

Financial Innovation in Sierra Leone: Is the Money Demand Still Stable?

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Abstract

This study seeks to examine the stability of the money demand function in Sierra Leone taking into account financial innovation and structural break for the period 1980 to 2016 using the autoregressive distributed lag (ARDL) framework. The empirical results show that there is a unique cointegrated and stable long-run relationship among real broad money and its determinants. The estimated results also revealed that in the long-run, financial innovation, real income, inflation rate and exchange rate significantly impact real money balances in Sierra Leone. Specifically, financial innovation has a negative relationship with real money balances. This implies that financial innovation is crucial in explaining money demand in Sierra Leone, given that financial innovations are becoming more prominent in aiding financial intermediation. In the short-run, only financial innovation and inflation have an impact on real money balance. All the other variables in the model are not statistically significant. Finally, the CUSUM and CUSUMSQ tests revealed that demand for real money balances in Sierra Leone is stable, despite the inclusion of financial innovation and accounting for structural break.

Keywords

Money Demand, Financial Innovation, ARDL

1. Introduction

The principal objective of the Bank of Sierra Leone's monetary policy is to achieve price stability, which is defined as low and stable inflation that supports economic growth. To achieve this objective, the Bank has over the past decades implemented monetary policy within the monetary targeting framework. This is based on Friedman's popular doctrine that "inflation is always and everywhere a monetary phenomenon" and that targeting the growth in money supply is an ef-

fective way of tackling price pressures in the economy. From monetary literature, the effectiveness of this framework to guide the conduct of monetary policy and achieve the price stability objective rest on the assumption that there exist a stable and predictable relationship between the demand for money and its determinants. Therefore, interrogating the determinants and stability of the money demand in a country like Sierra Leone is crucial in the control of inflation, contributing towards the achievement of macroeconomic stability and ultimately guiding in framing an appropriate monetary policy framework.

Given its policy relevance, the demand for money has been the subject of considerable research in Sierra Leone. Earlier attempt to estimate the determinants and stability of money demand was by [Kallon \(1992\)](#). This study was revisited in 2009. Following [Kallon \(1992\)](#), other authors have also estimated variants of the money demand function ([Tucker, 2003](#); [Bathalomew & Kargbo, 2009](#); [Mansaray & Swaray, 2012](#); [Neewhord, 2019](#)) using different methodologies and sample period. These studies concluded that money demand in Sierra Leone remained stable, giving credence to the use of the monetary targeting framework by the Bank of Sierra Leone. Although these studies have provided useful insights into the determinants of money demand and its stability in Sierra Leone, they, except the study by [Neewhord \(2019\)](#), are confronted with a major empirical challenge since they did not account for financial innovation. There is an emerging consensus in the empirical literature that, to fully account for “missing money”, financial innovation arising from financial and monetary reforms should be included in the money demand function ([Arrau & Gregorio, 1991](#)); otherwise, the model would be mis-specified. In addition, financial innovation has been identified as one of the main reasons for the observed instability in money demand in many advanced and developing economies ([Dunne & Kasekende, 2016](#)).

This is particularly relevant for Sierra Leone given that the financial sector has witnessed significant reforms over the past decades. These reforms are reflected in the increase in the number of financial institutions, especially banks; improvement in the payments system infrastructure such as the Automated Clearing House (ACH), Real time Gross Settlement (RGTS) to handle large volume transactions and the Script less Securities Settlement (SSS) systems; digital payment services ranging from ATMs, debit cards, POS, mobile money services, internet banking services and agent banking. These reforms could have an impact on the stability of money demand in the context of Sierra Leone. Given these developments, the important empirical questions then are: 1) is the money demand function for Sierra Leone still stable? and 2) what are the potential determinants of money demand in light of the recent financial and structural reforms? To address these questions, the objective of this paper is to estimate money demand function for Sierra Leone by reflecting the recent developments in the money demand literature, which includes financial innovation in addition to the traditional determinants of money demand and taking account of structural break in the data. For estimation purposes, we utilized annual data over the period 1980 through 2016

using the Autoregressive Distributed Lag (ARDL) approach to cointegration developed by Pesaran et al. (2001). The key takeaways from this study is that financial innovation impacts money demand negatively and that although the study incorporated financial innovation as one of the explanatory variables and accounted for structural break in the data, the money demand was found to be stable.

For purposes of easy exposition, the study is divided into five parts. Part 1 is this introduction. Part 2 presents relevant theoretical and empirical literatures while part 3 addresses methodological issues including model specification data description and sources and estimation techniques. Part 4 presents and analyses the empirical results and part 5 contains the conclusion of the study with relevant policy recommendations.

2. Review of Related Literatures

2.1. Theoretical Review

The theoretical foundation of money demand dates back to the classical school led by Irving Fisher (1911). Following the classical theory, several other theories emerged in trying to shed light on why economic agents demand money. Thus, the demand for money theories can be broadly classified into the classical, Keynesian and post Keynesian theories. Each of these theories will be summarized below:

Fisher's version of the demand for money is encapsulated in the equation of exchange $MV = PT$, where M is the stock of money, V is the velocity of circulation, P is the price level and T is the volume of transaction. Based on the classical assumption that the economy operates at full employment, T is assumed fixed and in the short-run the velocity of circulation V is also assumed fixed. Therefore, P would move strictly proportional to movements in M , implying that an increase in the economy's stock of money would lead to an increase in prices. Within this framework, money is neutral as far as its effect on output is concerned. In this context money is needed only to facilitate transactions. The Cambridge cash balance approach built on Fisher's approach by incorporating the store of value function of money in addition to the medium of exchange function. In addition, it is more of a microeconomic approach describing individual choice rather than market equilibrium as was presented by Fisher.

The Keynesian theory of money demand focused on the motives for holding money by economic agents. In his theory, Keynes distinguished three motives for holding real money balances: the transactions demand for money; the precautionary motives and the speculative motive for holding real money balances.

The transactions and precautionary motives depend on the level of income whilst the speculative motive depends on the rate of interest. Thus the money demand function is presented as:

$$M^d = L_T + L_S = kY + L_S(r) \quad (1)$$

where M^d is real money demand, kY is the transaction and precautionary motives for holding money which together depend on income and $L_S(r)$ is spe-

culative motive which is a function of interest rate. The fundamental assumption of Keynes demand for money theory is that in the speculative demand for money people hold their assets in either all money or all bonds. However, in reality, financial wealth is held in a mixture of money and bonds. To address this challenge, [Friedman \(1956\)](#) extended Keynes's speculative money demand within the framework of asset price theory. To Friedman, permanent income and not current income as in the Keynesian theory determines the demand for money and his money demand function was specified as:

$$L^n = f \left(P \quad r_B \quad r_E \quad \frac{\dot{P}}{P} \quad Y^n \right) \quad (2)$$

where L^n is the real money demand, P is the price level, r_B is the return on bonds, r_E is the return on equity, $\frac{\dot{P}}{P}$ is inflation, and Y^n represents total wealth.

The post-Keynesian theories are rooted in the inventory and the portfolio models of money demand. The inventory model assumes that money can be store either as money and bonds while the portfolio theory assumes that the utility economic agents derive from their asset holdings is positively related to the expected return of the portfolio and negative related to the risk of the asset portfolio. These models conclude that the cash demand is influenced by interest rate.

2.2. Empirical Literature

The determinants of money demand and its stability have been studied extensively, albeit with mixed findings, reflecting differences in methodology used, the data span and the sample of countries selected. However, in this study our review will focus on few empirical works that have included financial innovation in their analysis.

In a recent study, [Mwanzia, Ndanshau and Luvanda \(2015\)](#) using quarterly data for the period 1996:Q1 to 2011:Q2 investigated the effect of stock market prices on money demand in Kenya. Their study supports the wealth effect argument and stable money demand in Kenya, despite the flourishing financial innovations in the Kenyan financial system. [Nampewo and Opolot \(2016\)](#) estimated the impact of financial innovations on the stability of money velocity using quarterly data for the period 2000-Q1 to 2013-Q4. Using the ARDL estimation framework, the authors find significant negative and positive effects of financial innovations, proxied by the ratio of currency in circulation to broad money, and ratio of time deposits to demand deposits, on the money velocity in the short and long-run, respectively. Similarly, [Dunne and Kasekende \(2016\)](#) employed the Dynamic Fixed effect estimation techniques using a panel data of 34 Sub-Saharan countries from 1980 to 2013, to investigate whether financial innovation is very important in determining money demand. They found a negative relationship between financial innovation and money demand for the selected sample of countries. [Sichei and Kamau \(2012\)](#) carried out a related study on Kenya using

Automated Teller Machines (ATMs) as proxy for financial innovation, but find no evidence of any significant impact of financial innovation on money demand. The results additionally indicated money demand instability in Kenya particularly after the year 2007. [Yu and Gan \(2009\)](#) investigate the dynamic relationship between money demand and financial innovation in the case of ASEAN-5 by utilizing a monthly timespan from 1987: M1 to 2007: M4. The [Engle-Granger \(1987\)](#) two-step cointegration technique and ECM conclude that there exists a long-run relationship among the variables, particularly after financial innovation. [Deckle and Pradhan \(1997\)](#) estimated long-run money demand in four ASEAN countries, utilizing simple linear time trends and the time dummy variables approach to capture financial innovation, and concluded that money demand equations are cointegrated. [Bahmani-Oskooee and Rehman \(2005\)](#) examined the impact of financial innovation on the stability of Nigeria money demand function using Johansen ECM and they found that financial innovation has impact but not a significant impact. [Arrau et al. \(1995\)](#) examined money demand by utilizing quarterly data for different time periods for 10 developing countries. They mention that after considering different proxies for financial innovation, money demand and its fluctuations were well explained.

2.3. Empirical Studies on Money Demand in Sierra Leone

Given the policy relevance of money demand function, a number of empirical studies have attempted to estimate the money demand function for Sierra Leone. Earlier attempt was by [Kallon \(1992\)](#). The study was revised in 2009 utilizing the Johansen's cointegration methodology for the period 1964-2005. The 2009 study reaffirmed the central findings in his study ([Kallon, 1992](#)) that there is a stable long-run relationship between the quantity of real money balances and its determinants. [Tucker \(2003\)](#) also using the Johansen's cointegration approach to investigate the stability of broad money demand (M2) function in Sierra Leone concluded that there is a stable long-run relationship between money demand and its determinants excluding foreign developments. [Bathalomew and Kargbo \(2009\)](#) used quarterly data for the period 1983Q1-2008Q4 to investigate the relationship between money demand and its determinants in Sierra Leone using the autoregressive distributed lag (ARDL) approach. They concluded that the demand for broad money is stable in the long-run. [Mansaray and Swaray \(2012\)](#) used ARDL modelling and Granger causality test to assess the impact of financial liberalization on money demand in Sierra Leone during the period 1981-2010. The empirical outcome suggests a stable demand for real money balances, despite several and ongoing financial reforms in the Sierra Leonean economy. [Neewhord \(2019\)](#) also estimated the money demand function for Sierra Leone that includes financial innovation and testing for structural breaks in the data. The study concludes that the money demand was stable in spite of the financial sector reforms.

A review of the empirical literature suggests that the key determinants of money demand include, real income, interest rate, exchange rate and financial

innovation. Additionally, recent developments have motivated the need to include foreign interest for open economies where there are diverse forms of portfolio assets and different exchange rate regimes. However, previous studies on Sierra Leone ignored the potential impact of shocks such as financial innovations and structural breaks on stability of money demand. As far as the authors are aware there is only one study [Neewhord \(2019\)](#) that have estimated the money demand function for Sierra Leone taking cognizance of the role of financial innovation and endogenously identifying the break points in the data. However, in his model specification, the domestic interest which is a crucial opportunity cost variable was left out and the narrow definition of financial innovation was used in the model. The current study is motivated by the desire to close these empirical gaps by re-estimating money demand which explicitly takes into account interest rate spread as an opportunity cost variable and include the linear time trend in the model to also capture the impact of financial innovation in addition to the traditional measure of financial innovation. The linear time trend variable has been extensively used in the empirical literature to reflect financial innovation over time (see [Lieberman et al., 1977](#)) and [Arrau et al. \(1995\)](#).

3. Model Specification, Estimation Techniques and Data Issues

3.1. Model Specification

Based on the traditional money demand theories as well as the empirical model utilized by [Dunne and Kasekende \(2016\)](#), the dependent and independent variables used in modelling money demand in this study are functionally related as follows:

$$\frac{M}{P} = f(\text{RGDP}, \text{INF}, \text{EXCH}, \text{INTSPR}, \text{FINV}, \text{USTB}, \text{DUM}) \quad (3)$$

Components in Equation (1) were transformed into natural log, with the exception of inflation, interest rate spread, foreign interest, and the ratio of financial innovation, which are expressed in Equation (3) as:

$$\begin{aligned} \text{LRM2}_t = & \alpha_0 + \alpha_1 \text{LRGDP}_t + \alpha_2 \text{INF}_t + \alpha_3 \text{LEXCH}_t + \alpha_4 \text{INTSPR}_t \\ & + \alpha_5 \text{FINV}_t + \alpha_6 \text{USTB}_t + \alpha_7 \text{DUM}_t + \varepsilon_t \end{aligned} \quad (4)$$

where L refers to variable in logarithmic form, $\text{RM2} = \text{M2/P}$ denoting Real Money Balances, RGDP is Real Gross Domestic Product (the scale variable that represent the income effect), INF is inflation, INTSPR is the interest rate spread, which is a proxy for the opportunity cost variable (interest rate), EXCH is the nominal exchange rate of the Leone against the US dollar, FINV refers to financial innovation which is defined by the ratio of broad money to narrow money, USTB is the foreign interest rate proxied by the 91-day US treasury bill rate, DUM is a dummy variable representing the iron ore boom (2013 = 1 and otherwise = 0) and ε is the error term.

From Equation (2) α_0 is the intercept term, $\alpha_1 - \alpha_7$ are the slope coeffi-

coefficients of the independent variables. Based on the literature reviewed, we would expect the scale variable (real GDP) and opportunity cost variable (interest rates) to be positively and negatively related with money demand, respectively. The coefficients of the exchange rate may have a positive or negative relationship with money demand, indicating either a currency substitution effect or a wealth effect, depending on the sign of the coefficients. The coefficient of the inflation rate is expected to be positive or negative. If prices of goods and services increase then economic agents will demand more money to maintain the same basket of goods, in this case the coefficient is positive, however, higher price will erode the purchasing power of economic agents and rational agents could preserve their purchasing power by holding real assets.

In this case, demand for money would have a negative sign. The coefficient for financial innovation may be positive or negative in sign, depending upon either institutional and technological advancement (negative sign) or increasing monetization of the economy and financial deepening (a positive sign).

3.2. Estimation Techniques

Although the ARDL technique to cointegration does not require pre-testing the variables to ascertain their order of integration, however, in this study we used the Augmented Dickey Fuller (ADF) and Philips-Perron (PP) unit root tests to eliminate the possibility of I(2) variables. In the presence of such variables the computed F-statistics provided by Pesaran et al. (2001) are no more valid because they are based on the assumption that the variables are I(0) or I(1). In addition, the Sierra Leone authorities have over the years rolled out several reforms in the financial sector which could have resulted in some structural break in the data. These structural breaks could have a tendency to make the conventional unit root test bias toward a false unit root as proposed by Perron (1989). Thus, Perron's unit root with structural break was performed to endogenously determine the break dates in the data series.

Once we ascertained that none of the variables is I(2), we then proceeded with the ARDL bounds testing approach to cointegration developed by Pesaran et al. (2001). This approach has a robust finite sample properties and is adequate in the face of variables with mixed levels of integration i.e. I(0) and I(1) variables. In addition, it addresses the issue of serial correlation often found in economic time series (Pesaran et al., 2001). The bounds test procedure was applied for cointegration by estimating the following conditional (restricted) version of the ARDL model specified below:

$$\begin{aligned} \Delta LRM2_t = & \alpha_0 + \alpha_1 t + \sum_{i=1}^{n1} \theta_{1i} \Delta LRM2_{t-i} + \sum_{i=0}^{n2} \theta_{2i} \Delta LRGDP_{t-i} \\ & + \sum_{i=0}^{n3} \theta_{3i} \Delta INF_{t-i} + \sum_{i=0}^{n4} \theta_{4i} \Delta LEXCH_{t-i} + \sum_{i=0}^{n5} \theta_{5i} \Delta INTSPR_{t-i} \\ & + \sum_{i=0}^{n6} \theta_{6i} \Delta FINV_{t-i} + \sum_{i=0}^{n7} \theta_{7i} \Delta USTB_{t-i} + \delta_1 LRM2_{t-1} \\ & + \delta_2 LRGDP_{t-1} + \delta_3 INF_{t-1} + \delta_4 LEXCH_{t-1} + \delta_5 INTSPR_{t-1} \\ & + \delta_6 FINV_{t-1} + \delta_7 USTB_{t-1} + \delta_8 DUM + \varepsilon_t \end{aligned} \quad (5)$$

where α_0 and α_{1t} denote the drift and trend components, ε_t is the vector of white noise error process which is assumed to be serially uncorrelated and homoscedastic. Δ is the first difference operator and $n1 - n7$ are the ARDL model maximum lag order and $\theta_{1i} - \theta_{7i}$ and $\delta_1 - \delta_7$ are the short run and long-run parameters respectively.

To identify the long-run relationship among the variables, we estimated Equation (3) using the ordinary least square technique and the joint significance of the numerical values of the lagged levels of the variables using the following hypotheses:

$$H_0 : \delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = \delta_7 = 0$$

$$H_1 : \delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq \delta_5 \neq \delta_6 \neq \delta_7 \neq 0$$

The F-statistic was utilized to obtain the joint hypothesis on the basis that the coefficients of the lagged variables are zero in the long run. The null hypothesis of no cointegration is rejected if the F-statistics is above the upper bound and accepted if it falls below the lower bound. It, however, remains inconclusive if it lies between the lower and the upper bound critical values.

Once cointegration among the variables is confirmed, we then estimated Equation (3) to extract the long-run and short-run dynamics among the variables. The restricted version of the ARDL long run model for the money demand function is presented below.

$$\text{LRM2}_{t-1} = \beta_0 + \beta_1 T + \delta_1 \text{LRM2}_{t-1} + \delta_2 \text{LRDGP}_{t-1} + \delta_3 \text{INF}_{t-1} + \delta_4 \text{LEXCH}_{t-1} + \delta_5 \text{INTSPR}_{t-1} + \delta_6 \text{FINV}_{t-1} + \delta_7 \text{USTB}_{t-1} + \delta_8 \text{DUM} + \varepsilon_t \quad (6)$$

The final step in the ARDL model to estimate an Error-Correction Model (ECM) Equation (5), captures the short run dynamics parameters of the model. This is presented below in Equation (5):

$$\begin{aligned} \Delta \text{LRM2}_t = & \alpha_0 + \sum_{i=1}^{n1} \theta_{1i} \Delta \text{LRM2}_{t-i} + \sum_{i=0}^{n2} \theta_{2i} \Delta \text{LRGDP}_{t-i} + \sum_{i=0}^{n3} \theta_{3i} \Delta \text{INF}_{t-i} \\ & + \sum_{i=0}^{n4} \theta_{4i} \Delta \text{LEXCH}_{t-i} + \sum_{i=0}^{n5} \theta_{5i} \Delta \text{INTSPR}_{t-i} \\ & + \sum_{i=0}^{n6} \theta_{6i} \Delta \text{FINV}_{t-i} + \sum_{i=0}^{n7} \theta_{7i} \text{USTB}_{t-i} + \text{DUM}_t + \mu_t \end{aligned} \quad (7)$$

In addition to the ARDL technique, a battery of diagnostic tests including serial correlation, normality, heteroscedasticity and functional form were carried out to ensure that the parameter estimates are reliable and robust for policy analysis. It is argued in the empirical literature that the existence of a cointegration derived from Equation (9) does not necessarily imply that the estimated coefficients are stable (see Bahmani-Oskooee & Brooks, 1999). Consequently, cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) stability tests based on the recursive regression residuals are carried out to test the stability of the money demand function in this study.

3.3. Data Issues

The study utilizes annual data for the period 1980-2016. The data on Real gross domestic product, nominal exchange rate and the interest rate spread were sourced from World Bank database 2019 (<http://www.worlddevelopmentindicator.org/>)

while the remaining data were obtained from the IMF International Financial Statistics (IFS) database.

4. Empirical Results and Discussions

4.1. Descriptive Statistics

The descriptive statistics are presented in **Table 1** below. The p-values from the Jarque-Bera (J-B) statistical test shows that all the series are normally distributed but for inflation and nominal exchange rate. In addition, the mean to median ratio of each variable is within the unit proximity except for inflation and the standard deviations of the data set shows very slight and small variability because they are quite low except for inflation which shows high variability during the sample period.

4.2. Unit Root Test Results

Before estimating the money demand model using the ARDL model, it is important to test the stationary properties of the variables included in the model to ensure that none of the selected variable is integrated of order two i.e., $I(2)$, otherwise the use of the ARDL becomes invalid. To this end, we have applied the widely used Augmented Dickey-Fuller (ADF) and the Philips-Perron unit root tests and the results are presented in **Table 2**. LRM2, LRGDP, INF, USTB and FINV, foreign interest is non-stationary (contain a unit root) at level, nonetheless, they became stationary at the first difference. EXCH was found to be stationary in both the ADF and PP unit root tests, while the INTSPR was found not be stationary at but levels and difference in the ADF but was found to be stationary at level when the PP test was used. Thus, we conclude that EXCH and INTSPR were stationary at level.

Table 1. Summary statistics of money demand and its determinants.

	LRM2	LRGDP	INF	EXCH	FINV	INTSPR	USTB
Mean	8.687830	29.26207	32.77386	5.947572	12.02958	1.652286	4.469459
Median	8.651350	29.18852	16.97000	7.354758	12.44417	1.561610	4.660000
Maximum	10.47979	29.99979	178.7000	8.746707	23.45833	2.313383	14.08000
Minimum	7.662540	28.87805	-0.918000	0.048597	1.833333	1.180445	0.040000
Std. Dev.	0.766228	0.308397	38.51044	2.826387	4.846194	0.332362	3.604850
Skewness	0.677282	0.867979	1.941469	-1.027680	-0.003154	0.573542	0.623486
Kurtosis	2.920644	2.908496	6.973951	2.604929	2.958965	2.193764	2.927701
Jarque-Bera	2.838429	4.658802	47.59046	6.753407	3.030633	0.002657	2.405255
Jarque-Bera Probability Statistics	0.241904	0.097354	0.000000	0.034160	0.219739	0.998672	0.300404
Observations	37	37	37	37	37	37	37

Source: Authors' computation.

4.3. Perron Breakpoint Unit Root Test

The results of the unit root with structural breaks shows that, all the variables are stationary at level in the presence of structural break at the 1% level of significance. The break date 2013 for the dependent variable-money demand - coincides with the period when Sierra Leone experienced a significant growth rate of her gross domestic product of 20.5 percent, driven mainly by robust iron ore production and exports (Table 3).

4.4. Bounds Test for Cointegration

Table 4 below shows the bounds test results, with real broad money as the dependent variable. The result indicates that the calculated F-statistics (7.041989) is greater than the upper critical bound value (3.5). Thus, we can reject the null hypothesis of no cointegration and conclude that there is a long-run relationship between real broad money and its determinants.

4.5. Long-Run Results

From Table 5 below, the long run results shows the coefficient of the financial

Table 2. Augmented dickey fuller test and Phillip Perron unit roots test results.

Variables	ADF in levels	ADF in first differences	PP in Levels	PP in First Differences
LRM2	-0.716	-5.371***	-0.281	- 5.437***
LRGDP	-0.109	-5.449***	-0.033	-5.455***
INF	-1.360	-6.471***	-2.758*	-10.105***
EXCH	-4.032***	-6.561***	-3.611**	-2.919**
INTSPR	-1.760	-1.973	-3.322**	-9.861***
FINV	-0.181	-5.906***	-0.186	-5.973***
USTB	-1.519	-5.611***	-1.814	-5.304***

***, **, * denotes 1%, 5% and 10% significant level respectively.

Table 3. Perron unit root with break test.

Variable	Trend Specification	ADF Test Statistic	Break Date	Coefficient of Break Dummy(P values)	Conclusion
LRM2	Intercept	4.984135 (0.0046)***	2013	0.782144 (0.0000)***	I(0)
LRGDP	Intercept	4.826624 (0.003)***	2012	0.627257 (0.0003)***	I(0)
EXCH	Intercept	5.084029 (0.000)***	1984	0.797234 (0.0000)***	I(0)
FINV	Intercept	3.249118 (0.0027)***	2004	0.200501 (0.000)***	I(0)
INF	Intercept	-2.884619 (0.0120)**	1991	-55.82653 (0.0000)***	I(0)
INTSPR	Intercept	3.028482 (0.0048)***	1986	6.07939 (0.0000)***	I(0)
USTB	Intercept	-3.406098 (0.0019)***	2000	-1.737289 (0.0000)***	I(0)

Source: author's computation. The critical values from the test statistic with intercept at 10%, 5% and 1% are -4.193649, -4.443649 and -4.949133 respectively.

Table 4. Bounds test results.

Dependent Variable	F-statistic	Decision
LRM2	7.041989	Cointegration
Level of Significance	Critical Value Bounds	
	Lower Bound I(0)	Upper Bound I(1)
1%	3.07	4.23
5%	2.5	3.5
10%	2.22	3.17

Table 5. Long and short run parameters of the ARDL model (2, 0, 1, 2, 1, 2, 1, 1) selected by Akaike Information criterion of the money demand function with Intercept, trend and regime shifts.

Variable	Long Run Model			Variable	Short Run Model		
	Coefficients	T-statistics	P-values		Coefficients	T-statistics	P-values
C	-17.3643	-7.4924	0.0000***	-	-	-	-
Trend	0.1114	6.8751	0.0000***	Δ lrm2 (-1)	0.0509	0.4797	0.6379
lrgdp	1.0332	4.4321	0.0004***	Δ lrgdp	0.0729	1.0981	0.2884
Inf	-0.0070	-2.9786	0.0089***	Δ inf	-0.0035	-4.7415	0.0002***
lexch	-0.3710	-7.2772	0.0000***	Δ lexch	-0.1046	-1.0139	0.3257
Intspr	-0.0164	-1.8609	0.0812*	Δ lexch (-1)	0.1305	1.1782	0.2559
finv	-0.5825	-2.7496	0.0142**	Δ intspr	-0.0068	-1.4839	0.1573
dum	0.6482	6.0845	0.0000***	Δ finv	0.1847	1.0637	0.3032
ustb	0.0227	1.5970	0.1298	Δ finv (-1)	0.6921	3.3067	0.0045***
				Δ ustb	-0.0107	-0.8244	0.4218
				Δ dum	-0.1135	-1.0284	0.3191
				ECM _{t-1}	-0.7580	-7.2583	0.0000***

Note *, **, *** are 1%, 5% and 10% significant level respectively.

innovation is significant at five percent and has the expected sign indicating that an increase in financial innovation leads to 0.58 percent reduction in real money balances in the long run. The result is consistent with theoretical literature which suggests that increased financial innovation will reduce the demand of economic agents for cash. This is consistent with other previous studies (see [Dunne & Kassekende, 2016](#)). The trend coefficient was also found to be significant and impacts money demand positively. The coefficient of real income also has the expected positive sign and significant at the one percent level. This suggests that a percentage increase in real income will lead to an increase in the demand for real money balances by 1.0332 percent per year. The unit-elastic income coefficient of demand for money is consistent with the theory and consistent with the findings in [Kallon \(2009\)](#). As expected, the sign of the inflation variable is negative

and highly significant in the long run. This means that, a one percent increase in inflation will lead to a 0.0070 percent decrease in real money balances. This implies that, people tend to substitute cash balances for physical assets as the rate of inflation increases. Similar results were obtained in previous studies by [Bathalomew and Kargbo \(2009\)](#), [Mansaray and Swaray \(2012\)](#) and [Hossain \(2007\)](#).

The result also indicates that the coefficient of exchange rate is negative and significant at 1 percent level. This implies that a percentage increase in nominal exchange rate (depreciation) decreases average the demand for real money balances by 0.37 percent. The negative coefficient is consistent with the substitution enhancing effect as economic agent's hedge to maintain the future purchasing power of the domestic currency. The depreciation of the domestic currency may decrease the possessions of real money balances. This outcome is consistent with [Bathalomew and Kargbo \(2009\)](#) but contradicts [Khan and Sajjid \(2005\)](#) and [Mansaray and Swaray \(2012\)](#) who found a positive relationship between exchange rate and real money balances. Interest rate spread does carry the expected negative sign and is weakly significant at 10 percent, implying that economic agents in Sierra Leone are insensitive to interest dynamics. Similarly, foreign interest rate did not have the required sign and is insignificant. Meanwhile, the dummy is highly significant at one percent, indicating that during the economic boom economic agents demanded more money to undertake transactions.

4.6. Short Run Dynamics: Error Correction Model

The results of the error correction model are presented in [Table 4](#). All the coefficients of the variables maintain their signs as in the long run equation except the coefficients of financial innovation, foreign interest rate and the dummy whose signs changed. Apart from inflation and financial innovation, all the other variables in the model are not statistically significant. This suggests that these variables have relatively lower impacts on money demand in the short-run. The result shows that financial innovation is significant at one percent implying that a 1 percent increase in financial innovation leads to 0.69 percent increase in the demand for real money balances in the short run. This result is different from its impact in the long-run, meaning that, financial innovation is a key determinant of the money demand function but it comes with a lag effect. Inflation has a negatively effect on real money balances in the short run. That is, as the level of inflation increases economic agents' demand for real money balances would decline. Finally, the coefficient of the error correction term is properly signed (-0.7580) and highly significant, a confirmation that long-run equilibrium relationship exists among the variables of interest and further indicates that about 75 percent of the disequilibrium error is corrected within one year.

4.7. Diagnostic Tests

For robustness of results and the reliability of the estimates obtained, it becomes imperative that we conduct some tests on the estimates obtained. Essentially,

four of these tests stand out. These include tests for serial correlation, functional form, normality and heteroscedasticity. The results show the absence of heteroscedastic errors, serial correlation, model misspecification and non-normality of residuals as reflected in **Table 6**.

4.8. Stability Test

Stability of the money demand function was also tested using Cumulative sum (CUSUM) and cumulative sum squares (CUSUMSQ) tests. **Figure 1** indicates that both CUSUM and CUSUM squares recursive residuals remain within the critical boundaries of the 5% significance level hence confirming the stability of the model in the face of financial innovations.

5. Conclusion

This study is one of few efforts in evaluating the impact of financial innovation on the stability of the money demand function in Sierra Leone. Specifically, it attempts to evaluate the stability of the money demand function in Sierra Leone for the period 1980 to 2016 taking into account structural break and financial innovation. During this period, the Sierra Leone authority implemented significant reforms under the financial sector development plan. Thus, it is imperative to evaluate the stability of the money demand function in light of these reforms. The **Perron (1989)** unit root breakpoint test was employed to endogenously

Table 6. Diagnostic tests of the ARDL model.

	F-Statistics	LM-Version
Serial correlation	0.7855 (0.4750)	0.3.5313 (0.1711)
Functional Form	0.6884 (0.4197)	-
Normality	-	0.5117 (0.7742)
Heteroscedasticity	1.5019 (0.2092)	21.9875 (0.2325)

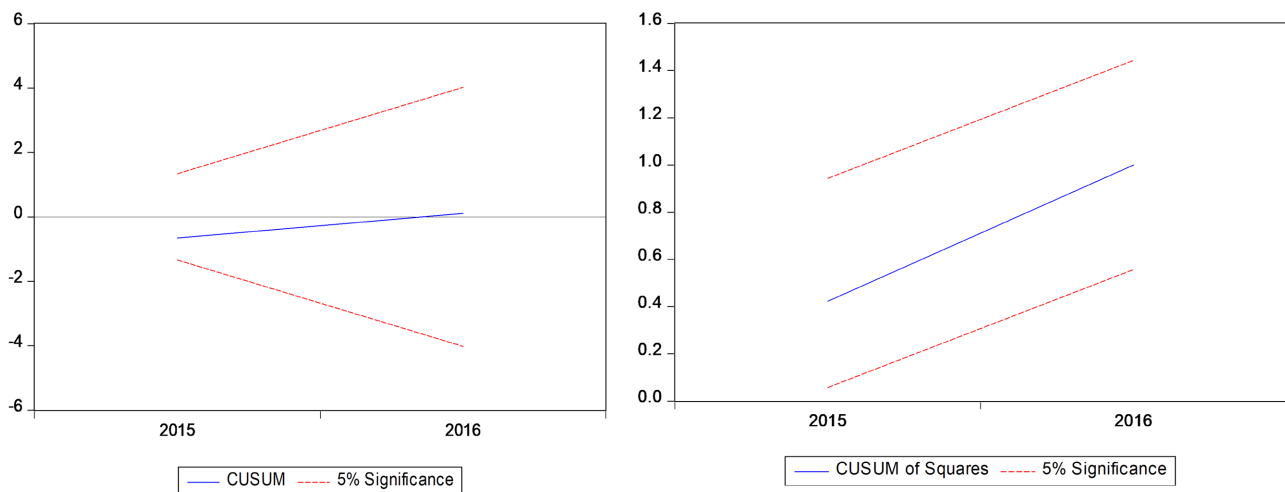


Figure 1. CUSUM and CUSUMSQ stability tests.

identify potential structural breaks in the series. Also, the study makes use of error correction mechanism and bounds testing approach to cointegration within an ARDL framework. The empirical outcome shows that there is a cointegrating relationship between real money balances and its determinants in Sierra Leone.

The result further revealed that in the long-run, inflation, nominal exchange rate and financial innovations were negative and statistically significant while real gross domestic product was positive and statistically significant. In the short-run, all the coefficients of the variables maintain their signs as in the long run equation except the coefficients of financial innovation, foreign interest rate and the dummy whose signs changed. Apart from inflation and financial innovation, all the other variables in the model were not statistically significant. Furthermore, we observed that despite significant reforms in the financial sector which have engendered improvement in financial innovation, the CUSUM and CUSUMSQ tests indicate that the recursive plots of the money demand function were within the 5 percent critical lines. Thus, we can conclude that the money demand function is stable. This outcome is consistent with previous studies on money demand in Sierra Leone.

Having established a stable money demand function for Sierra Leone in the face of financial innovations and structural break, the following policy implications may be drawn. First, the Bank of Sierra Leone should continue to use monetary aggregates as an intermediate target within the enhanced monetary policy framework in order to achieve the inflation objective. Second, the Bank of Sierra Leone should take financial innovation and structural breaks into account when forecasting money demand to guide on the appropriate stance of monetary policy.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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