Exchange Rate and External Reserves in Nigeria: A Threshold Cointegration Analysis

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This paper models the long-run relationship between the Bureau De Change exchange rate and external reserves in Nigeria in a Threshold Vector Error Correction Model (TVECM) framework using daily data that spans from Jan 1, 2014 to Jul 31, 2015. Modeling BDC exchange rate and external reserves within this context can be motivated by the fact that the transition mechanism between the variables is controlled by the degree of BDC exchange rates premium which is within central bank of Nigeria's policy oversight. The supLM test result indicates that there is a non-linear long-run relationship between the series, providing empirical support in favor of a TVECM specification. Thus, Cointegration occurs when the divergence between the two variables is above the threshold point estimate. Two regimes are implied by the model: the "usual" regime, which accounts for 93.1per cent of the observations and the "unusual" one, representing about 6.9 per cent of the observations of the sample. We also find that the error correction coefficients for both the bureau de change exchange rate and external reserves equations were not statistically significant at the 5 per cent significance level. While in the second regime, error correction coefficient for the external reserves equation was found to be statistically significant at 10 per cent. This implies that the adjustment mechanism between the two variables flow from external reserves to BDC exchange rate.

Key Words: Bureau de Change Exchange Rates, External Reserves, Threshold Cointegration Analysis, Macro-economic policy

JEL Classification: F31, F33, C2

1.0 Introduction

Over the past three decades, Nigeria has implemented numerous policy initiatives and measures in the management of its external reserves. Although very little was achieved because the structure in place could not support sustainable external reserves management, hence fundamental lessons could be extracted from the nation's past experience. The World Bank (2014) stated that "mono product economies, especially those dependent on oil would remain vulnerable due to volatility of oil prices". Since the 1970s, Nigerian

economy has persistently depended on oil as the main source of foreign exchange earnings with the attendant cycles of economic booms and bursts. Nigeria's dependence on oil for over 90 per cent of its foreign exchange earnings makes its capital account vulnerable to the fluctuations in crude oil prices. This, in addition to its high import bills contributed to the fluctuations in the level of external reserves over the years, and consequently, the way the external reserves are being managed.

As at May 20, 2014, Nigeria expressed concern over the drop in fiscal buffers stating that the development had exposed the economy to weaknesses arising from both domestic and external shocks. This had drawn the attention of monetary authorities to the regime of persistently high interest rates as well as elevated demand for foreign exchange. The Central Bank of Nigeria (CBN) at the end of the 93rd Monetary Policy Committee (MPC) meeting pointed out that the Nigeria's gross external reserves stood at US$42.85 billion as at December 31, 2013, which indicated a decline of US$0.98 billion or 2.23 per cent, when compared with US$43.83 billion recorded as at end-December 2012. The CBN attributed the decline to slowdown in foreign portfolio and direct investments in the fourth quarter of 2013, which consequently led to increased funding of the foreign exchange market by the CBN to stabilize the international value of the currency. The CBN sold about $19.8 billion to currency dealers in 72 auctions through the wholesale Dutch Auction System (wDAS) between January and September 2013, while it offered $6.8 billion to the dealers in 22 auctions through the retail Dutch Auction System (rDAS) between October and December 2013. This is indicative of the CBN's behavior, which is characterized by the deployment of external reserves to stabilize the exchange rates. The CBN had on October 2, 2013 replaced the wDAS with the rDAS because of the ineffectiveness of the wDAS to address hitches in the foreign exchange market (CBN 2014).

The CBN as part of its core function is mandated to ensure monetary and price stability, promote a sound financial system and maintain external reserves to safeguard the international value of the legal tender currency in Nigeria. Macro-economic stability is itself a function of price stability which is the ability of a Central Bank to moderate inflation, attain stable interest and exchange rates and create a conducive investment climate for long term growth and development. The price stability objective will therefore enable the CBN to adopt the necessary measures, in collaboration with the fiscal authorities, to control price volatility.

This study focuses on examining the long run relationship between bureau de change rates (BDC) and external reserves (RES) in Nigeria during the period January 2, 2014 to July 31, 2015. The study departs from the work done by Ajibola et al. (2015), which employed the TVECM approach to investigate the existence of non-linear cointegration between Official exchange rate and external reserves in Nigeria in two regards. First we used daily data as opposed to the quarterly data used by Ajibola et al. (2015) and secondly we considered the BDC exchange rates instead of the official exchange rates, because policy makers and economic agents seems to be getting quite concerned since the 2nd quarter of 2014 about the movement in the BDC rates as it reflects the dynamics of the market.

The paper is, therefore, divided into five sections. Following the introduction is section two which presents review of relevant literature on threshold co-integration analysis and a recap of major developments on external reserves management in Nigeria. Section three focuses on methodological framework adopted for estimation, while section four looks at the estimation results and discussions. The final section contains conclusions and policy recommendations of the paper.

1.1 Trend Analysis on Nigeria's External Reserves and Exchange Rates (Jan 2014-Jul 2015)

This section provides some stylized facts on the developments in external reserves and exchange rates from January 2014 to July 2015. The persistent decline in the external reserves as well as increased foreign exchange demand can be largely attributed to uncertainty over the impact of the falling crude oil prices on the Nigeria's external reserves and the exchange rate of the naira.

The efforts by the CBN to stabilize the naira at the interbank market depleted the Nigeria's external reserves by $4.9bn in the first quarter of 2015 as reserves fell by 14.3 per cent, down from $34.24 billion at the end of December 2014 to $29.36billion at the end of March 2015. The CBN spent the sum of N136.96 billion to support the exchange rate and ensure the stability of the financial system in 2014. This development led to an increase of about 220.2 per cent in forex supply in 2014 as compared to 2013.The reserves for March 2015 dropped by $8bn when compared to the level at end-March 2014. The CBN attributed the decline in the external reserves to its

intervention at the interbank market, funding of the retail Dutch auction system and the bank's drive to stabilize the naira.

The managed float exchange rate regime, which the CBN had adopted following the liberalization of the foreign exchange market, has for the most part been successful in ensuring exchange rate stability in line with its mandate. However, the sharp decline in global oil prices and the resultant fall in the country's foreign exchange earnings, gave rise to widening margin between the rates in the interbank market and the rDAS window. This creates unhealthy practices by economic agents. Such development continued to put pressure on the external reserves with no visible benefits to the productive sector of the economy.

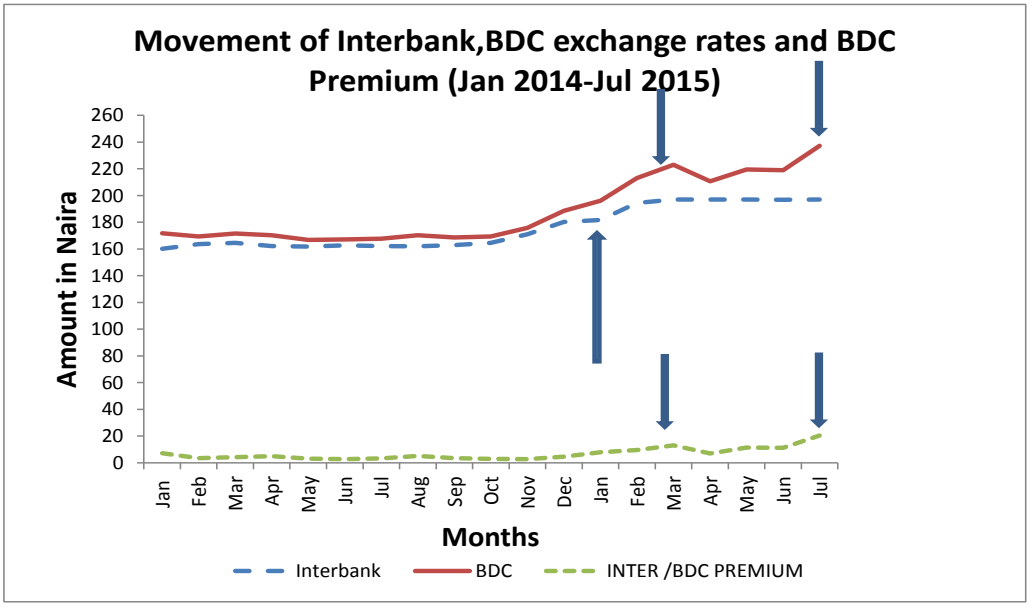

Figure 1: Monthly BDC, Interbank exchange rates and BDC/interbank Premium from Jan 2014 to Jul 2015

On the 20th and 21st January 2014, the Monetary Policy Committee of the Central Bank of Nigeria took key decisions to redress the supply-demand imbalance in the BDC segment, also on 24th and 25th November 2014 it moved the midpoint of the official window of the foreign exchange market from ₦155/US$ to ₦168/US$ and widen the band around the mid-point by 200 basis points from +/-3 per cent to +/-5 per cent.

As a result of the closure of the rDAS foreign exchange window on 18th February, 2015, and subsequent channeling of all demand for foreign

exchange to the interbank foreign exchange market. The interbank segment of the market continues to maintain a constant movement since 3rd march 2015 thereby allowing only the BDC exchange rates to truly show the relationship between it and the external reserves.

Based on visual inspection of the graph in Figure 1, the interbank rates and the BDC exchange rates were relatively stable from Jan 2014 to Dec 2014. However, the margin widened in Jan, March and July 2015, respectively. This development could be attributed to the 2015 general elections and the uncertainties that were perceived during the period. The observed increase in exchange rate premium for the same period could also be attributed to undesirable practices by economic agents, such as round-tripping, speculative demand and inefficient use of scarce foreign exchange resources.

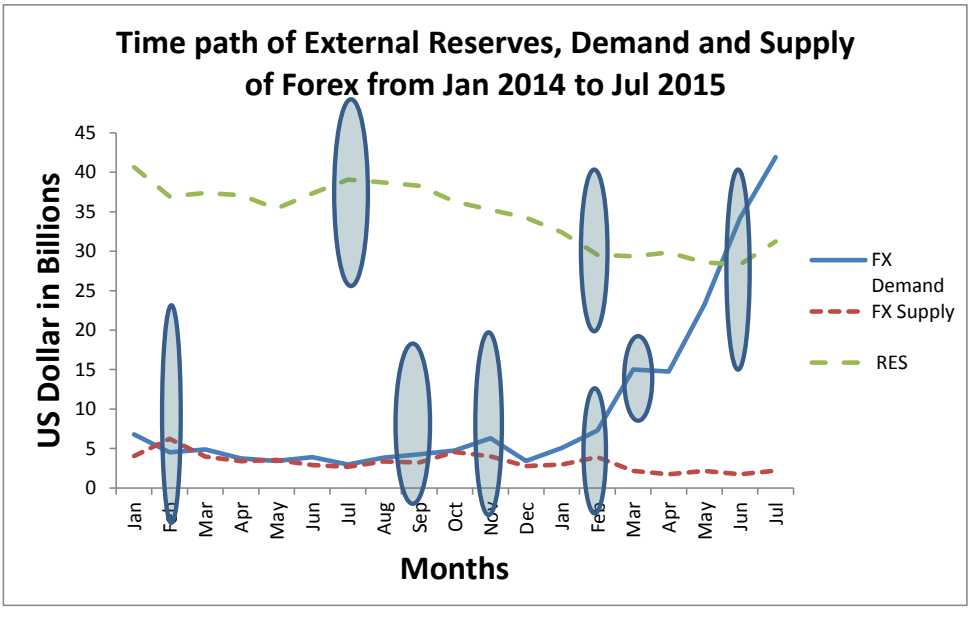

Figure 2: Monthly Position of Reserves, Demand and Supply of Forex from Jan 2014 to Jul 2015

Figure 2 above shows that the gap between demand and supply of foreign exchange rate (forex) remained stable from January 2014 to October 2014, while in November and December 2014, there was a slight fluctuation in the demand for foreign exchange. The increase in demand for forex during this period and dwindling foreign exchange earnings of Nigeria has continued to put pressure on Nigeria's external reserves. Thus, as the margin between demand and supply of forex increases, the Nigeria's external reserves were

perceived to have a downward trend. The implication is that the apex bank could no longer use the country's reserve position to fund the excessive demand in market in other to stabilize the exchange rate. The external reserves fell sharply between Jan 2015 to Feb 2015 and continued to decline until Jun 2015 due to restriction of forex cash deposit into Nigerian banks. The reserves regained upward trend in June 2015.

This pictorial evidence suggest that BDC exchange rate may be leading external reserves instead of the interbank rate which has continued to be stable, because of the intervention of CBN in the foreign exchange market. In view of this development, an empirical investigation to ascertain this fact has become imperative.

The response of the monetary authority to the depreciating exchange rate at the BDC market towards the last quarter of 2014 was evident in the increased supply of Forex and the consequent decline in the country's external reserves (Figures 1.1 and 1.2). This is indicative of the CBN's behavior of leveraging on the country's external reserves to maintain exchange rate stability.

2.0 Literature Review

The relationship between external reserves and exchange rate is well established in the literature as the former is used to stabilize the latter. Indeed many empirical studies now use reserves volatility as a proxy for exchange rate. The International Monetary Fund (IMF) in 1999 started including reserves volatility among the exchange rate determinants. Other research papers that have linked exchange rates and external reserves are Abdullateef and Waheed (2010), Rizvi (2011) and Emmanuel (2013).

The discussions and contributions dating the period preceding the flexible exchange rate regimes were restricted to the relationship between external reserves and global liquidity. But with the introduction of market driven exchange rate and the development of the capital markets around the globe in the 1970s, opinion on such issues of sufficiency of international reserves vis-à-vis the global liquidity were usually discarded. However, the discussion on the subject was revived after the financial crises of the 1990s, based on the need for countries to accumulate appropriate reserves level in order to protect itself from currency crises. Presently, the drift in the developing countries is the accumulation of reserves, predominantly in the Asian and African countries. Other related arguments according to experts and financial regulators is that reserves holdings safeguard the value of the domestic

currency and acts as store of value to accumulate excess wealth for future consumption purposes in order to boost a country's credit worthiness and provide a cushion at a time when access to the international capital market is difficult or not possible, i.e. provides a buffer against external shocks.

Eliza et al (2008) studied both the short-run and long-run demand for international reserves in Malaysia for the period 1970-2004 using the autoregressive distributed lag (ARDL) bounds testing approach. The result suggests that current account balance and short-term external debt significantly affect the demand for international reserves both in the long run and short run.

It could be summarized from the literature that there exist a long run relationship between exchange rate and external reserves. Similarly, external reserves accumulation is found to be a veritable tool for exchange rate management, it helps to improve the flow of investments into an economy, as well as expressed the credit worthiness of a nation amongst others.

The post Asian crises gave an insight to reserve accumulation and management; in the sense that the Asian Central Bank had to intervene to prevent exchange rate appreciation in order to promote an export led growth (Folkerts and Garber, 2004). However, Aizenman (2012) examined the impact of international reserves in the short and intermediate-term on the real exchange rate, due to commodity terms of trade shock. His finding showed that international reserves are important tools to reduce real exchange rate volatility. Beak (2004) was of the opinion that regardless of other causes in the demand for reserves, countries size, real openness and financial openness were the real determinants of reserves holdings, while opportunity cost and export volatility are not significant.

Shegal and Chandan (2008) analyzed the demand function of India's reserves holdings with a large number of quarterly time series data, using the co-integration and VECM approach. They found that the variables considered had significant impact on reserves demand of India. The analysis in this case showed that growth was inversely related to reserves, while capital flows and volatility in the external sectors are the key drivers in external reserves accumulation. Based on this analysis, the reason for reserve accumulation in India was mainly precautionary and not transactionary or speculative.

Although many literatures looked at different scenario in explaining the relationship between exchange rate and accumulation of reserves, different authors attributed the development to the dramatic increase of capital flows to developing countries in the last three decades due to globalization. GÜRĐ (2012) used the threshold error correction model (ECM) and the threshold granger causality test to examine the relationship between international reserves and exchange rates in the Turkish economy. The author found that the international reserves and exchange rate of Turkey are jointly determined and affected, indicating the existence of high degree of correlation between them.

Ahmad and Pentecost (2009) examines the long-run relationship between exchange rate and international reserves in a sample of African countries for 34 years, using the threshold co-integration technique. They found that a long-run dynamics exist between the series. Although it was evident in their study that the threshold point estimate varies from country to country, as a result of different country's exchange rate regimes. They concluded that floating regimes seem to have higher threshold than the pegged regimes.

Gokhale & Raju (2013) also studied the "Causality between Exchange Rate and Foreign Exchange Reserves in the Indian Context". Contrary to most research works, their findings showed that the huge foreign exchange reserves do not essentially exhibit a long-run or short-run correlation with the exchange rates. This could be attributed largely to the anticipation of overcoming financial crisis than a tool for regulating the exchange rates. It could also be looked upon as a face lift to the Indian economy through enhanced credit ratings, which in turn, would attract investors to India in the form of foreign direct and portfolio investments, thereby supplying the much needed capital that would help stimulate economic growth.

Daud and Ahmad (2013) considered the cost of international reserves management for Malaysia due to the unprecedented increase of reserves among the crisis hit countries of Asia from 1997 to 1998. Thus, holding international reserves positively affects most of the nation and develops the country's capacity to guard itself from sudden shock. The results also suggested that Malaysia should hold international reserves of at least 4.96 months of imports cover, which is higher than the conventional rule of thumb (3 months of imports cover).

Cetin (2013) adopted the granger causality analysis to investigate China's external debt components of foreign exchange reserves and economic growth rates after adapting the open economy system from 1982-2009. The study found that China's short term external debts, foreign exchange reserves, total external debts have significant impact on her economic growth rates within the period under study. The result from the impulse response and variance decomposition analyses implies that her foreign exchange reserves innovation impacts on economic growth rates.

Tariq et al (2014) used the mercantilist approach to determine the interaction between the real exchange rate and foreign exchange reserves for Pakistan during 1973 – 2008. The analysis they carried out revealed that the reserves holdings in the case of Pakistan were as a result of the export led growth strategies through real exchange rate depreciation. In the contrary, Oputa and Ogunleye (2010) adopted Shcherbakov (2002) model to estimate the optimal level of international reserves for Nigeria along the line of the drivers of external reserves. They explained that the accumulation of reserves in recent period were in line with global trend, especially in emerging economies and concluded that the country's external reserves during their study period could not be adjudged to be sufficient or in excess of expectations.

Ajibola et al (2015) studied the long-run relationship between exchange rate and external reserves in Nigeria during 1990Q1 – 2012Q4 using the two-regime threshold vector error correction model (TVECM) via maximum likelihood procedure. They confirmed the existence of threshold co-integration between the variables in Nigeria, as against linear co-integration. Consequently, the results indicated that co-integration between the variables occurs only when the equilibrium error exceeds an estimated threshold parameter of 0.52. Based on the obtained threshold, the result showed that the error correction coefficients of the exchange rate in the two regimes were not significant, implying that exchange rates do not respond to equilibrium error during the estimation period. Conversely, external reserves adjust to correct past divergence, albeit only when the equilibrium error exceeds the threshold parameter. Their result also revealed that external reserves adjust to maintain long run equilibrium; while exchange rates do not. They concluded that their findings aligned to the monetary authority's action of deploying external reserves to maintain exchange rate stability in Nigeria.

3.0 Econometric Framework

Modeling BDC rates and external reserves within the threshold cointegration framework can be driven by the fact that the transition mechanism is controlled by CBN interventions in the market. In other words, it allows for differentiating between the effect of the interventions on the BDC exchange rates when there is a huge reserves and their effect on BDC exchange rates when reserves are less. A key feature of threshold model is its capacity to capture persistent behaviour while remaining stationary. The economic agents usually consider the cost associated with their intervention policy and will always want to intervene when there is a persistent deviation from the equilibrium, especially when such deviations are seen to exceed a certain threshold thereby creating an atmosphere where benefits outweighs the cost implication. This behavior makes the movement back to equilibrium not to take place all the time.

Balke and Fomby (1997) introduced the threshold cointegration which combines non-linearity with cointegration. Models that have cointegrating variables can be characterized by an error correction model (ECM) that describes how the variables react to equilibrium in the face of deviations in such a way that the ECM represents an adjustment process through which long-run equilibrium is achieved. Balke and Fomby (1997) explain that it is not possible that movement around the equilibrium occurs at every time period due to the presence of associated adjustment costs. Altering the level of exchange rate or dampening volatility by economic agents occurs only when the exchange rate is outside the threshold or approaching the edge of the threshold.

Within the TVECM, cointegrating relationship between the variables would not hold until when the system is far away from the equilibrium, exceeding a certain threshold. This is akin to a situation when the authorities intervene due to excessive widening of premium between the BDC exchange rate and the official rate. The threshold cointegration would capture any possible non-linear relationship between the BDC rate and the external reserves in such a way that a mean-reverting dynamic behaviour of the exchange rate can be expected after exceeding a given threshold.

Based on Balke and Fomby (1997), the threshold vector of a set of two endogenous variables, log of bureau the change rates (LBDC) and log of reserves (LRES) is given as:

$$y_t = (LBDC_t, LRES_t)' \quad (1)$$

The model assumes that there is a long-run relationship between the series with a cointegrating scaler of β. A linear VECM of order l + 1 takes the following:

$$\Delta y_t = A' Y_{t-1} + \eta_t \tag{2}$$

$$Y_t = \begin{pmatrix} 1 \\ w_{t-1} \\ \Delta y_{t-1} \\ \Delta y_{t-2} \\ \cdot \\ \cdot \\ \Delta y_{t-l} \end{pmatrix} \tag{3}$$

where Δ is the first order difference operator, the regressor Y_{t-1} is $k \times 1$ and A is $k \times 2$ and $k = 2l + 4$. The error μ_t is assumed to be a (2×1) with finite covariance matrix $\sum = E(\mu_t \mu_t')$. ***A*** is a coefficient matrix that describes the dynamics in each of the regimes. If log of BDC rate $(LBDC)$, is non-stationary. then equation (1) represents a cointegrated system in which $w_{t-1} = BDC_{t-1} - \beta RES_{t-1}$ represents a stationary error correction term. The parameters (A, Σ) are estimated by maximum likelihood under the assumption that the errors μ_t are *iid* Gaussian.

$$\Delta y_t = \begin{cases} A_1' Y_{t-1}(\beta) + \mu_t, if & w_{t-1}(\beta) \le \gamma \\ A_2' Y_{t-1}(\beta) + \mu_t, if & w_{t-1}(\beta) > \gamma \end{cases} \tag{4}$$

where γ is the threshold parameter. The above equation can also be written as:

$$\Delta y_t = A_1' Y_{t-1} d_{1t}(\gamma) + A_2' Y_{t-1} d_{2t}(\gamma) + \mu_t \tag{5}$$

Where

$$d_{1t}(\gamma) = I(w_{t-1} \le \gamma)$$

$$d_{2t}(\gamma) = I(w_{t-1} > \gamma)$$

Where $I(.)$ denotes the indicator function.

The threshold model in (5) is a two-regime threshold VECM, defined by the value of the error correction term. A_1 and A_2 manage the dynamics in the system and are also known as the coefficient matrices. The coefficients in this model are all allowed to switch between the two regimes. Although, constraint may be placed on A_1 and A_2 to get a special case of the model, this allows the coefficients on constant and that of the error correction w_{t-1} to switch, while, the coefficients on the lagged y_{t-j} remains constant across the regimes. For example, the threshold effect only has content if $0 < p(w_{t-1} \le \gamma) < 1$, otherwise the model simplifies to linear cointegration. A constraint is imposed by assuming that

$$\pi_0 \le p(w_{t-1} \le \gamma) \le 1 - \pi_0 \qquad (7)$$

where π_0 is a trimming parameter and positive.

When the deviations from the equilibrium are less than or equal to the threshold level, it implies that the variables would not be cointegrated, thereby making it unlikely for the variables y_t to revert back to the equilibrium. Likewise when the deviations are greater than the threshold, it becomes more likely that the variables are cointegrated and would revert back to equilibrium.

In order to assess evidence for threshold effects and compare a linear cointegration against the presence of threshold effects, Hansen and Seo (2002) developed two LM test statistics. The LM statistic is:

$$SupLM = \underset{\gamma L \le \gamma \le \gamma U}{SupLM}(\tilde{\beta}, \gamma) \qquad (8)$$

where $\tilde{\beta}$, is the estimated β and γL and γU represent the search is set so that γL is the $\pi_0 = 0.05$ and γU is the $1 - \pi_0 = 0.95$ percentile.

The model results in one threshold if the adjustment parameter differs significantly between the two-regimes. i.e., when the adjustment parameter for the inner regime is not different from zero, this implies that the threshold level is as a result of the transaction cost which needs to be high.

4.0 Estimation Results and Discussions

We examine daily reserve positions (RES) and Bureau de Change exchange rates (BDC) for the Nigerian Naira relative to the US dollar for the period January 2014 to July 2015, coinciding with the period where the Nigerian economy was faced with sudden drop in the global oil price and an apparent political uncertainty in the wake of the 2015 general elections. The CBN adopted certain interventions in order to stabilize price during this volatile period in Nigeria's history and the premium between the BDC rates and the official rates necessitated monetary authorities intervention. Data for this study are the Bureau de Change exchange rates, which are obtained from the Statistics Department (STD), while the daily external reserves positions were obtained from the Reserve Management Department, Central Bank of Nigeria. Both series are used in their natural logarithms.

4.1 Unit Root Test

In order to avoid the problem of non-stationarity, we examine whether the LBDC and LRES series are stationary. Table 1 below shows the results of DF-GL test proposed by Elliott (1999), augmented Dickey-Fuller test and Kwiatkowski et al. (1992) KPSS test.

Table 1: Unit root and stationarity test

Variables	ADF-t-test		DF-GLS		KPSS test	
	t_μ	t_τ			η_μ	η_τ
LBDC	-1.239	-2.298	-0.73	-1.62	2.131	0.479
ΔLBDC	-6.194*	-6.053*	-3.571*	-2.332	0.187*	0.068*
LRES	-1.315	-2.351	-0.013	-2.571	2.073	0.334
ΔLRES	-20.982*	-20.956*	-20.791*	-18.846*	0.062*	0.0651*

BDC and RES are, respectively, the bureau de change rate and external reserves.

t_μ and t_τ are the standard augmented Dickey-Fuller test statistics when the relevant auxiliary regression contains a constant and a constant & a trend, respectively. The response surface regressions of MacKinnon (1991, 1996) are used for determining the significance of the ADF test statistics. The 5% critical values are -2.870 and -3.423 for the case of an equation with only a constant and for an equation with a constant and trend, respectively.

The DF-GLSu by Elliott (1999) is a test with an unconditional alternative hypothesis. The critical values for the DF-GLSu test at the 5% significance level are: -1.942 (with constant) and -2.904 (with constant and trend), respectively (Elliott, 1999).

η_μ and η_τ are the Kwiatkowski et al., 1992(KPSS) test statistics for level and trend stationarity, respectively. For the computation of these statistics, a Newey and West (1994) robust kernel estimate of the "long-run" variance is used. The 5% critical values for level and trend stationarity are 0.461 and 0.148, respectively.

4.2 Summary Statistics

Table 2 below presents the summary statistics of the series under consideration. The average BDC rate returns is 0.0003, while that of the external reserves shows an average of about -0.0004. Based on the results of the Jarque-Bera test for normality, we reject the null hypothesis of normality in the two series. Finally, the standard deviation indicates that there is less variance in the BDC rate returns than in the external reserves in the study period.

Table 2: Summary statistics on daily BDC rates and External Reserves return rates

Statistics	DLBDC		DLRES
Mean	0.0003		-0.0004
Median	0.0000		-0.0010
Std. Dev.	0.0031		0.0067
Skewness	0.4140		3.0211
Kurtosis	40.1865*		15.1552*
Jarque-Bera	22539.8700		3001.8580
Probability	0.0000*		0.0000*
DBDC =100[log BDClog BDC-1];*			
B-J is the Bera-Jarque test for the null hypothesis of no			
the LBDC and LRES series, respectively			
An asterisk denotes statistical significance at			
the 5% critical level.(*)			

4.3 Optimal Lag Selection

An optimal lag length test was conducted to avoid the risks associated with under-specification or over-specification of the model. The results of the lag length selection test criteria shown in Table 3 identified one lag for the model.

Table 3: Optimal lag length selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	1227.867	NA	0.000000774	-8.396347	-8.371164	-8.38626
1	2335.853	2193.206*	4.02e-10*	-15.95790*	-15.88235*	-15.92764*
2	2338.47	5.145169	4.06E-10	-15.94843	-15.82251	-15.89799
3	2342.906	8.658399	4.05E-10	-15.95141	-15.77513	-15.8808
** indicates lag order selected by the criterion*						

4.4 Tests for Cointegration

Since the test result from Table 4.1 indicates that both series are individually integrated of order one, we proceed to test for cointegration between them using Johansen cointegration test approach. The result for the Johansen co-integration test (based on one lag) is shown in Table 4 Both the trace test and max-eigen values test indicates no cointegration at the 0.05 level of significance between the variables. Thus, the Johansen tests failed to establish cointegration between the variables.

Table 4: Johansen Cointegration test

Unrestricted Cointegration Rank Test (Trace)					
Hypothesized No. of CE(s)		Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None		0.031104	11.35858	15.49471	0.1904
At most 1		0.003133	1.025942	3.841466	0.3111
Trace test indicates no cointegration at the 0.05 level					
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)					
Hypothesized No. of CE(s)		Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None		0.031104	10.33264	14.2646	0.191
At most 1		0.0031	1.0259	3.8415	0.3111
Max-eigenvalue test indicates no cointegration at the 0.05 level					
ıotes rejection of the hypothesis at the 0.05 level					
*MacKinnon-Haug-Michelis (1999) p-values					

The next step of our analysis is to test the hypothesis of linearity against threshold-type of non-linearity with the application of the SupLM test given

by Figure 4.1.The supLM test for linear versus threshold cointegration proposed by Hansen and Seo (2002) was also carried out to examine whether there exists linear or threshold cointegration between the two variables. The p-values of the supLM test were calculated using both the fixed regressor bootstrap and residual bootstrap experiment with 2000 simulation replications. The results show support for the threshold cointegration hypothesis at around 5 percent significance level as the p-values are 0.031 and 0.004 for both bootstraps. The result is in line with works done by Nektarios et al. (2005), Ajibola, et al (2015) who examined threshold cointegration between the parallel and official exchange rates in Greece, and the Official exchange rates and external reserves in Nigeria, respectively. Since the adjustments to the equilibrium path does not occur at all times, the result is a confirmation that the framework of a threshold cointegration analysis is better in describing the long run relationship between bureau de change and external reserves in Nigeria.

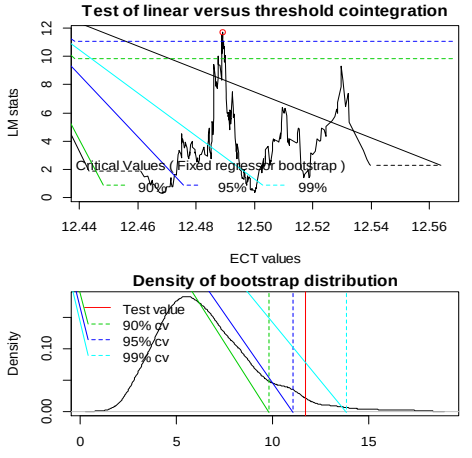

Figure 3: Test For Linear Versus Threshold

4.5 Threshold Vector Error Correction Model

To investigate possible non-linearity in the adjustment to long-run equilibrium between the BDC rates and external reserves, we estimate a threshold linear VECM choosing a lag length l=2, since the third-order lags are not statistically significant. The results of the estimated TVECM are given in Table 5.

Table 5: Linear and threshold VECM for Bureau de Change (BDC) and External Reserve (RES) for Nigeria Naira versus US dollar

Variables	**Linear VECM**		**Threshold VECM**			
			1st regime (93.1%)		**2nd regime (6.9%)**	
	RES model	**BDC model**	**RES model**	**BDC model**	**RES model**	**BDC model**
Intercept	0.6314	0.1126	-0.0006	0.0003	0.0288	0.0039
	(0.1882)***	-0.0883	-0.0796	-0.0781	-0.0562	-0.5757
Wt-1	-0.0503	-0.0089	0.0006	-0.0003	0.0506	0.0104
	(0.0150)***	-0.007	-0.6346	-0.6698	(0.0736)**	-0.4216
RESt-1	-0.0798	0.0035	-0.1125	-0.0088	-0.2428	-0.0293
	-0.0505	-0.0237	(0.0370)*	-0.7211	-0.1175	-0.6798
RESt-2	0.0221	0.016	-0.0395	0.0161	0.17	-0.0718
	-0.0501	-0.0235	-0.4597	-0.5121	-0.2554	-0.2942
BDCt-1	-0.1969	0.0656	-0.2766	0.0126	0.195	0.8671
	-0.1111	-0.0522	(0.0160)*	-0.8101	-0.773	(0.0053)**
BDCt-2	0.1139	0.1742	0.0421	0.1363	-0.0303	0.7291
	-0.1122	(0.0527)**	-0.7146	(0.0101)*	-0.9701	-0.05
Linearity tests (p-values)						
Fixed regressor bootstrap = 0.031 **						
Residual Bootstrap =0.004***						
Threshold Values = 0.4594048						
Estimation period 2014:01–2015:07; values in parentheses are Eicker-White standard errors; diagnostic test results are presented as p-values. (*) indicates significance level below 5% , (**) indicates significance level below 10% and (***) indicates 1% level significance, respectively.						

The estimated threshold parameter equals 0.459 which forms the basis for partitioning the TVECM into two regimes. The first regime prevails when the equilibrium error was below or equal to the estimated threshold. This case accounts for 93.1% of the observations and is known as the "typical regime". The second regime is when the equilibrium error exceeds the threshold. This case applies only to 6.9% of the observations of the sample, and is referred to as the "unusual" or the "extreme" regime. It is important to note that the linear model has a statistically significant error correction term in the external reserve (RES) adjust to ensure equilibrium in Regime 2, though at 10%.

In the first regime, the error correction coefficients for both the bureau de change rate and external reserves equations were not statistically significant at the 5 per cent significance level. This implies that the two variables did not respond to equilibrium error when such divergence was below the estimated

threshold of 0.459. Although in terms of magnitude, external reserves seemed to adjust more than the bureau de change rate. In the second regime, error correction coefficient for the external reserves equation was found to be (0.0562), and statistically significant at 10%. However, the adjustment coefficient for the bureau de change rate was statistically insignificant and of a lower magnitude. This implies that external reserves adjust in the unsual regime to ensure equilibrium between the two variables. This in line with the findings of Nektarios et al (2005) which estimated a threshold value of 0.115 and rejected the assumption of linearity in favor of threshold-type of non-linearity in Greece. Based on their findings, the error-correction effect appears in both linear and threshold VECM, although the threshold model uncovers strong asymmetries such that the speed of adjustment to the long-run equilibrium is higher in the "unusual" regime than in the "typical" one. Ajibola el at (2015) also confirmed the existence of threshold cointegration as against linear cointegration having estimated threshold parameter of 0.5173. Ahmad and Pentecost (2009) estimated two-regime threshold for Nigeria and has a threshold of 0.97%. Their findings show that; the adjustment in the second regime seems to be placed more on the reserve than in the exchange rate and the error correction effects are significant in both regimes. Their result also shows that the reserve has more positive effects than the exchange rate on the left side of the threshold while the exchange rate has negative effects on the right side of the threshold. "Calvo and Reinhart (2001) observed that developing countries seem to be more tolerant of foreign reserve fluctuations than exchange rate volatility. This means that as a country experiences exchange rate fluctuations, the authorities use their reserves stock to intervene in the foreign exchange market with the purpose of dampening the exchange rate volatility." This therefore, suggests that the findings in this study conforms to other studies, and further confirms the presence of a long run relationship between LBDC rates and LRES.

5.0 Conclusions

In this paper, we model the non-linear relationship between the bureau de change rates and external reserves in Nigeria during the period January 2014 to July 2015, using daily data. This was motivated by the fact that policy makers and economic agents had increasingly expressed worries about the movement in the BDC rates (with wide premium) as it reflects the dynamics of the foreign exchange market since the second quarter of 2014. Thus, the paper examined the long-run relationship in order to identify the co-integration threshold point where the series diverge.

We checked the stochastic properties of the series and found them to be stationary after first differencing. From the result of the summary statistics, the average BDC exchange rate returns is 0.0003 with less variance (standard deviation), when compared with about -0.0004 average for external reserves. Furthermore, the lag length selection test criteria identified one lag for the model.

The main findings of our analysis can be summarized as follows. First, we estimated a 2-regime threshold VECM for the relationship between the bureau de change exchange rates and external reserves for US dollars in Nigeria. The results show that linearity is rejected in favour of threshold-type non-linearity and the estimated two-regime TVECM forms statistically an adequate representation of the data with distinct regimes. The regime classification tells us that the "typical" regime concerns 93.1per cent of the sample with the "unusual" one associated with the economic and political events that took place in Nigeria before and during the 2015 general elections. Error-correction effect appears only in the BDC exchange rate in both linear and threshold VECM but the threshold model uncovers strong asymmetries in that the speed of adjustment to the long-run equilibrium is higher in the "unusual" regime than in the "typical" one.

It is important to note that this paper examine the long run relationship between BDC rate and external reserves in Nigeria using daily data, unlike Ajibola et al (2015) who studied official exchange rate and the external reserves using quarterly data. In spite of change of exchange rate and data frequency, this result confirms the use of threshold cointegration analysis as a better framework for examining long run relationship between exchange rate and external reserves in Nigeria; supporting the work of Nektarios et al (2005) and Ajibola et al (2015). Also, in line with their findings and those of Ahmad and Pentecost (2009), the linearity assumption was rejected in favour of threshold-type of non-linearity. The speed of adjusted to the long run equilibrium is higher in the 'unusual' regime than in the 'typical' regime. Furthermore, the findings of Nektarios et al (2005), Ahmad and Pentecost (2009), and Ajibola et al (2015) showed that the adjustment in the second regime seems to be placed more on the reserve than in the exchange rate, with significant error correction effects in both regimes. Their result also showed that the reserve has more positive effects than the exchange rate on the left side of the threshold; while the exchange rate has negative effects on the right side of the threshold.

Therefore, we recommend that the current practice of intervening in the foreign exhange market to dampen exchange rate volatility by the monetary authority in Nigeria should be sustained with increase efficiency in the conduct of the auction system; until such a time when foreign exhange earning sources will be diversify, from mainly oil sources.

References

Abdullateef,U and Waheed, I. (2010). *External reserve holdings in Nigeria: Implications for investment, inflation and exchange rate.* University, Ilorin, Nigeria: Journal of Economics and International Finance Vol. 2(9), pp. 183-189.

Acheampong, I. (2007). A Monetary Approach to Exchange Rate Liberazation Regime in Ghana. International Journal of Management Research and Technology, 1-18.

Ahmad, A. H. and E. J. Pentecost.(2009). "Exchange Rates and International Reserves: A Threshold Cointegration Analysis." 14th Annual Conference on Econometric Modelling for Africa. University of Bath, 1-18.

Aizenman, J., D. Riera-Crichton, and S. Edwards. (2012). The Role of Exchange Rate and International Reserves Policies. *Review of Economics and Statistics*, 1-20.

Aizenmann J. and J. Lee (2005). International reserves: Precautionary versus Mercantilist Views, Theory and Evidence. Working Paper 05/198. Washington, DC: International Monetary Fund

Ajibola, I.O et-al.(2015) Nonlinear Adjustments between Exchange Rates and External Reserves in Nigeria: A Threshold Co-integration Analysis. CBN Journal of Applied Statistics Vol. 6 No. 1(a) (June, 2015)

Balke and Fomby(1997). "Threshold Cointegration," International Economic Review, vol 38, no 3, 627-645.

Bankole, A. S. and Shuaibu, M. I. (2013). *Internal Reserve and Crude oil price movement.* Forthcoming Ibabdan Journal of Social Sciences

Bawa, S. and I. S. Abdullahi (2012). "Threshold Effect of Inflation on Economic Growth in Nigeria", CBN Journal of Applied Statistics, Vol. 3, No. 1

Beak, C.C.G. (2004). Exchange Rate Regimes and International Reserves. 1-20.

CBN (2014). The 93rd Monetary Policy Committee Communique, January 20 – 21.

Cetin, H. (2013). The Series Analysis of China's External Debt Components of Foreign Exchange Reserve and Economic Growth Rates. *The International Journal of Social Sciences*, Vol 13 no 1.

Daud, S. N. M and A.H. Ahmed. (2013). The Cost of International Reserves: An Empirical from Malaysia. *Journal of Economic Cooperation and Development, 34,4*, 23-46. December,1 2013.

Eliza, N and Azali M. and Siong-Hook Law and Chin Lee (2008): Demand For International Reserves in ASEAN-5 Economies. Universiti Putra Malaysia.

Emmanuel, F. (2013). *Dilemma not Trilemma? Capital Controls and Exchange Rates with Volatile Capital Flows.* Washington, DC: 14th Jacques Polak Annual Research Conference.

Gokhale, M.S. and R. Raju (2013). Causality Between Exchange Rate and Foreign Exchange. *Global Journal of Management and Business Research*, 1-12.

GÜRĐ (2012).Threshold granger causality test to examine the relationship between ER and EXR in Turkey: Journal of Economics

Guillermo A. Calvo. (2012). Optimal Holdings of International Reserves:. National Bureau of Economic Research, 1-28.

David Irefin and Baba N. Yaaba (2012) CBN Journal of Applied Statistics Vol. 2 No.2: Determinants of Foreign Reserves in Nigeria: An Autoregressive Distributed Lag Approach

Nektarios A,. Kouretas G.P (2005) Department of Economics, University of Crete, University Campus, GR-74100, Rethymno, Greece (2005) . Testing for two-regime threshold co-integration in the parallel and official markets for foreign currency in Greece

Oputa, N.C. and T.S. Ogunleye (2010). "External Reserves Accumulation and the Estimation of the Adequacy Level for Nigeria". *Economic and Financial Review* , Volume 48/3.

Shcherbakov, S. G. (2002). *Fifteenth Meeting of the IMF Committee on Balanace.* Australia.

Shegal, S. and Chandan. (2008). International Reserve holding in India: Self Insurance for Future. *International Journal of Economics*.

Tariq, M., Z. Haq, S. Jan, M. Jehangir, and M. Aamir. (2014). Real Exchange Rate and Foreign Exhange reserves: A Mercantilist View. *Life Science Journal*, 11(3s).