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This paper estimates the money demand function in Nigeria in the aftermath of the recent global financial crisis and examines whether its underlying properties has changed over the years. Specifically, the existence of a stable long-run demand for money function during the period 1991:Q1-2013:Q4, while accounting for the possibility of structural breaks is investigated. The Gregory-Hansen residual based test for cointegration detected both intercept and regime shifts in 2007:Q1 as the null of no cointegration is rejected at 1 per cent significance level, indicating that long run relationship exists between real money supply, real income, real monetary policy rate, exchange rate spread and movements in exchange rate in Nigeria. This estimation technique is robust to structural break, which ensures that the estimated parameters are unbiased. The CUSUMSQ test provides evidence of a stable money demand function before and after the crisis. The paper infers that since the relationship among the variables holds over a fairly long period of time, the estimated money demand model provides important foundations for monetary policy setting in Nigeria.

Key words: Demand for money, Structural breaks, Cointegration

JEL Classification: C33, E41

1.0 Introduction

The stability of the money demand function is crucial for any credible monetary policy. This is underscored by the studies of Friedman (1959), Friedman and Schwartz (1982) and Melnick (1995), amongst others. However, as important as the demand for money function is in the overall macroeconomic management, the question remains whether the function is stable over a given period. This is because a stable money demand function is necessary for establishing a direct link between relevant monetary aggregate and nominal income. In other words, the stability of the money demand function enhances the ability of a Central Bank to achieve its predetermined monetary growth targets. It is in this regard that the stability of money demand

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is seen as a crucial issue for the efficacy of monetary policy. This is particularly true in the presence of significant exogenous shocks to the monetary system as was witnessed during the global financial crises of 2008/09.

In the context of Nigeria, and from a policy perspective, it is important to establish whether there exists a stable long-run relationship between real money balances and its conditioning variables. The conditioning variables often included in the function are the scale variable (GDP) and the opportunity cost variables, which include monetary policy rate (MPR), interbank rate (IBR), interest rate spread (IRS), treasury bill rate (TBR), parallel market exchange rate (PMR) and exchange rate premium (SPREAD). Over time, the Central Bank of Nigeria has relied on setting predetermined growth targets for the broad money (M2) as a tool for achieving price stability. This is based on the belief that inflation cannot be sustained over the long-term, if it is not accommodated by excessive growth in money supply.

Several empirical works have been done to understand the dynamics of money demand in Nigeria, starting from the TATOO debate articulated in Tomori (1972), Ajayi (1974), Teriba (1974), Ojo (1974) and Odama (1974). Also, Anoruo (2002) investigated the stability of broad money demand function in Nigeria focusing on the post structural adjustment program (SAP) period. His results confirmed that money demand (broadly defined) was stable during 1986 – 2002. Other studies with similar conclusions include Nwafor *et.al.* (2007), Kumar, *et. al.* (2010) and Iyoboyi and Pedro (2013).

The recent global financial crisis that started from the United States in 2008 has, however, increased the concern of policy analysts in most economies as to whether the underlying properties of money demand function has not been affected. The consensus in literature is that the incorporation of structural break issues in the modeling of money demand is methodologically imperative. Thus, the stability of money demand function is being re-examined especially for countries that still use monetary target as instrument of monetary policy, with particular reference to structural breaks. However, to the best of our knowledge, empirical works in this regard are sparse in Nigeria as none of the studies cited above accommodated structural breaks in their modeling approaches. Hence, the need to estimate the money demand function in Nigeria while accounting for the possibility of structural breaks.

This study seeks to estimate the money demand function in Nigeria in the aftermath of the 2008/09 global financial crisis and to test whether its underlying properties has changed over the years. In other words, the broad objective of this paper is to assess whether there exists a stable long-run demand for money function in Nigeria during the period 1990Q1-2013Q4, while accommodating the issues of structural breaks. The theory of cointegration and error correction model is used to estimate the income and interest rate elasticities of the money demand function, while the CUSUMSQ stability test proposed by Brown, *et al.* (1975) is used to investigate parameter stability.

The paper is structured into six sections with section one as the introduction. Section 2 provides a review of empirical literature. The money demand model is discussed in section 3 while the study methodology is elucidated in section 4. Section 5 presents data, results and discussion. Section 6 concludes the paper.

2.0 Literature Review

In literature, several attempts have been made to examine the determinants of demand for money and two broad categories of exogenous variables are usually considered. The first set of variables captures the relative importance of income or wealth to demand for money, while the second set considers the opportunity cost variables on demand for money. For instance, Owoye and Onafowora (2007) suggest that economic agents hold money either to bridge the short fall of income over expenditure or for returns on assets. Also, Carpenter and Lange (2002) argue that for a money demand function to measure the opportunity cost of holding non-interest earning asset, interest rate or interest rate spread should be included in the specification. This finding about interest rate should be given due consideration since the desire to hold cash increases as the return on alternative assets drops. Some selected studies done within and outside Nigeria are succinctly presented in Table 1.

About a decade after 1960 independence in Nigeria, there has been a recurring debate on the effectiveness of monetary policy to stabilize the Nigerian economy in terms of price stability and economic growth anchored on the nature and stability of money demand function (Busari, 2006). Consequently, some authors have, over the years, examined the demand for money function in Nigeria with a view to determining its stability and finding its determinants

Table 1a: Review of Previous Studies on Nigeria

Author	Data Frequency/ Coverage	Money Demand (MD) Proxy	Scale Variable	Opportunity Cost Variable	Estimation Technique/Test	Findings
Teriba (1974)	Annual data: 1958 to 1972	Narrow money supply	Currency outside bank	Long term bond, Treasury bill, time deposit and savings rates	Ordinary Least Squares (OLS)	Evidence of high significant income-elasticity of demand deposits in Nigeria , but interest rates were not statistically significant
Ojo (1974)	Annual data: 1960 to 1970	Narrow money supply	None	Interest rate and expected rate of inflation	OLS and partial adjustment model	Demand for money is inelastic with respect to income and price change expectations
Oresotu and Mordi (1992)	Annual data: 1960 to 1991	Broad Money, Narrow Money, Quasi Money	Real GDP	Expected rate of inflation, Expected domestic interest rate, Foreign interest rate, Change in exchange rate and SAP dummy	Ordinary Least Squares (OLS) and some diagnostics tests	Current Income, foreign interest rate, domestic interest rate, inflationary expectations and exchange rate matter for money demand in Nigeria,
Anoruo (2002)	Quarterly data: 1986:Q2 to 2000:Q1	Broad Money Supply	Real Industrial Production Index	Real discount rate	Johansen and Juselius cointegration test	Cointegration among the series is established. CUSUM and CUSUMSQ suggest Stability of Money Demand during the sample period
Nwafor et al (2007)	Quarterly data: 1986Q3 to 2005Q4	Seasonally adjusted broad money supply	Real GDP	Real interest rate and expected inflation rate	Johansen and Juselius cointegration test	Cointegration among the series is established. CUSUM and CUSUMSQ reveal the money demand function is stable during the sample period
Kumar et al (2010)	Annual data:1960 to 2008	Narrow money supply deflated by GDP deflator	Real GDP	Nominal rate of interest, real exchange rate and inflation rate	Conical specification with unknown break point	Demand for money was stable in Nigeria after accounting for a break in 1986
Omanukwue (2010)	Quarterly data:1990:Q1-2008:Q4	Broad Money Supply	Real GDP	Consumer price index and maximum lending rate	Engle-Granger two–stage test for cointegration	A long-run relationship exists. Weak uni-directional causality from money supply to core consumer prices.

Table 1b: Review of Previous Studies on other Countries

Author	Objective	Data Frequency/ Coverage	Money Demand (MD) Proxy	Scale Variable	Opportunity Cost Variable	Estimation Technique/Test	Findings
Miyao (1996)	To know whether a cointegrating relation of M2 demand. exists in the United State	Quarterly data of three sub-samples: 1959:Q1 to 1988:Q4, 1990:Q4 and 1993:Q4	Broad Money Supply	Real GDP	Treasury bill rate, commercial paper rate, Treasury bond rate and their log forms, each at a time	Augmented Dickey-Fuller test, Stock and Watson's, filtered test and Johansen's maximal eigen value test	Cointegration established for first sub-sample and the full sample, but not with second sub-sample
Irfan (2003)	To investgate the relationship between money, real income, interest rates, inflation and expected exchange rate in Turkey	Monthly data: 1987:M1 to 1999:M12	Broad Money Supply	Industrial production index	Interest rate on government securities, Interest rate on deposits, inflation rate, expected exchange rate	Johansen Test of Cointegration	Expected exchange rate is significant, inflation and income effects are smaller in short-run than long-run and demand for money in Turkey is stable.
Emerson (2006)	To examine the long−run relationship between money, prices, output, and interest rates in the United State	Quarterly data: 1959:Q1 to 2004:Q1	Seasonally adjusted broad money supply	Seasonally adjusted real GDP	Corporate bond yield	Johansen Test of Cointegration	The result established a convincing evidence in support of the quantity theory of money
Mohsen and Abera (2009)	To investigate the stability of the M2 demand for money in 21 African countries	Quarterly data: 1971:Q1 to 2004:Q3	Broad Money Supply	Real GDP	Inflation rate and exchange rate	A bounds testing approach to co-integration and error-correction modeling	CUSUM and CUSUMSQ tests to the residuals of error-correction models reveals that in almost all 21 countries, M2 demand for money is stable.
Rup and Saten (2010)	To evaluate the stability of narrow money demand functions in some selected Pacific Island Countries	Annual data: 1974 to 2004	Narrow money supply	Real GDP	Nominal interest rate on short-term time deposits	LSE-Hendry's General to Specific and Johansen's Maximum Likelihood	CUSUM and CUSUMSQ indicate that the demand for money functions for these countries are stable.
Amin (2011)	To establish the linkage between money and prices in Bangladesh	Annual data: 1976 to 2006	Money Supply	Real GDP	Inflation rate and Interest rate	Johansen Test of Cointegration and Granger Causality	Long-run relationship exist among the vairables. Uni-directional relationship running from money supply to inflation.

as well as understanding its long-run relationship with some macroeconomic variables. The methodologies adopted to achieve this objective at the earlier years are less robust than those currently applied in recent literature.

3.0 Money Demand Model

The macroeconomic foundation for the money demand function stems from two important functions of money, namely, medium of exchange and store of value. The implication of this is that economic agents are faced with the options of holding money partly in cash and partly in the form of assets. In this regard, changes in money demand are commonly explained in terms of the scale variable and the opportunity cost of holding it. Whereas the scale variable captures the impact of income (say RGDP) on money demand, the opportunity cost variable refers to the substitution effect arising from the relative attractiveness of economic agents to investments assets (this impact is usually captured by the interest rate on assets which are close substitutes to money). From the foregoing argument, real money balances are usually expressed as a function of interest rate and income as follows:

$$\frac{\mathrm{M}}{\mathrm{P}} = \mathrm{f}\,(RMPR, \mathrm{RGDP}) \qquad (1)$$

where $M, P, RMPR$ and RGDP denotes money demand, price level, real interest rate and national income, respectively. In addition to the above standard right hand side variables identified in macroeconomic literature, researchers in different economic jurisdictions and monetary policy frameworks have included other variables deemed relevant to their peculiar circumstances. For instance, Busari (2004) highlighted the need to recognise exchange rate depreciation, financial sector innovations and technological growth as factors affecting demand for money in Nigeria. This study leverages the standard money demand function with relevant country-specific factors as proposed above. Thus, our modified demand for money function is as follows:

$$\frac{\mathrm{M}}{\mathrm{P}} = \mathrm{f}\,(RMPR, \mathrm{RGDP}, BDCAD, SPREAD) \qquad (2)$$

where $BDCAD$ is the movements in Bureau de Change exchange rates, $SPREAD$ is the exchange rate premium and the other variables are as earlier defined. Equation (2) can be specified as:

$$Log(RM2_t) = \beta_0 + \beta_1 RMPR_t + \beta_2 Log(RGDP_t) + \beta_3 BDCAD_t + \beta_4 SPREAD_t + \varepsilon_t \quad (3)$$

Where RM2=M2/P denotes real money demand, *RMPR* is the real monetary policy rate (a proxy for the opportunity cost variable - interest rate), *RGDP* is the real gross domestic product (a proxy for the scale variable – income) while *BDCAD* and *SPREAD* are other opportunity cost variables, representing movements in the BDC exchange rate and exchange rate spread, respectively, to capture the effect of capital flight, currency substitution and developments in the foreign exchange market. The choice of BDC exchange rate as a proxy for explaining developments in the foreign exchange market was based on preliminary investigation. The residual error ϵ is the random error term. Equation (3) as a money demand model can only be relevant for effective policy making if the relationship amongst the variables holds over a fairly long period of time. As argued by Kumar and Webber (2013), if the estimation technique for a typical money demand function does not explicitly account for structural changes, then such estimates will be statistically biased.

4.0 Methodology

In order to avoid the spurious regression problem, the order of integration of the variables is investigated using the Augmented Dickey Fuller (ADF) and Phillip-Perron's (PP) unit root tests. In a second step, a test for cointegration with structural breaks amongst the variables was conducted based on Gregory and Hansen (1996). If there is evidence of cointegration with structural breaks, an appropriate error correction model is estimated. Finally, the stability of the model parameters is investigated using the Cumulative Sum of Squares (CUSUMQ) of the recursive residuals.

4.1 Gregory and Hansen Cointegration Test

We employ the Gregory and Hansen (1996) residual based test for cointegration in order to test for structural break in the cointegrating relationship amongst the included variables. This approach is superior to the Engle and Granger (1987) approach to testing for cointegration which tends to under-reject the null of no cointegration if there is a cointegration relationship that has changed at some (unknown) time during the sample period. The Gregory and Hansen test is an extension of the Engle and Granger approach and it involves testing the null hypothesis of no cointegration against an alternative of cointegration with a single regime shift in an unknown date based on extensions of the traditional *ADF*-, Z_α and Z_t – test types.

The standard approach for cointegration (as used by Engle and Granger, 1986) with no structural change and four independent variables x, z, e and s is based on the model given as:

$$y_t = \mu + \alpha_1 x_t + \alpha_2 z_t + \alpha_3 e_t + \alpha_4 s_t + \epsilon_t \qquad (4)$$

where x_t, z_t, e_t, s_t and the dependent variable y_t are I(1), the error term ϵ_t is I(0) and the parameters $\mu, \alpha_1, \alpha_2, \alpha_3$ and α_4 are time invariant. However, it may be desirable to think of cointegration as holding over a fairly long period of time, and then shifting to a new long run relationship. Thus, the timing of the shift is unknown but can be determined endogenously. The structural change will be reflected in changes in the intercept (μ) and/or changes in slopes ($\alpha_1, \alpha_2, \alpha_3$ and α_4). To model the structural change, Gregory and Hansen (1996) defined the indicator variable as follows:

$$\varphi_t = \begin{cases} 0, if\ t \le [n\tau] \\ 1, if\ t > [n\tau] \end{cases} \qquad (5)$$

where the unknown parameter $\tau \in (0, 1)$ denotes the relative timing of the change point and [ ] denotes integer part. In order to test for cointegration with structural breaks, they proposed some models, amongst which are level shift, level shift with trend, and intercept with slope shifts.

4.1.1 Level Shift (C) Model:

$$y_t = \mu_1 + \mu_2 \varphi_t + \alpha_1 x_t + \alpha_2 z_t + \alpha_3 e_t + \alpha_4 s_t + \epsilon_t \qquad (6)$$

This is a simple case in which there is a level shift in the cointegrating relationship, modeled as a change in the intercept μ, where the slope coefficients are held constant. This implies that the cointegration relationship has shifted in a parallel fashion. In this parameterization, μ_1 represents the intercept before the shift and μ_2 represents the intercept after the shift.

4.1.2 Level Shift with Trend (C/T) Model:

$$y_t = \mu_1 + \mu_2 \varphi_t + \beta t + \alpha_1 x_t + \alpha_2 z_t + \alpha_3 e_t + \alpha_4 s_t + \epsilon_t \qquad (7)$$

where β is the coefficient of the trend term, t.

4.1.3 Intercept and Slope Shifts (C/S) Model:

$$y_t = \mu_1 + \mu_2 \varphi_t + \alpha_1 x_t + \alpha_{11}\varphi_t x_t + \alpha_2 z_t + \alpha_{22}\varphi_t z_t + \alpha_3 e_t$$
$$+\alpha_{33}\varphi_t e_t + \alpha_4 s_t + \alpha_{44}\varphi_t s_t + \epsilon_t \qquad (8)$$

$\alpha_1, \alpha_2, \alpha_3$ and α_4 denote the cointegrating slope coefficients before the regime shift and α_{11}, α_{22}, α_{33} and α_{44} denote the change in the slope coefficients.

In principle, the same approach used in equation (4) could be used for testing models (6) to (8) if the timing of the regime shift were known a priori. However, such breakpoints are unlikely to be known in practice without some appeal to the data. Within this framework, Gregory and Hansen (1996) proposed the test for cointegration with an unknown break date, which involves computing the usual statistics (ADF and Philips test statistics) for all possible break points τ and then selecting the smallest values, since this will potentially present greater evidence against the null hypothesis of no cointegration. In this regard, the relevant statistics are the ADF (τ), $Z_\alpha(\tau)$ and $Z_t(\tau)$.

4.2 Stability Test

Having estimated the error correction model for Nigeria's money demand, we then proceed to investigate the stability of the model. This is done based on the CUSUM and CUSUMSQ tests of Brown *et al* (1975).

The CUSUM test statistic is given as:

$$W_t = \sum_{j=k+1}^{t} \frac{\hat{\epsilon}_j}{\hat{\sigma}_\epsilon} \qquad (9)$$

where $\hat{\epsilon}_j$ is the recursive residual and $\hat{\sigma}_\epsilon$ is the standard deviation of the recursive residual, defined as

$$\hat{\sigma}_\epsilon = \sqrt{(\frac{1}{T-k}\sum_{t=1}^{T}(\epsilon_t - \hat{\epsilon})^2)} \qquad (10)$$

For robustness, the cumulative sum of squares test is also applied.

$$S_t = \left(\sum_{r=k+1}^{t} \omega_r^2\right) \Big/ \left(\sum_{r=k+1}^{T} \omega_r^2\right) \qquad (11)$$

where ω_t is the recursive residuals computed for $t=k+1,\ldots,T$. The expected value of S_t under the hypothesis of parameter constancy is:

$$E(S_t) = (t-k)/(T-k) \qquad (12)$$

which goes from zero at $t=k$, to unity at $t=T$. The significance of the departure of S from its expected value is assessed by reference to a pair of parallel straight lines around the expected value. See Brown, Durbin, and Evans (1975) or Johnston and DiNardo (1997, Table D.8) for a table of significance lines for the CUSUM of squares test. This test is applied on the cumulative sum of squares of the recursive residuals obtained from the estimated error correction model. The statistic is plotted alongside the 5% critical lines. Evidence of parameter instability is found when the cumulative sum of squares goes outside the area between the two critical lines.

Table 2: Unit Root Test

Variable	**Levels**		**First Difference**	
	ADF	**PP**	**ADF**	**PP**
SPREAD	-1.5490	-1.6070	-9.2505*	-9.2505*
LRM2	0.3009	0.1857	-8.7999**	-8.8139**
LRGDP	5.0002	0.3342	-3.1408**	-14.7897**
BDCAD	-6.1760*	-6.1323*	-9.3895*	-38.2557*
RMPR	-2.3141	-2.1542	-6.5848**	-6.6166**

and denote variable is integrated at 1% and 5%, respectively. MacKinnon (1996) critical values with constant are -3.5031 (1%), -2.8932 (5%) and -2.5837 (10%)*

5.0 Data, Results and Discussion

The study uses quarterly data covering the period 1991:Q1 – 2013:Q4. Data are sourced from the statistics portal of the Central Bank of Nigeria (CBN) which is available at http://statistics.cbn.gov.ng/cbn-onlinestats. Necessary transformations are done on the variables in order to ensure that they enter the model in a stationary and linear form. The scale variable is proxied by RGDP while the opportunity cost variables are represented by RMPR, movements in BDC exchange rate (BDCAD) and exchange rate premium (SPREAD).

5.1 Unit Root Test Result

We begin by testing the null hypothesis of unit root for variables of interest using the Augmented Dickey Fuller and Philips Perron unit root tests. This is to determine the order of integration of the variables. The results of the tests are presented in Table 2.

The ADF test results indicate that the null hypothesis of unit root cannot be rejected for LRM2, LRGDP, SPREAD and RMPR in their level form but were found to be stationary at first difference. Similar results are obtained at levels and first difference of the series when PP unit root test is performed. However, BDCAD is level stationary.

Table 3: Unit Root Test on the Residual of Equation (13)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.7381	0.0718
Test critical values:		
1% level	-3.5083	
5% level	-2.8955	

**MacKinnon (1996) one-sided p-values.*

5.2 Cointegration Test

The results of the cointegration tests conducted are presented in this section.

5.2.1 Engle and Granger Residual Test

From equation (3), the estimated long run money demand function without the structural break is of the form:

$$Log(RM2_t) = -7.7141 - 0.0026\,RMPR_t + 1.5672\,Log(RGDP_t) - 0.0020SPREAD_t - 0.0070BDCAD_t \qquad (13)$$

All the parameters of equation (13) are significant at 1 per cent level, except real monetary policy rate and movements in BDC rate which are significant at the 10 per cent level. The result of the unit root test conducted on the residual from equation (13) presented in Table 3 shows that there is no evidence to suggest that the variables are cointegrated. This could be as a result of possible structural break in the cointegrating relationship amongst the variables. Hence the need for further investigation using the Gregory and Hansen cointegration test.

5.2.2 Gregory and Hansen Cointegration Test

The implied Gregory and Hansen specifications for equation (3) are:

$$Log(RM2_t) = \mu_1 + \mu_2\,\varphi_t + \alpha_1 RMPR_t + \alpha_2 Log(RGDP_t) + \alpha_3 BDCAD_t + \alpha_4 SPREAD_t + \epsilon_t \qquad (14)$$

$$Log(RM2_t) = \mu_1 + \mu_2\,\varphi_t + \beta t + \alpha_1 RMPR_t + \alpha_2 Log(RGDP_t) + \alpha_3 BDCAD_t + \alpha_4 SPREAD_t + \epsilon_t \qquad (15)$$

$$Log(RM2_t) = \mu_1 + \mu_2\,\varphi_t + \alpha_1 RMPR_t + \alpha_{11}\varphi_t RMPR_t + \alpha_2 Log(RGDP_t) + \alpha_{22}\varphi_t Log(RGDP_t) + \alpha_3 BDCAD_t + \alpha_{33}\varphi_t BDCAD_t + \alpha_4 SPREAD_t + \alpha_{44}\varphi_t SPREAD_t + \epsilon_t \qquad (16)$$

The results of Gregory and Hansen residual-based test of the null of no cointegration for the 1(1) series in the presence of structural break applied to equations (14) to (16) are presented in Table 4.

Table 4. Gregory Hansen Cointegration Test

Equation	ADF	Break Date	Z_t	Break Date	Z_α	Break Date	SIC
Equation 14 (Level Shift)	-5.8507**	2006Q4	-5.9445**	2006Q3	-55.0989	2006Q3	-0.0673
Equation 15 (Intercept Shift with Trend)	-5.2467	2006Q4	-5.2749	2006Q3	-43.2587	2006Q3	-0.1888
Equation 16 (Intercept & Regime Shifts)	-6.5293**	2006Q3	-6.4722**	2007Q1	-58.1799	2007Q1	-0.1441

The 5 per cent critical values for ADF (and Z_t) are -5.56, -5.83 and -6.41 for equations 14, 15 and 16, respectively while the Z_α for the same equations are -59.40, -65.44 and -78.52, respectively (Table 1 of Gregory and Hansen, 1996)

*** indicates the existence of cointegration at 5% level*

This result confirms that long run relationship exists among real money supply, real income, real monetary policy rate, exchange rate spread and movements in BDC exchange rate. It shows that cointegration is established under the assumption of shifts in both the level and the slope (equation 16), with the shift occurring in 2007:Q1 with minimum SIC. Having established a structural break in 2007:Q1, the indicator function φ_t= 0 for periods 1991:Q1 to 2006:Q4 and φ_t= 1 for periods after 2006:Q4. Hence, the results of the estimated implied Gregory and Hansen equation (16)[2] is presented in Table 5. In terms of the main effects, the SPREAD and LRGDP are correctly signed and significant at 1 per cent level. The interaction term of the RMPR is significant at 5 per cent level after the break and in line with *a priori* expectations. The implication of this finding is that structural break should be considered when modeling long run relationship of money demand function in Nigeria within the study period.

Table 5: Long and Short Run Parameters of the Money Demand Functions with Intercept and Regime Shifts

Variable	Long Run Model	Variable	Error Correction Model
C	-4.537[b]	C	0.023[a]
ϕ_t	10.714[a]	$\Delta\phi_t$	1.125
$RMPR_t$	-0.001	$\Delta RMPR_t$	2.54E-04
$LRGDP_t$	1.286[a]	$\Delta LRGDP_t$	0.082
$BDCAD_t$	0.007	$\Delta BDCAD_t$	0.005[c]
$SPREAD_t$	-0.002[a]	$\Delta SPREAD_t$	-4.36E-04[c]
ϕ_t $RMPR_t$	-0.014[b]	Δ ϕ_t $RMPR_t$	-5.00E-03
ϕ_t $LRGDP_t$	-0.852[a]	Δ ϕ_t $LRGDP_t$	0.080
ϕ_t $BDCAD_t$	-0.011	Δ ϕ_t $BDCAD_t$	-0.006
ϕ_t $SPREAD_t$	0.002	$\Delta\phi_t$ $SPREAD_t$	-0.003
		ECM_{t-1}	-0.234[a]
Adjusted R2	0.97		0.15
SIC	-0.827		-2.094
Serial Correlation LM Test	13.024[a]		0.251
ARCH LM Test	18.980[a]		0.374

Note: a, b and c denotes significance at 1%, 5% and 10% level, respectively

5.2.3 Error Correction Estimates

With the identified breakpoint in 2007:Q1, Table 5 also presents the results of the error correction model, which enables us gain insights into the short run dynamics of money demand in Nigeria. It is revealing to note that a decline in spread increases economic agents' desire to hold cash, as the incentive for

[2] The Eviews subroutine to carry out Gregory-Hansen procedure for testing cointegration in the case of level, trend and regime shifts is available at http://forums.eviews.com/viewtopic.php?t=976&f=15.

arbitrage transactions wanes. The implication of this is that the monetary authority should ensure that the spread is contained at any point in time. The coefficient of the error correction term is negative (-0.234) and highly significant. This implies that 23 per cent of the disequilibrium error is corrected within one quarter. It is comforting to observe that the short run model has corrected for the problems of serial correlation and heteroscedasticity identified in the long run model.

5.2.4 Stability Test Result

The CUSUM and CUSUMSQ tests of Brown *et al.* (1975) were applied to determine if the money demand function for Nigeria is stable over the study period. Whenever the recursive residual of the estimated money demand function is located outside the boundaries of the two critical lines, then we have evidence of parameter instability in that period. As presented in Figure 1, the CUSUM test shows that the money demand function is stable while the CUSUMSQ test indicates parameter instability during the global financial crisis. However, the parameters are stable pre- and post-crisis periods.

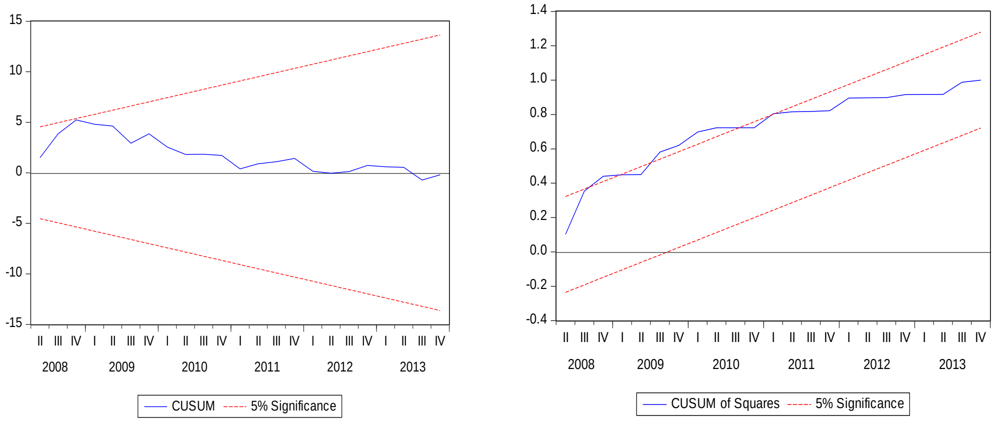

Figure 1: CUSUM and CUSUMSQ Stability Tests

6.0 Summary and Conclusions

This paper examined the issues of structural breaks, cointegration and the stability of money demand Function in Nigeria during 1991:Q1 to 2013:Q4. We employed the Gregory-Hansen test to detect possible structural breaks and to also estimate the cointegrating equation. In addition, the error correction mechanism was used to investigate the short run dynamics and stability of the money demand function.

The results suggested that the real money supply is cointegrated with real GDP, real monetary policy rate, exchange rate premium and exchange rate movements, albeit with a break in 2007:Q1. In addition, the coefficient of one period lag of the error correction term suggested that about 23.4 per cent of the disequilibrium is corrected after one quarter. The results confirmed that there are intercept and regime shifts in 2007:Q1. The identified break date coincides with a period of persistent excess liquidity exacerbated by the monetization of excess crude receipts and the distribution of enhanced statutory allocation to the three tiers of government. Other contributory factors to the liquidity surfeit include huge autonomous inflow of foreign exchange and pre-election spending.

The CUSUM and CUSUMSQ tests show the recursive residual plots of the demand for money function are within the 5% critical lines, hence, providing evidence of stable demand function for Nigeria pre- and post-global financial crisis period.

The effect of the identified structural break was accommodated in our modeling approach to ensure that the estimated parameters are unbiased. The short run model revealed that a decline in spread will lead to an increase in economic agents' desire to hold cash, as the incentive for arbitrage transactions moderates. The preliminary analysis shows that BDC exchange rate was more robust than other rates in explaining developments in the foreign exchange market. The implication of this is that the monetary authority should ensure that the spread is contained.

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