e - ISSN - 2348 - 2168
Print ISSN - 2348 - 215X

Acta Biomedica Scientia

Journal homepage: www.mcmed.us/journal/abs

EXCHANGE RATE VOLATILITY AND STATIONARITY: A NIGERIA-UNITED STATES RELATIONSHIP

Ibraheem A.G, Raji I.I. and Adetunji A.A.*

Department of Mathematics and Statistics, Federal Polytechnic Ado-Ekiti, Ekiti State, Nigeria, West Africa.

Article Info

Received 29/04/2015
Revised 16/05/2015
Accepted 19/06/2015

Keywords :-
Exchange Rate, Non-Stationarity, Volatility, Autocorrelation Function.

ABSTRACT

This paper examines trends in exchange rate of Nigeria Naira to U.S. Dollar from 1970 to 2007. Using method of Autocorrelation Function (ACF), it was observed that the series are non-stationary. An autoregressive conditional heteroscedasticity (ARCH) reveals that the series is statistically non-volatile. The results show that time series data can be statistically non-volatile even when such series is non-stationary.

INTRODUCTION

It is a general notion that volatility of the exchange rates of developing countries like Nigeria is one of the main sources of economic instability around the world. Its impact on is driven significantly by swings in the currencies of the major economic powers like United State. Recently, these swings have been enormous, volatile and frequently unrelated to underlying economic fundamentals [1].

The result of this has prompted monetary authorities in developing countries that keep close trade ties with the developed nations to intervene on totally ad hoc and episodic basis, without any clear sense of a sustainable equilibrium. Such exchange rate stability intervention typically comes too late to prevent severe currency misalignment and volatility. These imbalances, in turn, trigger major economic distortions, protectionist trade pressures, and inevitably sharp currency reversals [1]. Though, currency instability and volatility could only exist during flexible exchange rate regime where the cross-country exchange rate is determined by the forces of demand and supply. The liberalization of capital flows in developing countries over the last decades and the enormous increase in the scale and variety of cross-border financial transactions have clearly increased the magnitude of exchange rate movements in most countries with underdeveloped capital markets and where there is not yet a track record of consistently stable economic policies. Currency crises in emerging markets, which have become more frequent in the last two decades, are especially notable cases of large exchange rate volatility [2]. Also, the transition to a market-based system often involves major adjustments in the international value of these economies' currencies. Other changes in the world economy may have reduced the impact of exchange rate volatility. For multinational firms, fluctuations in different exchange rates may have offsetting effects on their profitability [2]. As a growing fraction of international transactions is undertaken by these multinational firms, exchange rate volatility may have a declining impact on world trade. On the balance, it is not certain whether the major changes in the world economy over the past two decades have operated to reduce or increase the extent to which international trade is adversely affected by fluctuations in exchange rates. One aspect of this issue is the extent to which such volatility itself has changed, and another is the degree to which firms

Corresponding Author

Adetunji A.A
Email: - adecap4u@yahoo.com

are sensitive to exchange rate risk and can take steps to mitigate it at low cost.

Rate of exchange regime varies with the level of financial development. Throughout the developing world, the choice of exchange rate regime stands as perhaps the most contentious aspect of macroeconomic policy [3]. Witness, on the one hand, the intense international criticism of Africa's inflexible exchange rate system and on the other hand, West African policy makers are chastised for not doing enough to stabilize their country's highly volatile currency. Despite the perceived implications of the exchange rate regime to long- run growth and economic stability, the existing theoretical and empirical literature on Africa (Nigeria in particular considering the level of the country's economic integration through trade and foreign capital inflows) offers little guidance.

Financial time series often exhibit phenomenon of volatility clustering, that is, periods in which values show a wide swing for an extended time period followed by periods in which there is relative calm. It is a general assumption that if a series is non-stationary, it is most likely to be volatile. Using U.S.-U.K. (dollar per pounds) exchange rate for the period of 276 months (1973 to 1995) to study volatility in exchange rate [4] finds that there are considerable ups and downs in the exchange over the sample period. He plots the changes in the logs of the exchange rate (relative changes) and observes that the exchange rate shows a wide swings in other time periods thus exemplifying the phenomenon of volatility clustering. He used ARCH(1) model to statistically establish the volatility in the exchange rate.

[5] use U.S. Consumer Price Index (CPI) data from 1947 to 2001 to test the presence of ARCH effect in the U.S. inflation rate. The plot of the logarithms of the CPI shows that the time series data is non-stationary but the plot of the first differences of the logs of the CPI shows a considerable volatility even though the first differences are stationary.

[6] examines exchange rate volatility and export trade in Nigeria in order to quantitatively assess the impact of exchange rate volatility on non-oil export flow in Nigeria. He employed fundamental analysis where the flow of non-oil exports from the Nigerian economy is assumed to be predicated on fundamental variables such as: the naira exchange rate volatility, the US dollar volatility, Nigeria's terms of trade and index of openness. His empirical results show the presence of unit root and as expected, the hypothesis of non-stationarity was rejected at first difference. Cointegration results reveal that a stable long run equilibrium relationship exists between non-oil exports and the fundamental variables. Using quarterly observations for twenty years, vector cointegration estimates reveal that the naira exchange rate volatility decreased non-oil exports by 3.65% while the same estimate for the US dollar volatility increases export of non-oil in Nigeria by 5.2% in 2003. He recommends measures that would promote greater openness of the economy and exchange rate stability in the economy.

Despite the saturation of the literature with studies on exchange rate volatility, the literature is still scanty with respect to developing countries. [3] seeks to analyze the relationship between exchange rate regimes and short-term volatility of the effective real exchange rate. The aim of their study was to set out the relative importance of these links, specifically by analyzing the exchange rate regime influence on the RER volatility using a dynamic panel data analysis. For this ends a sample of 92 countries for the 1980-1999 period was considered. The study finds evidence on how other variables influence RER volatility and it also analyses the persistence of shocks in RER. The study further finds more evidence of more openness, acceleration in per capita GDP growth, reduction in volatility. Conversely, positive monetary shocks and growth in capital inflows and in public expenditure increase this real volatility. Evidence from the study also supports the view that the analysis of the dynamics of the exchange rate regimes needs to differentiate between developed and developing countries.

[7] studied the daily volatility of the exchange rate between the US Dollar and 43 other currencies in 1990-2001. The study uses several macroeconomic variables, that proxy for the domestic economy uncertainty, wealth, and openness to international markets, as controls in the analysis. The well-known GARCH statistical behavior of exchange-rate volatility was also accounted for. The main finding of the study was that exchange rate volatility was positively correlated with the real domestic interest rate and with the degree of central bank intervention. In the panel, the study finds positive correlations between exchange rate volatility, real interest rates and the intensity of central bank intervention. Most of the studies on exchange rate volatility in Nigeria measure the impacts of exchange rate volatility on trade balance with little attention to other internal macroeconomic variable shocks. For instance, [8] explored the exports and imports effects of exchange rate volatility with specific reference to the non Communaute Financiere Africaine (non-CFA) countries of Africa during the period, 1986 – 2006. The countries chosen included Ghana, Lesotho, Malawi, Nigeria, Sierra Leone, South Africa, Uganda and Zambia. A GARCH approach was employed to generate on annual basis the real exchange rate volatility series for each country. The study reveals a negative effect of exchange rate volatility on exports and imports in the selected African countries. The adverse effect of exchange rate volatility on exports in the sampled countries, as found in the study suggests the need for policy interventions that will help to minimize and, where possible, eradicate exchange rate volatility.

Also, [9] investigated the relationship between nominal exchange rate volatility and dollarization in Nigeria by applying Granger causality test for the period 1986–2003

using quarterly data. The study reported a bi-causality between them but the causality from dollarization to exchange rate volatility appears stronger and dominates. He however concluded that policies that aim to reduce exchange rate volatility in Nigeria must include measures that specifically address the issue of dollarization. But, the exact measure of exchange rate volatility in the study was not reported. Also, [10] investigated the relationship between exchange rate volatility and Foreign Direct Investments (FDI) inflows in Sub- Saharan Africa using Nigeria and South Africa as case studies. By endogeneizing exchange rate volatility, the study uses a two – stage Least Squares methodology. The study finds that in Nigeria, there is a statistically significant relationship between the variables, with exchange rate volatility retarding FDI inflows and FDI inflows increasing exchange rate volatility. As revealed by the study, this relationship is however weak for South Africa. The possible reason adduced by the study is the sound capital flow management policy of the South African Reserve Bank.

[11] examines the pass-through of exchange rate to both domestic price level and output in Nigeria using a Vector Auto-Regressive (VAR) model that incorporates a distribution chain with the Nigerian real annual data (oil price, exchange rate, money supply, output and CPI) from 1970 to 2006. The study, though establishes long run relationships among the variables employed, finds no evidence of any exchange rate volatility induced inflation and growth (both in the short and long-run) in the period under consideration. On the other hand, much of the variability in the domestic price level, apart from its own shock, has been explained significantly by both output and money supply shocks. Hence, the policy implication here is that the volatility of exchange rate has no significant effect on domestic inflation and output in Nigeria. Therefore, domestic policies (monetary or fiscal) could play a significant role in controlling domestic inflation and output variability in Nigeria.

[12] study the effect of the trends in exchange rates on Stock Markets and Foreign Exchange Market in Ghana. The Exponential Generalized Autoregressive Conditional Heteroscedasticity (EGARCH) model was used to establish the relationship between exchange rate volatility and stock market volatility. It was found that there is negative relationship between exchange rate volatility and stock market returns – a depreciation in the local currency leads to an increase in stock market returns in the long run. Additionally, they found volatility persistence in most of the macroeconomic variables; current period's rate has an effect on forecast variance of future rate. It was also revealed that an increase (decrease) in trade deficit and expectation in future rise in trade deficit will decrease (increase) stock market volatility. They found that the consumer price index has a strong relationship with stock market volatility indicating that an increase in consumer price will lead to a rise in stock market volatility. Finally, they found leverage effect and volatility shocks in stock returns on the Ghana Stock Exchange.

MATERIALS AND METHOD

The dataset used for this research work is from Nigerian Foreign Exchange Rate from 1970 to 2007 from Central Bank of Nigeria's Statistical Bulletin, 2008.

One of the simple tests of stationarity is the autocorrelation function (ACF). The ACF at lag *k*, denoted by ρ_k, is defined as

$\rho_k = \frac{\gamma_k}{\gamma_0}$, where Y_k is the covariance at lag k and Y_0 is the variance

The values of ρ_k lies between -1 and +1, as any correlation coefficient does. In any time series, if the autocorrelation at various lags hover around zero, such series is said to be stationary. However, if the autocorrelation coefficients at various lags are very high and possible declining as the lag lengthens, such series are non-stationary. To test for stationarity of exchange rate using Autocorrelation Function (ACF), a rule of thumb is to compute ACF up to one-third to one-quarter the lag length of the time series. Since both variables under consideration are 38 years, by this rule lag length 12 will be sufficient.

In order to use ARCH to test for volatility, the mathematical procedures to be followed are: (assuming the variable to be tested is *Y*)

Obtain $Y_t^* = \log Y_t ; \Delta Y_t^* = Y_t^* - Y_{t-1}^*$; $\Delta \bar{Y}_t^*$, the mean of ΔY_t^* $X_t = \Delta Y_t^* - \Delta \bar{Y}_t^*$, the mean-adjusted relative change in the exchange rate.

Therefore, X_t^2 is used as measure of volatility. X_t^2 is used and not variance of X_t, $Var(X_t) = \Sigma X_t^2 / n$, because in order to take changing volatility of exchange rate over time into account. If $Var(X_t)$ is used, it will give a single value for the given data set.

After the volatility measures are obtained, an autoregressive model of order *p*, AR (*p*) is formulated: $X_t^2 = \beta_0 + \beta_1 X_{t-1}^2 + \beta_2 X_{t-2}^2 + \ldots + \beta_p X_{t-p}^2 + u_t$. In most econometric analysis however, only AR (1) model is usually significant. The existence of volatility in the series is ascertained if the coefficient of the lagged-volatility measure is found to be statistically significant, otherwise, the series is non-volatile.

RESULTS AND DISCUSSION

The table below gives the Autocorrelation of exchange rate (Naira to Dollar). The time plot above shows that there is an upward trend in the exchange rate of Naira to Dollar for the periods under review (1970 – 2007).

a. The underlying process assumed is MA with the order equal to the lag number minus one. The Bartlett approximation is used.
b. Based on the asymptotic chi-square approximation.

Since the autocorrelation coefficient starts at a very high value at lag 1 (0.923) and declines rapidly as the lag lengthens, this indicates that exchange rate (Naira to Dollar) is a non-stationary series. [5]. Regressing the volatility measure, X_t^2, on its one lagged period, X_{t-1}^2, the following results are obtained.

a. Dependent Variable: Volatility Measure

From the table above, the model for volatility measure is $X_t^2 = 0.018 - 0.036X_{t-1}^2$. Volatility measure is not significant at 5 percent level (P value of 0.833). Therefore, it can be concluded that the exchange rate of Nigeria Naira to U.S. Dollar is statistically non-volatile.

Figure 1. Time plot of exchange rate (naira to Dollar)

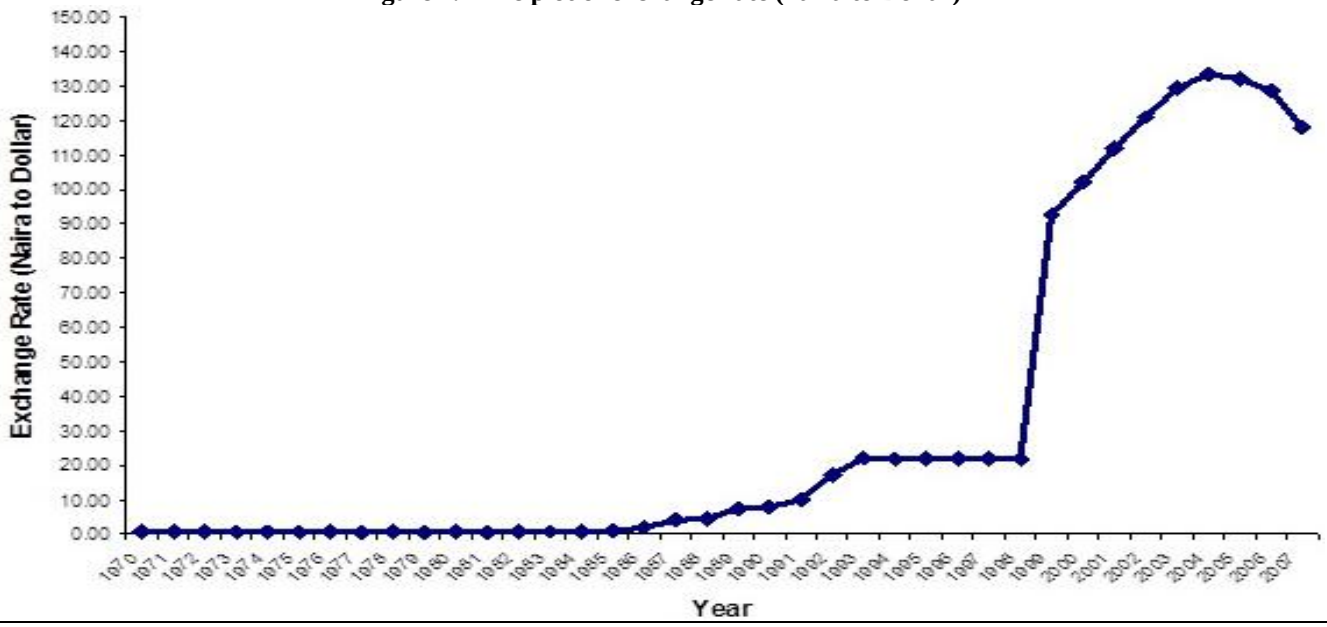

Table 1. Autocorrelations: Series: Exchange Rate (Naira to Dollar)

Lag	Autocorrelation	Std. Error	Box-Ljung Statistic		
			Value	df	Sig.
1	.923	.162	35.015	1	.000
2	.825	.267	63.733	2	.000
3	.713	.327	85.795	3	.000
4	.592	.366	101.447	4	.000
5	.469	.390	111.568	5	.000
6	.352	.405	117.451	6	.000
7	.242	.413	120.330	7	.000
8	.139	.416	121.315	8	.000
9	.051	.418	121.451	9	.000
10	.027	.418	121.492	10	.000
11	.000	.418	121.492	11	.000
12	-.030	.418	121.543	12	.000

Table 2. Model Summary table for regression of Volatility Measure on its one-lagged period.

Model Summary					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.036[a]	.001	-.028	.055698364	2.006

a. Predictors: (Constant), Volatility Measure Lag 1. b. Dependent Variable: Volatility Measure.

Table 3. ANOVA table for regression of Volatility Measure on its one-lagged period

ANOVA						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	.000	1	.000	.045	.833[a]
	Residual	.105	34	.003	-	-
	Total	.106	35	-	-	-

a. Predictors: (Constant), Volatility Measure Lag 1. b. Dependent Variable: Volatility Measure

Table 4. Coefficients for regression of Volatility Measure on its one-lagged period

Coefficients						
Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	**Std. Error**	**Beta**		
1	(Constant)	.018	.010	-	1.827	.076
	Volatility Measure Lag 1	-.036	.171	-.036	-.212	.833

CONCLUSION

From analyses carried out using autocorrelation function (ACF), it was found that exchange rate (Naira to Dollar) is a non-stationary series. Despite this non-stationarity, autoregressive conditional heteroscendasticity (ARCH) was used to test for the volatility of the series and surprisingly, it was found that exchange rate of Nigeria Naira to U.S. Dollar is statistically non-volatile. It is therefore relevant for researchers and policy analysts to follow statistical procedure in testing volatility even when series is non-stationary.

REFERENCES

1. Philippe A, Philippe B, Romania R and R Kenneth. (2006). Exchange Rate Volatility and Productivity Growth: The Role of Financial Development. NBER Working Paper (10.1.1.153.3468)
2. Carrera J and G Vuletin. (2003). The Effects of Exchange Rate Volatility: A Dynamic Panel Data Approach. http://www.ucema.edu.ar/conferencias/download/Carreras.pdf.
3. Calvo G and C Reinhart. (2002). Fear of Floating. *Quarterly Journal of Economics*, 117(2), 379-408.
4. Engle, R. (1996). Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United Kingdom Inflation. *Econometrica*, 50(1), 987 – 1007.
5. Gujarati DN and Sangeetha B. (2007). Basic Econometrics, 4th ed, *Tata McGraw-Hill, New Delhi.*
6. Aliyu S.U.R. (2008). Exchange Rate Volatility and Export Trade in Nigeria: An Empirical Investigation. *Unpublished PhD thesis, University of Abuja.*
7. Benita G and B Lauterbach. (2007). Policy Factors and Exchange rate Volatility: Panel Data versus a Specific Country Analysis. *International Research Journal of Finance and Eeconomics*, 7.
8. Akpokodje G. (2009). Exchange rate volatility and External Trade: The Experience of Selected African Countries. In. Adeola Adenikinju, Dipo Busari and Sam Olofin (ed.) Applied Econometrics and Macroeconomic Modelling in Nigeria. Ibadan University press.
9. Yinusa DO. (2008). Between dollarization and Exchange Rate Volatility: Nigeria's Portfolio Diversification Option. *Journal of Policy Modeling*, 30(5), 811-826.
10. Ogunleye ER. (2009). Exchange Rate Volatility and Foreign Direct Investment in Sub-Saharan Africa: Evidence from Nigeria and South Africa In. Adeola Adenikinju, Dipo Busari and Sam Olofin (ed.) Applied Econometrics and Macroeconomic Modelling in Nigeria. Ibadan University Press.
11. Olusegun AO. (2007). Exchange Rate Pass Through to Domestic Price and Output in Nigeria. *Economia Aplicada*, 11(3), 38-42.
12. Adjasi C, Harvey SK and Agyapong D. (2008). Effect of Exchange Rate Volatility on the Ghana Stock Exchange. *African Journal of Accouting, Economics, Finance and Banking Research*, 3(3), 28-47.