RESEARCH PAPER

ASYMMETRICAL EFFECT OF EXCHANGE RATE CHANGES ON MONEY DEMAND: EMPIRICAL EVIDENCE FROM GHANA

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ABSTRACT

In this paper, we account for currency substitution by including exchange rate in the money demand function. Numerous recent studies have shown that exchange rate could have an asymmetric effect on demand for money in different countries. In this study, we consider the experience of Ghana and found that exchange rate changes have an asymmetric impact on the demand for money. Specifically, our non-linear Autoregressive Distributed Lag Model (NARDL) estimates revealed that the appreciation of Ghana Cedi against the US dollars reduces the demand for money whereas depreciation of Ghana Cedi against the US dollars increases the demand for money in Ghana, likely due to currency substitution or wealth effect. Other supplementary findings from the study show that increase in real national income generates an increase in demand for money in Ghana likely due to an increase in purchasing power of Ghanaians. The results of this study suggest that effort should be geared towards stabilizing exchange rate over a long period in order to stabilize money demand in Ghana. Additionally, real income and interbank interest rate should also be considered as essential tools when formulating monetary policies that aimed at stabilizing money demand in Ghana's economy to boost economic development.

Keywords: Exchange rate, money demand, asymmetric, income, nonlinear ARDL and Ghana

INTRODUCTION

Monetary authorities use demand for money as an instrument for transmitting monetary policy to the real economy (Sichei and Kamau, 2012). From theoretical perspective, money demand elasticities are vital tools used to conduct monetary policy (Hoffman and Rasche, 1989). For these reasons, a good part of the empirical studies focuses on estimating the money demand function from different perspectives with the sole objective of obtaining a long-run stable money demand function which is essential for conducting monetary policy. However, majority of these existing empirical studies were done around the transaction, speculative and precautionary motive for holding money which suggest that income and interest rate are the main determinants of the money demand function (Mall, 2013, Baidoo and Yusif, 2019, Alsamara and Mrabet, 2019). A subset of these empirical studies also found that exchange rate influences the stability of money demand in both developed and developing countries (Mundell, 1963, Bahmani-Oskooee et al., 2017, Abdulkheir, 2014). However, such empirical studies are very scanty in Ghana as most of the existing studies focused on examining how interest rate and income influence the stability of money demand in Ghana (Akosah, 2017, Asiedu et al., 2020).

Ghana is an open economy in West Africa that trade with different economies around the globe. Ghana is well known on the global market for the exportation of raw materials including cocoa, timber, bauxite, diamond, timber, rubber and many more (Kolavalli and Vigneri, 2011). Ghana is also an import driven economy as significant proportion of finished product in Ghana are imported from the rest of the world. Nevertheless, approximately 4.5 million of the population hold foreign asset as well as save and accumulate foreign currency especially, in dollars and euros (World-Bank, 2019). Thus, fraction of the populace holds more foreign currency compared to the domestic currency for both international and domestic transactions revealing the lack of confidence in the domestic currency due to persistent fluctuations in exchange rate (Musah et al., 2017). Persistent increase in exchange rate depreciates the domestic currency (Ghana cedis) which reduces the value of domestic assets and securities such as bonds and stocks. Figure 1 supports this argument as it reveals that the Ghana cedis has continually been weaken over time due to persistent increase in the exchange rate (Ghana cedis against the US dollars specifically), especially between the period of 2010 to 2018. However, there were some few periods where the Ghana cedis appreciated against the US dollars due to a fall in the exchange rate (2000-2010). Thus, figure 1 portrays that around 2000-2010, the Ghana cedi performed well against the US dollars since it appreciated within these periods. Domestic economic activities of Ghana could be worsening due to continues depreciation of the Ghana cedis over the years since Ghana's economy is an import-intensive economy. This is so because when Ghana cedis continually depreciate overtime its increases domestic burden of paying import taxes and external debt to the rest of the world, decrease international transaction and business which is likely to reduce importation goods and services. This also lowers the purchasing power parity of Ghanaian households making them pays more now as compared to previous payment which likely to increase the demand for money (Mahmood and Alkhateeb, 2018).
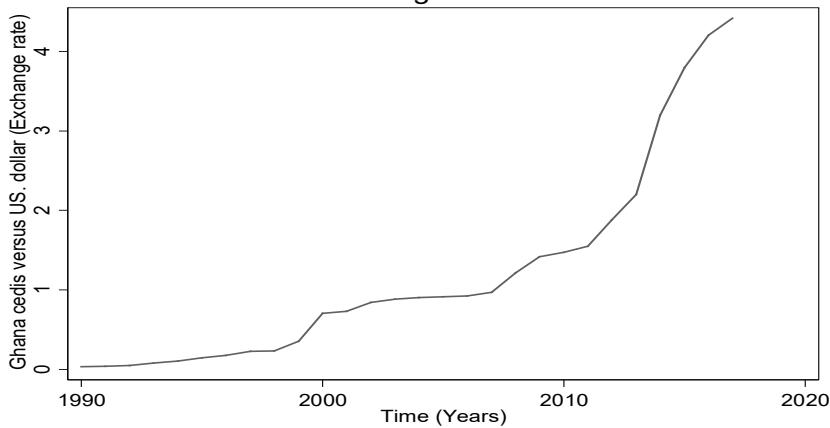
Line Graph of exchange rate from 1990-2019 in Ghana

This study extends the rather scant literature on money demand in Ghana by examining the asymmetric effect of exchange rate changes on money demand in Ghana. Specifically, this study contributes to literature by focusing on the individual effect of appreciation and depreciation of the Ghana cedis on demand for money since most of the existing studies in Ghana are geared toward examining the effect of depreciation of the Ghana cedis on money demand (Akosah, 2017, Asiedu et al., 2020). The study makes use of quarterly time series data over long period (1980Q to 2020Q) to be able to capture both depreciation and appreciation of the Ghana cedi efficiently. Further, although our empirical findings are for Ghana, exchange rate is a global issue, hence, our findings are relevance for developing countries (especially those in Sub-Sahara Africa) with similar socioeconomic and demographic setting like Ghana. This shows that our findings are significant beyond Ghana's boundaries. Further, given the recent increasing demand for money and increasing trend in exchange rate in Ghana raises a possibility of a possible relationship between demand for money and exchange which the present study try to explore.

The rest of the paper is organized as follows: literature review, methodology and data, discussion, and conclusion.

LITERATURE REVIEW

The traditional macroeconomic variables that influence money demand include income and interest rate (Keynes, 1936). These variables were identified by Keynes (1936) based on three motives for holding money including transaction, speculation, and precaution motives. However, Mundell (1963) argued that aside these traditional variables, exchange rate could also be a significant factor that influences the demand for money in an economy. This is so because movement of capital and increasing foreign trade among open economies influences exchange rate which tend to affect the stability of money demand. He is the first person to introduce this ideology but was not able to test it empirically.

Following the above ideologies by Mundell (1963) and Keynes (1936), voluminous existing studies tested the money demand function empirically. For instance, Bahmani-Oskooee and Fariditavana (2015) examined the demand

for money with the sole objective of obtaining stability in M2 using quarterly data over the period of 1971-2004. The study used panel ARDL co-integration model as estimation strategy and found that demand for money (M2) was stable in 21 countries in Africa. This finding is consistent with the finding from Edet et al. (2017) who did a similar study in Nigeria.

Budha (2012) investigated the demand for money in Nepal using the Autoregressive Distributed Lag (ARDL) model as an estimation strategy. The data used spanned from the period of 1975-2011. The study found that real income, inflation, and interest rate are the significant factors that affect demand for money in Nepal. In the same vein, Mall (2013) found that real income and foreign exchange are significant factors of demand for money in Pakistan. ÖZÇALIK (2014) added that aside inflation and exchange rate, gross domestic product (GDP) also affect the demand for money adversely in Turkey.

In a related study, Haider et al. (2017) investigated the asymmetric effect of exchange rate on demand for money in India using monthly time series data from the period of 2004 to 2015. The study employed the non-linear ARDL (NARDL) as estimation strategy. The results from the NARDL model show that exchange rate appreciation and depreciation affect demand for money in India negatively and positively, respectively. This result was not statistically different from that of Alsamara and Mrabet (2019) who also did similar studies on demand for money in Turkey. However, the negative shock in exchange rate (appreciation) was stronger than its reaction to a positive shock (depreciation) in Turkey. Similarly, Sharifi-Renani (2007) used the same estimation strategy by Haider et al. (2017) and found a positive associated between M1 and income but inflation rate negatively affects M1.

Regarding related studies in Ghana, Havi and Enu (2014) examined the determinants of demand for broad money in Ghana using vector error correction model as estimation strategy. The study found that nominal foreign interest rate and expected inflation were the long run determinants of demand for money while real income and nominal exchange rate were short run determinants in Ghana. Contrary, Baidoo and Yusif (2019) employed the autoregressive distributed lag (ARDL) model as the estimation technique and found that interest rate has no significant influence on demand for money in Ghana.

In a related study, Osei (2015) estimated the money demand function in Ghana by employing yearly time series data spanning from 1991 to 2011. The study used M1, M2 and M2+ to measure money demand. The study found that the real money demand function of M1 and M2 remained relatively unstable in Ghana. In the same vein, Abasimi et al. (2019) employed the ordinary least square and autoregressive distributed lag model as estimation strategy and found that the money demand function is stable over the period of 1983 to 2013. These findings were not different from that of Asiedu et al. (2020) who employed the ARDL to examine the stability of the demand function in Ghana. In contrast, Akosah (2017) employed structural VAR framework as a methodology to examine the pass through effect of money demand growth to inflation and exchange rate. The study showed evidence of an unstable money demand function in Ghana.

Most of the existing studies focused on finding the determinants (income and interest rate specifically) of money demand (Sharifi-Renani, 2007, Mall, 2013, ÖZÇALIK, 2014). Other studies also focused on examining the effect of exchange rate on money demand (Bahmani-Oskooee et al., 2017, Havi and Enu, 2014). The study contributes to literature in Ghana by examining the asymmetric effect of exchange rate on money demand in Ghana which appears to be scanty in Ghana. Thus,

the study re-estimates the money demand function in Ghana while introducing exchange rate as an additional variable of the money demand function, using the nonlinear autoregressive distributed lag model (NARDL) as estimation strategy. Specifically, the unique contributions of this study are the partial effect of exchange rate increase and decrease on money demand in Ghana. In addition, the study is differentiated from the other existing empirical studies by using more recent (1990Q to 2020Q) and relatively larger sample size data to contribute to our understanding of the impact of exchange rate changes on money demand in a more contemporary era.

METHODOLOGY

Data

This study utilized quarterly time series data from 1990 to 2020 to analyze the long-run and short-run asymmetric relationship among some selected economic variables. The outlined economic variables include Real Demand for Money (M2), income(Y), Interest rate (INTR), inflation (INF) and Exchange rate (ER). Data on these variables were sourced from Bank of Ghana (2020) database.

Empirical model

This study implements the following specification of real demand for money function based on a theory proposed by Mundell (1963) which posit that aside income and interest rate, exchange rate could be another important variables that influences money demand. The study followed this theory and specified the general money demand function with exchange rate and inflation as additional variable which is shown below:

$$M_t = f(Y_t, INTR_t, INF_t, EXR_t)\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (1)$$

Where M_t $Y_t, INTR_t, INF_t$ and EXR_t *are* Money Stock (M2), Real Income, Interest Rate, Inflation and Exchange rate, respectively.

The estimable form of equation (1) is given as follows:

$$M_2 = \beta_0 + \beta_1 Y_t + \beta_2 INTR_t + \beta_3 ER_t + u_1 \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (2)$$

Where M_t $Y_t, INTR_t, INF_t$ and EXR_t are as explained earlier. B_0 is the constant and B_i (i=1, 2, 3) are the coefficients of the respective variables and u_1 is the error term. Where $\beta_0, \beta_1, \beta_2$ and β_3 are the expected coefficients to be estimated in the model.

Brief variable description

Money demand is basically defined as total stock of money which includes all money denominated by currency in circulation plus demand deposit and foreign deposit. In this research paper, the demand for money is represented by M_2. This means M_2 that was used as a proxy to measure the stock of money in Ghana. M_2 in Ghana comprises of currency in circulation, demand deposit, foreign deposit, and savings deposit.

The study measured real income (Y_t) using real gross national income. Gross national income is the total value of all final goods and services produced in a country for a specific time period usually a year. Gross national income

can be measured in three (3) ways: By income, expenditure, or value of final goods approach. Any of these approaches yield the same outcome. Real gross national income captures the value of final goods and services after accounting for inflation. In the money demand function, this variable basically captures the transaction and pre-cautionary motive for holding money. Consistent with literature, the study expect a positive association between real income and money demand (Keynes, 1936, Mall, 2013).

Inflation (INF_t) refers to the persistent increase in prices of goods and services in an economy. In this study inflation was measured with consumer price index. Consumer price index depicts the percentage change in price of goods and services consumed by households. Simply put, it shows the total basket of goods and services that a consumer can purchase. The study expects a positive association between inflation and total money stock. This is so because when inflation increases it reduces an individual's purchasing power. Hence, for the individual to purchase the same of basket of goods and service he/she must demand more money.

Interest rate ($INTR_t$) is often measured with interest on bond or stock. Interest is the price paid for the use of capital or the price borrowers pay for using some amount of money (Auld et al., 1983). In other words, it is the return lenders enjoy for deferring the use of their money. Liquidity preference theory suggests that investors or lenders should charge higher interest on securities with long-term maturities rate regardless of the risk involved. Hence, as individuals demand more money for transaction purposes, interest rate increases. As a results, we expect a positive association between interest rate and money demand. In this study, interbank real was used as a proxy for interest rate.

Exchange rate (EXR_t) is the price of a nation's currency compared to a different country's currency. Ghana cedi to United States dollar was used as a proxy to measure exchange rate since it is the currency which is widely used in Ghana as compared to other foreign currencies. The study expects a positive relationship between exchange rate and money demand following theory developed by Mundell (1963).

Estimation strategy

Numerous existing empirical studies used linear autoregressive distributed lag (ARDL) model by Pesaran et al. (2001) as an estimation strategy to examine the effect of exchange rate on money demand. These studies assumed that there is a linear relation between money demand and exchange rate (Mall, 2013, Sharifi-Renani, 2007). ARDL model does not account for the asymmetries in the movement of the exchange rate variable. However, exchange rate in Ghana has exhibited a nonlinear trend over the period of 1990 to 2019. Thus, there are periods where the Ghana's currency appreciated (2000-2010) and there are periods where the currency depreciated (2011-2020). As a result, the effect of exchange rate on money demand might be asymmetric as it could be negative when the domestic currency (Ghana cedis) depreciates against foreign currency (US dollars specifically) and could also be positive when the domestic currency appreciates against major foreign trading currencies (Alsamara and Mrabet, 2019). Thus, there are some periods where the Ghanaian cedi appreciated against the US dollars and there are some periods where the Ghanaian cedi depreciated against the US dollars which might have individual different effect on money demand. Hence, applying the ARDL model to estimate equation (2) would generate spurious regression results. The present study therefore employed the nonlinear ARDL (NARDL) as estimation strategy because exchange rate changes have potential asymmetric effect on money demand (Shin et al., 2014, Bahmani-

Oskooee et al., 2017). NARDL model is efficient and performs well in small sample as well as able to account for endogeneity among all the variables. The model considers the short and long run asymmetries in the movement of the variables (exchange rate specifically) and applicable in mixed order of integration. The general asymmetric long run regression for examining the asymmetric effect of exchange rate on demand for money is shown below:

$$lnM_{2t} = \beta^- lnEXR_t^- + \beta^+ lnEXR_t^+ + u_t \dots\dots\dots (3)$$

$$\Delta\, lnEXR_t = u_t$$

Where lnM_{2t} and $lnEXR_t$ are scalar (1) variables and $lnEXR_t$ is decomposed as $lnEXR_t = lnEXR_0 + lnEXR_t^- + lnEXR_t^+$ where $lnEXR_t^-$ and $lnEXR_t^+$ are partial sum processes of negative and positive changes in EXR_t, respectively. Thus, the study filtered the depreciation of the Ghana cedis from the appreciation of Ghana cedis to be able to examine their individual effect on money demand in Ghana. The partial sums are formally defined as follows:

$$lnEXR_t^+ = \sum_{i=1}^{t} \Delta lnEXR_i^+ = \sum_{i=1}^{t} \max(\Delta\, ln\, EXR_i, 0)\dots\dots\dots(4)$$

$$lnEXR_t^- = \sum_{i=1}^{t} \Delta\, ln\, EXR_i^- = \sum_{i=1}^{t} \min(\Delta\, lnEXR_i, 0)\dots\dots\dots(5)$$

This simple approach to modelling asymmetric co-integration based on partial sum has been applied by numerous existing studies (Bahmani-Oskooee and Fariditavana, 2015, Alsamara and Mrabet, 2019, Adabor and Buabeng, 2021). To obtain the estimable NARDL model, equation (4) and (5) was used. This is done by substituting equation (4) and (5)[1] of the partial sum into the original ARDL model to arrive at the following nonlinear ARDL model for money demand (Shin et al., 2014) shown below:

$$ln\Delta M2_t = \alpha_0 + \sum_{t=1}^{p1} \beta_1 \Delta \ln M2_{t-i} + \sum_{t=1}^{p2} \pi_1 \Delta \ln INTR_{t-i} + \sum_{t=1}^{p3} \eta_1 \Delta \ln Y_{t-i} +$$

$$\sum_{t=1}^{p4} \gamma_1 \Delta \ln INF_{t-i} + \sum_{t=1}^{p} \lambda_1 \Delta lnEXR_{t-i}^+ + \sum_{t=1}^{p} \varphi \Delta lnEXR_{t-i}^- + \delta_1 M2_{t-1} + \delta_2 \ln INTR_{t-1} +$$

$$\delta_3 \ln Y_{t-1} + \delta_4 \ln INF_{t-1} + \delta_5 lnEXR_{t-i}^+ + \delta_6 lnEXR_{t-i}^- +$$

$$\varepsilon_t\dots\dots\dots (6)$$

[1] The NARDL model presented here is a summary of the model. For the full derivation and further understanding of the NARDL model see Shin, Y., Yu B. & Greenwood-Nimmo M. (2014).

In model (6), the partial sums of Positive ($InEXR_t^+$) and Negative ($InEXR_t^-$) are the asymmetric changes in exchange rate. Model (6) is an error-correction model that is labelled as Nonlinear ARDL model as compares to the linear ARDL model. Nonlinearity is introduced through the partial sum's variables in model (4) and (5). Shin, Yu and Greenwood-Nimmo (2014) shown that Pears, Shin and Smith approach of estimating the linear ARDL and testing of co-integration is equally applicable to the nonlinear ARDL model. The difference between these two models is that, for the nonlinear ARDL, exchange rate changes would have symmetric (linear) effect on money demand if the coefficient of the Positive and Negative in model (6) have the same size and sign. Any result aside this outcome makes the model asymmetric. For instance, if the sign and size of $InEXR_t^+$ and $InEXR_t^-$ are different, then we can conclude that the effect of exchange rate changes on money demand is asymmetric. Additionally, few asymmetric assumptions need to be tested. Firstly, if $\Delta lnEXR_{t-i}^-$ and $\Delta lnEXR_{t-i}^+$ take different lag order in the short run, that would be indication of adjustment asymmetries, implying that the time it takes for money demand to respond to depreciation is different than the time it takes to respond appreciation. Secondly, the short run asymmetric impact of exchange rate on demand for money will be established if we reject the null hypothesis of $\sum \varphi_i = \sum \lambda_i$. This hypothesis would be tested by the Wald test. The long-run effect is obtained by setting the non-first-difference lag component of equation (6) to zero and normalizing δ_1, δ_2 and δ_6. Following NARDL by Shin et al. (2014) we can also apply bound testing procedure by Pesaran et al. (2001). The $p1, p2, p3, p4, p5$ and $p6$ are the optimal lag selected through Akaike Information Criterion. The study restricted the lag length to a maximum lag of 2 to save the degree of freedom which also best fit data with low frequency like yearly, quarterly, and monthly data.

Empirical results and discussions

This section presents result of the paper in the following sequential order. First, we present descriptive statistics followed by stationarity test. Next, we present the results from the NARDL and diagnostic test results.

Descriptive Statistics

This sub-section presents the descriptive statistics of the variable used in the empirical model. The results are presented in Table 1.

Table 1 Descriptive statistics of the variables

Variable	Observation	Mean	Std. Dev.	Min	Max	Skewness	Kurtosis
*In*M2	120	5.342	2.5683	0.013	14.047	0.089	1.339
*In*Y	120	1.952	1.8990	1.012	5.672	0.834	2.344
*In*INTR	120	3.089	0.442	2.321	3.755	0.862	5.751
*In*INF	120	2.841	0.515	1.963	4.085	-0.256	3.813
*In*EXR	120	-0.543	1.487	-3.422	1.522	-0.112	2.323

Source: Authors elaboration based on data from Bank of Ghana (2019). Note: we took natural logarithm of the variables to enables us account for the differences in the magnitude of the variables.

Table 1 reports descriptive statistics for all the variables. The results show that the minimum and maximum money demand (*In*M2) can attain is 0.013 and 14.047, respectively.

Demand for money averaged at 5.3417 with a standard deviation of 5.3417. National income (lnY) variable also averaged 1.953 with a minimum value of 1.012 and a maximum value of 5.6721 while its standard deviation is 1.899. For interest rate (lnINTR), the maximum and the minimum values were 3.755 and 2.321, respectively with an average of 3.089. The deviation of interest rate from its mean is 0.442. Furthermore, the average inflation rate (lnINF) was 2.841 and with a minimum and maximum values of 1.9638 and 4.0853 respectively. It also had a standard deviation of 0.515. Lastly, exchange rate averaged (EXR) at -0.543 and ranges between -3.422 and 1.522. Exchange rate also had a standard deviation of 1.487.

With respect to skewness and Kurtosis, all the variables are positively skewed with fatter tails at the end. Furthermore, by the rule of thumb of Kurtosis, money supply, national, interest rate, inflation rate and exchange rate were normally distributed with values of 1.339, 2.344, 5.751, 3.813 and 2.323, respectively.

Unit root test results

Table 2: Results of Unit Root Test using the ADF and PP Tests

Variables	ADF				PP			
	Levels		1st difference		Levels		1st difference	
	Constant	Constant with trend	Constant	Constant with trend	Constant	Constant with trend	Constant	Constant with trend
lnM2	1.143	-3.929**	-5.543**	-5.613***	1.081	-3.387**	-6.069***	9.035***
lnY	-1.322	1.640	-6.135***	2.909***	-1.375	-1.746	-6.431***	-6.022***
lnINTR	-2.581	-2.032	-5.989***	-5.856***	-2.612	-1.739	-7.717***	-8.373***
lnINF	-2.311	-2.628	-4.287***	-4.341***	-2.321	-2.571	-4.238**	-4.314**
lnEXR	-3.022*	-3.441*	-5.504***	-5.350***	-3.073**	-3.123*	-5.820***	-5.666***

Source: Authors elaboration based on data from Bank of Ghana (2019). Note: ***, **, and * represent significance at 1%, 5% and 10% respectively.

To minimize erroneous application in the estimation and the interpretation of the NARDL model, the study established the necessary time series properties that merit the NARDL model. Firstly, the study conducted a stationarity test by employing the Augmented Dicky Fuller (ADF) and Phillips–Perron unit root tests to determine the order of integration of the underlying variables. As evident in Table 2, with the exception of money supply (LNM2+) and exchange rate (*ln*EXR) which can be classified as I (0) variables, especially when the trend version is considered, all of the other variables achieved stationary after their first difference implying order of integration I (1). Evidently, all the variables are integrated of either I (0) or I (1). The statistical implication is that the OLS estimator is likely to produce spurious results.

Table 3: Zivot and Andrews unit root structural break test

Variable	Level		First Difference	
	T-statistic	Time Break	T-statistic	Time break
*ln*M2	-8.121**	2001-Q1	-5.101**	2010-Q4
*ln*Y	-1.121	1990-Q2	-4.121**	1993-Q2
*ln*INTR	-1.821	2000-Q4	-6.031**	2001-Q3
*ln*INF	-2.001	1997-Q3	-7.213**	2003-Q1
*ln*EXR	-5.321**	2011-Q1	-4.921**	1998-Q2

Note: Q1 depicts first quarter (March), Q2 represent second quarter (June), and Q3 shows third quarter (September) and Q4 depicts fourth quarter (December).

Our goal in this section is the test for structural break in the series using Zivot and Andrews (2002) unit root approach. Table 3 empirically confirms the presence of structural break for money supply, national income, interest rate, inflation, and exchange rate. However, money supply and exchange rate attained stationarity at level while national income, interest rate and inflation attained stationary after differencing one time which conform to the results from the Augmented Dicky Fuller (ADF) and Phillips–Perron unit root tests. The presence of structural breaks and mix order of integration that does not exceed one confirms the suitability to utilize NARDL to examine the nonlinear relationship between exchange rate and money demand in Ghana. Hence, the present study adopted the NARDL approach.

Estimated long results using NARDL

Table 4 reports the long results using the NARDL model as an estimator.

Table 4: Long-run results using the NARDL

Variable	Coefficient	Std. Error	T-Statistic
Δln	-0.413**	0.062	-6.661
Δln	0.140**	0.022	6.363
Δln	1.820***	0.466	3.899
Δln	-0.339 **	0.039	-8.692
Δln	0.124**	0.021	5.905
Constant	0.066**	0.0258	2.5613

*** represents significant levels 1%, ** represents 5% and * represent 10% level of significance. and represent positive (appreciation of Ghana cedis) and negative (deprecation of Ghana cedis) changes in exchanges rate, respectively

The long-run estimates in table 4 provided empirical evidence that exchange rate changes have an asymmetric effect on money demand as shown by the coefficients of the $lnEXR_t^+$ and $lnEXR_t^-$, respectively. Thus, our NARDL long run estimates empirically confirms an asymmetric effect of exchange rate (Ghana cedis against US dollars) on demand for money in Ghana because the coefficient of $lnEXR_t^+$ and $lnEXR_t^-$ carry different sign and size. Specifically, the study found that the positive changes (appreciation of Ghana cedis against the US dollars) in exchange rate [$lnEXR^+$] exerts a significant negative effect on demand for money while the negative changes (depreciation of the Ghana cedis against the US dollars) in exchange rate [$lnEXR^-$] exerts a significant positive effect on money demand in Ghana. Thus, one percent appreciation of the Ghana cedis causes 0.4139 percent decrease in demand for money in Ghana whiles one percent depreciation of the Ghana cedis increases the demand for money by 0.0409 percent, all else equal. The results of this study support Robert Mundell theory that the demand for money also influence by exchange rate. On one hand, economically, the results of our study imply that the appreciation of Ghana cedis against the dollar would raise the domestic currency value of foreign assets held by domestic residents. Domestic residents would rather hold less money when the local currency appreciates in order to hold more foreign assets to earn more profit or return. Thus, rational Ghanaian would want to hold more foreign assets when the Ghana cedis appreciate which would results in an increase wealth or investment portfolio of domestic residents, reducing demand for money in the Ghanaian economy. On the other hand, the depreciation of Ghana cedis would lead to an increase in money demand economy for foreign transaction. Thus, depreciation of the cedis would reduce the value of the Ghana cedis, hence, for one to be able to purchase the same amount of foreign goods and services, additional Ghana cedis must be demanded. In addition, if further depreciation is expected in the future, Ghanaians would prefer to hold more foreign currency and asset rather than holding domestic currency (currency substitution) to avoid losing the value of their assets/wealth. Our finding Ghana is consistent with the findings from Bahmani-Oskooee et al. (2017) who did a similar study in Turkey.

Our results also revealed that real income (*lnY*) exerts a positive and significant effect on demand for money in the Ghanaian economy. Real income had a coefficient of 0.4682 which implies that one percent increase in real income generates 0.4682% increase in money demand. An increase in real income would induce an increase in disposable income influencing money demand in the Ghanaian economy. Thus, individuals would demand more money for transaction purposes when their real income increases likely due to an increase in their purchasing power. This finding is consistent with that of Sharifi-Renani (2007).

Regarding the other control variables, interest rate (*INTR*) and inflation (*INF*) exerts a significant negative and positive impact on demand for money, respectively. For interest rate, one percent increase in interest rate causes an approximately 0.02 percent decrease in demand for money. The economic intuition behind this result is that increase in interest rate would result in Ghanaian purchasing more assets on the financial market for returns thereby decreasing money demand in the Ghanaian economy. For inflation, the result revealed that it had a linear positive and significant relation with demand for money in Ghana. Thus, one percent increase in inflation generates 0.21 percent increase in demand for money in Ghana. Persistent increase in price level decreases the purchasing power of majority of Ghanaian, especially, those living below poverty line (The poor and vulnerable group in Ghana). Hence, to be able to purchase the same basket of goods to maintain the same standard of living, individuals would have to increase their demand for money. High inflation also decreases the value or purchasing power of the Ghana cedi. Hence, anytime there is a high inflation individual would demand more money in order to maintain the same standard of living. These findings are different from that of ÖZÇALIK (2014) study in Turkey.

Table 5: Estimated short-run results using the NARDL

Variable	Coefficient	Std. Error	T-Statistic
$\Delta\ln EXR^+_t$	-0.127**	0.021	-6.021
$\Delta\ln EXR^+_{t-1}$	-0.041**	0.004	-11.34
$\Delta\ln EXR^-_t$	0.617**	0.065	9.492
$\Delta\ln EXR^-_{t-1}$	0.059**	0.009	6.655
$\Delta\ln EXR^-_{t-2}$	0.015**	0.004	3.440
$\Delta\ln NY_t$	1.45***	0.212	6.849
$\Delta\ln INTR_t$	-0.339 **	0.039	-8.692
$\Delta\ln INF_t$	0.120**	0.013	9.230
ECM (-1)	-0.322**	0.041	7.854

*** represents significant levels 1%, ** represents 5% and * represent 10% level of significance. and represent positive (appreciation of Ghana cedis) and negative (deprecation of Ghana cedis) changes in exchange rate, respectively

From table 5, our NARDL short run estimates empirically confirm an asymmetric effect of exchange rate (Ghana cedis against US dollars) on demand for money in Ghana. This is so because the coefficient of *lnEXR⁺* and *lnEXR⁻* have different signs and size. Thus, our results revealed the different direction of the impact of appreciation (*lnEXR⁺)* and

depreciation ($lnEXR^+$) of the Ghana cedis on money demand in the short run. Specifically, appreciation of the Ghana cedis had a positive effect on demand for money at 5% level of significance while depreciation of the Ghana cedis had a negative effect on demand for money at 1% level of significance. Thus, the positive changes in exchange rate (increase) had a positive significant impact on quantity of money demanded while the negative changes in exchange rate (decrease) had a negative significant effect on quantity demanded of money. Further, $lnEXR^-_{t-1}$ and $lnEXR^+_{t-2}$ took different lags order of lag (1) and lag (2), respectively in the short run, which indicate adjustment asymmetries, implying that the time it takes for money demand to respond to depreciation is different than the time it takes to respond appreciation.

Regarding the control variables, the coefficient of real income ($lnNY_t$) exerts positive and statically significant effect on demand for money at one percent level of significance. Specifically, one percent increase in real income causes 1.45 percent increase in demand for money, holding all other variables constant. For inflation ($lnINF_t$) it also had a positive and significant relationship with demand for money in Ghana. Thus, one percent increase in general prices of goods and services, demand for money would increase by 0.12 percent in Ghana, all things been equal. However, interest rate ($lnINTR_t$) exerts a negative and significant effect on demand for money in Ghana. Thus, one percent increase in interest rate leads to 0.33 percent decrease in demand for money in Ghana, all other things being equal.

The error correction term [ECM (-1)] illustrates the speed of adjustment which in this case is negative and significant confirming the existence of a long-run relationship between the dependent and the independent variables. The coefficient of the ECM is -0.3223 which implies that co-integration and stability exist between exchange rate, real national income, interest rate, inflation and demand for money. Therefore, there is a one percent significance level of stability in the model and equilibrium in the long-run would adjust by approximately 49 percent annually after any short-run shock.

Model diagnostic and reliability test results

Table 6: Diagnostic Test

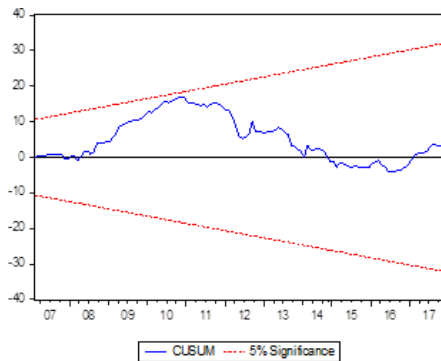| Diagnostic test	Test Statistics	Prob. Value
Normality	1.119	0.571
Serial correlation	2.451	0.446
Heteroskedasticity	0.835	0.731
Functional form	0.093	0.761
Wald-short run	5.991	0.012
Wald-long run	7.771	0.014
CUSUM	Stable	
CUSUMQ	Stable	

The results in Table 6 shows that the NARDL estimates are free from econometric and statistical problems since all the probability values of normality, serial correlation,

heteroscedasticity, and functional form are greater than 0.05. Also, the CUSUM and CUSUMQ graph shown below revealed that money demand over the sample period is stable. This is because the plots of the Cumulative sum and Cumulative sum of square (CUSUM and CUSUMQ) lie within the 5 percent critical bound. However, the Wald-test estimates for both short and long run are significant which suggest the existence of the asymmetric effect of exchange rate changes on money demand in Ghana.

Figure 2

Figure 3
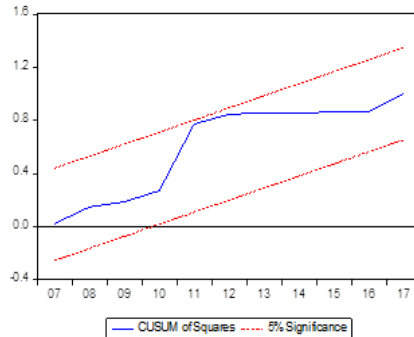
CONCLUSIONS AND POLICY IMPLICATIONS

This paper sought to investigate the long-run and short-run asymmetrical effect of exchange rate on demand money in Ghana. Recognizing the potential asymmetric behavior of exchange rate, the study employed the nonlinear ARDL to capture both long-run and short-run asymmetric relationship between exchange rate and demand for money in Ghana. The study measured exchange rate with the cedi/US dollar rate with 1990 to 2020 as the time periods under study to be able to capture the depreciation and appreciation of the Ghana cedi efficiently.

The result from the study revealed the presence of asymmetric relationship between exchange rate and demand for money in Ghana. Specifically, in the long-run, positive changes (appreciation) in exchange rate tends to result in significant decrease in money demand in Ghana while negative changes (depreciation) in exchange rate generates a significant decrease in demand for money in Ghana. The short-run estimates were not statistically different from those obtained from the long run estimates in terms of sign and significant level. For real income, the long-run results revealed that increase in real income generates a significant increase in money demand in Ghana. Again, the short run estimates for income were not statistically different from results obtained in the long run. Following these findings, the following recommendations are made:

Firstly, given that the nonlinear ARDL model revealed an asymmetric effect of exchange rate changes on money demand due to the fact that the Ghanaian economy largely depends on foreign currency for foreign transaction, saving and investment (foreign stocks, bond, real estate and durables), the study recommends that monetary policy authorities should work with commercial banks, government, international body

and other private institutions to engineer an effective mechanism for reducing and stabilizing the exchange rate in Ghana. Thus, to avoid persistent fluctuations in the quantity of money demanded by Ghanaian, there is the need to put in measures to stabilize the exchange rate in Ghana over a long period of time. Such policies include creating import substitution industries to limit the importation of goods and services, the gap between foreign interest rate and domestic interest rate on assets should not be too wide to decrease the outflow of domestic investment, value should be added to raw materials before exportation and the tax rate for imported goods should be increased substantially to limit importation of goods and services.

Regarding real income, the study found a positive and a significant relationship between real income and demand for money, hence, the study recommends that government and the monetary authorities should considered real income as vital tool for designing monetary policies that aimed at stabilizing money demand to boost economic development of Ghana. The study also established a negative and significant relationship between interest rate and demand for money in Ghana using the interbank interest rate as proxy for interest rate. Hence, the study recommends that the interbank interest rate in Ghana should also be considered as means of controlling money circulation in Ghana. Thus, the interbank interest rate should also be considered as a tool for conducting monetary policy in Ghana.

Our strength cometh from God……….

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