

Full Length Research Paper

Comparative analysis of modes of monetary exchange rates in Nigeria

Joseph N. Mojekwu^{1*}, Okwy P. Okpala² and Ismail A. Adeleke³

¹Department of Actuarial Science and Insurance, University of Lagos, Lagos, Nigeria.

²Department of Accounting, University of Lagos, Lagos, Nigeria.

³Department of Actuarial Science and Insurance, University of Lagos, Lagos, Nigeria.

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The study examined and compared the three modes of monetary exchange rates available in the Nigerian financial sector. The study utilized the data on the three alternative modes of monetary exchange rates, namely, Central Bank of Nigeria, Bureau de Change rates and Inter-bank rate against US Dollar. Time series was fitted to the three sets of data and the result examined for effective comparison. The results reveal that Central Bank of Nigeria yields the most stable exchange rate while Bureau de Change rates and the Inter-bank exchange rates fluctuate over the periods. Autoregressive integrated moving average (ARIMA) model was used to fit time series to the three sets of data. Findings reveal that there are variations in the performances of the three modes of exchange rates against US Dollar. The study concluded that Central Bank of Nigeria exchange rate is most stable while Bureau de Change and Inter-bank exchange rates to US Dollar fluctuate over the period under investigation.

Key words: Exchange rates, time series, exponential smoothing, Nigerian financial sector.

INTRODUCTION

The evolution of Nigerian foreign exchange market was influenced by such factors as the changing patterns of international trade, Institutional changes in the economy and structural shifts in production (CBN, 2011). Initially, Nigerian pound was tied to British pound sterling at par and active foreign exchange market did not develop until early nineteen seventies. The oil boom experienced in nineteen seventies led to enhanced foreign exchange receipts; hence, the need to develop a local foreign exchange market became paramount. The increase in demand for foreign exchange in the year 1982 when supply was shrinking encouraged the development of parallel market for foreign exchange. Consequently, comprehensive exchange controls were applied to deal with the crisis.

The inability of the Exchange Control System to evolve a mechanism for foreign exchange allocation that will ensure internal balance led to the introduction of second-

tier foreign exchange market (SFEM) in September 1986. Under SFEM, the determination of the naira exchange rate and allocations of foreign exchange were based on market forces. In order to enlarge the scope of the Foreign Exchange Market, Bureau de Change was introduced in 1989 to cater for privately sourced foreign exchange.

Further reforms were introduced in 1994 to cater for volatility in rates. These included the formal pegging of the naira exchange rate, the centralisation of foreign exchange in the CBN, the restriction of Bureau de Change to buy foreign exchange as agents of the CBN, the reaffirmation of the illegality of the parallel market and the discontinuation of open accounts and bills for collection as means of payments.

The Foreign Exchange Market was liberalised in 1995 with the introduction of an autonomous foreign exchange market (AFEM) for the sale of foreign exchange to end-users by the CBN, through selected authorised dealers at market determined exchange rate. In addition, Bureau de Change was once more accorded the status of authorized buyers and sellers of foreign exchange. The

*Corresponding author. E-mail: jnmoje@yahoo.com.

Foreign Exchange Market was further liberalized in October, 1999 with the introduction of an inter-bank foreign exchange market (IFEM).

The Dutch auction system (DAS) was introduced in the year 2001 and the objectives include to:

- i. determine the exchange rate of the Naira through interplay of demand and supply;
- ii. Conserve external reserve position;
- iii. Reduce to the barest minimum the premium between official rate and that of the parallel market and or the bureau de change rates.
- iv. Ensure stability of the naira exchange rate.

A review of Dutch auction system (DAS) later led to the introduction of wholesale Dutch auction system (WDAS) in the year 2006. The difference between retail DAS and WDAS are as follows:

- i. Under the retail DAS, end-users were allowed to bid through their banks.
- ii. Under the WDAS, authorised dealer (banks), bid on their accounts and the successful banks would then sell to their customers.
- iii. As a result of successful consolidation of bank, the number of banks has reduced from 89 to 25 banks. That means only successful banks among the 25 banks would buy up the foreign exchange offered to the market.
- iv. The exchange rate under the new WDAS has stabilized and continued to improve the operations of the foreign exchange market.

The Inter-bank market helped to stabilize supply gaps between auctions.

LITERATURE REVIEW

One of the important variables that have considerable influence on other socio-economic variables in Nigeria is the Nigerian naira / dollar exchange rate (Ismail, 2009). The economies of all countries of the world are linked directly or indirectly through assets or goods markets. This linkage is made possible through trade and foreign exchange (Umar and Soliu, 2009). Ismail (2007) found evidence to suggest that alignment of exchange rates has a critical influence on the rate of growth of per capita output in low income countries.

In the period between 1970 and 2010, Nigeria's financial system has been bedeviled with series of fiscal and monetary policy changes (Ismail, 2009). The changes that characterize the period include trade liberalization, economic deregulations and actual devaluation of naira (Babatope-Obasa, 2004). Structural adjustment programme (SAP) introduced in mid 1980s led to devaluation of naira against other currencies (Obatan, 1994). A substantial increase in price of petroleum and the attendant official increase in minimum

wage in 1991 contributed to inflation, which in turn had impact on naira-dollar exchange rates. The implementation of about 300% increase in salaries and wages of public servants in 1999 also led to a jump in naira – dollar exchange rates.

Nigeria, like many other low income open economies, has adopted the two main exchange regimes. Direct administrative control exchange rate was used until 1986, when the country changed over to market regulated regime. Since the adoption of market regulated regime, Nigeria has, and is still, experimenting with various market arrangements. As an integral part of Structural Adjustment Programme introduced in 1986, Nigeria adopted the flexible exchange rate through Second-tier Foreign Exchange Market (Umar and Soliu, 2009). Since then, several variants (Auction System, Dutch Auction System, Wholesale Dutch Auction System, and Rental Dutch Auction System) have been operated in determining the exchange rate of naira to US dollar.

Presently, there are three modes of monetary exchange rate available in Nigeria: The Central Bank rate, Bureau de Change rate and Inter-bank rate. Umar and Soliu (2009) established that exchange rate under Dutch Auction System (Central Bank rate) converge to long term equilibrium.

Ezirim and Ojukwu (2002); and Ezirim and Muoghalu (2004) posited that Foreign Direct Investment growth affect exchange rate positively. Obaseki (1997) examined the convergence of foreign exchange in the sense of unifying all foreign exchange rate (that is, parallel and official) into a single realistic one. Umar and Soliu (2010) examined whether Interbank Foreign Exchange Market and Dutch Auction System (CBN) would bring about a long run equilibrium in Nigeria Foreign Exchange rate. This paper is interested in analyzing the three allocative arrangements for foreign exchange and determining how they may affect long term stability of exchange rate.

Data

The study employed secondary data sourced from the statistical bulletin of the Central Bank of Nigeria and annual publications of some selected Bureau de Change operators. The study covers the period of thirty-five years from 1974 to the year 2008.

METHODS

Autoregressive integrated moving average (ARIMA) models

The ARIMA modeling approach proposed by Box and Jenkins (1976) is recognized as a benchmark technique in modeling and forecasting methods because of its structured modeling basis and acceptable forecasting performance (Goh and Teo, 2000). ARIMA (p, d, q) are in theory and practice, the most general class of models for forecasting a time series data which can be stationarized by transformation such as differencing and logging of the series Y_t .

The non-seasonal ARIMA model is classified as an ARIMA

Table 1. Summary descriptive statistics for the monetary exchange rates.

Statistics	CBN DAS/WDAS rate	Bureaux de Change	Interbank rate
Mean	126.30	131.95	126.60
Standard error	0.79	1.42	0.86
Median	128.28	130.02	128.39
Mode	132.85	119.00	128.43
Standard deviation	5.47	9.86	5.97
Kurtosis	-1.06	-1.37	-1.06
Skewness	-0.62	0.11	-0.48
Minimum	117.72	118.70	116.79
Maximum	133.23	148.46	135.94
90th percentile	130.81	142.33	132.55
10th percentile	117.98	119.57	117.79

Source: Authors' computation from the study.

(p, d, q) model, where p is the number of autoregressive terms, d is the number of non-seasonal differences, and q is the number of lagged forecast errors in the prediction equation. An auto regressive integrated moving average (ARIMA) model predicts future values of a time series by a linear combination of its past values and a series of errors $\{a_t\}$. For a response series $\{y_t\}$, the general form for the ARIMA model is:

$$\phi(B)(W_t - \mu) = \phi(B)a_t$$

where t is the time index, B is the lag operator defined as $B y_t = y_{t-1}$, $W_t = (1 - B)^d y_t$ is the response series after differencing and μ is the intercept or mean term. Contrariwise, in seasonal ARIMA modeling, the differencing, autoregressive, and moving average operators are the product of seasonal and non-seasonal polynomials. Thus, we have

$$W_t = (1 - B)^d (1 - B^s)^D y_t$$

where 's' is the number of periods in a season. The seasonal ARIMA models are denoted as seasonal ARIMA (p, d, q) (P, D, Q)s, where the additional orders are seasonal autoregressive order (P), seasonal differencing order (D) and seasonal moving average order (Q).

Model performance evaluation methods

In the pool of model selection criteria, the article considers the Bayesian information criterion (BIC) and Akaike information criterion (AIC) in addition to the R^2 for model performance exercises. Given that the residual sum of squares, RSS of our model is defined as $RSS = \sum_{i=1}^n \hat{\epsilon}^2$ with n samples and k parameters, then the BIC is

$$BIC = n \ln \left(\frac{RSS}{n} \right) + k \ln(n)$$

In the general case, the AIC is

$$AIC = 2k - 2 \ln(L)$$

where k is the number of parameters in the model and L is the maximum of the likelihood function for the model. With the correction for finite sample sizes, the corrected AIC is

$$AIC_c = AIC + \frac{2k(k + 1)}{n - k + 1}$$

AIC_c was proposed by Hurrich and Tsai (1989) although AIC has theoretical advantage over BIC (Burham and Anderson, 2002) since it was derived from principles of information and can be derived in the same framework as BIC simply by using a different prior. Further, Yang (2005) argued that AIC is asymptotically optimal in selecting model with the least mean square error. In this article we consider the AIC as appropriate model evaluation method. The procedure selects the best model with the least AIC. Using the AIC results in Tables 2 to 4, we can generally state with high degree of confidence that the time series of the monetary exchange rates can be modeled as the additive version of winter's method of exponential smoothing is

$$y_t = \mu_t + \beta_t t + s(t) + a_t$$

where, α_t is the time-varying mean term, α_t is the time-varying slope term, $s(t)$ is one of the s time-varying seasonal terms, a_t are the random shocks.

The smoothing equations in terms of weights ϕ , ω , and ϑ are

$$\begin{aligned} L_t &= \phi(y_t - S_{t-s}) + (1 - \phi)(L_{t-1} - T_{t-1}) \\ T_t &= \omega(L_t - L_{t-1}) + (1 - \omega)T_{t-1} \\ \text{and } S_t &= \vartheta(y_t - L_t) + (1 - \vartheta)S_{t-s} \end{aligned}$$

where, L_t is smoothed level, T_t is a smoothed trend that estimates B_t , S_{tj} for $j = 0 \dots s-1$ are the estimates of the $s(t)$. This model is equivalent to a seasonal ARIMA (0, 1, s+1) (0, 1, 0)s model of the form

$$(1 - B)(1 - B^s)y_t = (1 - \sum_{i=1}^{s+1} \theta_i B^i)a_t.$$

RESULTS ANALYSIS AND DISCUSSION

The results in Table 1 show the summary of descriptive statistics of the three available monetary exchange rates of Nigerian currency (naira) against the dollar. The

Table 2. Summary of model performance statistics for CBN DAS/WDAS rate.

Model	Variance	AIC	SBC	Rsquare	-2LogLH
AR (1)	2.35	45.00	48.74	0.92	41.41
MA (1)	9.22	110.62	114.36	0.68	108.47
IMA (1, 1)	2.25	42.19	45.89	0.93	36.33
Seasonal ARIMA (0, 0, 0) (1, 1, 1)12	3.78	53.84	58.59	0.74	76.26
Simple exponential smoothing	2.36	42.45	44.30	0.92	39.44
Double (brown) exponential smoothing	2.32	40.72	42.55	0.92	37.82
Linear (holt) exponential smoothing	2.36	43.47	47.13	0.92	37.61
Damped-trend linear exponential smoothing	2.27	44.51	50.06	0.93	35.68
Seasonal exponential smoothing	2.71	38.95	42.06	0.85	49.24
Winters method (additive)	2.28	34.91	39.57	0.88	42.82

Source: Authors' computation from the study.

Table 3. Summary of model performance statistics for Bureaux de change.

Model	Variance	AIC	SBC	Rsquare	-2LogLH
AR (1)	10.73	117.92	121.66	0.89	113.97
MA (1)	29.85	167.02	170.77	0.68	164.87
ARIMA (1, 1, 1)	10.31	115.64	121.20	0.90	106.88
IMA (1, 1)	10.30	113.63	117.33	0.90	107.81
I (1)	10.95	114.48	116.33	0.89	292.42
Seasonal ARIMA (0, 0, 0) (1, 1, 1)12	27.60	125.45	130.20	0.35	136.77
Simple exponential smoothing	10.95	114.49	116.34	0.89	111.47
Double (brown) exponential smoothing	10.79	111.41	113.24	0.89	108.41
Linear (holt) exponential smoothing	11.03	114.43	118.09	0.89	108.40
Damped-trend linear exponential smoothing	10.36	115.89	121.44	0.90	107.09
Seasonal exponential smoothing	12.87	93.42	96.53	0.75	103.71
Winters method (additive)	11.47	91.38	96.05	0.79	99.43

Source: Authors' computation from the study.

Table 4. Summary of model performance statistics for interbank rate.

Model	Variance	AIC	SBC	Rsquare	-2LogLH
AR(1)	6.63	94.76	98.51	0.82	90.48
ARIMA (1, 1, 1)	6.72	95.51	101.06	0.82	86.80
MA (1)	13.26	128.06	131.80	0.62	125.90
IMA (1, 1)	6.65	93.04	96.74	0.82	87.26
I (1)	6.82	92.20	94.05	0.81	270.15
Seasonal ARIMA (0, 0, 0) (1, 1, 1) 12	11.68	94.49	99.24	0.56	100.72
Simple exponential smoothing	6.82	92.21	94.06	0.81	89.19
Double (brown) exponential smoothing	6.74	89.77	91.59	0.81	86.77
Linear (holt) exponential smoothing	6.89	92.78	96.44	0.81	86.76
Damped-trend linear exponential smoothing	6.77	95.89	101.44	0.82	87.10
Seasonal exponential smoothing	7.51	74.55	77.66	0.65	84.84
Winters method (additive)	6.80	73.07	77.74	0.70	80.43

Source: Authors' computation from the study.

computed statistics are the mean, standard error, median, mode, standard deviation and kurtosis. Also from

the descriptive statistics results are the skewnesses which indicate the degree of departure from symmetry of

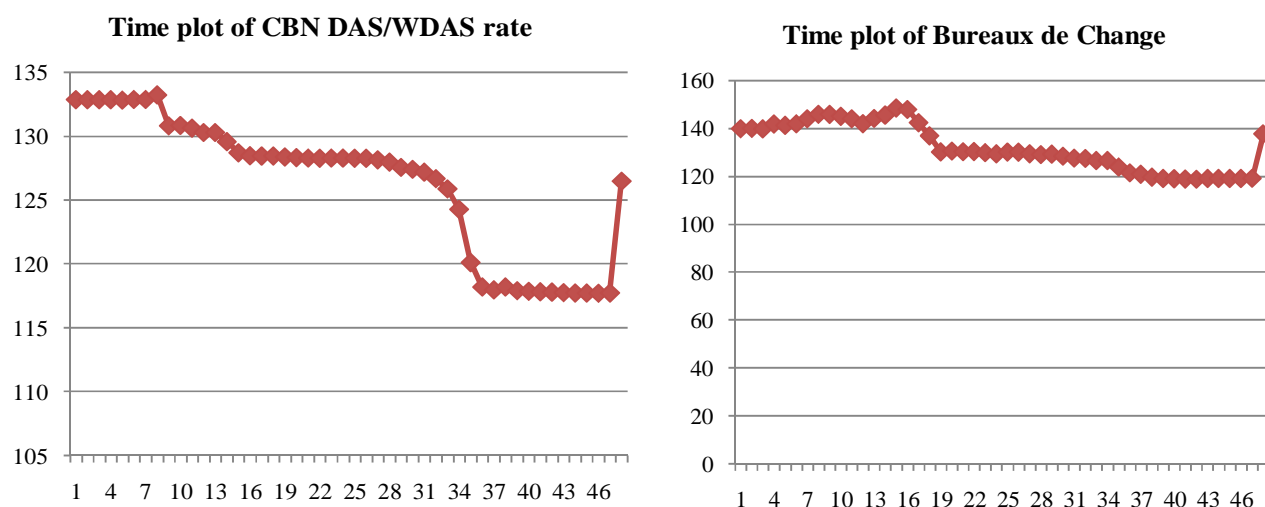


Figure 1. Time plots of the three modes of monetary exchange rates.

a distribution from normal (Ibiwoye and Adeleke, 2008). The study examined the skewness of the rates to determine the direction of their movement.

Preliminary exploratory data analysis (EDA) results show that CBN and Interbank rates are negatively skewed, though the magnitude of the skewness is quite small. On the other hand, all the rates have negative kurtosis: -1.06 for CBN, -1.37 for Bureau de change and -1.06 for interbank. For the period under study, the average exchange rate was highest in Bureau de (131.95) with the CBN having the least rate of 126.30. Most of the business days, the exchange rates for CBN is 132.85, 119.00 for Bureau de change and 128.43 for interbank. Fifty percent of the rates in CBN are greater than 128.28 with a maximum of 133.23; 50 percent of rates in interbank is greater than 128.39 with a maximum of 135.39. The afore-stated descriptive can easily be noticed from the series of plots in Figure 1.

Conclusion

The study compared Central Bank of Nigeria exchange rates, Bureau de Change rates and Inter-bank exchange rates over a period of thirty-five years. The study utilized autoregressive model to compare the trends of each of the modes of exchange rates. The study further applied model performance evaluation methods so as to have effective comparative analysis of the modes of monetary exchange rates available in Nigerian financial sector against US dollars.

The study concluded that although, there are variations in modes of monetary exchange rates against US dollars in Nigeria over the period under investigation, Central Bank of Nigeria exchange rate seems to be more stable amongst the three modes. Furthermore, the results of the study reveal that the other two modes of exchange rates;

Bureau de Change and Inter-bank fluctuate from time to time against US dollar.

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