.01 level of significance and at eight degrees of freedom. Furthermore, this value of $\hat{\beta} = 0.860$ lies between 0.5 (when square root transformation is required) and 1 (when Logarithmic transformation is required). Since this value (0.86) appears closer to 1 than to 0.5, we examine the suitability of the logarithm transformation. Thus, the null hypothesis tested is $H_0: \beta = 1$ (and the appropriate transformation is the logarithm) against the alternative $H_1: \beta \neq 1$ (and the appropriate transformation is not logarithm). When the calculated t-value (0.5521) is compared with the tabulated value (2.26) at α = 0.05 level of significance and 8 degrees of freedom, the null hypothesis is not rejected, indicating that the logarithmic transformation may be the appropriate transformation.

The logarithm of the original data was taken to obtain the transformed series: $X_t = \log Y_t$ shown in Appendix B. The transformed series was also checked for the adequacy of this transformation, following the whole process of choice of appropriate transformation as outlined earlier. The annual means ($\bar{X}i$), standard deviations ($\hat{\sigma}_{x_i}$), and their corresponding logarithms are shown in Table 3.3 while the corresponding graphs are shown in Figure 2. As Figure 2 shows, the annual standard deviations appears to be moving horizontally, indicating that the variance has been stabilized while the mean appears to be moving upwards in a linear form.

Furthermore, the slope ($\hat{\beta}_x$) of the regression equation of logarithm of the annual standard deviation [log ($\hat{\sigma}_x$)] on the logarithm of the annual means ($\log_e \bar{X}$) is - 1.24 with standard error, 2.444 and coefficient of determination $R^2 = 3.1\%$. The p-value (0.625) associated

Table 3.4: Annual and overall means and standard deviations (and their natural logarithms) of transformed Nigeria external reserve (in US $ Million).

Year	Mean ($\bar{X}i$)	Standard Deviation (σX_i)	Log (($\bar{X}i$))	Log ($\sigma(Xi)$)
1999	8.5720	0.1020	2.1485	-2.2828
2000	8.9240	0.1550	2.1887	-1.8643
2001	9.2380	0.0280	2.2233	-3.5756
2002	9.0540	0.1030	2.2032	-2.2730
2003	8.9400	0.0520	2.1905	-2.9565
2004	9.3740	0.2280	2.2379	-1.4784
2005	10.0920	0.1240	2.3117	-2.0875
2006	10.5260	0.1020	2.3538	-2.2828
2007	10.7210	0.0700	2.3722	-2.6593
2008	10.9750	0.0470	2.3956	-3.0576
Overall Mean	9.6420			
Overall STD		0.827		

with the slope ($\hat{\beta}_x$) clearly indicates that it is not significantly different from zero and also indicates that the logarithm transformation is adequate for the study data. Therefore, model building for Nigerian external reserve will be based on logarithm transformed series (X_t) shown in Appendix B.

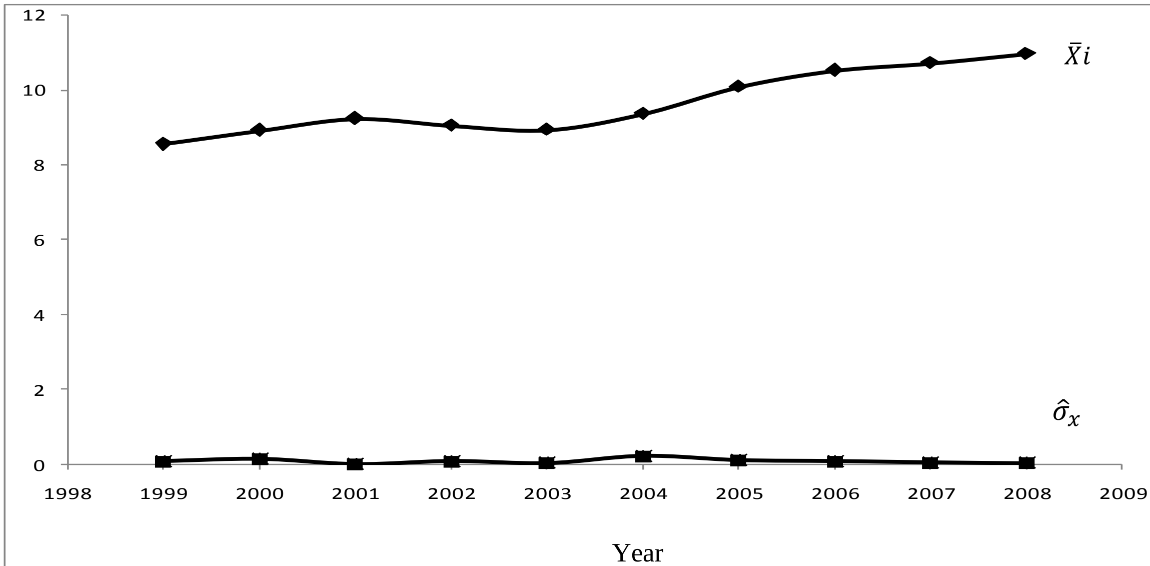

Fig 3: Annual means ($\bar{X}i$) and standard deviations ($\hat{\sigma}_x$) of the transformed series (X_t)

4.0 ARIMA Model For The Logarithm Transformed Series

The logarithm transformed monthly record of Nigeria external reserves (in US $ Million) from January 1999 to December 2008 is shown in Appendix B, while the corresponding time plot is shown in Figure3. As Figure 3 and plot show, the series appears to be moving upward in what appears like a linear trend of the annual means in Figure 2. Furthermore, the autocorrelation function (ACF) of the transformed series (X_t), shown in Table 4.1 decayed slowly from a value of 0.9838 at lag 1 to value of 0.2159 at lag 30 confirming the presence of trend. The corresponding partial autocorrelation function (PACF) on the other hand has a spike at lag 1 only. This ACF suggests that the transformed series requires differencing to remove the trend. The ACF and PACF of W_t, also shown in Table 4.1 shows that the ACF dropped from about 0.24 at lag 2 and to about 0.20 at lag 6.

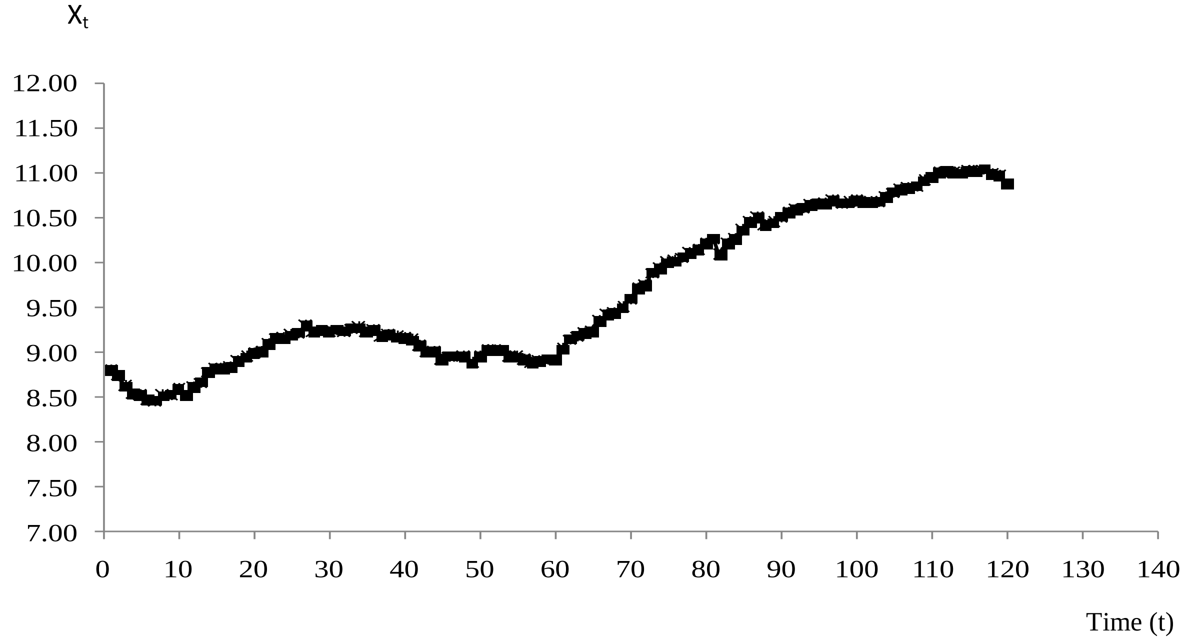

Fig. 4: Time plot of the transformed series (X_t)

These suggest that the model to be tentatively entertained is the ARIMA (p, d, q) with p = 2, d = 1 and q = 0.
The time plot of the first order differenced series (Wt) shown in Figure 4 indicates that the trend may have been removed. The suggested model (ARIMA (1, 1, 0)) was fitted to the transformed series (Wt) and the resultant residuals (e_t) were evaluated to assess the adequacy or otherwise of the fitted model. The ACF and PACF of the residuals (e_t) from the fitted model, also shown in Table 4.1 indicate that the fitted model is adequate (in terms of residual ACF and PACF) to describe the pattern in the transformed series. All the ACF and PACF lie within the 95% confidence limits ($\pm\frac{2}{\sqrt{n}} = \pm 0.1833$).

The estimates of the parameters of the selected model given by MINITAB software are $\widehat{\phi}_1 = 0.1985$ with a standard error of 0.0913, $\widehat{\phi}_2 = 0.2329$ with a standard error of 0.0914 and constant $\widehat{\phi}_0 = 0.009072$ with a standard error of 0.004716. The t-value (1.92) associated with the constant indicates that the model is not significant. Hence, the model is fitted without the constant. The estimates of the parameters of the selected model without the constant are $\widehat{\phi}_1 = 0.2385$ with a standard error of 0.0893 and $\widehat{\phi}_2 = 0.2817$with a standard error of 0.0893. The t-values, 2.67 associated with $\widehat{\phi}_1$ and 3.15 associated with $\widehat{\phi}_2$, are both significant even at 1% level of significance. Hence, the fitted model is

$$\widehat{W}_t = 0.2385\,\widehat{W}_{t-1} + 0.2817\widehat{W}_{t-2} + \hat{e}_t \qquad (4.1)$$

where

$$W_t = (1 - B)X_t = X_t - X_{t-1} \qquad (4.2)$$

Or

$$\widehat{X}_t = 1.2385\widehat{X}_{t-1} + 0.0432\widehat{X}_{t-2} - 0.2817\widehat{X}_{t-3} + \hat{e}_t \qquad (4.3)$$

This indicates that the current value of the transformed series depends on the three immediate past values.

Table 4.1 : ACF and PACF transformed (X_t) and differenced (Wt) series

Lag K	X_t Series		W_t Series		e_t Series	
	ACF	PACF	ACF	PACF	ACF	PACF
1	0.9838	0.9838	0.2372	0.2372	-0.0618	-0.0618
2	0.9644	-0.1066	0.2471	0.2022	-0.1365	-0.1408
3	0.9418	-0.1012	0.1200	0.0279	-0.0529	-0.0730
4	0.9165	-0.0807	0.2310	0.1699	0.1014	0.0748
5	0.8898	-0.0338	0.1565	0.0638	0.0507	0.0483
6	0.8615	-0.0509	0.2037	0.0994	0.1216	0.1551
7	0.8318	-0.0384	0.0981	-0.0086	0.0278	0.0785
8	0.8018	-0.0132	0.0662	-0.0459	-0.0095	0.0371
9	0.7706	-0.0407	-0.0107	-0.0817	-0.0773	-0.0607
10	0.7398	0.0060	0.0538	0.0073	0.0355	-0.0012
11	0.7083	-0.0347	0.0395	0.0107	0.0254	-0.0195
12	0.6776	0.0148	0.0506	0.0133	0.0161	-0.0142
13	0.6477	0.0052	0.0445	0.0414	0.0300	0.0358
14	0.6188	0.0079	0.0453	0.0291	0.0817	0.0980
15	0.5897	-0.0335	-0.0415	-0.0676	-0.0394	0.0051
16	0.5607	-0.0216	-0.1370	-0.1697	-0.1395	-0.1245
17	0.5330	0.0169	-0.0137	0.0300	0.0401	0.0045
18	0.5061	0.0019	-0.1158	-0.1125	-0.0871	-0.1707
19	0.4801	-0.0035	-0.0032	0.0485	0.0736	0.0315
20	0.4539	-0.0384	-0.0594	0.0225	0.0274	0.0139
21	0.4275	-0.0268	-0.1127	-0.0812	-0.0736	-0.0505
22	0.4024	0.0150	-0.1016	0.0191	-0.0581	0.0146
23	0.3781	0.0036	-0.1201	-0.0691	-0.0757	-0.0862
24	0.3535	-0.0405	-0.0427	0.0280	0.0433	0.0303
25	0.3294	-0.0062	-0.0244	0.0223	0.0969	0.0656
26	0.3053	-0.0217	-0.0998	-0.0728	-0.0547	-0.0316
27	0.2824	0.0141	-0.1972	-0.1542	-0.1504	-0.1293
28	0.2596	-0.0201	-0.0705	0.0630	0.0585	0.0681
29	0.2374	-0.0053	-0.1947	-0.1313	-0.1009	-0.1338
30	0.2159	-0.0010				

4.1 Forecasting

One of the objectives of model building is to provide forecasts of future values. In producing the forecasts using the fitted model, it is assumed that the condition(s) under which the model was constructed would persist in the periods for which forecasts are made. If we denote the forecast made at time $t_0$for the lead time l by X_{t_0} (l) , then the estimate of the forecast function ($\widehat{X}_{t_0}$ (l)) is given by

$$\widehat{X}_{t_0}(l) = 0.2385\,.\widehat{X}_{t_0+l-1} + 0.0432\widehat{X}_{t_0+l-2} - 0.2817\widehat{X}_{t_0+l-3} \qquad (4.4)$$

The corresponding forecast error $\hat{e}_{t_0}$ (l) at lead time l is given by

$$\hat{e}_{t_0}(l) = X_{t_0}(l) - \widehat{X}_{t_0}(l) \qquad (4.5)$$

Using the model in (4.4) with $t_0 = 120$, the MINITAB software gave the forecasts $\widehat{X}_{t_0}(l), l = 1, 2, \ldots 12$ for the 12 months of 2009. The values of the forecast and the actual values are shown in Table 4.1 while the plot of the actual and forecasts are shown in Figure 4. As Figure 4 show, between 1999 and up to July 2009, the actual and fitted values of the transformed Nigeria external reserve agreed strongly. Table 4.1 shows that the forecast values lie within two standard deviations from the actual values. However, for the subsequent six months of the later part of 2009, the plot of the forecast and actual values given in Figure 4 shows a great disparity between the actual and forecast as the forecast values appears higher, which suggests that circumstances under which the model was constructed may have changed considerably. This is understandable considering the dwindling proceeds from petroleum products since Nigeria external reserve is derived mainly from oil.

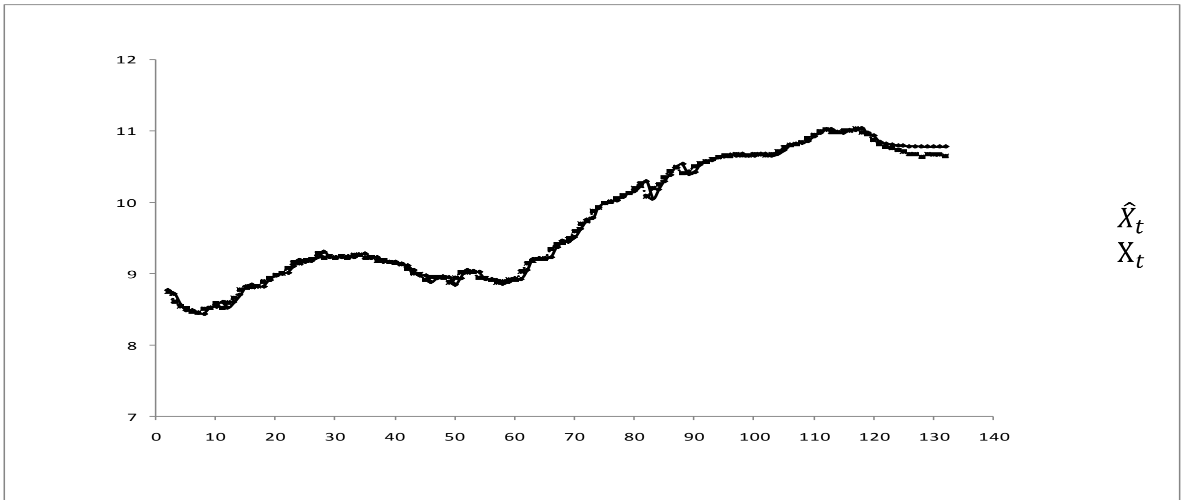

Fig. 5: Time plot of the actual (X_t) and fitted ($\hat{X}_t$) values of the Nigeria external reserve

5.0 Conclusion

This work discusses fitting of ARIMA Model to Monthly record of Nigeria external reserve for the period January 1999 to December 2008 obtained from the CBN Statistical Bulletin Golden Jubilee Edition December 2008, while the 2009 figures were used to obtain the forecast error. The ultimate objective is to construct a statistical model which may be used

Table 4: 2 Actual and forecast of monthly records of Nigeria external reserve 2009 ($x10^6$)

Lead l	t_{0+l}	Months	Actual X_t	Forecast $\hat{X}_{t_0}(l)$	Error $\hat{e}_{t_0}(l)$	Error $\left[\hat{e}_{t_0}(l)\right]^2$	95% confidence limits	
							Lower	Upper
1	121	January	10.8219	10.8536	-0.0317	0.0010	10.6323	11.0116
2	122	February	10.7813	10.8249	-0.0436	0.0019	10.5916	10.9710
3	123	March	10.7596	10.8112	-0.0516	0.0027	10.5699	10.9493
4	124	April	10.7345	10.7998	-0.0653	0.0043	10.5449	10.9242
5	125	May	10.7108	10.7932	-0.0824	0.0068	10.5211	10.9005
6	126	June	10.6797	10.7884	-0.1087	0.0118	10.4900	10.8693
7	127	July	10.6771	10.7854	-0.1083	0.0117	10.4874	10.8668
8	128	August	10.6396	10.7834	-0.1438	0.0207	10.4499	10.8292
9	129	September	10.6769	10.7821	-0.1052	0.0111	10.4872	10.8666
10	130	October	10.6702	10.7812	-0.1110	0.0123	10.4806	10.8599
11	131	November	10.6695	10.7806	-0.1111	0.0123	10.4799	10.8592
12	132	December	10.6545	10.7802	-0.1257	0.0158	10.4648	10.8442
MSE						0.009365		

to obtain forecast of future values of Nigeria external reserve necessary for policy formulation, implementation and monitoring. The result of data evaluation (for the assumptions of ARIMA models) shows that data requires logarithm transformation to make the distribution of data normal and stabilize the variance. The logarithmic transformed series was then subjected to Box, Jenkins and Reinsels [21] iterative modeling procedure for model building. The result of the analysis shows that appropriate model for the transformed series is Auto-regressive Process of order two [AR (2)]. The forecast for the twelve months of 2009 using the model agreed strongly with the actual values at 95 percent level of confidence. This model has therefore been recommended for use in the study of Nigeria external reserve until further studies prove otherwise.

Acknowledgement
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Appendix A: Monthly record of Nigeria external reserve for the period 1999 to 2008

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Mean	StD
1999	6550	6275	5507	5115	4989	4772	4708	4971	5032	5343	5022	5425	5309	571
2000	5789	6495	6683	6693	6790	7272	7635	7959	8118	8788	9484	9386	7591	1186
2001	9705	10016	10787	10176	10354	10167	10390	10204	10564	10582	10178	10267	10282	284
2002	9669	9768	9546	9403	9226	8675	8143	8089	7424	7742	7737	7681	8592	885
2003	7134	7655	8226	8217	8270	7673	7644	7449	7170	7306	7490	7468	7642	399
2004	8324	9352	9684	9976	10084	11441	12228	12482	13223	14657	16345	16955	12063	2799
2005	19593	20554	21808	22210	23291	24367	25162	26951	28638	23921	27076	28279	24321	2986
2006	31318	34319	36202	33064	34094	36479	38074	39248	40458	41478	42442	42298	37456	3787
2007	43511	42551	42634	43531	43169	42626	43264	45010	47930	49210	49964	51333	45394	3264
2008	54216	56908	59757	60816	59180	59157	60342	60202	62082	58534	57480	53000	58473	2682
Mean	19581	20389	21083	20920	20945	21263	21759	22257	23064	22756	23322	23209	21712	
StD	17472	17998	18778	18955	18611	18750	19218	19529	20475	19743	19713	19066		18177

Appendix B: Logarithm of monthly record of Nigeria external reserve for the period 1999 to 2008

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Meanj	StD j
1999	8.787	8.744	8.614	8.54	8.515	8.471	8.457	8.511	8.524	8.584	8.522	8.599	8.572	0.102
2000	8.664	8.779	8.807	8.809	8.823	8.892	8.94	8.982	9.002	9.081	9.157	9.147	8.924	0.155
2001	9.18	9.212	9.286	9.228	9.245	9.227	9.249	9.231	9.265	9.267	9.228	9.237	9.238	0.028
2002	9.177	9.187	9.164	9.149	9.13	9.068	9.005	8.998	8.912	8.954	8.954	8.947	9.054	0.103
2003	8.873	8.943	9.015	9.014	9.02	8.945	8.942	8.916	8.878	8.896	8.921	8.918	8.94	0.052
2004	9.027	9.143	9.178	9.208	9.219	9.345	9.412	9.432	9.49	9.593	9.702	9.738	9.374	0.228
2005	9.883	9.931	9.99	10.008	10.056	10.101	10.133	10.202	10.262	10.083	10.206	10.25	10.092	0.124
2006	10.352	10.443	10.497	10.406	10.437	10.504	10.547	10.578	10.608	10.633	10.656	10.652	10.526	0.102
2007	10.681	10.658	10.66	10.681	10.673	10.66	10.675	10.715	10.778	10.804	10.819	10.846	10.721	0.07
2008	10.901	10.949	10.998	11.016	10.988	10.988	11.008	11.005	11.036	10.977	10.959	10.878	10.975	0.047
Mean j	9.552	9.599	9.621	9.606	9.611	9.62	9.637	9.657	9.675	9.687	9.712	9.721	9.642	
StD j	0.832	0.825	0.846	0.855	0.856	0.87	0.882	0.886	0.912	0.875	0.887	0.871		0.827

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