# Do exchange rate changes have symmetric or asymmetric effects on money demand in Nigeria?

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***Abstract***

*Previous studies of the effects of exchange rate changes on Nigeria's demand for money have assumed symmetry relationship. In this paper, we examine the asymmetric effect of exchange rate on demand for money by constructing naira depreciation and appreciation. The study employed the linear and nonlinear auto-regressive distributed lag (ARDL) approach using quarterly data for the period 1960-2017. The results show that exchange rate changes do have short-run and long-run asymmetric effects on demand for money in Nigeria and that when nonlinearity was introduced there is stability of money demand.*

**Keywords:** Money demand; exchange rate; asymmetry; nonlinear ARDL; Nigeria
**Jel Classification:** F31; E40; C22

## I Introduction

There is an extant literature that have examined the relation between two macroeconomic variables, such that it has enticed much devotion and thereby having its own different literature. Thus, the literature on demand for money is not an exception. In reference to the quantity theory of money by Fisher (1911), the theory implies that if there is an increase in money supply, there will be a corresponding increase in the price level. However, for the increase in money supply to be transmitted to a change in the price level, the velocity of money must be stable. This is because the velocity of money is represented by the linear combination of the money supply and the price level, thus establishing the stability of the demand for money. Asides from the stability of demand for money being influenced by price level and the level of income, there is a case of unstable demand for money being championed by Mundell (1963). He argued that in a flexible exchange rate policy regime, exchange rate in addition to interest rate and the level of income would marginally reduce the usefulness of a change in the quantity of money and marginally increase the effectiveness of fiscal policy on the level of income and employment. From the assertion of Mundell, we can conclude that for a well specified model of demand for money, exchange rate must be included.

Drawing inference from the work of Mundell (1963), a lot of authors have included exchange rate in their specification of demand for money function. Some of which are; Arango and Nadiri (1981) for Canada, Germany, United Kingdom and the United States of America; Domowitz and Elbadawi (1987) for Sudan; Marquez (1987) for Venezuela, Bahmani-Oskooee and Pourheydarian (1990) for Canada, Japan and the United States of America; Karfakis (1991) for Greece; McNown and Wallace (1992) for the United States of America; Bahmani-Oskooee (1996) for Iran; Bahmani-Oskooee and Shin (2002) for Korea; Mutluer and Barlas (2002) for

Turkey; Bahmani-Oskooee, Wang and Xi (2012) for China; Barriss, Faria and Gil-Alana (2016) for Angola; Bahmani-Oskooee, Halicioglu and Bahmani (2017) for Turkey. In view of the above studies, it shows that each country has its own literature, thus Nigeria is no exception and the empirical literature is reviewed in Section II. Going by the literature in Section II, several studies on that included exchange rate in demand for money function in Nigeria assumes that the effects of exchange rate changes are symmetric. Thus, the kernel of this paper is to test for the possibility of asymmetric cointegrating relationship. Following the literature in Section II is the methodologyin Section III. Section IV is devoted to the analysis of results and Section V concludes.

## II Empirical Literature

Empirical literatures on demand for money in Nigeria could be categorized into two. The first set includes studies that excludes exchange rate from the demand for money function specification and the second group includes exchange rate in the demand for money function specification. Among the first group are Tomori (1972), Ajayi (1974), Teriba (1974), Ojo (1974), Odama (1974), Iyoha (1976), Arize and Lott (1985), Arize (1987), Ajewole (1989), Anoruo (2002), Nwaobi (2002) and Nwafor, Nwakanma, Nkansah and Thompson (2007). The first five studies in this group is referred to as the TATOO debate. Tomori (1972) was the pioneer work on the stability of demand for money in Nigeria. Using the ordinary least squares estimates for the period 1960-1970 result shows that the demand for money function in Nigeria is table. In the works of Ajayi (1974), Teriba (1974), Ojo (1974), Odama (1974), they all agreed that that demand for money was stable, but the major difference is on the validity of the Keynesian-

monetarist dichotomy to the relevance of interest rates in the model and other questions on specification and interpretation.

Iyoha (1976) examined the demand for money equations for Nigeria using regression analysis data for the period 1950-1965. Their results show that there is evidence of a stable demand for money in Nigeria. A major contribution of this work asides from the stability demand for money is that the study examined whether the permanent income specification is superior to the current income specification and whether the income and interest elasticities of demand for money are smaller (in absolute value) than those of advanced countries like the United States. The results show that current income is a better predictor of the demand for real balances than permanent income in Nigeria and that it was impossible to tell whether the income elasticity of demand for money is significantly lower in Nigeria than it is in the United States. This is because the values of the income elasticity of demand obtained were of the same order of magnitude as those obtained for the United States.

Arinze and Lott (1985) re-examined the stability of money demand in Nigeria for the period 1960-1977. Using OLS their results show of real income and the expected rate of inflation (extrapolative) have positive and significant impact on demand for money in Nigeria, this study is different from previous studies on Nigeria (see Ajayi, 1977 and lyoha, 1976) where the interest rate is negative and statistically not significant, this may be due to the difference in the sample frame and the specification of the demand for money function. Arinze (1987) also examined the past inflation variability and demand for money in Nigeria for the period 1951-1982. Using the OLS, results suggest that the past variability of the rate of inflation was found to be an importantvariable in the money-demand function ofNigeria.

Ajewole (1989) examines the relevance and workability of the McKinnon model for money demand in Nigeria. The kernel of this paper is the use of both the broad and the narrow definition of money. The results shows that the real demand for money in Nigeria is considerably influenced by real income and return on physical assets; and that the broad definition of money performs much better than the narrow definition in the stability of money demand function in Nigeria.

Anoruo (2002) explores the stability of money demand in Nigeria for the period 1986:2 – 2000:1 Using Johansen and Juselius cointegration test results suggest that there is a long run relation between real discount rate, economic activity and money supply. The Hansen (1992), CUSUM and CUSUMQ stability test results indicate that money demand function is stable in Nigeria. Nwaobi (2002) employed the vector valued autoregressive process (VAR) to examine the stability of demand for money in Nigeria for the period 1960-1995. Results suggests that there is stability of the money demand function in Nigeria. In addition, there is evidence that the non−nested tests suggest that income is the more appropriate scale variable in the estimation of money demand function in Nigeria. Nwafor*et al* (2007) examined the quantity theory of money in Nigeria using quarterly data from 1986:3 to 2005:4. Results from the Johansen and Juseliuscointegration test Cointegration suggest long run relationship between road money supply Real GDP Real interest rate and expected inflation rate and that using CUSUM and CUSUMSQ there is evidence of a stable money demand function in Nigeria.

The second category were studies that includes exchange rate in their demand for money specification and some of them are; Akinlo (2006), Owoeye and Onafowora (2007), Aiyedogbon, Ibeh, Edafe and Ohwofusa (2013), and El-Rasheed, Abdullah and Dahalan (2017).

Akinlo (2006) examined the stability of demand for money in Nigeria using the autoregressive distributed lag (ARDL thereafter) cointegration approach of Pesaran and Shin (1995) for the period 1970:1 – 2002:4. The results show that M2 is cointegrated with income, interest rate and exchange rate and that the CUSUM stability test shows that the demand for money function is stable. The results show that exchange rate changes do not have short-run and long-run effects. In the long run, a depreciation of the Nigeria naira increases the demand for M2, thus supporting the wealth effect.

Owoeye and Onafowora (2007) also examines M2 money targeting, the stability of real M2 money demand. Using the Johansen and Juselius cointegration test for the period 1986:1 – 2001:4, results suggests presence of long run relationship and stability of the money demand function. However, the shows that exchange rate changes have both short-run and long-run effects. In particular, in the long-run the coefficient of exchange rate is negative, this implies that a depreciation of the Nigeria naira will reduce the demand for M1and thus supporting the speculative effect argument.

Aiyedogbon et al (2013) investigates the stability of money demand function in Nigeria for the period 1986-2010. The cointegration test and the stability test results show that there is evidence of a cointegrating relationship and that the demand for money function in Nigeria is stable. In addition, exchange rate changes do not have short-run and long-run significant impact on the money demand. Also, in the long run the coefficient of exchange rate is negative, thus supporting the speculation effect.

Doguwa et al (2014) examines the money demand function in Nigeria for the period 1991:1 to 2013:4 and found evidence for stability of demand for money function in Nigeria. A major contribution of this study from previous studies is accounting for the possibility of structural

breaks. Both the Engle-Granger and the Gregory-Hansen structural breaks test for cointegration suggests presence of long run relationship. The results also revealed that the exchange rate changes have significant impact on money demand in the short-run, but not in the long-run. Specifically, they find that in the long-run, the exchange rate coefficient is positive, thus providing evidence for the wealth effect argument.

El-Rasheed et al (2017) investigates monetary uncertainties and the stability of demand for money in Nigeria for the period 1980 to 2014, using the ARDL cointegration approach. Results show that there is a long-run cointegrating relationship and stability of the demand for money function in Nigeria. The results also show that exchange rate changes have both short-run and long-run effects, while in the long run a depreciation of the naira increases the demand for money, thus supporting the wealth effects and in the short-run the coefficient of exchange rate is negative implying that a depreciation of the naira will reduce the demand for money in Nigeria, sporting the speculation effect.

From the reviewed literature on the second category of demand for money in Nigeria, it was observed that the results are mixed, concerning the effects of exchange rate changes on demand for money. This is not unconnected with different in methodology employed as well the sample frame. In addition, from the previous studies the assumption is that exchange rate changes have symmetric effects on the demand for money. However, exchange rate changes can be asymmetric, where depreciations can have different effects than appreciations. This remains the major gap to be filled in the literature using the Shin, Yu and Greenwood-Nimmo (2014) nonlinear ARDL cointegration approach.

## III Methodology

Following the review of the theoretical literature of Mundell (1963), the specification for examining the stability of demand for money in log-linear form is given as:

$$LnM_t = \propto_0 + \propto_1 LnY_t + \propto_2 LnCPI_t + \propto_3 LnEX_t + \varepsilon_t \quad (1)$$

Equation (1) is the long-run determinants of demand for money. M is the monetary aggregate in real terms (M2), Y is the real GDP, CPI is the consumer price index and EX is the nominal exchange rate. The scale variable Y measured by GDP is included to account for the transactionary demand for money and $\propto_1$ is expected to be positive. The consumer price index is a measure of opportunity cost and the value of $\propto_2$ is expected to be negative. Exchange rate is included in the demand for money function to account for likelihood of currency substitution. The coefficient of exchange could be positive or negative, if $\propto_3$ is positive, it implies that the wealth effect dominates. However, if $\propto_3$ is negative, it connotes that the speculative effect holds and $\varepsilon$ is the error term and $Ln$ is the natural logarithm.

To distinguish the short-run effects of demand for money from their long-run effects, equation (2) is specified in an error–correction modeling form. Following Pesaran et al.'s (2001) bounds testing approach and rewrite (1) as follows:

$$\Delta LnM_t = \alpha + \sum_{i=1}^{n1} \beta_i \Delta LnM_{t-k} + \sum_{i=0}^{n2} \delta_i \Delta LnY_{t-k} + \sum_{i=0}^{n3} \varphi_i \Delta LnCPI_{t-k} + \sum_{i=0}^{n4} \omega_i \Delta LnEX_{t-k} + \rho_0 LnM_{t-1} + \rho_1 LnY_{t-1} + \rho_2 LnCPI_{t-1} + \rho_3 LnEX_{t-1} + \mu_t \quad (2)$$

Without lagged level variables equation (2) will be a standard VAR model. The linear combination of lagged level variables have replaced the lagged error term from equation (1), resulting in error–correction model expressed in equation (2). To test for cointegration, the Pesaran et al. (2001) F-test for joint significance of the lagged level variables was used. Once cointegration is established, estimates of $\rho_1 - \rho_4$normalized on $\rho_0$will yield the long-run effects of all exogenous variables. The short-run effects are reflected by the estimates of coefficients attached to first-differenced variables.

The main assumption behind models like equation (2) is that all exogenous variables (gross domestic product, inflation rate, interest rate and exchange rate have symmetric effects on the monetary aggregates. Concentrating on the exchange rate, the assumption is that appreciation of the exchange rateraises the monetary aggregates, while depreciation of the exchange rate lowers monetary aggregates. The question is how valid is this assumption? In order to test the symmetry versus asymmetry effects of exchange rate changes, we follow Shin et al. (2014) and separate exchange rate appreciations from exchange rate depreciations. This amounts to constructing changes in the exchange rateas$\Delta LnEX$. In this new time series, negative exchange rate changes is denoted by $\Delta LnEX^{-}$and positive exchange rate changes is denoted by $\Delta LnEX^{+}$. Using these notations,we then construct two new time-series variables, one reflecting only positive shocks, denoted by POS, and one reflecting only negative shocks denoted by NEG. These are simply defined as a partial sum of negative and positive changes as follows:

$$POS_t = \sum_{j=1}^{t} \Delta Ln\, EX_j^{+} = \sum_{j=1}^{t} max\left(\Delta LnEX_j, \quad 0\right) \qquad (3)$$

$$NEG_t = \sum_{j=1}^{t} \Delta Ln\, EX_j^{-} = \sum_{j=1}^{t} min\left(\Delta LnEX_j, \quad 0\right) \qquad (4)$$

The next step is to replace $LnEX$ in (2) by POS and NEG variables. Once we do this, we arrive at a new error-correction model as follows:

$$\begin{aligned}\Delta LnM_t = \alpha &+ \sum_{i=1}^{n1} \beta_i\, \Delta LnM_{t-k} + \sum_{i=0}^{n2} \delta_i \Delta\, LnY_{t-k} + \sum_{i=0}^{n3} \gamma_i \Delta\, LnCPI_{t-k} + \sum_{i=0}^{n4} \varphi_i \Delta\, Ln^{+}POS_{t-k} \\ &+ \sum_{i=0}^{n5} \phi_i \Delta\, Ln^{-}NEG_{t-k} + \rho_0 LnM_{t-1} + \rho_1 LnY_{t-1} + \rho_2 LnCPI_{t-1} \\ &+ \rho_3 Ln^{+}POS_{t-1} + \rho_4 Ln^{-}NEG_{t-1} + \xi_t \qquad (5)\end{aligned}$$

Shin et al. (2014) then demonstrate that Pesaran et al.'s (2001) bounds testing method explained above is equally applicable to model (5). Since the method of constructing the POS and NEG variables introduces nonlinearity into the adjustment process, they call this model (5) a nonlinear ARDL model, whereas model (2) is labelled the linear ARDL model.

Estimates of nonlinear model by OLS are then used to judge three types of asymmetry. First, short-run asymmetry is established if; $\varphi_i \neq \phi_i$ for each individual k. Second, adjustment asymmetry is established by comparing a number of short-run lags on the $\Delta POS$ and $\Delta NEG$ variables. Third, long-run asymmetry is established if $\rho_3$ is different from $\rho_4$.

## IV. Results

Two unit root tests were conducted to determine the order of integration of the variables. The unit root tests used for the study are; the Augmented Dickey Fuller (ADF) and Phillips and Perron (PP) which test the null hypothesis of a unit root. Results from the ADF and PP unit root tests in Table 1 shows that all the series are non-stationary in levels, but stationary in first differences. The exception to this finding is the inflation rate which is significant at level for the PP test.

**Table 1: Unit Root Test, 1960Q1-2015Q04**

| Series | ADF | PP |
|---|---|---|
| CPI | 1.998 | -9.373*** |
| ΔCPI | --11.908*** | -47.286*** |
| LnEXR | -1.974 | -1.956 |
| ΔlnEXR | -12.761*** | -12.755*** |
| $LnEXR^{--}$ | -1.058 | -1.096 |
| $\Delta ln\ EXR^{--}$ | -12.273*** | -12.342*** |
| $LnEXR^{+}$ | -2.146 | -2.161 |
| $\Delta ln\ EXR^{+}$ | -13.004*** | -13.004*** |
| LnMS | -1.728 | -1.874 |
| ΔlnMS | -14.382*** | -14.382*** |
| LnRGDP | -1.749 | -1.796 |
| ΔlnRGDP | -14.807*** | -14.808*** |

Notes: ADF is the Augmented Dickey Fuller unit root test and PP is the Phillip and Perron unit root test.
* Indicates significance at the 10% level.
** Indicates significance at the 5% level.
*** Indicates significance at the 1% level.

The above results show that the variables are of different order of integration, thus the need for adopting the Pesaran et al.'s (2001) approach to estimate error–correction model in equation (2). Since data are quarterly, we follow the literature and impose a maximum of four lags on each first-differenced variable. We then use Akaike's information criterion (AIC) to select optimum lags. The results are reported in Table 2.

Panel A reports in Table 2 reports the short-run estimates, Panel B reports the long-run estimates. Finally, Panel C reports diagnostic statistics. From the short-run coefficient estimates in Panel A, it is clear that only the nominal exchange rate have short-run significant coefficient obtained for every first-differenced variable, while the real GDP and the consumer price index is statistically insignificant. In addition, all the coefficient estimates are in conformity with the theoretical a-priori, the nominal exchange rate and consumer price have negative effects on the demand for money, while the real GDP have positive effects on the demand for money in Nigeria.

Panel B, examine whether or not the short-run effect is permanent or transitory. It was discovered that nominal exchange rate and CPI have significant negative long-run effects on the demand for money in Nigeria. This implies that public in Nigeria seems to strong support substitution effects as compared to precautionary effect. However, income elasticity is also positive and it implies that a 1 per cent in the real GDP requires about 0.14 per cent decrease in money supply growth. In addition, the exchange rate is a significant determinant in the long run and it reflects that there are no obstacles for Nigeria in reshuffling their portfolio between domestic and foreign assets. The result shows that if exchange rate depreciates by 1 per cent, money supply growth will decline by 0.37 per cent. However, for these long-run coefficients to be meaningful, we must establish that the variables are cointegrated. To this end, we proceed to Panel C.

The results of the F-test along with other diagnostic statistics are reported in Panel C of Table 2. Given the 5% upper bound critical value of the F-test at 4.45, our calculated statistic of 3.87 is insignificant. Thus, we must seek an alternative test. Another sign of cointegration could stem from the fact that variables are adjusting toward their long-run equilibrium values. To test this hypothesis, we use the normalized long-run coefficient estimates from Panel B, generate the error term, and call it ECM. We then replace the linear combination of lagged level variables in Equation (2) by $ECM_{t-1}$ and estimate this new specification after imposing the same optimum lags reported in Panel A. If variables are to adjust toward their long-run equilibrium values, $ECM_{t-1}$ must carry a significantly negative coefficient. This is indeed the case from Panel C. The estimated coefficient itself reflects the adjustment speed. In Nigeria, for example, 7% of the adjustment takes place within one quarter.

**Table 2: Full Information Estimates for Linear ARDL Equation for Demand for Money**

**Panel A: Short-run estimates**

| Lag Order | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| ΔlnRGDP | 0.010 | | | | |
| | (0.877) | | | | |
| ΔlnEXR | -0.029** | | | | |
| | (2.042) | | | | |
| ΔINFR | -0.003 | | | | |
| | (0.938) | | | | |

**Panel B: Long-run estimates**

| Constant | Trend | lnRGDP | lnEXR | INFR |
|---|---|---|---|---|
| -0.323* | 0.015*** | 0.137 | -0.373** | -0.118** |
| (1.831) | (3.851) | (0.906) | (2.176) | (2.467) |

**Panel C: Diagnostic Statistic**

| F | $ECM_{t-1}$ | LM | RESET | BPG | Adj $R^2$ | CUSUM | CUSUMSQ |
|---|---|---|---|---|---|---|---|
| 3.873 | -0.07*** | 0.589 | 0.802 | 1.514 | 0.99 | Stable | Unstable |
| | (3.471) | | | | | | |

**Notes:** Numbers inside the parentheses are absolute values of the t-ratios..The upper critical bound value of the F-statistic at the 5% significance level is 4.45. LM , RESET and BPG are the Lagrange multiplier test of first-order serial correlation, Ramsey's test for functional form and the Breusch-Pagan-Godfrey heteroscedasticity test respectively. ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. CUSUM and CUSUMSQ tests are applied to the residuals to test for stability of all coefficients. As indicated, only the CUSUM estimate is stable.

Reported in Panel C are also the Lagrange multiplier (LM), Ramsey's RESET statistics and Breusch-Pagan-Godfrey test. The LM statistic is used to test for first-order serial correlation, the RESET statistic is for model specification and BPG is used to test for heteroscedasticity. The three tests suggest the following: the successive error term are of the estimated model are not correlated, the model were correctly specified and it has equal finite variance. Lastly, we examine whether all the coefficient estimates, that is, the short-run as well as the long-run estimates, are stable. We applied the well-known CUSUM and CUSUMSQ tests proposed by Brown, Durbin, and Evans (1975) to the residuals of the optimum error-correction model. For the stability of the model, the plot of the statistics should stay within a significance level of 5 percent. All coefficient estimates seem to be stable, at least by CUSUM test.

Next, we turn to the main focus of the study, that is, is there the possibility of asymmetric effects of exchange rate on the demand for money in Nigeria? To provide answer to the question we analyze the estimates of the non-linear ARDL model (5) and Table 3 in details. The results are presented in panels A-C. Panel A gives the short-run estimates, it was discovered that the real GDP, consumer price index and depreciation of the naira have short-run significant effects on the demand for money except the variable representing the appreciation of the naira, i.e. ΔPOS.

However, the long-run estimates in Panel B indicate that only the depreciation of the naira and the consumer price index has negative long-run significant effects on the demand for money in Nigeria. In addition, both the positive and negative partial sum of exchange rate changes differ in sign and in size, supporting the asymmetric effects of exchange rate changes on the demand for money in Nigeria. As the naira appreciates, Nigerians expect further appreciation of the naira; hence they hold more naira, supporting the expectation effects of exchange rate changes on the demand for money. This study is in support of Bahmani-Oskooee et al (2016) who examined asymmetric effects of exchange rate changes on the demand for money in China.

On the other hand, as the naira depreciates, i.e., NEG declines, due to the negative coefficient, Nigerians demand more naira. This supports the wealth effect of exchange rate changes. For the validity of the long-run estimates, cointegration must be established. The *F*-statistic test reported in Panel C shows that the calculated F statistic is much larger than its upper bound critical value of 4.57, supporting cointegration. The second test for establishing cointegration is the error correction model. Results show that the $ECM_{t-1}$ carries a highly significant and negative

**Table 3: Full Information Estimates for Non-Linear ARDL Equation for Demand for Money**

**Panel A: Short-run estimates**

| Lag Order | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| ΔlnRGDP | -0.075** | -0.049 | 0.101 | -0.414*** | 0.334*** |
| | (2.035) | (0.722) | (1.447) | (5.951) | (7.692) |
| ΔNEG | -0.227 | -0.472 | -0.109 | 2.547*** | -2.152*** |
| | (0.630) | (0.819) | (0.189) | (4.418) | (5.765) |
| ΔPOS | 0.015 | | | | |
| | (0.959) | | | | |
| ΔINFR | 0.009** | 0.006 | -0.011** | 0.043*** | |
| | (2.129) | (1.158) | (2.214) | (7.761) | |

**Panel B: Long-run estimates**

| Constant | Trend | lnRGDP | NEG | POS | INFR |
|---|---|---|---|---|---|
| -0.392 | -0.007 | 0.040 | -4.990** | 0.317 | -0.674** |
| (1.606) | (0.514) | (0.172) | (2.044) | (0.799) | (2.570) |

**Panel C: Diagnostic Statistic**

| F | ECM | LM | RESET | BPG | Adj R2 | CUSUM | CUSUM2 |
|---|---|---|---|---|---|---|---|
| 9.242*** | -0.047*** | 0.044 | 0.396 | 1.32 | 0.99 | Stable | Unstable |
| | (3.471) | | | | | | |

| Wald Joint Significant | Wald Short-run | Wald Long-run |
|---|---|---|
| 359.41 | 36.31 | 227.84 |
| [0.000] | [0.000] | [0.000] |

**Notes:** Numbers inside the parentheses are absolute values of the t-ratios..The upper critical bound value of the F-statistic at the 5% significance level is 4.0. LM , RESET and BPG are the Lagrange multiplier test of first-order serial correlation, Ramsey's test for functional form and the Breusch-Pagan-Godfrey heteroscedasticity test respectively. ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. CUSUM and CUSUMSQ tests are applied to the residuals to test for stability of all coefficients. As indicated, only the CUSUM estimate is stable.

coefficient; suggesting the adjustment of variables towards the long run and that the adjustment is about 5 per cent within a quarter. Furthermore, both the LM, RESET and the BPG statistics are insignificant, indicating that the residuals of the optimum non-linear model do not suffer from serial correlation, the model is not mis-specified and the error term have equal finite variance. In addition, the CUSUM test support the stability of all estimated coefficients in the model.

Finally, since lags are shorter for appreciation (ΔPOS) as compared to those of depreciation (ΔNEG), there is evidence of adjustment asymmetry. Furthermore, there is evidence of short-run asymmetry effects since the first and second lags on the two variables carry coefficients that are different in size and significance. The Wald statistic is statistically at 1 per cent, thus supporting short-run asymmetry effects of exchange rate changes on demand for money. How about short-run impact asymmetry? The result of the Wald test applied to the equality of sum of the coefficients of ΔPOS versus sum of the coefficients of ΔNEG does also support impact asymmetry. Also, the Wald test applied to equality of the two coefficients does support this claim since our calculated Wald statistic reported under Wald-Long run in Panel C is significant.

## V. Summary and Conclusion

The literature on demand for money stability has grown so large that each country has its own literature, because it is an effective tool for monetary policy and Nigerian is no exception. Most studies try to identify the determinants of demand for money and equally apply new econometrics method to test its stability. Mundell (1963) argued that the exchange rate is a major variable in determining the stability of money for a country and that it should be included to account for the likelihood of currency substitution. Thus, few studies in Nigeria, includes the exchange rate in their specification for demand for money, thus in this paper we not only include the exchange rate, but also account for its asymmetric effects on the demand for money.

In achieving this objective, we decompose exchange rate changes to the partial sum of the negative changes and the partial sum of the positive changes; we show that in Nigeria exchange rate changes do have asymmetric effects on the demand for money. Using the Shin et al. (2014) non-linear ARDL approach to cointegration and error-correction modeling, there is evidence that when the naira appreciates, Nigerian expects further appreciation of the naira, hence they hold more naira. However, when the naira depreciates, they still demand less of naira. In addition, we

find support for three types of asymmetric effects of exchange rate changes. Short-run asymmetry is evidenced due to the fact that naira appreciation has different effects on the demand for money as compared to naira depreciation, mostly measured by the sign of the estimated coefficients.

Adjustment asymmetry is evidenced due to the fact that the impact of naira depreciation lasts for a much longer period of time than the impact of naira appreciation. Finally, long-run asymmetric effect is evidenced by the different size effect of naira appreciation versus naira depreciation. This is because they carried different signs and the estimated coefficient for naira depreciation is greater than naira appreciation. The policy implication of these findings is that since the asymmetry in naira depreciation is greater than the appreciation policy makers in the country should strive to achieve the gains from naira depreciation.

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