A Statistical Analysis of the Nigerian External Reserve and the Impact of Military and Civilian Rule

Ohakwe J^{1*} Odo I. V² Nwosu C³

¹Department of Mathematics and Statistics, Faculty of Sciences,
Anambra State University, P.M.B. 02, Uli, Anambra State, Nigeria.

²Department of Mathematics and Computer Science
Institute of Ecumenical Education, Thinkers Corner, P. O. Box, 20001, Enugu
Enugu State, Nigeria.

³Department of Statistics, Faculty of Sciences, Nnamdi Azikiwe University,
P.M.B. 5025, Awka, Anambra State, Nigeria

Keywords: External Reserve; Descriptive Time Series Technique; Box-Jenkins Model; Relative Percentage Change

Abstract: In this paper, the Nigerian External Reserve (ER) for the period 1960 – 2010 was modeled using descriptive time series technique and Box-Jenkins (ARIMA) model. Prior to the analysis the logarithm transformation was found to be the most appropriate to stabilize the variance of the data after the Bartlett's test of homogeneity of variance suggested non-constant variance. Applying the descriptive time series technique on the transformed data, a linear trend was found adequate which suggest an exponential trend for the untransformed data. However, the seasonal indexes were found to be insignificant which implies that the data is completely dominated by the trend. Furthermore, considering that the model obtained using the descriptive time series technique was found inadequate as suggested by the autocorrelation function (ACF) of the irregular component and therefore cannot be used for forecasting, a Box-Jenkins model was then fitted and was found adequate as suggested by the p-value = 0.00 for the model significance. Furthermore using the Relative Percentage Change (RPC) to assess the impact of the various regimes on the ER data, it was found that the regimes of General Yakubu Gowon (Rtd) and Alhaji Shehu Shagari respectively had the most positive and negative impact on the ER data. Finally using the cumulative RPC in assessing the impact of civilian and military regimes on the ER data, it was discovered that the military had a higher positive impact than the civilian regimes.

1. INTRODUCTION

External reserves (ER), variously called International reserves, Foreign reserves or Foreign exchange reserves has several definitions, but the most widely accepted is the one proposed by the IMF in its balance of payments manual, 5th edition. It defined ER 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 effect the currency exchange rate and/or for other purposes.

These are assets of the central bank held in different reserve currencies, mostly the US dollar and to a lesser extent, the euro, the UK pound and the Japanese yen, and used to back its liabilities, e.g. the local currency issued, and the various bank reserves deposited with the central bank, by the government or financial institutions.

Recently the global ER has increased significantly. This significant increase is as a result of the enormous importance countries attach to holding an adequate level of ER among which are; (i) to safeguard the value of the domestic currency (ii) timely meeting of international payment obligations and (iii) wealth accumulation.

For Nigeria, Act 1991 vested the custody and management of Nigeria's ER to the central bank of Nigeria (CBN). The period beginning from the later end of 1999 marked a turning point from hitherto culture of fiscal misappropriation characterized by reckless spending to a new era of

prudent management and saving. This very fact is clearly evidenced by the unprecedented jump in ER level from USD 4.98 billion in May, 1999 to USD 59.37 billion in March, 2007 (CBN, 2007). These robust domestic economic performances according to Magnus (2007) were occasioned by microeconomic fundamentals like internal reforms, complemented by favourable external conditions like the persistent rise in crude oil prices joined with decline in the external obligations like debt services.

Economic Policymakers in emerging market countries have typically viewed ER as money in the bank – the more, the better. Over the past three decades, a shift to flexible exchange rate regimes and an ability to borrow in domestic currency eased pressure on industrial countries to accumulate reserves. Meanwhile emerging market and developing countries continue to struggle with maintaining adequate reserve levels. Only recently has the large scale of reserve accumulation in developing countries raised questions about its necessity and even its wisdom (Russel and Tom, 2007). Common to every economic phenomenon in Nigeria, these development have earned the praises of many as it equally drew severe criticisms from others who question the rationale for building ER in the face of crippling domestic economic activities and high incidence of poverty in the country. Abdullateef and Waheed (2010), in their study strengthened the need for broader reserve management strategies that will aim at maximizing the gains from oil export revenue by utilizing more of these resources to boost domestic investment.

Government Statisticians and accountants measure and record the levels of domestic output and ER, national income and prices of the economy. For sure, with such information in hand the country can gauge her economic health (McConnel and Brue (1986). For this reason, the purpose of this paper is to provide an appropriate statistical model for the monthly Nigeria's External Reserve for the period 1960 – 2009 with a view to understanding its pattern for the purpose of making some statistical and economic predictions using time series approach. Furthermore considering that the Nigeria's political landscape is characterized with military and civilian rules, we would also assess the impact of each regime on the external reserve. Our measure of assessment would be the Relative Percentage Change (RPC) given by

$$RPC = \frac{ER_c - ER_0}{ER_0} * 100\% \quad (1)$$

where ER_0 = the external reserve value at the inception of a particular regime (say i)

ER_c = the external reserve value at the end of a regime i

The paper is organized into seven Sections. While Section 1 contains the introduction, Section 2 considers a preliminary analysis and detailed descriptive time series analysis of the data with a view to understanding the trend-cycle and seasonal components of the data. In Section 3, Box-Jenkins (ARIMA) modeling would be carried out while the results of the data analysis would be discussed in Section 4. Finally the conclusion, references and Appendix would be contained in sections 5, 6 and 7 respectively.

2. PRELIMINARY ANALYSIS

According to Wei (1990), the analysis of seasonal time series with periodicity, s , (length of the periodic interval) requires the arrangement of the series in a two-dimensional table called Buys-Ballot table after Buys-Ballot (1847). This brings out the within-periods and between-periods relationships. Within-periods relationships represent the correlation among $\dots, X_{1-2}, X_{t-1}, X_t, X_{t+1}, X_{t+2}, \dots$ and the between-periods relationships represent the correlation among $\dots, X_{t-2s}, X_{t-s}, X_t, X_{t+s}, X_{t+2s}, \dots$. In general, the within-period relationships represent the non-seasonal part of the series while the between-periods represent the seasonal part.

Iwueze and Nwogu (2004), Iwueze and Ohakwe (2004) and Iwueze and Nwogu (2005) have developed an estimation technique based on the row and column averages of the Buys-Ballot table for the parameters of the trend-cycle and the seasonal components.

The original data denoted by $1, 2, 3, \dots, 612$. X_t , $t = 1, 2, 3, \dots, 612$ are arranged in a Buys-Ballot Table (Table 2), to enable us calculate the periodic means and standard deviations required in

determining the appropriate data transformation if need be and also to be used in computing the RPC needed for yearly comparisons.

Prior to the descriptive time series analysis, homogeneity of variance of the data was assessed using Bartlett's test for homogeneity of variance. Here we tested the homogeneity of the periodic/yearly variances, $\sigma_i^2, i = 1, 2, \dots, 51$ where i denotes year (that is $i = 1$ implies 1960, and so on to $i = 51$ which implies 2010). The hypothesis of interest is given by

$$H_0; \sigma_1^2 = \sigma_2^2 = \dots = \sigma_{51}^2 = \sigma^2$$

against

$$H_1; \sigma_1^2 \neq \sigma_2^2 \neq \dots = \sigma_{51}^2 \neq \sigma^2$$

This test was performed using Minitab 14 and the calculated value of the test statistic and the p-value were respectively obtained as 1739.347 and 0.000. Based on this test there is no question that the null hypothesis of homogeneity of variance is rejected even at 1% level of significance, hence the data requires transformation.

The essence of data transformation is to stabilize the variance of a data or to normalize it or both which are the basic assumptions needed to perform a parametric data analysis. For details on reasons for data transformation, see Box et al., (1994) and Iwueze et al (2011).

In order to determine the appropriate transformation, we would adopt Bartlett's (1947) transformation technique as applied by Akpanta and Iwueze (2009) that will not only stabilize the variance, but will also make normalize it. This method involves finding the linear relationship between the natural logarithm of the periodic averages and the natural logarithm of the periodic standard deviations and the slope of the linear relationship obtained is used to determine the type of transformation to be made. For the data under study, we have a slope of 0.93 (≈ 1.0) as shown in Figure 2, which indicates a logarithmic transformation as suggested by Bartlett (1947) [see Ogbonna and Haris (2003) and Akpanta and Iwueze (2009)] for more recent work on Bartlett's method].

As a result of the suggested data transformation, we now define a new variable

$$Y_t, t = 1, 2, 3, \dots, 612, as$$

(2)

$$Y_t = \log_e X_t$$

After the logarithm transformation, the original time series model given as

$$X_t = M_t * S_t * e_t \quad (3)$$

Where M_t is the trend-cycle component, S_t , the seasonal component and e_t , the irregular or error component now becomes an additive model given by

$$Y_t = M_t^* + S_t^* + e_t^* \quad (4)$$

where $\log M_t = M_t^*, \log S_t = S_t^*$ and $\log e_t = e_t^*$

After the logarithm transformation, the plot of the periodic mean and standard deviation (Figure 3) suggest a stable variance, hence justifying the logarithm transformation. The details fassessing stability of variance using the plot of the periodic mean and standard deviation can be found in Iwueze and Nwogu (2004) and Iwueze and Ohakwe (2004).

A time series plot of Y_t (Figure 1) suggests either a linear or quadratic trend curve for the transformed series, so we explore only the curves suggested by the plot in our descriptive analysis. The Mean Absolute percentage Error (MAPE), Mean Absolute Deviation (MAD) and Mean Square Deviation (MSD) are used as criteria for choice between the two trend curves (Iwueze and Nwogu (2004)). The ACF and PACF in Figures 4 and 5 were also used to assess the significance of the seasonal components. For a series with significant seasonal component, the ACF and PACF have significant systematic pattern at the seasonal lags (Delurgio (1998)). However in own case, Figures and 5 suggest no systematic pattern at the seasonal lags (12, 24, 36 and so on) which suggest insignificant seasonal component. Furthermore considering the importance of significance test on

seasonal indexes, because without them, one may be misled to believe that there is seasonality where none exists, therefore the technique of regression analysis is adopted in the estimation of the trend and the seasonal components because of the fact that it provides a test of significance of the seasonal indexes through the regression coefficient t-test (Delurgio (1998)). This method involves in addition to the appropriate trend equation, the creation of dummy variables to represent the seasons and then performing a regression analysis.

By employing the dummy variables the time series model of interest now becomes

$$Y_t = M_t^* + \sum_{j=2}^{12} \beta_j S_j^* + e_t^* \quad (5)$$

where β_j is the coefficient of S_j . $S_{j's}$ are the seasonal dummy variables. These dummy are defined as follows

$$S_j = \begin{cases} 1, & \text{if the value } y_t \text{ was observed in month } j \text{ of the year, } j = 2, 3, \dots, 12 \\ 0, & \text{otherwise} \end{cases} \quad (6)$$

Since we have twelve months whose seasonal indexes are required to be calculated, we therefore need 11 dummy seasonal variables. This is as a result of the fact that only eleven variables are necessary to measure the effect of twelve months. More important, for mathematical reasons, multiple regression will not work, if all twelve dummy variables are used to represent the twelve dependent events (i.e. months), however, the interpretation of the model results for the indexes would be related to the month whose seasonal dummy variable was not included in the model (in this case the month of January) (Delurgio (1998)).

For the data of this study the results of the regression analysis for the linear trend is given in Tables 4. For the quadratic trend even though the linear case outperformed it in terms of MAPE, MAD and MSD, the coefficient of t^2 was also found to be statistically insignificant (t – values = - 0.20 and p -value = 0.839).

The estimated linear trend-curve is given by

$$\text{Log}_e M_t = 4.5295 + 0.0097t \quad (6)$$

Hence

$$M_t = e^{4.5295+0.0097 t} \quad (7)$$

Using the p -values of the seasonal indexes in Table 4, it is clear that seasonal component is statistically insignificant; hence the data is purely dominated by the trend.

Finally the adequacy of the fitted model was assessed using the ACF of the Irregular component (residual series). The plot of the ACF of the residual series is given in Figure 6 and there is a clear evidence of non-randomness. For randomness at 5% level of significance, the

autocorrelation coefficients must lie in the interval $\pm \frac{1.96}{\sqrt{n}}$ which in our case is 0.0808 and this is not true for the ACF of our residual series. Thus there is evidence of inadequacy of fit, hence the model cannot be recommended for forecasting.

3. ARIMA MODELING

The descriptive analysis of Section 2 did not provide an adequate model whose Irregular component (residual series) is random. We therefore need a probability model that takes account of the trend and seasonal components of the series. Such models called Box-Jenkins models (Box et al. (1994)) are analysed by the seasonal multiplicative ARIMA (p, d, q) $\times$ (P, D, Q)s time series model given by

$$\phi_p(B)\Phi_P(B^s)W_t = \theta_0 + \theta_q(B)\Theta_Q(B^s)e_t \quad (8)$$

Where

$$W_t = (1-B)^d (1-B^s)^D X_t \quad (9)$$

$$\phi_p(B) = 1 - \phi_1 B - \phi_2 B^2 - \dots - \phi_p B^p \quad (10)$$

$$\theta_q(B) = 1 - \theta_1 B - \theta_2 B^2 - \dots - \theta_q B^q \quad (11)$$

$$\Phi_P(B^s) = 1 - \Phi_1 B^s - \Phi_2 B^{2s} - \dots - \Phi_P B^{Ps} \quad (12)$$

$$\Theta_Q(B^s) = 1 - \Theta_1 B^s - \Theta_2 B^{2s} - \dots - \Theta_P B^{Ps} \quad (13)$$

and e_t is the zero mean purely random process with constant variance $\sigma^2 < \infty$. $(1-B)^d$ is the regular differencing operator to remove the stochastic trend. $(1-B^s)^D$ is the seasonal differencing operator to remove the seasonal variation. Usually the order of d and D where needed is always 1 or 2. Equations (10) through (13) are polynomials of s B or B^s with no common roots but with roots that lie outside the unit circle. The parameter θ_0 represents the deterministic trend.

Usually the values of p , q , P , Q , s , d and D of (8) are always determined by examining the autocorrelation function (ACF) and partial autocorrelation function (PACF) [See Box et al.(1994)]. By plotting the ACF (Figure 4) and PACF (Figure 5) of Y_t , we observe that while the autocorrelation coefficients do not die off quickly suggesting non-stationarity, which may be attributed to the presence of the linear trend and as a result the series was differenced once. The ACF and PACF of the first order differenced series are respectively shown in Figures 7 and 8. It can be seen in Figures 7 and 8 that there are significant spikes at Lags 1 and 5 for both functions which suggest the presence of mixed autoregressive moving average model. As a result of these behaviour the suggested model is a non-seasonal ARIMA (5, 1, 5) (seasonal multiplicative ARIMA (5, 1, 5) x (0, 0, 0)₀) model on Y_t denoted as ARIMA (5, 1, 5) =

$$W_t = Y_{t-1} = \sum_{p=1}^5 \phi_p w_{t-p} + \sum_{q=1}^5 \theta_q e_{t-p} + e_t \text{ where } \phi_2 = \phi_3 = \phi_4 = 0 \text{ and } \theta_2 = \theta_3 = \theta_4 = 0, \text{ which}$$

implies

$$W_t = Y_{t-1} = \phi_1 W_{t-1} + \phi_5 W_{t-5} + \theta_1 e_{t-1} + \theta_5 e_{t-5} + e_t \quad (14)$$

Model (14) was fitted using stata (Statacorp LD, College Station, Texas) and $N_5=09956$ with p -value = 0.182 was found insignificant, thus the appropriate model is given by

$$Y_{t-1} = W_t = \underset{(p\text{-value} = 452.71)}{0.9979} W_{t-1} - \underset{(p\text{-value} = -3.98)}{0.4075} e_{t-1} + \underset{(p\text{-value} = 2.72)}{0.1454} e_{t-5} \quad (15)$$

where for the fitted model the number of observations = 611, Log-pseudo likelihood = -134.5198,

Wald Chi-square $(\chi^2) = 378740.09$ and p -value = 0.000. The p -value for the model significance = 0.000 suggests adequacy of the model at 5% level of significance even at 1%. The fitted model is given in Table 5 while the model equation is given in equation (15). It is important to note that there was no observable seasonal pattern at the seasonal lags (12, 24, 36 and so on) as shown by the ACF and PACF of the logarithm transformed series, Y_t (Figures 4 and 5) This is as a result the insignificance of the seasonal component which was evidenced in the descriptive time series analysis of Section 2, therefore the value of D is zero.

4. Results and Discussions

Using the relative percentage changes (RPC) in Table 1 it is seen that the regime of Alhaji Shehu Shagari (October 1, 1979 – December 31, 1983) had the most negative RPC (-92.2%) while that of General Yakubu Gowon (July 29, 1966 – July 29, 1975) had the most positive (RPC = 2521.0%). Surprisingly on cumulative basis, civilian regime had an RPC of 665.8% while that of military is 3737.0% which implies that military regimes had impacted more positively on Nigerian ER than the civilian regimes. Finally from the yearly RPC given in Table 4, it is seen that 1974 has the highest figure (672.3%) followed by the year 1996 whose figure is 239.4% and these years were under military regimes of Gen. Yakubu Gowon (Rtd) and late Gen. Sani Abacha while the years 1983 (Alhaji Shehu Shagari) and 1993 (Chief Earnest Shonekan/ Late Gen. Sani Abacha) whose values are respectively -81.2% and -82.9% had the most negative RPC values.

From the results of the descriptive time series analysis, linear trend was found to be the most appropriate for the logarithm transformed data, hence the exponential trend-curve (Equation 7) is then the best fit for the untransformed data. That is to say that the Nigerian ER increased exponentially for the period 1960 – 2010. Furthermore, even though the data were collected on monthly basis, the monthly seasonal indexes (Table 3) were found to be statistically insignificant. Finally, since the ACF (Figure 6) of the Irregular component suggested non-randomness, therefore the fitted descriptive time series model would not be recommended to be used for forecasting.

Finally the fitted Box-Jenkins (ARIMA) model on the logarithm transformed data after one regular differencing was found to be ARMA (1, 5) (Model equation given in (15)) where the autoregressive part has a significant value at lag 1 and the moving average part has significant values at lags 1 and 5 and all other values are zero. Considering that the ARIMA model was fitted on the logarithm transformed data, it is important to note that in forecasting, the predicted values resulting from the fitted model can be reversely-transformed (Anti-logarithm) to obtain the forecasts for the original data.

5. Conclusion

In this study, we modeled the Nigerian external reserve (ER) data for the period 1960 – 2010 using descriptive time series technique and Box-Jenkins (ARIMA) model. While the descriptive time series model was found inadequate, the ARIMA model was found adequate and hence would be recommended to be used for forecasting. Furthermore using the relative percentage changes (RPC) in assessing the impact of various regimes on the ER data, it was discovered that the regimes of General Yakubu Gowon (Rtd) and Alhaji Shehu Shagari respectively had the most positive and negative impacts on the Nigerian ER for the period 1960 – 2010. Using the cumulative RPC in assessing the overall impact of civilian and military regimes on ER, it was found that the military regimes had impacted more positively on the Nigerian ER than the civilian regimes.

In conclusion, the result of this study would correct the common thought that military regimes are generally wasteful than the civilian regimes as evidenced by the cumulative assessment of the two regimes using relative percentage change.

6 Appendix

Table 1: Government Regimes in Nigeria (October 1, 1960 – December 31, 2010)

Regime i	Date	Type of Government./ Head of Government	PC
1	01/10/1960 – 15/01/1966	Civilian/Alh. Tafawa Balewa	-20.7
2	15/01/1966 - 29/07/1966	Military / Gen A. Ironsi	4.6
3	29/07/1966 – 29/07/1975	Military / Gen. Y. Gowon	2521.0
4	29/07/1975 – 13/02/1976	Military / Gen. M. Mohammed	-8.8
5	13/02/1976 – 01/10/1979	Military / Gen. O. Obasanjo	-16.9
6	01/10/1979 – 31/12/1983	Civilian / Alh. Shehu Shagari	-92.2
7	31/12/1983 – 27/08/1985	Military / Gen. M. Buhari	237.8
8	27/08/1985 – 27/08/1993	Military / Gen. I.B. Babangida	1040.8
9	27/08/1993 – 17/11/1993	Civilian / Chief E. Shonekan	-3.9
10	17/11/1993 – 08/06/1998	Military / Gen. S. Abacha	-4.3
11	08/06/1998 – 29/05/1999	Military / Gen. A. Abubakar	-37.2
12	29/05/1999 – 29/05/2007	Civilian / Gen O. Obasanjo (Rtd)	765.3
13	29/05/2007 – 31/12/2010	Civilian / Alh. U. Yar'adua	-24.1

Note: The year 2010 was assumed to be Alh. Yar'adua administration even though Dr Goodluck Jonathan completed it after his death.

Cumulative RPC for civilian rule = 665.8%

Cumulative RPC for military rule = 3737.0%

Table 2: Data on Nigerian External Reserve (US Dollars' Million) for the period 1960 - 2010

Year	Jan	Feb.	Mar.	Apr	May	Jun	Jul	Aug.	Sept	Oct	Nov.	Dec.	$\bar{X}_i$	S_i
1960	150.23	168.91	147.12	149.45	143.93	143.85	157.20	152.03	176.60	173.58	159.03	217.32	161.6	20.80
1961	146.59	164.82	143.55	145.83	140.44	140.36	153.39	148.35	172.32	169.37	155.17	212.05	157.7	20.29
1962	148.29	166.73	145.22	147.52	142.07	141.99	155.16	150.07	174.32	171.33	156.97	214.51	159.5	20.53
1963	124.51	139.99	121.93	123.87	119.29	119.22	130.29	126.01	146.37	143.86	131.80	180.12	133.9	17.24
1964	149.65	168.25	146.55	148.87	143.37	143.29	156.59	151.44	175.91	172.90	158.41	216.48	161.0	20.72
1965	159.52	179.36	156.22	158.70	152.83	152.74	166.92	161.44	187.52	184.31	168.87	230.77	171.6	22.09
1966	137.61	154.73	134.77	136.90	131.84	131.77	144.00	139.27	161.77	159.00	145.68	199.07	148.0	19.05
1967	69.45	78.09	68.01	69.09	66.54	66.50	72.67	70.28	81.64	80.24	73.52	100.46	74.7	9.61
1968	66.02	74.23	64.66	65.68	63.25	63.22	69.09	66.82	77.61	76.28	69.89	95.51	71.0	9.14
1969	85.11	95.70	83.35	84.67	81.54	81.49	89.06	86.13	100.05	98.34	90.10	123.12	91.6	11.78
1970	108.24	121.70	106.00	107.68	103.70	103.64	113.26	109.54	127.24	125.06	114.58	156.58	116.4	14.99
1971	161.94	180.40	202.62	171.64	202.22	242.16	199.00	109.96	208.16	251.82	198.40	281.38	200.8	44.62
1972	216.70	166.60	233.80	234.00	228.60	209.08	202.54	202.76	241.10	223.72	201.00	243.58	217.0	21.97
1973	219.65	222.01	280.98	309.72	339.79	330.10	356.30	301.37	282.93	280.77	246.14	377.98	295.6	50.52
1974	447.00	587.20	802.30	1,029.50	1,386.50	1,484.80	1,884.70	2,133.10	2,472.20	2,823.60	2,969.20	3,452.30	1789.4	994.27
1975	3,674.40	3,690.30	3,757.20	4,115.70	3,985.10	3,789.50	3,774.30	3,593.80	3,549.40	3,702.00	3,615.00	3,583.70	3735.9	168.12
1976	3,569.10	3,441.30	3,475.30	3,881.00	3,823.40	3,773.40	3,751.20	3,734.70	3,703.70	3,704.40	3,344.60	3,286.30	3624.0	195.40
1977	3,076.90	3,220.40	3,224.70	3,241.20	3,159.90	3,124.30	2,965.20	3,064.60	3,051.10	2,993.70	3,009.70	2,814.50	3078.8	125.08
1978	2,073.20	2,676.10	2,470.20	2,179.70	1,926.10	1,840.90	1,485.80	1,523.50	1,315.50	1,385.50	1,367.50	1,298.90	1795.2	474.12
1979	1,200.90	1,233.40	1,351.10	1,231.20	1,522.20	1,748.70	1,910.00	2,388.60	2,628.40	2,858.70	2,946.60	3,059.80	2006.6	728.63
1980	3,072.40	3,412.70	3,667.10	3,970.10	4,288.00	4,496.40	4,937.60	5,206.60	5,524.00	5,395.00	5,374.10	5,462.00	4567.2	874.67
1981	5,177.90	5,163.60	5,572.10	5,283.30	6,123.10	5,515.10	5,268.20	5,105.20	4,224.80	3,467.80	2,852.10	2,441.60	4682.9	1166.83

Table 2: Continues

Year	Jan	Feb.	Mar.	Apr	May	Jun	Jul	Aug.	Sept	Oct	Nov.	Dec.	$\bar{X}_i$	S_i
1982	1,679.90	1,726.60	977.40	773.80	756.70	858.30	857.30	804.50	871.50	1,072.80	902.20	1,043.30	1027.0	330.87
1983	1,193.60	647.00	562.20	593.50	580.60	641.90	699.80	582.70	557.20	513.90	374.60	224.40	597.6	227.53
1984	224.40	210.80	333.10	478.40	443.00	582.50	532.90	315.90	479.90	705.60	463.10	710.10	456.6	164.75
1985	567.10	779.40	804.30	1,191.90	1,148.60	1,031.60	804.70	758.00	784.00	1,017.70	1,236.50	1,657.90	981.8	295.84
1986	1,308.90	1,320.30	1,030.80	893.10	859.70	986.20	828.80	948.10	2,120.05	3,292.00	2,497.50	2,836.60	1576.8	873.49
1987	2,287.02	2,558.10	9,449.51	2,651.80	4,241.67	5,831.55	3,976.60	4,889.00	7,237.74	7,255.09	4,671.60	7,504.59	5212.9	2274.19
1988	7,925.66	8,240.60	8,555.53	6,438.41	5,458.61	4,478.81	5,458.61	5,132.01	5,024.17	5,204.93	5,120.37	5,229.10	6022.2	1415.87
1989	4,310.46	4,769.78	4,540.12	9,236.52	5,157.92	1,079.31	1,053.73	2,430.32	2,309.66	3,033.53	2,984.25	3,047.62	3662.8	2211.19
1990	3,386.77	3,960.74	3,770.03	3,696.20	3,170.34	2,644.47	2,839.61	2,884.81	2,762.12	2,828.85	3,807.81	4,541.45	3357.8	597.21
1991	4,003.75	4,682.28	4,428.32	4,222.38	4,085.36	3,902.19	3,833.02	3,681.72	3,869.67	4,023.91	3,738.14	4,149.30	4051.7	289.33
1992	4,109.65	5,517.36	4,109.65	1,885.98	2,789.49	2,834.30	2,727.33	2,764.40	2,095.33	1,762.82	1,241.03	1,554.61	2782.7	1250.74
1993	8,365.69	1,016.36	9,505.26	1,351.74	1,206.16	1,351.39	1,161.48	8,647.24	7,651.78	8,830.28	8,307.18	1,429.59	4902.0	3835.48
1994	7,596.17	8,388.87	9,181.57	8,466.90	9,207.54	9,948.17	9,803.26	9,658.35	1,497.92	4,689.69	7,881.47	9,009.11	7944.1	2475.59
1995	1,295.18	1,217.14	8,028.99	5,481.87	7,478.68	1,429.44	1,165.48	1,156.85	1,161.17	1,159.01	1,160.09	1,611.11	2695.4	2659.37
1996	1,002.95	1,437.33	1,849.15	1,848.10	1,825.34	2,072.76	1,811.06	2,218.05	2,310.06	2,808.98	3,307.90	3,403.91	2158.0	714.03
1997	4,480.52	5,352.18	6,180.59	5,664.65	5,372.50	6,141.33	6,038.96	6,645.60	6,773.48	6,750.37	6,869.71	7,222.22	6124.3	793.82
1998	7,464.73	8,402.39	8,319.60	8,318.31	7,836.21	7,947.26	7,305.16	7,298.06	8,192.32	7,933.69	7,651.50	7,107.50	7814.7	447.67
1999	6,549.60	6,274.90	5,507.10	5,115.10	4,988.90	4,772.30	4,708.20	4,971.00	5,032.10	5,343.50	5,021.90	5,424.60	5309.1	571.14
2000	5,789.20	6,494.80	6,682.80	6,692.60	6,786.80	7,272.40	7,634.90	7,958.60	8,118.10	8,788.50	9,484.40	9,386.10	7590.8	1186.46
2001	9,705.00	10,016.25	10,787.50	10,176.30	10,353.70	10,166.70	10,389.90	10,204.00	10,563.90	10,581.68	10,117.80	10,267.10	10277.5	286.46
2002	9,668.78	9,768.47	9,546.10	9,403.40	9,226.30	8,674.70	8,143.03	8,089.20	7,424.00	7,741.90	7,737.10	7,681.10	8592.0	885.40
2003	7,134.42	7,655.06	8,226.16	8,216.82	8,269.57	7,673.09	7,643.95	7,448.96	7,170.46	7,305.84	7,489.55	7,467.78	7641.8	398.92
2004	8,324.00	9,352.40	9,684.49	9,975.91	10,083.87	11,441.36	12,228.31	12,482.40	13,222.90	14,657.00	16,345.40	16,955.02	12062.8	2799.23
2005	19,592.64	20,554.09	21,807.98	22,210.20	23,290.50	24,367.12	25,161.60	26,951.24	28,638.24	23,921.01	27,075.63	28,279.06	24320.8	2985.71
2006	31,317.94	34,319.11	36,201.54	33,063.87	34,094.35	36,479.00	38,074.22	39,247.82	40,457.86	41,477.69	42,441.55	42,298.11	37456.1	3786.52
2007	43,510.78	42,550.61	42,633.86	43,530.55	43,168.67	42,626.20	43,263.88	45,010.40	47,930.22	49,209.74	49,963.62	51,333.15	45394.3	3263.67
2008	54,215.79	56,908.42	59,756.51	60,815.85	59,180.14	59,157.15	60,342.13	60,201.74	62,081.86	58,534.15	57,480.50	53,000.36	58472.9	2681.94
2009	50,108.65	48,113.06	47,081.96	45,914.47	44,836.40	43,462.74	43,351.39	41,754.31	43,343.33	43,054.77	43,024.68	42,382.49	44702.4	2572.96
2010	42,075.67	41,410.10	40,667.03	40,322.01	38,815.79	37,468.44	37,155.19	36,769.65	34,589.01	33,597.02	33,059.30	32,339.25	37355.7	3390.02
$\bar{X}_j$	7322	7428	7972	7561	7510	7354	7395	7659	7707	7760	7824	7791		
S_j	13077	13203	13360	13344	13113	13126	13342	13380	13809	13448	13559	13298		

Note: $\bar{X}_i$ and S_i are respectively the periodic/yearly average and standard deviation while $\bar{X}_j$ and S_j are monthly average and standard deviation respectively.

Data source: Central Bank of Nigeria (CBN)

Table 3: Yearly Relative Percentage Change in Nigerian External Reserve for the period 1960 – 2010

Year	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
RPC	44.7	44.7	44.7	44.7	44.7	44.7	44.7	44.7	44.7	44.7	44.7	73.8	12.4	72.1	672.3	-2.5	-7.9	-8.5	-37.3	154.8	77.8
Year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
RPC	-52.8	-37.9	-81.2	216.4	192.3	116.7	228.1	-34.0	-29.3	34.1	3.6	-62.2	-82.9	18.6	24.4	239.4	61.2	-4.8	-17.2	62.1	5.8
Year	2002	2003	2004	2005	2006	2007	2008	2009	2010												
RPC	-20.6	4.7	103.7	44.3	35.1	18.0	-2.2	-15.4	-23.1												

Table 4: Summary of the Regression Analysis when Trend-Cycle $((M_t^* = a + bt))$ is Linear

Parameter	Estimate	Standard error	T-value	P-value
a	4.5295	0.1335	33.92	0.00
b	0.0097	0.0002	49.47	0.00
β_2	0.0046	0.1694	0.03	0.98
β_3	0.1027	0.1694	0.61	0.55
β_4	0.0229	0.1694	0.14	0.89
β_5	0.0177	0.1694	0.10	0.92
β_6	-0.0455	0.1694	-0.27	0.79
β_7	-0.0477	0.1694	-0.28	0.78
β_8	-0.0190	0.1694	-0.11	0.91
β_9	0.0112	0.1694	0.07	0.95
β_{10}	0.0589	0.1695	0.35	0.73
β_{11}	0.0011	0.1695	0.01	0.10
β_{12}	0.0812	0.1695	0.48	0.63
MAPE	9.8392			
MAD	0.6783			
MSD	0.7185			

The MAPE, MAD and MSD for the quadratic trend-curve are respectively 9.8506, 0.6791 and 0.7185.

Table 5: Model Estimates

Model	Coefficients	Semi- robust Standard error	Z-value	P > Z
AR (1)	0.9979	0.0022	452.71	0.000
MA (1)	-0.4075	0.1025	-3.98	0.000
MA (5)	0.1454	0.0534	2.72	0.007
$\hat{\sigma} = 0.3003$; N = Number of observations = 611; log-pseudo likelihood = -134.52; Wald Chi-square $(\chi^2) = 378740.09$

Figure 1: A Time Series Plot of the Logarithm Transformed External Reserve Data (Y_t)

Figure 2: Linear Relationship between the Logarithms of the Yearly Averages and Standard deviation

Figure 3: A Line Plot of the Periodic Average and Standard Deviation of the Logarithm Transformed External Reserve Data (Y_t) (1960- (2010))

Figure 4: ACF of the Logarithm Transformed External Reserve Data (Y_t) (1960- (2010))

Figure 5: PACF of the Logarithm Transformed External Reserve Data (Y_t) (1960- (2010)

Figure 6: ACF of the Irregular component of Logarithm Transformed External Reserve Data (Y_t) (1960- (2010)

Figure 7: ACF of the First order differenced Series of the Logarithm

Transformed External Reserve Data (Y_t) (1960- (2010))

Figure 8: PACF of the First order differenced Series of the Logarithm

Transformed External Reserve Data (Y_t)
(1960- (2010))

7 References

- [1] Abdullateef U. and Waheed T (2010). External reserve holdings in Nigeria: Implications for investment, inflation and exchange rate. *Journal of economics and International Finance* Vol. 2(9), pp. 183 – 189, September 2010. www.academicjournals.org/JEIF
- [2] Akpanta, A. C. and I. S. Iwueze (2009). On applying the Bartlett transformation method to time series data, *Journal of Mathematical Sciences*, Vol. 20, No. 3, pp. 227-243.
- [3] Box, G. E. P, Jenkins, G. M. and Reinsel, G. C.(1994). *Time Series Analysis: Forecasting and Control*. 3rd ed., Prentice-Hall, Englewood Cliffs, N. J.
- [4] Buys –Ballot, C. H. D. (1847). *Leo Claement Periodiques de Temperature*, Utrech, Kemint et Fils.
- [5] Delurgio, S. A. (1998). *Forecasting Principles and Applications*, McGraw-Hill, New York.
- [6] Iwueze, I. S. and E. C. Nwogu (2004). Buys-Ballot estimates for time series decomposition, *Global Journal of Mathematics*, Vol. 3, No. 2, pp 83-98.
- [7] Iwueze, I. S. and J. Ohakwe (2004). Buys-Ballot estimates when stochastic trend is quadratic, *Journal of the Nigerian Association of Mathematical Physics*, Vol. 8, pp 311-318.
- [8] Iwueze, I. S. and E. C. Nwogu (2005). Buys-Ballot estimates for exponential and s-shaped curves, for time series, *Journal of the Nigerian Association of Mathematical Physics*, Vol. 9, pp 357-366.
- [9] Iwueze I.S, Nwogu E.C., Ohakwe J and Ajaraogu J.C, (2011).New Uses of Buys-Ballot Table. *Applied Mathematics*, 2011, 2. 633 – 645. DOI: 10.4236/am.2011.25084.
- [10] www.SciRP.org/journal/am
- [11] Magnus, O. A. (2007). Foreign Exchange Reserves Accumulation: "Implication for the Nigerian Economy". Central Bank of Nigerian Working paper, pp. 31 – 43.
- [12] McConnell, C.R and Brue, S.L (1986). *Macroeconomics: Principles, Problems and Policies*, 13th ed. McGraw – Hill Inc. New York.
- [13] Ogbonna, E and Harris, L.C (2003)> Innovative organizational structures and performance. A case study of structural transformation to groovy community centers. *Journal of organizational change management*, 16 (5): 512 – 533.
- [14] Russel G and Tom T (2007). Are High Foreign Exchange reserve in Emerging Markets a Blessing or a Burden? *Ocassional paper* No. 6, March 2007.
- [15] Wei, W.W.S. (1990). *Time series Analysis, Univariate and Multivariate Mehtod*, Addison-Wesley California